TANZANIA
JOURNAL OF HEALTH RESEARCH

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Needs for Establishment and Adoption of Regional One Health Approach for Preparedness and Response to Public Health Threats in the East African Community

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Abstract
Introduction: One Health approach integrates human, animal, and environmental health, recognizing their intricate relationship. It is an important approach to address complex public health challenges such as zoonoses, anti-microbial resistance (AMR), food safety and security, the impact of climate change, biodiversity degradation and many other health challenges that require collaborative efforts. East African Community (EAC) is among the regions that face such challenges. Hence, there is a dire need to adopt the One Health approach to prevent and control many of the public health threats.
Aim and objectives: To develop and implement a comprehensive regional One Health approach for the East African Community (EAC) that enhances collaborative efforts in addressing public health threats through an integrated approach to human, animal, and environmental health. The objectives of the work were to assess and strengthen current One Health initiatives, to assess the status of One Health implementation in the region and to recommend the best approach to develop a Regional One Health Strategy that would enhance the sustainable One Health approach in the EAC.
Data Collection: Data was collected through consultations with sector representatives from the EAC Partner States, the EAC Secretariat, and the EAC Expert Working Group (EWG). Between October 2020 and May 2022, documents and reports from the EAC secretariat and Partner States were also extensively reviewed.
Findings: The EAC has been facing numerous public health threats due to several factors, including its geographical location, high population density and movements, limited access to healthcare, limited disease surveillance and control, etc. Although a formal regional One Health strategy was lacking during the time of the data collection exercise, key initiatives like contingency plans development, risk analysis and communication, development of Standard Operating Procedures (SOPs) as well as capacity-building efforts for various health risks had been carried out, all under the umbrella of One Health. Some EAC Partner States have developed national One Health strategies and created multi-sectoral platforms to address public health challenges. Including the Democratic Republic of Congo (DRC) in the EAC region in April 2023 emphasized the need for a more comprehensive regional approach due to the DRC's vast tropical forests and history of infectious disease outbreaks.
Conclusion: Most public health threats do not recognize borders. Hence, there is a need to unify EAC Partner States' efforts to effectively and efficiently address regionally evolving public health threats. This requires implementing a One Health approach, thereby emphasizing the significance of a regional One Health strategy. The unified approach will safeguard the well-being of human and animal health, the ecosystems in the region, and the socio-economy. Challenges may include securing adequate, sustainable resources, harmonizing efforts among Partner States, and aligning regulatory frameworks and resource capacities.

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Introduction
The East Africa Community
The East African Community (EAC) consists today of seven Partner States: the Republic of Burundi, the Democratic Republic of the Congo (Kinshasa) (DRC), the Republic of Kenya, the Republic of Rwanda, the Republic of South Sudan, the United Republic of Tanzania (URT), and the Republic of Uganda. The DRC became the latest addition to the EAC partnership (Fig. 1).

Figure 1: A map showing EAC Partner States

One Health approach
One Health approach is an integrated strategy to achieve a sustainable balance to optimize human, animal, and ecosystem health. It recognizes the intricate interdependence between humans, domestic animals, wildlife, plants, and the broader environment with the ecosystem. The approach engages local, regional, national, and global stakeholders to attain optimal health and well-being outcomes, contributing to sustainable development (Andrew A. et al 2020, AVMA, 2020).

The recent COVID-19 pandemic and other outbreaks experiences have produced compelling evidence to adopt the One Health approach as a multisectoral and multidisciplinary approach to address complex challenges and a 'whole of societal' strategy to address health hazards. It underscores the importance of involving all stakeholders who could be affected by an infectious disease outbreak or public health event and their role in both preparedness and response efforts. One Health approach provides a comprehensive framework for the long-term prevention of pandemics and facilitates the transformative change needed to minimize complex risks (AVMA, 2020; Bechir et al., 2004; Bett et al., 2020).

Public health threats requiring One Health approach
Zoonotic diseases are diseases that can be transmitted between humans and animals. Animals include wildlife and domestic animals kept by humans for various purposes, including food and companionship. Research indicates that over 60% of human infectious diseases originate from animals, and over 70% of emerging and re-emerging infectious diseases affecting humans are zoonotic (Bechir et al., 2004; Bett et al., 2020). Zoonoses affect the well-being of both animals and humans, impacting their health and socioeconomic aspects. Zoonoses can also negatively impact other sectors beyond

health, including trade, tourism, education, and the overall economy (AVMA, 2020; Bechir et al., 2004; Bett et al., 2020).

Population growth, deforestation, human encroachment into habitats previously occupied by wildlife, international travel, and trade are key factors in the spillover and spread of zoonotic pathogens. Despite increased awareness of the risks associated with spillover and pathogen spread, the situation remains a significant threat to humans, animals, plants, and ecosystems (CDC, 2022).

Three months after the onset of COVID-19, local and international trade, agriculture, international travel, and tourism were severely impacted. Lockdowns, restrictions on social gatherings, the closure of schools and colleges, and limitations on air, water, and road travel exacerbated the economic downturn and made life more challenging. In the EAC region, the pandemic resulted in a high number of fatalities and overwhelmed the health sector, leading to an increase in domestic violence, teenage pregnancies, and mental health challenges, resulting in substantial economic losses (CDC; 2022, Cisse, G et al 2022).

Antimicrobial resistance (AMR) has emerged as a significant public health threat in the EAC and globally. AMR poses a substantial challenge to the prevention and control of disease-causing agents. The effectiveness of treatment regimens against infectious diseases caused by bacteria, viruses, parasites, and fungi largely depends on the collective ability to combat AMR (AVMA, 2020; FAO, 2018; Gumi B et al., 2012; Grace D et al., 2012). AMR calls for a cohesive and comprehensive global response across all sectors and disciplines. Globally, the key areas of focus in addressing AMR involve detection, surveillance, stewardship, and infection prevention and control.

Other public health emergencies of concern include food safety and security, such as dealing with locust swarms, addressing contaminated food and water sources (e.g., aflatoxins and cholera, respectively), addressing biodiversity degradation, and mitigating the impacts of climate change (AVMA, 2020; Gumi B et al., 2012; Grace D et al., 2012; Greter, H et al., 2014; Jones, K., et al 2008).

To better address these challenges in the future, the EAC secretariat established the One Health concept as a guiding principle in addressing risks of public health concerns. Here, we describe the consultative process of stocktaking One Health initiatives and consensus building on needed One Health action points at the regional level, which feeds into a regional One Health strategy.

Aim: To develop and implement a comprehensive regional One Health approach for the EAC that enhances collaborative efforts in addressing public health threats through an integrated human, animal, and environmental health approach.

Objectives: The work's objectives were to assess and strengthen the current One Health initiatives, assess the status of One Health implementation in the region, and recommend the best way to develop a regional strategy that enhances a sustainable One Health approach in the EAC.

Materials and Methods:

Data collection

Qualitative data was collected primarily through consultations with representatives from the EAC Partner States' sectors, representatives from the EAC secretariat (also regional sector representatives), and the EAC EWG. Meetings and consultative workshops were conducted to obtain information on One Health activities at Partner States and regional levels, including Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis, One Health platforms and multi-sectoral coordination, One Health networks, policies supporting One Health, etc.

Data was also collected from an extensive review of documents and reports from the EAC and its Partner States. The combined data collection and compilation efforts spanned from October 2020

to May 2022. The DRC joined the EAC in April 2022, just a month after the data collection and compilation phase concluded. As a result, experts and stakeholders from the DRC were not actively involved in the process. The data did not include information regarding implementing the One Health approach in the DRC.

Findings

Global One Health efforts

In 2008, the Food and Agriculture Organization of the World (FAO), The World Organization for Animal Health (WOAH), The World Health Organization (WHO), the United Nations International Children Education Fund (UNICEF), the World Bank (WB), and the United Nations System Influenza Coordination (UNSIC) jointly developed a consensus document entitled 'Contributing to One World, One Health'. It issued a shared strategic framework for 'Reducing Risks of Infectious Diseases at the Animal-Human-Ecosystems Interface' (Kelly T. R et al, 2020). The framework has been one of the benchmarks for countries to prevent and control health risks globally using a One Health approach; such risks include AMR and emerging and re-emerging pathogens.

In early 2022, the United Nations Environment Programme (UNEP) officially joined the Tripartite Alliance of the WHO, FAO and WOAH (formerly OIE) to form a 'Quadripartite.' The partnership is advised by the One Health High-Level Expert Panel (Andrew et al. et al., 2020; Bechir M. et al., 2004; Gumi B. et al., 2012). The panel's primary focus has been to provide policy-relevant scientific assessments on the emergence of health crises at the human-animal-ecosystem interface and offer guidance on developing a long-term strategic approach to reduce the risk of zoonotic pandemics. The panel also underscores the importance of a monitoring and early-warning framework and the synergies necessary to institutionalize and implement the One Health approach.

Factors contributing to pandemic risks have been addressed in the Global Health Security Agenda, launched in 2014 and endorsed by 70 countries to bolster their core capacities for preventing, detecting, and responding to disease threats. Governmental bodies, intergovernmental organizations, universities, non-governmental organizations, and others have, in principle, endorsed the agenda. Through the Agenda, countries, including those in the EAC region, conducted voluntary Joint External Evaluation (JEE) in which areas for strengthening core capacities under IHR-2005 were identified, and strategies to address them were developed (Andrew et al., et al 2020, Bechir, M. et al 2004; Gumi, B.,2012; Nabarro, D; 2012)

One Health Implementation in Africa

Challenges in One Health implementation in Africa are mainly caused by a lack of policy frameworks to guide a multi-sectoral approach, limited resources, and the increasing burden of threats at the human-animal-environment interface (Nyatanyi, T. et al 2017; OIE 2009). However, a collaborative project in Chad where livestock and child vaccination in pastoralist communities yielded economic savings for the Chadian Ministries of Public Health and Animal Health, resulting in improved vaccination coverage for children and women (Nyatanyi, T., et al 2017; OIE 2009, Schelling, E., et al 2008; Taylor et al., et al 2001). Such collaborative programs allow African professionals to enhance the spirit of working together (OIE 2009, Schelling, E., et al. 2008); The Global AMR R&D Hub;).

Africa CDC has worked with the African Union (AU) on the One Health Framework. The framework is aligned with the Sustainable Development Goals of the African Union (AU) Agenda 2063, 'The Africa We Want' (WHO; 2005). The framework guides National Public Health Institutes and provides valuable insights for all involved in the One Health approach in the continent. It covers zoonotic disease prevention and control and offers guidance to National Public Health Institutes and Ministries of Health in addressing priority zoonotic diseases using a One Health approach. Other areas

include One Health coordination, coordinated surveillance, diagnostic capacity, laboratory networks, coordinated response, and multisectoral workforce (WHO; 2005). The Southern Africa Development Community (SADC) Joint Technical Committee approved a Regional AMR Strategy aligned with the Global Action Plan for Anti-microbial Resistance (GAP) during a meeting in Johannesburg, South Africa, in 2019. SADC member countries will collectively implement the AMR Strategy to address key areas in the region's prevention and control of AMR. This marks a significant step toward adopting a One Health approach to combat the spread of AMR in the region (WHO; 2020)

One Health implementation in the EAC region

The EAC sector council of ministers is an important decision-making body overseeing various regional sectors, including health. Its roles include policy formulation, coordinating the response to public health threats, mobilizing resources, establishing disease surveillance systems, facilitating capacity-building programs, advocating for harmonized health policies, and ensuring coordinated regional responses. **The EAC Secretariat, along with Partner States' ministries and their**

Expert and Technical Working Groups provide the political framework for One Health activities in the region. Various sectors, including health, animal health, environmental health, trade, tourism, and more, contribute to the region's resilience in the face of public health threats. This collaborative effort is critical to maintaining essential services, such as water supply, sewage systems, and waste collection, which are key to disease prevention.

Points of entry,, including airports, seaports, and land border posts, play roles in monitoring, detecting, and responding to public health threats. Their responsibilities involve surveillance and monitoring, travellers' screening, quarantine, isolation, notification/reporting, contact tracing, coordination, resource provision, public awareness, and international collaboration.

The private sector, including various businesses and industries, plays an important role in preparedness and response to threats by producing medical supplies, providing healthcare services, and contributing to research and development. **Civil society organizations** advocate for equitable health, engage with communities, monitor authorities' actions, mobilize resources, offer humanitarian assistance, and provide psychosocial support.

Research and development institutions contribute to vaccine and drug development, epidemiological studies, surveillance, innovative technologies, and risk assessment, vital for preparedness and response to risks. **International, continental, and regional institutions and organizations, including UN institutions and One Health networks,** collaborate with EAC member states to enhance their preparedness and response to public health emergencies, offering technical expertise, resources, coordination, and capacity-building to strengthen the region's ability to prevent, detect, and respond to health threats effectively.

Even though there was no formal regional plan to implement One Health in East Africa during the data collection exercise, several EAC One Health documents had been developed, and a few One Health activities had been conducted under the guidance of the EAC Secretariat. These included creating a regional contingency plan for pandemic preparedness and response, developing a regional risk and crisis communication strategy and establishing One Health SOPs for effective implementation. Additionally, simulation exercises, joint meetings, and workshops were important in promoting the One Health approach in the region.

One Health Implementation in EAC Partner States

The republics of Kenya, Rwanda, Tanzania, and Uganda had developed national strategies to guide the One Health approach in their respective countries when visited for data collection. The Republic of South Sudan and Burundi were yet to develop their national One Health strategies. The Republics of Kenya, Rwanda, Tanzania, and Uganda had established One Health National Committees/Platforms with multi-sectoral coordination mechanisms (MCM). In Kenya, the One Health Platform was found to be affiliated with the Ministry of Health (MoH), while in Tanzania, the platform was found operating under the Prime Minister's Office (PMO). The Directors of Health Services and Veterinary Services in Rwanda agreed on a Memorandum of Understanding (MOU) to coordinate One Health activities in the country (WHO; 2020).

Republic of Burundi

Besides the fact that there was no formal One Health coordination mechanism, the Republic of Burundi had established One Health committees, commissions, and platforms that occasionally convened to exchange updates on issues of mutual interest. Burundi ratified the International Health Regulations (IHR) in 2005, and implementation commenced in 2007. Since the outbreak of the Avian Flu in 2010, the public health and animal health sectors in Burundi have been collaborating to prepare and prevent further Avian Flu outbreaks. The effort involved resource mobilization, including human and financial resources, to support joint initiatives. JEE was conducted in Burundi in March 2018, and efforts to prepare the National Action Plan for Health Security were ongoing during the data collection exercise.

Republic of Kenya

In Kenya, the National Influenza Task Force, formed in 2005, evolved into the Zoonotic Technical Working Group (TWG) in 2006 and began planning meetings in 2008. This multi-sectoral TWG comprised members from various ministries, research institutions, agencies, and regional and international organizations. In 2011, the Zoonotic Disease Unit (ZDU), also known as the One Health Office, was established following the signing of a Memorandum of Understanding between the Ministry of Public Health Services and the Ministry of Livestock Development.

One Health Office became operational in 2012 with the launch of the One Health Strategic Plan (2012-2017). Among other successes, the plan has promoted One Health and applied research. The establishment of a molecular diagnostic laboratory at the Kenya Wildlife Service and Avian Influenza surveillance was implemented in wild birds, RVF surveillance, and vector-borne disease surveillance. However, key challenges persist, including the absence of specific legal frameworks and policies, limited resources for essential activities, weak zoonotic disease surveillance, insufficient cross-sectoral collaboration, and evolving global priorities influenced by political interests.

Republic of Rwanda

The Republic of Rwanda embraced the One Health approach in 2011 and has undertaken many activities. The national One Health platform was established in the same year under the Prime Minister's Office. The platform comprises the One Health Secretariat, the One Health MCM, TWGs, representatives from various government institutions, bilateral and multilateral partners, civil society organizations, private sectors, and communities involved in One Health implementation. The platform oversees the overall governance of One Health activities, including developing strategies, prioritizing funding allocations, and resource mobilization.

Through the platform, the first Rwanda One Health Strategic Plan (ROHSP 2014-2018) was developed, leading to several joint activities, such as zoonotic disease prioritization and the creation of preparedness and response plans for priority zoonotic diseases, including Rift Valley Fever, Avian Influenza, and Rabies. Now, the country is in the second ROHSP (2021-2026). In March 2021, the One Health Policy was signed to guide planning, monitoring, and evaluating activities under the One Health Approach. Additionally, Rwanda has developed its National AMR Action Plan and disaster management plan.

Republic of South Sudan

The Republic of South Sudan has faced outbreaks of Ebola Virus Disease, Yellow Fever, Anthrax, Brucellosis, bovine Tuberculosis, highly pathogenic Avian Influenza, Rabies, and Rift Valley Fever. AMR also poses an emerging problem due to the unregulated use of antimicrobials in humans and animals. The lack of surveillance systems to track antimicrobial susceptibility trends has further exacerbated the problem. At the time of data collection, the Republic of South Sudan had not developed a One Health Strategy. The National Action Plan for Health Security (NAPHS) 2020-2024 launching and Joint Risk Assessment were done in 2021.

Health Emergency Risk Profiling/Strategic Tool for Assessing Risks (STAR), Rapid Response Teams (RRT) and the national laboratory capacity to confirm priority zoonotic diseases in animals and humans have been developed, and the country was developing a One Health platform. South Sudan has also adopted and implemented the 3rd edition of the Integrated Disease Surveillance and Response (IDSR) at the national and county levels, incorporating the One Health approach into all these measures.

United Republic of Tanzania

The URT initiated its One Health agenda in 2013 by developing the National One Health Strategic Plan (NOHSP) for 2015-2020. Establishing the One Health Coordination Desk within the Prime Minister's Office's Disaster Management Department and four multi-sectoral Technical Working Groups covering surveillance, research and development, training and advocacy and preparedness, and response were the hallmarks of implementing the NOHSP. 2018, the National One Health Strategic Plan and the One Health Coordination Desk were officially launched. The Desk served as the Secretariat of the National One Health Platform, coordinating One Health activities across the country.

Tanzania prioritized zoonotic diseases in 2017, resulting in the development of strategic disease control plans, guidelines, and SOPs. The country also created the National Antimicrobial Resistance Action Plan (2017-2022), specific plans for Zanzibar, and the National Action Plan for Health Security (2017-2021). The latter addresses gaps identified during the JEE conducted in 2016. Through the platform, several activities have been conducted under the coordination of the coordination PMO OH desk (later changed to the OH section).

Republic of Uganda

In 2016, The technical heads of four ministries in the Republic of Uganda met and endorsed a One Health framework prepared by One Health stakeholders. The ministries included the Ministry of Health, the Ministry of Agriculture, the Ministry of Animal Industry and Fisheries, the Ministry of Water and Environment, and the Ministry of Tourism, Wildlife, and Antiquities. The framework led to the formation of the National One Health Platform following the signing of a Memorandum of Understanding (MoU) by the four-line ministries. Through the MoU, the first National One Health

Strategy (2018-2022) was prepared with a focus on three priority public health threats: zoonotic diseases, AMR, and biosafety and biosecurity (BSS).

Applying the One Health approach, the AMR National Action Plan (2018-2023) was also created and integrated into the One Health Strategic Plan. Other activities include the adoption of the 3rd edition of the Integrated Disease Surveillance and Response (IDSR) framework incorporating the One Health approach, JEE in June 2017, and the launching of the NAPHS in 2019.

Table 1: Summary of One Health implementation status in EAC Partner States as of Dec 2022

LEVEL (REGIONAL/ PARTNER STATE)	PARAMETER	OBSERVATION(S)
EAC	Policy	No policy exists
	Strategic Plan	Regional Contingency Plan and Emergency Structure reflect the One Health approach Regional Risk and Crisis Communication Strategy reflects the One Health approach
	Legal Framework	None
	Action Plans	None exist
	Institutional arrangement	Decision to place One Health under Health
Burundi	Policy	None One Health policy in place
	Strategic Plan	None in place
	Legal Framework	None
	Action Plans	COVID-19 Response Plan , EBOLA Contingency Plan, National Laboratory Risk Management Plan, AMR Plan, Multi-sectoral Cholera Elimination Strategic Plan, Malaria Control Strategic Plan, Outbreak Response Plan, Integrated disease surveillance and Response plan
	Institutional Arrangement	Ministry of Health is currently implementing One Health activities
Kenya	Policy	No One Health Policy in place,
	Strategic Plan	OHSP in place
	Legal Framework	Operates on an MoU, supported by the Health Act, Animal Health Act, Veterinary Practitioners and Para-professionals Act, Public Health Act
	Action Plans	RVF contingency plan, Avian influenza contingency plan, Rabies elimination plan, Anthrax prevention and control plan, Brucellosis prevention and control plan, Public health events of initially unknown etiology preparedness plan, Contingency Plan for COVID-19
	Institutional Arrangement	A zoonotic Diseases Unit exists housed in the MOH, AMR steering committee, Food safety coordinating, Technical Working Groups, No overarching One Health body, role currently taken up by Zoonotic disease Unit (ZDU)
Rwanda	Policy	Policy in place
	Strategic Plan	In place (Rwanda One Health Strategic Plan II (2019-2023))
	Legal Framework	Not sure
	Action Plans	National Action Plan for Health Security, AMR plan with One Health approach, RVF plan
	Institutional Arrangement	One Health multi-sectoral Coordination Mechanism the inter-ministerial leadership and coordination level exists, Technical

		Working Groups are envisaged to provide expert forums, One Health Secretariat and Ministry of Health and line ministries (with clear responsibilities)
South Sudan	Policy	No policy, no legal framework but have a coordination unit
	Strategic Plan	There is no strategic plan in place, however two consultative meetings were conducted with support from WHO.
	Legal Framework	No legal framework
	Action Plans	COVID-19 preparedness and response plan, EVD preparedness plan, Cholera response plan
		The PHEOC is ready to staff One Health approach and there is a coordination mechanism in place between key ministries.
Tanzania	Policy	No specific One health policy exists
	Strategic Plan	OH SP exists but expired in 2020
	Legal Framework	In place using existing Acts
	Action Plans	Prepared annually
	Institutional Arrangement	Coordination through existing government coordination mechanisms and Coordination Office in place (One Health CD at PMO's Office)
Uganda	Policy	No policy exists. Just concluded a Regulatory Impact Assessment as a step towards formulation of a National One Health Policy
	Strategic Plan	One Health Strategic Plan (2018 – 2022) exists.
	Action Plans	Prepared annually in sectoral work plans A national Action Plan on AMR also exist
	Institutional Arrangement	A national One Health Coordination Office exists but with no permanent staff. Currently housed at MOH with 8 FPs/ members (2 institutional representatives from MOH, MAAIF, MWE and UWA)

Regional One Health networks and initiatives

Global health initiatives have led to the establishment of many One Health networks and consortia. These include the FAO/WOAH/WHO/UNEP Tripartite Plus collaboration, the One Health Workforce next generation, the One Health Alliance of South Asia, etc. In Africa, some regional economic communities have made One Health a focus area in their agendas. The " East and South African Livestock Common Market" policy framework is one example of such efforts (WHO 2022).

In 2000, the EAC Partner States, with support from the Rockefeller Foundation, launched the East African Integrated Disease Surveillance Network (EAIDSNet). The EAIDSNet represents a collaborative effort between EAC national human and animal health ministries, national health research, and academic institutions to facilitate communication among EAC Partner States for integrated cross-border animal and human disease surveillance and control. In 2008, the Southern Africa Centre for Infectious Disease (SACIDS) was launched with support from Google.org. Initially, SACIDS operated as a consortium of academic and research institutions focusing on infectious diseases in humans and animals in the Democratic Republic of Congo, Mozambique, South Africa, Tanzania, and Zambia. In 2018, SACIDS transformed into a regional One Health Institute.

The One Health Central and Eastern Africa (OHCEA), which later in 2019 changed to Africa One Health University Network (AFROHUN), supported by the USAID's Emerging Pandemic Threats (EPT) Programme, was established in six countries, URT, Uganda, Kenya, Ethiopia, DRC, and Rwanda. OHCEA expanded to include Cameroon, Senegal, Côte d'Ivoire, and Liberia. Now, AFROHUN is in 16 universities

across eight countries in the East, Central, and West Africa. AFROHUN, in collaboration with its partners, is actively supporting the implementation of One Health, particularly One Health workforce capacity building. In 2012, the Connecting Organizations for Regional Disease Surveillance (CORDS) was established across Africa, Asia, the Middle East, and Europe. CORDS focuses on strengthening the detection and control of infectious diseases through information exchange and collaboration among member states, employing a One Health approach. The Comprehensive Africa Agriculture Development Programme, under the African Union (AU), plays a crucial role in transforming agriculture for food security and nutrition and promoting economic growth and prosperity across the continent. On the other hand, the Livestock Development Strategy for Africa (LiDeSA), supports African countries in implementing the Strategic Framework for One Health developed in 2015 (WHO, 2022).

One Health Regional Network for the Horn of Africa (HORN) was initiated in 2018 with support from the UK Research Council Global Challenges Research Fund. HORN involves the University of Liverpool, the University of Nairobi, and Addis Ababa University, focusing on various aspects of health sciences, veterinary medicine, and public health in the Horn of Africa. The One Health Research, Education, and Outreach Centre for Africa (OHRECA), supported by the German Federal Ministry of Economic Cooperation and Development, leverages the expertise, resources, and research facilities of several centres of excellence within ILRI, including the Mazingira Centre in Kenya. It addresses issues at the intersection of livestock, the environment, and climate change. Other networks include the African Science Partnership for Intervention Research Excellence (Afrique One - ASPIRE), a pan-African research consortium established in 2009 for One Health capacity building.

The above networks and initiatives have spearheaded One Health capacity building and research to facilitate decision-making and policy change. AFROHUN, for instance, has supported universities in the EAC to foster collaboration across various disciplines, facilitating a more holistic approach and championing One Health with openness and flexibility. Their role has been instrumental in tackling infectious diseases before, during and after outbreaks. SACIDS, in collaboration with the Tanzania National Institute for Medical Research (NIMR) and OHCEA (now AFROHUN), hosted the first One Health conference in Arusha, Tanzania, in 2013. The conference provided a platform to share research conducted in various fields and raised awareness about the importance of One Health in research preparedness and response in the region.

Discussion on the rationale for adopting the One Health approach in the EAC
In 2017, the 35th Ordinary meeting of the EAC Council of Ministers emphasized adopting the One Health approach in the region. The emphasis was based on lessons from the West African Ebola Virus Disease (EVD) outbreak, the frequent occurrences of disease outbreaks in the EAC region, the recommendations of the EAC Regional Contingency Plan for Epidemics and other public health concerns. In November 2019, the 19th EAC Sectoral Council of Ministers of Health directed the EAC Secretariat to strengthen multi-sectoral collaboration and coordination by developing a regional One Health Strategy by June 2021. Partner States were further directed to promote and strengthen interdisciplinary collaboration to embrace One Health in preparedness and response to public health threats. The directives underpinned political will and the need to build outbreak response capacity in the region following the WHO IHR-2005 and the WOAH Terrestrial Animal Health Code.

According to the experts interviewed, regional One Health implementation will support national strategies and provide guidance and direction for integrated efforts to mitigate health risks in the EAC. Such efforts must harmonize and consolidate national efforts, offering guidance for multi-disciplinary and multi-sectoral preparedness, prevention, detection, and response to public health

threats across EAC borders. Ultimately, it will foster and promote the development of a regional One Health community of practice.

Including the DRC in the EAC in April 2022 is a significant step toward ensuring the active participation of more countries in the region in collaborative efforts to prevent, detect, and rapidly respond to emerging and re-emerging public health threats. However, it also underscores the need for a more comprehensive regional, multi-sectoral, and multidisciplinary approach.

The DRC hosts 500 million acres of wilderness around the Congo basin, characterized by tropical rainforests. The tropical ecosystem serves as a habitat for diverse animal species, some known as reservoirs for infectious diseases and pathogens. EVD outbreaks have occurred in the DRC more than ten times in the past decade, spreading to Uganda in 2018-2020. RVF occurred in Kenya between 2006 and 2007, in Tanzania in 2006-2007, and in Sudan in 2007-2008. Marburg outbreaks occurred in Kenya in 1980-1987 and Uganda in 2007, 2008, 2012, 2014, and 2017. Crimean-Congo Hemorrhagic Fever (CCHF) was reported in Uganda in 2013 and 2018. Yellow Fever occurred in Isiolo, central Kenya, in March 2022 but has been endemic in Uganda, the DRC, Burundi, and South Sudan. The Highly Pathogenic Avian Influenza (HPAI) outbreak occurred in the Lake Victoria region of Uganda in late 2016 and early 2017.

As mentioned earlier, AMR also poses a major threat to preventing and controlling bacteria, viruses, parasites, and fungi infection. Partner States have monitored the trends with support from development partners. AMR action plans have been developed to address gaps in key areas of AMR, particularly in detection, surveillance, stewardship, and infection prevention and control. Regional One Health efforts will undoubtedly complement the Partner States' plans, building capacity in the areas and promoting regional collaboration to address gaps from the community to the global level (Greater, H. et al. 2014).

There is increased travel for trade and tourism across EAC porous borders, the existence of extensive tropical rainforests in the Congo basin, savannah grasslands accompanied by weak surveillance systems, population growth, deforestation, and human habitation in or near animal habitats posing risks for spillover of pathogens (Andrew et al., et al 2016; Gumi, B., et al 2012; Grace, D et al, 2012). Environmental pollution, caused by harmful gases and chemicals, has substantially impacted climate and ecosystems. Consequences include floods, degradation of biodiversity, contaminated food and water, and food product contamination, leading to morbidity, fatalities, and economic losses at both the household and national levels. South Sudan, for example, experienced heavy rains and flooding, combined with the historical overflow of the River Nile and its tributaries, affecting many states. The flooding also led to an increased occurrence of cholera, affecting the health of local communities (Gumi, B. et al., 2012; Grace, D. et al., 2012).

Available opportunities

Several key opportunities can be harnessed to effectively implement the One Health approach in EAC. Global frameworks and partnerships, such as the Quadripartite Collaboration and the Global Health Security Agenda, offer comprehensive guidelines and support, providing a strong foundation for regional strategies. Additionally, regional networks like EAIDSNet and AFROHUN facilitate cross-border disease surveillance and capacity building, which is crucial for a unified approach. The EAC's political will and recent expansion, including countries like the DRC, enhance the potential for a coordinated regional response. Collaborative projects and international support from UNEP, WHO, and FAO present valuable resources and expertise. Moreover, leveraging existing national strategies and multi-sectoral platforms in Partner States can help harmonize and scale One Health efforts across

the region. These opportunities collectively offer a robust framework for advancing One Health in the EAC, improving regional health outcomes, and enhancing preparedness for health threats.

Conclusion

To effectively implement the One Health approach in the EAC region, it's important to tap into several key opportunities. Collaborative regional efforts, supported by global frameworks like the Quadripartite partnership and the Global Health Security Agenda, provide a strong foundation for a unified strategy. Regional networks such as EAIDSNet and AFROHUN enhance cross-border disease surveillance and capacity building, which is crucial for a coordinated response. The EAC's political will and the inclusion of countries like the DRC bolster the potential for a comprehensive regional approach. Furthermore, establishing a dedicated regional coordination body under the EAC, engaging stakeholders, and harmonizing national strategies can facilitate effective implementation. Capacity building, infrastructure development, and political advocacy are critical to promoting One Health and addressing disparities among Partner States. By utilizing these opportunities and implementing a strategic, well-coordinated plan with robust monitoring and evaluation, the EAC can enhance its regional health outcomes and preparedness for complex health threats.

Acknowledgements

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Impact of interventions on mosquitoes resting behaviour and species composition in Lugeye village in Magu district, Northwestern Tanzania

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Abstract
Background: Understanding the impact of intervention tools on vector behaviour, host preference, resting, and infectivity rates is paramount in malaria control planning. Magu district was one of the districts in lake zone regions in northwestern Tanzania covered with indoor residual spray and long-lasting insecticidal nets in the main malaria control campaign. After interventions, this study evaluated the mosquito's host preference and resting behaviour in Lugeye village in rainy and dry seasons.
Methods: Mosquitoes were collected both indoors and outdoors using the rest pots. The collection was done in both rainy and dry seasons. The samples were collected bi-weekly for three months each season.
Results: A total of 254 mosquitoes were collected in both dry and rainy seasons, indoors and outdoors. The most abundant species were *Anopheles funestus* s.s. and *An.arabiensis*. Most blood meals from bovines rested outdoors, while human blood meal sources rested outdoors. Sporozoite-positive mosquitoes were found only during the dry season.
Conclusion: This study's findings have shown that implementing IRS and LLIN interventions has led to a species shift from An.gambiae s.s. to An.funestus and An.arabiensis. The inclusion of vector insecticide resistance information can be of paramount importance in appropriate intervention tool selection.
Keywords: Bloodmeals, *An.funestus, An.arabiensis,* outdoor, indoor

Introduction
Malaria is still one of the public health challenges in sub-Saharan Africa(WHO, 2023). In sub -Saharan Africa, four countries have been reported contributing the highest malaria cases globally within the continent (Nigeria (26.8%), the Democratic Republic of the Congo (12.3%), Uganda (5.1%) and Mozambique (4.2%)) and other four countries contributing more than half of malaria death globally are, Nigeria (31.1%), the Democratic Republic of the Congo (11.6%), Niger (5.6%) and the United Republic of Tanzania (4.4%)(WHO, 2023). The malaria-related mortality has been decreasing from 25 in 2000 to 10 in 2019 deaths per 100,000 populations at risk (WHO, 2020). All these achievements have been attained due to the implementation of sensitive malaria diagnostic tools, the prescription of appropriate anti-malarial drugs and effective vector control tools (WHO, 2020). The effective vector control has been implemented widely using long-lasting insecticidal nets (LLINs), Indoor residual spray (IRS) and in very limited application of Larval Source Management (LSM)(Derua et al., 2019; Diouf et al., 2020; Tusting et al., 2013; Zhou et al., 2020).

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Tanzania's main efficient malaria vectors are the sibling species of *Anopheles gambiae* and *An. funestus* group (Kabula et al., 2011; Kweka et al., 2008a; Kweka et al., 2020). Among the *An. gambiae* sibling species, *An. arabiensis*, *An. gambiae* s.s. and *An. merus* have been reported to be vectors in Tanzania (Kweka et al., 2008a; Kweka et al., 2020; Kweka et al., 2008b). In *An. funestus* group, Tanzania's most efficient recorded vectors are *An. funestus* s.s (Kweka et al., 2008a; Kweka et al., 2020), *An. parensis*(Kweka et al., 2008a), *An. rivulorum* (Kweka et al., 2008a; Kweka et al., 2020) and *An. leesoni* (Kweka et al., 2020).

Since the wide community coverage with LLINs in 2000, the vector population has been shrinking across the country, and vector species have shifted. (Bayoh et al., 2010; Kitau et al., 2012)Due to the wide coverage of indoor surfaces with insecticides, either LLINs or IRS, mosquitoes have opted to forfeit the benefits of LLINs and IRS by feeding and resting outdoors. (Russell et al., 2011) or developing insecticide resistance for progeny survivorship (Kreppel et al., 2020; Kulkarni et al., 2006; Mahande et al., 2012; Mbepera et al., 2017; Nnko et al., 2017). The increased proportion of outdoor vectors leading to outdoor residual malaria transmission has been witnessed in different areas with high malaria transmission (Russell et al., 2011). Insecticide resistance in vector populations has been found to exist in all classes of Insecticides used for public health vector control. (Kabula et al., 2014; Matowo et al., 2014).

In Lake Zone regions, including the study areas, Magu District, with 91.8% coverage between 2015 to2017 were sprayed with Actellic 300CS (Primiphos methyl) (Kakilla et al., 2020; Mashauri et al., 2017). Insecticide resistance has been reported to occur in this region among vector species (Kakilla et al., 2020; Kisinza et al., 2017; Philbert et al., 2017)The occurrence of insecticide resistance threatens the use of tools with insecticides. This study assessed the impact of the intervention tools implemented in the study area on species composition, feeding and resting behavior, and infective rates among vector populations in rainy and dry seasons.

Material and Methods
Study Site
This study was conducted in the Lugeye village (02.332159S, 33.150529E) in Magu District, Mwanza Region. Mwanza is among the Lake Zone regions with high malaria prevalence in Tanzania. They are highly inhabited by peasants who produce maize, paddy, cotton, and vegetables in small-scale farming. The study area has two rain seasons: the long rain season starts from October to December, while the short rain season starts from February to April. This district had full coverage of IRS using Primiphos methyl insecticides and LLINs (Kakilla et al., 2020; Mashauri et al., 2017) .

Mosquitoes Collection and Identification
Mosquitoes were collected using two methods during the study. Firstly, the Center for Disease Control (CDC) light trap (model 512, John W. Hock Company, Gainesville, FL) was operated as elaborated by a previous study for the collection of indoor host-seeking mosquitoes (Lines et al., 1991; Shiff et al., 1995). Secondly, outdoor resting mosquitoes were collected using pots previously utilized for the purpose (Odiere et al., 2007; van den Bijllaardt et al., 2009). Twenty houses were used, each house trapping mosquitoes both indoors and outdoors over the same night. The collection was done for one month in the rainy and dry seasons. The mosquitoes collected were identified morphologically in the field using the key developed by Gillies and Coetzee (Gillies and Coetzee, 1987). The collected *An. gambie* s.l. mosquitoes were identified at species level using the method developed by Scot and others (Scott, Brogdon and Collins, 1993), while the *An. funestus* sibling species were identified using a

method developed by Koekemoer and others (Koekemoer et al., 2002). Mosquitoes were separated by seasons collected.

Host blood meal identification.

The blood-fed mosquitoes collected indoors and outdoors were prepared by smearing the abdomen in the Whatman filter paper No.1(Bray, Gill and Killick-Kendrick, 1984) .They were labelled by place and date of collection. The blood meal source host was identified using the Enzymes-linked immunosorbent assay (ELISA) protocol. (Beier et al., 1988). The study tested four hosts as possible blood meal sources: bovine, goat, dog, and human.

Sporozoite rates

The collected mosquitoes of both *An. gambiae* s.l. and *An. funestus* group, the head and thorax were taken and subjected to the ELISA protocol developed by Wirtz et al. 1987 (Wirtz et al., 1987). The specimen was considered positive when the cut-off value was similar to or above the positive control.

Data Analysis

The data analysis was done using 1BM SPSS Version 26 (IMB Corp., Armonk, NY, USA). The proportion of mosquitoes collected outdoors and indoors was compared using the Chi-square test. The comparison by seasons was done using the Chi-square test. The comparison was regarded to have significance when the P-value was less than 5%.

Results

Mosquitoes collection and species identification

A total of 254 mosquitoes were collected indoors and outdoors for both seasons. In the rainy season, eight (8) (100%) mosquitoes were sampled, and all were identified as *An. leesoni*. In dry season 246 mosquitoes were collected, 96 (39.02) were *An. arabiensis*, 129 (52.44%). *An. funestus s.s.*, 1 (0.41%) *An. constani* and 20(8.13%) specimens were not identified (Figure 1). The *An. funestus s.s.* abundance was statistically significantly higher in the dry season than in the rainy season (C^2 = 68.59, P<0.001, Figure 1). The abundance of *An. arabiensis* was statistically abounding in the dry season and then in the rainy season (C^2 = 45.13, P<0.001, Figure 1). *An. leesoni* population was higher in the rainy season than in the dry season, which was found to be statistically significant (C^2=192.08, P<0.001, Figure 1).
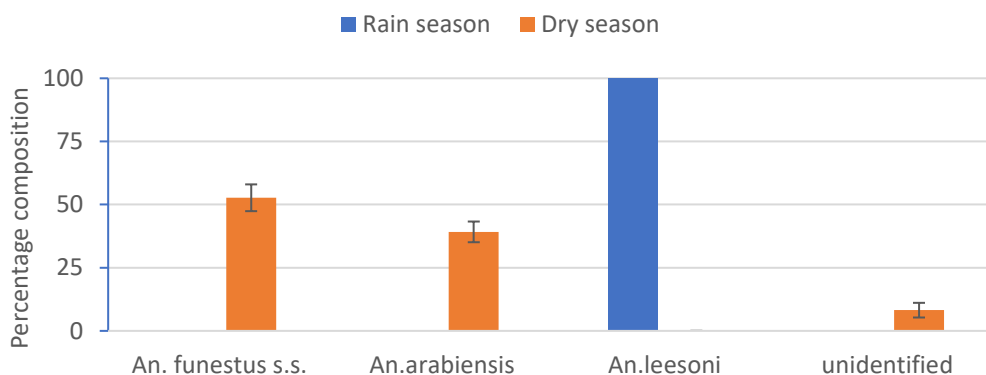
Figure 1: The species composition of mosquitoes collected in all seasons.

Blood meal host identification

A total of 115 blood meal samples were analysed. Twelve (12) samples were collected in dry season while one hundred and three (103) were sampled in dry season. In rainy season, 6(50%) were from Bovine, 5(41.67%) from Human, 1(8.33) from dog while none was found from goats (Figure 2). In dry season 103 samples of blood were collected. Twelve (12) (11.65%) were unidentified, 24(23.30%) were from bovine, 1(0.97%) was from Dog, 5(4.85%) were from Goat while 61(59.22%) were from Human (Figure 2). The comparison of blood meals source by season was found to be statistically significant for three host species. Bovine caught most outdoor(x^2=15.73, P<0.001), Human caught most indoor (C^2=5.78 P=0.016), Dog (C^2=5.70 P=0.017) and Goad (C^2=2.75, P=0.097) (Figure 2). The comparison of blood meal by site of mosquitoes collection (outdoor/indoor) found that, for the three host species, there was statistically significant different results between Indoor and outdoor. In Bovine (C^2=70.19, P<0.001), Human (C^2=85.62, P<0.001), Dog (C^2=7.79, P<0.005) and Goat (C^2=0.12, P<0.733) (Figure 3).
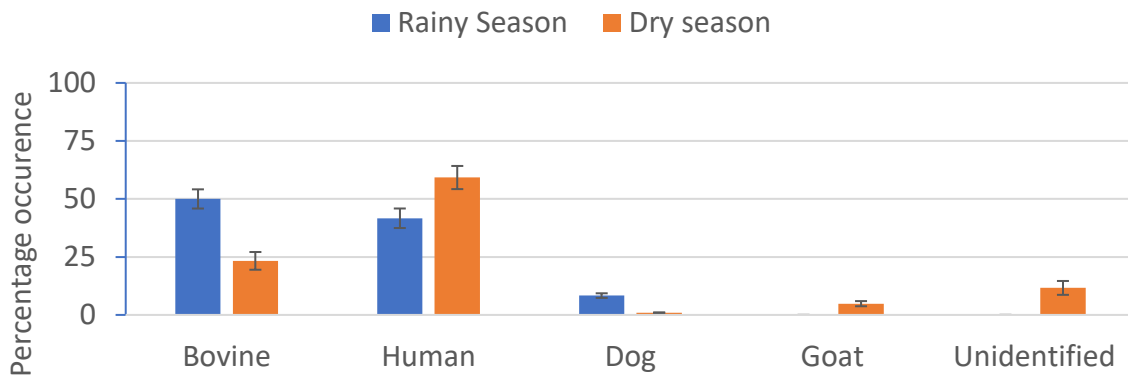
Figure 2: The bloodmeal analysis in seasonality from different hosts
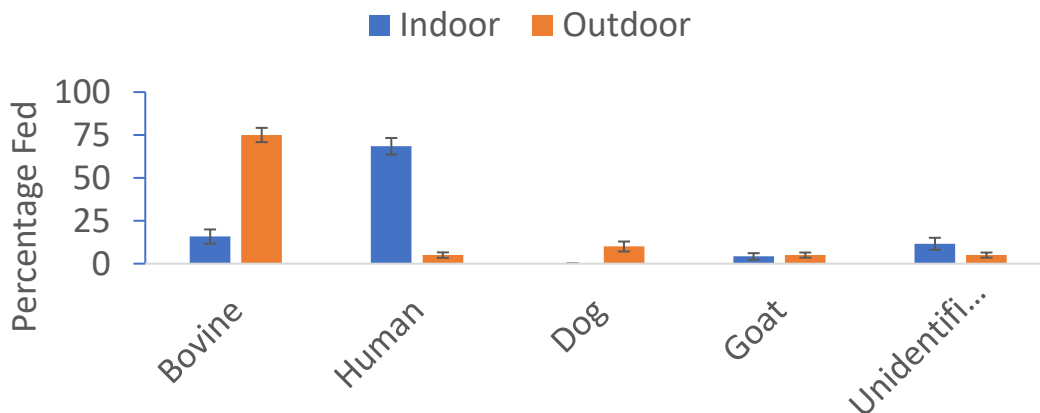
Figure 3: The bloodmeal analysis by resting position of vectors from different hosts.

Sporozoite rates
In the dry season, all eight (8) mosquitoes collected were found to be circumsporozoite protein-negative. In the rainy season, among 246 mosquitoes tested, 10 (4.07%) were found to be circumsporozoite protein positive. Among those tested positive, 6(60%) were An. arabiensis, and 4 (40%) were An. funestus s.s. All sporozoite-positive mosquitoes were collected in the dry season.

Discussion
The findings of this study have shown that malaria vector abundance has been influenced by seasonality in the population of *An. funestus* s.s. dominating during dry season while and *An. arabiensis* dominating the rainy season. The similar species composition was revealed by previous study conducted in a similar area (Kakilla et al., 2020). Also, in other areas of Tanzania, there has been predominance of *An. arabiensis* and *An. funestus* sibling species in the recent past (Kweka et al., 2008a; Kweka et al., 2020; Kweka et al., 2008b; Lwetoijera et al., 2014).

This confirms that, by far, *An. arabiensis* and *An.funestus* are the major malaria vectors in mainland Tanzania (Kweka et al., 2008a; Kweka et al., 2020; Kweka et al., 2008b; Lwetoijera et al., 2014). In this study site, there is a high population shift of the malaria vectors; in a study conducted in the district before the mass intervention of IRS and LLINs, *An. gambiae* s.s. had an upper hand over *An. arabiensis* (Kisinza et al., 2017)*This study revealed that the population of An. gambiae s.s. has been diminished and replaced by An. arabiensis and An. funestus s.s.*

These vectors recently have shown high tolerance to different classes of insecticides used in LLINs and IRS (Kabula et al., 2014; Kakilla et al., 2020; Kisinza et al., 2017; Matowo et al., 2014; Mbepera et al., 2017; Nnko et al., 2017). Different vector species have shown to have different mechanisms to tolerate insecticides toxicity such as biochemical and behavioral resistance (Kulkarni et al., 2006; Kweka et al., 2020; Matowo et al., 2014; Yewhalaw and Kweka, 2016)These mechanisms have enhanced the survivorship of the vector population and transmitted malaria across different ecological areas despite intensive interventions.

The vector abundance was found to be higher in the dry season than the rainy season; this agrees with the ecological studies of the species, which found that in rainy season habitat washing is higher in habitats with shallow water and stable in large water bodies such as in swamps were *An.funestus* and *An. gambiae* s.l. breed most (Kweka et al., 2012). In this study, the *An. arabiensis* and *An. funestus* were abundant in the dry season than in the rainy season. That was found to agree with the ecological conditions of the vector habitats which gain temperature to enhance larval growth and shorten the life cycle in the dry season (Mala et al., 2011). The study site has stable habitats, which become more productive in the dry season than in the rainy season.

A similar scenario has been found by previous studies in different area across Africa for having more vectors in the dry season than in rainy season (Fillinger et al., 2009; Kweka et al., 2011; Kweka et al., 2012). The results of the current study of having high population of vectors in dry season is contrary to what was found in other malaria endemic countries where the population was bottlenecked during the season (Dao et al., 2014) while in Brazil a study indicated reduced adult survivorship when the temperature is increased in the field (Chu et al., 2020). It's also known that, during the rainy season

the movements of mosquitoes are restricted due to rain (Roiz et al., 2010). This might have contributed to the observed scenario in this study.

The findings of this study also have shown that bovines and humans were highly preferred hosts while dogs and goats were the least. According to highly abundant species *An. arabiensis* (zoophilic species) and *An. funestus s.s.* (anthropophilic species) which prefers bovine and humans, respectively, most similar preference was observed in previous studies (Kibret et al., 2017).

In both seasons, the higher blood meal was found to be from humans and animals due to vector preference of vectors and accessibility of the hosts (Mahande et al., 2007). The high access to human blood by vectors was worrying as the community had high coverage IRS and LLINs interventions. This high blood meal access from human might be attributed by the insecticide tolerance level within the vector population (Kakilla et al., 2020; Kisinza et al., 2017). Similar has been found that insecticide tolerance enhances the vectors to access human bloodmeals regardless of intervention covering the population (Glunt et al., 2018).

The findings on sporozoite rates have shown that in this study, the infected mosquitoes were found during the dry season, while in the rainy season, none contained sporozoite protein. The dry season has been found to have no shelters outdoors to hide during the day and, therefore, resting mostly indoors. Resting indoors increases the human-vector contact risks. In a previous study it was revealed that adult mosquitoes cannot tolerate high temperatures, therefore during the day they have to hide under the shaded area which include human shelters and cowsheds (Faye et al., 1997; Magombedze, Ferguson and Ghani, 2018; Mayagaya et al., 2015)The increase in sporozoite rates in An. funestus and An. arabiensis characterizes the malaria transmission efficiency played by the two species in the lake zone.

Conclusion
The findings of this study have shown that *An. arabiensis* and *An. funestus* are the main malaria vectors in the study site, with high abundance and infectivity in the dry season. Assessing their insecticide resistance can generate complementary information for designing effective control programmes.

Declarations
Ethics approval and consent to participate: The Catholic University of Health and Allied Sciences gave the ethical approval.

Consent for publication: Not applicable

Availability of data and materials: All data used in this study will be available upon request from the corresponding author

Competing interests: Authors declared to have no competing interests

Authors' contributions: EJK conceptualized and designed the study, and HDM coordinated field activities. EJK and HDM also conducted data analysis and manuscript writing. Both have endorsed the submission of this manuscript.

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Awareness of Type 2 Diabetes Mellitus and Hypertension among Secondary School Adolescents in Morogoro Region, Tanzania

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Abstract
Background: Several studies have consistently shown that adolescents' awareness of diabetes mellitus and hypertension is inadequate. The main objective was to assess adolescents' awareness of type 2 diabetes and hypertension and identify areas for improvement.
Methods: A cross-sectional survey was conducted with 384 secondary school students from public and private day schools in Kilosa district and Morogoro municipality. Face-to-face interviews were undertaken to collect data on awareness of type 2 diabetes mellitus and hypertension. Data were analyzed using IBM Statistical Packages for Social Sciences (SPSS version 21), and total awareness scores for various sections were calculated by adding the results from all 34 questions and assigning a score of 1 for a yes response and a score of 0 for a no, or a don't know the response.
Results: The main awareness scores for hypertension and diabetes mellitus were 51.4% and 50.2%, respectively, of the possible total score. The scores for general diabetes awareness and hypertension were 53.5% and 42.6%, respectively. Other scores for type 2 diabetes and hypertension were 32.1% vs 42.6% on the "Awareness of Risk Factors" section, 49.5% vs 46% on the "Awareness of Symptoms and Complications" section, 54.1% vs 52.9% on the "Awareness of Treatment and Available Medication Section" and 67.6% vs 66.9% on the "Awareness of Lifestyle Changes and Management Section".
Conclusion: Except for a few areas, such as risk factors, symptoms, and complications that necessitate intervention, adolescents exhibited an average level of information regarding Type 2 Diabetes Mellitus and hypertension. Non-communicable disease risk factors, symptoms, and complications should be taught in schools at a young age to improve primary prevention.

Keywords: Awareness, risk factors, Type 2 diabetes mellitus, hypertension, adolescents

Introduction
Type 2 Diabetes Mellitus (T2DM) was previously regarded as an adult disease; nevertheless, there has been a significant rise in T2DM prevalence in adults and children worldwide in the last ten years (Serbis _et al.,_ 2021). Adolescent hypertension has also increased in significance in the last few decades as a global public health issue (Okpokowuruk _et al.,_ 2017). According to systematic reviews, between 1 and 7% of children and adolescents in poor countries have hypertension (Meena _et al.,_ 2021).

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Obesity prevalence has increased in both developed and developing countries, as has the incidence of T2DM and hypertension, owing to a more sedentary lifestyle and a greater intake of processed foods (Jaja & Yarhere, 2015; Song, 2012). However, many people are unaware that they have hypertension or T2DM until they acquire one of the diseases' life-threatening repercussions. One of the most essential components of T2DM and hypertension prevention techniques is raising public awareness and knowledge. This helps with early detection and changes in modifiable risk variables (Khan *et al.,* 2019). Increased awareness of hypertension and T2DM is expected to drive people to seek health care earlier and lower the likelihood of complications arising (Mbuya *et al.,* 2014).

According to studies from Kuwait and Nigeria, adolescent awareness of the symptoms, consequences, and treatment of diabetes mellitus and hypertension is low (Al-Hussaini & Mustafa, 2016; Omisore *et al.,* 2014). Furthermore, Sitaula et al. observed that awareness and knowledge scores were lower in the urban municipality and rural municipality compared to the metropolitan city in a rural-urban study on diabetes and hypertension among secondary school students in Nepal in 2022. This highlights the crucial need for school-based interventions focusing on non-communicable illnesses and lifestyle change while prioritizing rural populations. The primary objective of this study was to assess adolescents' awareness of T2DM and hypertension and to identify any weak points that require additional educational efforts and should be reinforced through interventions. The findings of this study would allow for changes to existing programs to address weak areas, which would aid in early disease detection and reduce the likelihood of repercussions.

Materials and Methods
Study areas
This study was conducted in two districts of the Morogoro region, Kilosa district representing a rural area and Morogoro municipality representing an urbanized population. Morogoro is one of Tanzania's 31 major regions, including seven districts: Morogoro Rural, Morogoro Urban (municipality), Ulanga, Kilombero, Gairo, Mvomero, and Kilosa. The region has a total population of 2,218,492 people, according to the 2012 Tanzania National Population Census. The rural and urban populations have different proportions, with the rural population being 1,582,434 and the urban population being 636,058. Adolescents aged 10 to 19 comprised 495 654 of the total population (NBS, 2012).

Study design and sample size
A descriptive cross-sectional study design was used for the investigation. The study comprised 14 to 19-year-old adolescent pupils from public and private secondary schools attending ordinary-level secondary schools. Boarding schools were excluded. The sample was selected from a sampling frame that included 50 secondary schools in the municipality of Morogoro and 43 secondary schools in the Kilosa district. Eight secondary schools, four public and four private, were randomly chosen from urban and rural locations to build up the sample. A stratified sampling strategy based on age, gender, and educational level was used to acquire a total sample of 405, following which 50 or more students were randomly picked from each school.

The sample size was computed using the Overall et al. (2006) formula;

$N = N_0 / (1 - DRP)$

Where:

N = desired sample size.

N_0 = Cochran's sample size recommendation where by $N_0 = \dfrac{Z^2 \, p \, (1-p)}{e^2}$

Z is level of statistically significant at 95% confidence interval =1.96, p is proportion of adolescents to be included = 50%/0.5 and e= precision = 5%/0.05

Therefore, $N_0 = ((1.96)^2 (0.5)(0.5))/(0.05)^2 = 384$

DRP = average dropout rate across all subjects (5%)

Substituting for this would be;

$$N = (384)/(1-0.05) = \textbf{405}$$

Therefore, the sample size was 405 respondents

Data collection methods

A self-administered questionnaire was adapted from Al-Hussaini and Mustafa (2016), and the survey instructions were explained to them. The students were directed to answer the pre-tested questions with a 'Yes,' 'No,' or 'Do not know' response. The questionnaire was divided into seven main sections, each focusing on a different aspect of diabetes mellitus, such as general awareness about T2DM and hypertension (eight questions), awareness of risk factors (seven questions), symptoms (seven in T2DM and six in hypertension), complications (five questions), treatment and available medications (two questions), lifestyle and non-medical measures (four in T2DM and five in hypertension), and management of the two diseases. Total awareness scores for each part were calculated by adding the results from all 34 questions and assigning a score of 1 for a yes response and 0 for a no or do not know response. The following parts received scores: general awareness, risk factors, symptoms and problems, drugs available, lifestyle adjustments, and management. The participants' first-degree relatives (mother, father, or sibling) were asked about their family history of diabetes and hypertension. Students were asked to check the box if any of their first-degree relatives had diabetes or hypertension.

Ethical consideration

This study commenced upon ethical approval from the National Institute for Medical Research (NIMR/HQ/R.8a/Vol.IX/3319) and Sokoine University of Agriculture. The regional administrative officer, the appropriate District Executive Officer, and the school's principals approved the study. Data was shared without revealing any personal information and was kept private. Students above 18 signed a consent form; for those under 18, a form of assent was signed along with parental consent.

Data analysis

The statistical analysis used the IBM Statistical Packages for Social Sciences (SPSS version 21). For categorical variables, data are provided as percentages (%). The scores for all 34 questions were added after assigning a score of 1 for the correct response and a score of 0 for no response or don't know. The five components, general awareness, risk factors, symptoms and problems, therapy, and management, received a score. The overall accurate score assessed adolescents' awareness of the causes, symptoms, consequences, and risk factors for T2DM and hypertension.

Results
Socio-demographic characteristics and family history of diabetes and hypertension
This study enrolled 405 adolescent pupils, and 384 (95%) completed the questionnaire. Most participants were in the age group of 14-16 years (79.7%), and only 20.3% were in the age group of 17-19 years, with a mean age of 15.53. As for education level, adolescents were selected equally (33.3%) in each level (Forms 2, 3 and 4). Diabetes and hypertension were **reported** in 15.6% and 16.7% of the subjects' first-degree relatives, respectively (Table 1).

Table 1: Socio-demographic characteristics and family history of diabetes and hypertension (N=384)

Variables	n (%)	Mean
Age (years)		
14-16	306 (79.7)	15.53
17-19	78 (20.3%)	
Education levels (Form 2, 3 and 4)	128 (33.3)	2.00
First-degree relatives with diabetes	60 (15.6)	0.16
First-degree relatives with hypertension	64 (16.7)	0.17

Awareness of T2DM and hypertension
Awareness on T2DM
The overall level of awareness (average correct answer) was 51.4%. The lowest percentage of the correct answer was for "Diabetes is not curable" (27.1%) in the general awareness section, "Pregnancy" (9.1%) in the risk factors section, "Headache" (32.8%) in the symptoms section, "Stroke and heart diseases" (34.9%) in the complications section, "Body weight maintenance" (52.6%) in the lifestyle section and "Regular eye check-up" (47.9%) in the management section (Table 2).

Table 2: Responses of the participants for different sections of the questionnaire (N = 384)

Questions	YES	NO	DON'T KNOW
General awareness of diabetes	n (%)	n (%)	n (%)
Diabetes is a condition of high blood sugar	250 (65.1)	68 (17.7)	66 (17.2)
Diabetes is a condition of not having enough insulin in the blood	198 (51.5)	48 (12.5)	138 (35.9)
Diabetes is a condition of the body not responding to insulin	156 (40.6)	63 (16.4)	165 (43.0)
Diabetes is not curable	104 (27.1)	205 (53.4)	75 (19.5)
Diabetes occurs in children, adolescents, and adults	319 (83.1)	33 (8.6)	32 (8.3)
Risk factors			
Family history of diabetes	85 (22.1)	143 (38.0)	153 (39.8)
Unhealthy diet	189 (49.2)	63 (16.4)	132 (34.4)
Overweight and obesity	158 (41.1)	96 (25.0)	130 (33.9)
Low physical activity	218 (56.8)	65 (16.9)	101 (26.3)
Age above 40 years old	42 (10.9)	211 (54.9)	131 (34.1)
Pregnancy	35 (9.1)	212 (55.2)	137 (35.7)
Alcohol consumption	136 (35.4)	114 (29.7)	134 (34.9)
Symptoms			

Headache	126 (32.8)	119 (31.0)	139 (36.2)
Tiredness and weakness	217 (56.5)	58 (15.1)	109 (28.4)
Visual disturbances or problems	168 (43.8)	100 (26.0)	116 (30.2)
Slow healing of cuts and wounds	217 (56.5)	87 (22.7)	80 (20.8)
Frequent urination	265 (69.0)	49 (12.8)	70 (18.2)
Constant feeling of thirsty	222 (57.8)	57 (14. 8)	105 (27.3)
Too much sweating	197 (51.3)	82 (21.4)	105 (27.3)
Complications			
Eye problems	206 (53.6)	58 (15.1)	120 (31.3)
Kidney problems or disease	182 (47.4)	75 (19.5)	127 (33.1)
High blood pressure	210 (54.7)	53 (13.8)	121 (31.5)
Loss of sensation in arms and legs	139 (36.2)	87 (22.7)	158 (41.1)
Stroke and heart diseases	134 (34.9)	79 (20.6)	171 (44.5)
Medications available			
Medicines are available for the control of BGL	223 (58.1)	26 (6.8)	135 (35.2)
Insulin injections are available for the control of BGL	192 (50.0)	37 (9.6)	155 (40.4)
Lifestyle changes and non-medical measures			
Regular physical activities	270 (70.3)	64 (16.7)	50 (13.0)
Stop alcohol use	251 (65.4)	45 (11.7)	88 (22.9)
Body weight maintenance	202 (52.6)	76 (19.8)	106 (27.6)
Diet modification	256 (66.7)	52 (13.5)	76 (19.8)
Management			
Testing blood sugar regularly	301 (78.4)	42 (10.9)	41 (10.7)
Regular eye check-up	184 (47.9)	90 (23.4)	110 (28.6)
Regular check-ups for general health	318 (82.8)	21 (5.5)	45 (11.7)
Healthy lifestyle changes	294 (76.6)	19 (4.9)	71 (18.5)

Awareness level for the five domains
The section on lifestyle changes and management received the most correct responses (67.6%), followed by the section on medications available (54.1%) and general information (53.5%). The sections on risk factor knowledge, symptoms, and complications had the lowest percentages (32.1% and 49.5%, respectively) (Table 3). More analysis was performed to identify the questions with a percentage of correct responses less than the average of 51.4%. Sixteen questions had a percentage that was lower than average, including two from the general awareness section, six from risk factors, three from symptoms, three from complications, one from drugs available, and one from the management area in question. Six questions had a lower percentage than the overall average, indicating that most students were unaware of the risk factors for T2DM. However, all questions in the lifestyle changes and non-medical measures section had a higher percentage than the overall average, demonstrating that they were aware of lifestyle changes that can be made to manage and prevent diabetes mellitus (Table 4).

Table 3: Maximum possible score (MPS) and average correct answer (ACA) for the 5 sections (N= 384)

Section	MPS	ACA n (%)
General Awareness	5	205 (53.5)
Risk factors	7	123 (32.1)
Symptoms and complications	12	190 (49.5)
Medications available	2	208 (54.1)
Lifestyle changes & management	8	260 (67.6)
Total score	**34**	**197 (51.4)**

Table 4: Questions with per cent correct answers less than the overall average, 51.4% (N= 384)

Questions	n (%)
General awareness about diabetes	
Diabetes is a condition of the body not responding to insulin	156 (40.6)
Diabetes is not curable	104 (27.1)
Risk factors	
Family history of diabetes	85 (22.1)
Unhealthy diet	189 (49.2)
Overweight and obesity	158 (41.1)
Age above 40 years old	42 (10.9)
Pregnancy	35 (9.1)
Alcohol consumption	136 (35.4)
Symptoms	
Headache	126 (32.8)
Visual disturbances or problems	168 (43.8)
Too much sweating	197 (51.3)
Complications	
Kidney problems or disease	182 (47.4)
Loss of sensation in arms and legs	139 (36.2)
Stroke and heart diseases	134 (34.9)
Medications available	
Insulin injections are available for the control BGL	192 (50.0)
Management	
Regular eye check-up	184 (47.9)

Awareness on hypertension
The average percentage of correct responses (general awareness) was 50.2%. The question with the lowest percentage of correctly answered questions in the general awareness section was "Hypertension is not curable" (14.3%), followed by "Pregnancy" (19.8%), "Blood in the urine" (16.7%), "Trouble with memory" (32.3%), "Hydrazaline injections are available for the control of hypertension" (42.2%), and "Regular eye check-up" (44.5%) in the management section (Table 5).

Table 5: Responses of the participants for different sections of the questionnaire (N = 384)

Questions	YES	NO	DON'T KNOW
General awareness of hypertension	n (%)	n (%)	n (%)
Hypertension is a condition of high blood pressure	238 (62.0)	32 (8.3)	114 (29.7)
A condition in which blood vessels have rapidly raised pressure	138 (35.9)	79 (20.6)	167 (43.5)
NBP is a blood pressure of 120mmHg SBP and 80mmHg DBP	122 (31.8)	35 (9.1)	227 (59.1)
Hypertension is not curable	55 (14.3)	193 (50.3)	137 (35.4)
Hypertension occurs in children, adolescents, and adults	266 (69.3)	40 (10.4)	78 (20.3)
Risk factors			
Family history of hypertension	140 (36.5)	117 (30.5)	127 (33.1)
Unhealthy diet	178 (46.4)	83 (21.6)	123 (32.0)
Overweight and obesity	235 (61.2)	53 (13.8)	96 (25.0)
Low physical activity	255 (66.4)	57 (14.8)	72 (18.8)
Age above 40 years old	91 (23.7)	156 (40.6)	137 (35.7)
Pregnancy	76 (19.8)	151 (39.3)	157 (40.9)
Cigarette smoking and alcohol consumption	171 (44.5)	86 (22.4)	127 (33.1)
Symptoms			
Severe headache and stress	256 (66.7)	53 (13.8)	75 (19.5)
Tiredness and weakness	219 (57.0)	62 (16.1)	103 (26.8)
Visual disturbances or problems	170 (44.3)	64 (16.7)	150 (39.1)
Chest pain and difficulty breathing	175 (45.6)	69 (18.0)	140 (36.5)
Irregular heartbeat	265 (69.0)	48 (12.5)	71 (18.5)
Blood in the urine	64 (16.7)	138 (35.9)	182 (47.4)
Complications			
Eye problems	173 (45.1)	90 (23.4)	121 (31.5)
Heart attack or stroke	183 (47.7)	73 (19.0)	128 (33.3)
Heart failure	169 (44.0)	99 (25.8)	116 (30.2)
Trouble with memory or understanding	124 (32.3)	90 (23.4)	170 (44.3)
Kidney problems or disease	146 (38.0)	71 (18.5)	167 (43.5)
Medications available			
Medicines are available for the control of hypertension	244 (63.5)	22 (5.7)	118 (30.7)
Hydrazaline injections are available for the control of hypertension	162 (42.2)	46 (12.0)	176 (45.8)
Lifestyle changes and non-medical measures			
Regular physical activities	286 (74.5)	50 (13.0)	48 (12.5)
Stopping cigarette smoking and alcohol consumption	259 (67.4)	47 (12.2)	78 (20.3)
Body weight maintenance	241 (62.8)	53 (13.8)	90 (23.4)
Diet modification	261 (68.0)	42 (10.9)	81 (21.1)
Not to use drugs and energizing products	236 (61.5)	37 (9.6)	111 (28.9)
Management			

Measuring blood pressure regularly	298 (77.6)	39 (10.2)	47 (12.2)
Regular eye check-up	171 (44.5)	83 (21.6)	130 (33.9)
Regular check-up for general health	292 (76.0)	33 (8.6)	154 (59.0)
Healthy lifestyle changes	268 (69.8)	35 (9.1)	81 (21.1)

Awareness level for the five domains (section)

The management and changes in lifestyle aspects had the most significant percentage of correct answers (66.9%), followed by the drugs available section (52.9%). The sections on general awareness, risk factor awareness, and symptoms and complications received the lowest ratings (42.6%, 42.6%, and 46.0%, respectively) (Table 6). More data analysis was performed on the acquired information to identify the questions with a lower percentage of correctly answered questions than the average, 50.2%. Three questions from the general awareness part, five from risk factors, three from symptoms, five from complications, one from drugs available, and one from the management section had a percentage lower than the average (Table 7). The fact that five questions in each section had a rate lower than the overall average shows that many of the adolescents were unaware of the risk factors for hypertension and its complications. However, they were aware of lifestyle changes that can be made to manage and prevent hypertension because all questions in this section had a percentage higher than the overall average.

Table 6: Maximum possible score (MPS) and average correct answer (ACA) for the five domains (N = 384)

Section	MPS	ACA n (%)
General Awareness	5	164 (42.6)
Risk factors	7	164 (42.6)
Symptoms and complications	11	177 (46.0)
Medications available	2	203 (52.9)
Lifestyle changes & management	9	257 (66.9)
Total score	**34**	**193 (50.2)**

Table 7: Questions with a percent correct answer less than the overall average, 50.2 % (N= 384)

Questions	n (%)
General awareness of hypertension	
A condition in which the blood vessels have persistently raised pressure	138 (35.9)
NBP is defined as a blood pressure of 120mmHg SBP and 80mmHg DBP	122 (31.8)
Hypertension is not curable	55 (14.3)
Risk factors	
Family history of hypertension	140 (36.5)
Unhealthy diet	178 (46.4)
Age above 40 years old	91 (23.7)
Pregnancy	76 (19.8)
Cigarette smoking and alcohol consumption	171 (44.5)
Symptoms	
Visual disturbances or problems	170 (44.3)

Chest pain and difficulty breathing	175 (45.6)
Blood in the urine	64 (16.7)
Complications	
Eye problems	173 (45.1)
Heart attack or stroke	183 (47.7)
Heart failure	169 (44.0)
Trouble with memory or understanding	124 (32.3)
Kidney problems or disease	146 (38.0)
Medications available	
Hydrazaline injections are available for the control of hypertension	162 (42.2)
Management	
Regular eye check-up	171 (44.5)

Discussion

Adolescent students had an average level of awareness regarding type 2 diabetes mellitus (T2DM) and hypertension. Contrary to expectations, this average level was lower than anticipated, considering that students at this stage typically possess information garnered from secondary school lessons or media exposure. Notably, students exhibited higher awareness of lifestyle changes and management but lower awareness regarding risk factors, symptoms, and complications. For instance, less than 20% of students were aware that pregnancy increases the risk of elevated blood glucose and hypertension due to physiological changes such as decreased maternal insulin sensitivity and increased insulin resistance, potentially leading to outcomes like pregnancy-induced hypertension (*Mwanri et al.,* 2014). Consequently, it is imperative to educate adolescents, particularly females, about pregnancy-induced diabetes and hypertension to prevent early onset.

Moreover, students showed a lack of awareness regarding the complications associated with diabetes and hypertension, possibly indicating shortcomings in our educational system. Therefore, further investigation is warranted. Although overall awareness levels are relatively high, there is a pressing need to enhance awareness through curriculum revisions or large-scale media campaigns. Understanding the risk factors and potential complications of diabetes and hypertension can empower individuals, especially when prevention efforts are initiated early. Comparative analysis with prior studies reveals similar patterns. Al Hussaini and Mustafa (2016), who assessed adolescents' knowledge and awareness of diabetes mellitus in Kuwait, found comparable levels of average diabetes awareness among adolescent students, with better performance in lifestyle change areas and poorer performance in other sections. Sitaula et al. (2022) reported lower awareness and knowledge ratings in urban and rural municipalities compared to metropolitan cities in Nepal, emphasizing the need for targeted educational interventions. Similarly, Divakaran et al. (2010) observed minimal awareness of lifestyle risk factors among school children.

Studies conducted among adult populations further emphasize the importance of comprehensive awareness campaigns. Anyanti et al. (2021) highlighted the need to provide accurate information on diabetes and high blood pressure to promote healthy practices, considering the prevalent lifestyle-related risk factors identified in Nigerian communities. Mbuya et al. (2014) revealed gaps in awareness among teaching staff regarding the hereditary nature of hypertension and the association of increasing age with diabetes and hypertension risk. Unfortunately, understanding the origins, symptoms, risk factors, and complications was lower than expected.

These adolescent groups should be well-informed about diabetes, hypertension, and other NCDs since they have the potential to be powerful advocates for the Tanzanian community and decision-makers.

Likewise, Abdullahi et al. (2011) noted limited awareness among the personnel of the University of Ibadan in Nigeria regarding hereditary factors contributing to hypertension. Moreover, findings from studies conducted in Tanzania underscore the lack of awareness surrounding T2DM. Ruhembe et al. (2014) reported alarmingly low levels of awareness among adult respondents regarding the symptoms, causes, management, and risk factors of T2DM. These findings suggest a critical need for targeted educational initiatives to improve public awareness and understanding of diabetes and hypertension. The influence of media, particularly television, on dietary habits and lifestyle choices cannot be overlooked. The prevalence of advertisements promoting unhealthy food choices may contribute to the low awareness of T2DM and hypertension risk factors observed in the study. Given the global significance of diabetes and hypertension as NCDs, efforts to raise awareness among children and families are paramount in combating the growing burden of NCDs in developing countries.

Conclusions and recommendations

Our study shows that adolescents were aware of T2DM and hypertension. However, they were unaware of the risk factors, symptoms, and repercussions. It is recommended that T2DM and hypertension awareness be spread at a young age to lower the risks of contracting these non-communicable diseases. The Ministry of Education should add lectures on noncommunicable diseases related to diet to primary and secondary school curricula. Furthermore, media awareness campaigns should be produced utilizing a simple communication language accessible to people of all ages.

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Asymptomatic Bacteriuria and Its Determinants Among Pregnant Women In Rural Southwestern Nigeria

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Abstract:
Background: The occurrence of asymptomatic bacteriuria in pregnancy has been associated with adverse maternal and fetal outcomes.
Objective: This study determined the prevalence of asymptomatic bacteriuria and its determinants among pregnant women in rural Southwestern Nigeria.
Methods: A hospital-based cross-sectional study was conducted between June 2021 and May 2023 among 400 pregnant women with no signs or symptoms of urinary tract infection. Demographic and clinical data were collected using structured questionnaires. Mid-urine samples were cultured using standard laboratory procedures. Bacterial colonies were isolated, and antimicrobial sensitivity was measured using the disc diffusion technique. Data were analyzed using SPSS version 22. The determinants of asymptomatic bacteriuria were measured using odds ratio and 95% confidence Interval (CI) with significant level (p-value <0.05).
Results: The prevalence of asymptomatic bacteriuria was 24.0% (95% CI = _18.2% - 30.5%)_. The determinants of asymptomatic bacteriuria were the absence of post-coital urination (AOR, 4.433; 95%CI: 1.462-7.116), diabetes mellitus (AOR, 2.468; 95% CI: 1.300 – 4.684), and anaemia (AOR, 2.699; 95%CI: 1.042 – 6.729). The most detected asymptomatic bacteriuria was _E. coli_ 52/96 (54.2%). The cultured isolates were 100.0% sensitive to ceftriaxone and ceftazidine but were 100.0% resistant to ampicillin and erythromycin.
Conclusion: Based on the urine culture and sensitivity results, the study suggests using ceftriaxone or ceftazidine as an empirical treatment for asymptomatic bacteriuria.
Keywords: Asymptomatic bacteriuria, pregnant women, determinants, rural Nigeria

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Introduction
In the absence of any sign or symptom of urinary tract infection (UTI) in pregnancy, the presence of bacteria actively multiplying and significantly greater than or equal to 105 colony-forming units per millilitre (ml) of urine is referred to as asymptomatic bacteriuria (ASB) (Bose et al., 2017).

The risk of ASB is doubled in pregnant women compared with their non-pregnant counterparts (Banda et al., 2020; Tadesse et al., 2018). Pregnant women's physiological and anatomical status changes caused by gestation and reduced immune systems contribute to ASB in pregnant women (Azami et al., 2019; Afunwa et al., 2017).

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During pregnancy, ASB enhances the likelihood of the infection progression to the symptomatic case, which may come with adverse maternal or fetal consequences (Sunkar et al., 2021; Sujatha et al.2021).

Globally, the prevalence of ASB among pregnant women is estimated to be 2-11%, although in Sub- Sahara Africa (SSA), higher rates have been reported (Tadesse et al. 2018; Edae et al., 2020). In Nigeria, prevalence of ASB in pregnant women varies from one region to the other, such as 10.3% in Jos, North central Nigeria (Banda et al. 2020), 13.6% in Port Harcourt, Southern Nigeria (Tosin et al.2004) and 23.9% in Sagamu, Southwestern Nigeria (Olusanya et al.1993). The observed variations in the prevalence of ASB among these regions are due to several factors, such as socio-demographics and pregnancy-related factors of pregnant women (Renko et al.2011). Shreds of evidence also support patients with co-morbid conditions such as diabetes, hypertension, Acquired Immunodeficiency Disease Syndrome (AIDS)/ Human Immunodeficiency Virus (HIV), defects of the urinary tract, and history of UTI with increased risk of ASB (Banda et al. 2020; Renko et al., 2011).

Previous studies have reported *Eschericial coli (E.coli)*, *Staphlococcus aureus (S. aureus)*, and *Klebsiella* species (K. species) as the most common bacterial isolates from pregnant women with ASB in SSA (Banda et al., 2020; Sunkar et al., 2021; Edae et al., 2020). However, in Nigeria, like many other countries in SSA, urine microscopy, culture, and sensitivity (m/c/s) do not form part of the standard laboratory investigations conducted in women during the antenatal visits, probably due to the cost and the long waiting time in getting the results. This lack of inclusion of m/c/s hindrances the understanding of the burden, bacterial aetiology, and sensitivity pattern of ASB in women, thus preventing proper management of women with ASB.

Moreover, the emergency of antimicrobial drug resistance by most uropathogens will increase the risk of women with pregnancy-associated complications. To prevent these adverse outcomes, many researchers have advocated for routine screening and treatment for ASB as part of antenatal care guidelines (Mirei et al., 2016).

Despite an association of ASB with adverse pregnancy, there is a paucity of data on the burden of ASB and its determinants in rural Southwestern Nigeria. Although few efforts to unravel the burden of ASB in urban and sub-urban centres have been documented in the literature, there is none in rural areas (Banda et al., 2020; Ezugwa et al., 2021). Therefore, this study aimed to determine the prevalence of ASB and its determinants among pregnant women presenting to annexes of a tertiary hospital in rural Southwestern Nigeria.

Materials and Methods:
Study setting: This study was conducted between June 2021 and May 2023 in one of the study institution's outreach centres in a rural community in Southwestern Nigeria. According to the recent 2006 national population census, the community has a population of 219,000, with an annual growth rate of 3.2% (Ekiti Profile, 2007).

Study design/population: The study was a health facility-based cross-sectional among pregnant women who presented for antenatal care between June 2021 and May 2023.

Inclusion/Exclusion Criteria
The inclusion criteria were consented to healthy pregnant women aged 18-45 years who presented for routine antenatal care services. Women were excluded in case they were less than 18 years, residents in an urban area, had signs or symptoms suggestive of UTI, had vaginal bleeding, or had used antibiotics in the preceding two weeks of their coming to the antenatal clinic.

Sample size determination
The sample size for the study was calculated using the formula Z^2PZ/d^2 (Araoye, 2003), where 'p' is the prevalence of 37.1% ASB observed in the study conducted by (Tosin et al., 2004), Z is the type 1 error at 5%, and d is the margin of error). Therefore, based on sample size calculations (p = 0.371, z = 1.96, d = 0.05), the requisite sample size was 358, which was increased to 400 to cater to attrition.

Selection of respondents
The researchers used systematic sampling to select the respondents for the study. Using the antenatal clinic register for the year 2020, an average of 10 pregnant mothers were seen weekly, giving a total of 1040 (sample frame) over the two years that the study was conducted.

The formula K (sampling interval), which is sample frame (1040) divided by sample size (400), is used. Therefore, K = approximately 3. At the beginning of each clinic day, the first respondent was randomly selected using a simple random technique. Each third respondent was selected by systematic sampling until the sample size of 400 was achieved. The folder of the selected mother was tagged to prevent its re-sampling at the subsequent antenatal visits.

Data collection methods

A standardized interviewer-administered questionnaire assessed the respondents' socio-demographics, obstetrics and gynaecological factors. Socio-demographics included age in years, marital status, educational level, occupation, and monthly income. Obstetrics and gynaecological factors (pregnancy-related factors) included parity, estimated gestational age, history of catheterization, previous history of UTI, and history of post-coital urination. Furthermore, a history of co-morbid conditions such as diabetes mellitus, hypertension, and HIV/AIDS was also assessed through face-to-face interviews.

Clean-catch midstream urine sample collection

The respondents were instructed to collect about 20 ml of standard midstream urine by the "clean catch" method into a wide-mouthed screw-capped universal urine container. The respondents' identification number, date, and time of collection were labelled outside the container. The collected samples were kept in a cold box and sent to the medical microbiology laboratory department of the study centre for processing within 45 minutes of collection time.

Bacterial isolation through urine culture

The urinalysis with microscopy examination was performed to identify bacteria. Positive samples were processed for culture and sensitivity. Urine culture was performed using the standard wire loop method. Briefly, a loop-full (0.001ml) of well-mixed urine was streak-inoculated on CLED, MacConkey and Chocolate agar plates. The plates were incubated aerobically at 37 $^{\circ}$C for 24 hours. A diagnosis of ASB was made if there were more than 10^5 colony forming units/ml (CFU/ml) of urine with 2 or fewer isolates. Significant isolates were identified using colonial appearance on culture plates, microscopic appearance on Gram-stain and biochemical techniques through standard laboratory identification methods (Prasanna et al.2015).

Antibiotic Susceptibility Testing

The Kirby-Bauer Disc diffusion test carried out the antibiotic susceptibility test with 0.5 McFarland Standard turbidity of the inoculums on Muller-Hinton agar. Inhibition Zone diameter (IZDs) was measured (Mary & PKSS, 2020). The following antibiotics discs (Oxoid, Ldd., UK) were tested on the isolates, which included representative of the antimicrobials against methicillin-resistant Staphylococcus aureus (MRSA) infections and cephalosporin group (Clindamycin (2ug), ceftriaxone (30ug), ceftazidine (30ug), ampicillin (10ug), amoxicillin-clavulanate (20/10ug), erythromycin (15ug), ciprofloxacin (5ug), fosfomycin (200ug), nitrofurantoin (300ug), and co-trimoxazone (25ug). Two medical microbiologists in the hospital carried out the selection for testing and results determination and were based on the Clinical Laboratory Standards Institute Protocols (PK et al. 2020, CaLSI, 2018). Moreover, a senior medical microbiologist was placed on standby to cross-check the results and ensure that quality control was followed.

Ethical consideration

Ethical clearance was obtained from the Ethics and Research Committee of the study institution with approval number ERC/2021/03/19/62A. All consented patients were thoroughly informed about the risks and advantages of the procedures. Written informed consent for the procedure and treatment was obtained from each respondent, and participation was entirely based on their willingness. Confidentiality and privacy were ensured throughout the study. The study was at no cost to the respondents. The reporting of this study conforms to the strengthening of the Reporting of Observational Studies in Epidemiology (STROBE) statement (Von Elm et al.2007).

Treatment of respondents with ASB

The respondents diagnosed with ASB were directed to see a physician for treatment. They were adequately counselled on good personal and environmental hygiene to prevent recurrence. After this, they were given a prescription for either ceftazidine or ceftriaxone.

Statistical analysis

The data collected were checked, cleaned, and entered EPI Info Version 7.0 and exported to SPSS version 22.0 for analysis. The prevalence of ASB was computed as a proportion by dividing the number of positive cultures by the total sample size, and it was reported as a percentage. The Chi (x^2) squared, and Fischers' exact tests were used to determine the association between maternal socio-demographics, obstetrics and gynaecological factors, and co-morbid conditions with ASB. All factors found to have a significant association with ASB in the bivariate analysis (p-value < 0.05) were entered in a stepwise multivariate logistic regression model to determine the factors independently associated with ASB. Results were presented as adjusted odds ratios with corresponding 95% confidence intervals.

Results:

This study studied 400 pregnant women. The mean age of the respondents was 28.2 ± 5.9 (range 18-40) years. Most were married, 378 (94.5%), and 380 (95.0%) had formal education. Most respondents were self-employed 210 (52.5%) but lived below the poverty line because they earned less than 2.2 dollars per day 240 (40.0%), Table 1.

Table 1: Socio-demographic characteristics of the patients (N = 400)

Variable	Frequency N = 400	Percentage (%)
Age (in years)		
< 20	18	4.5
20 – 29	234	58.5
30 – 39	138	34.5
≥ 40	10	2.5
Mean age ± SD	*28.2 ± 5.9*	
Range (min. – max.)	*18 – 42*	
Marital Status		
Single	10	2.5
Married	378	94.5
Divorced	8	2.0
Widowed	4	1.0
Education		
Informal	20	5.0
Formal	380	95.0
Occupation		
Self-employed	210	52.5
Civil Servant	92	23.0
House wife	98	24.5
Income level		
< 2.2 dollars per day	240	60.0
≥ 2.2 dollars per day	160	40.0

A total of 96/400 respondents were positive for ASB, giving an overall prevalence of 24.0% (95% CI = *18.2% - 30.5%*). The most detected ASB was *E. coli* 52/96 (54.2%); the only gram-positive organism was *S. aureus* 16/96 (16.6%). Few respondents had dual cultured isolates (Table 2).

Table 2: Asymptomatic Bacterium (ASB) and pattern of isolates (N = 400)

Variable	Frequency N = 400	Percentage (%)
Asymptomatic Bacteria		
Yes	96	24.0
95% Confidence Interval	18.2% - 30.5%	
Pattern of isolates	*n = 96*	
E.C. – *E. coli*	52	54.2
S.A. – *S. aureus*	16	16.6
K.P. – *K. pneumonia*	12	12.5
P.T. – *Proteus species*	12	12.5
PSA – *Pseudomonas aeruginosa*	4	4.2

In this study, the association between variables of socio-demographic characteristics and ASB was not statistically significant (P>0.05), Table 3.

Table 3: Association between ASB and socio-demographic characteristics (N = 400)

Variable	Asymptomatic Bacteria			Chi-square	p-value
	Positive n(%)	Negative n (%)	Total (%)		
Age (in years)					
< 20	4 (25.0)	12 (75.0)	16 (4.0)	0.277	0.964
20 – 29	50 (21.5)	183 (78.5)	233 (58.3)		
30 – 39	32 (22.9)	108 (77.1)	140 (35.0)		
≥ 40	2 (18.2)	9 (81.8)	11 (2.7)		
Marital Status					
Single	2 (25.0)	6 (75.0)	8 (2.0)	1.064	0.786
Married	84 (22.0)	298 (78.0)	382 (95.5)		
Divorced	2 (28.6)	5 (71.4)	7 (1.8)		
Widowed	0 (0.0)	3 (100.0)	3 (0.8)		
Education					
Informal	6 (33.3)	12 (66.7)	18 (4.5)	1.411	0.235
Formal	82 (21.5)	300 (78.5)	382 (95.5)		
Occupation					
Self-employed	41 (119.6)	168 (80.4)	209 (52.3)	2.138	0.343
Civil Servant	26 (27.1)	74 (72.9)	96 (24.0)		
Housewife	21 (22.1)	74 (77.9)	163 (40.8)		
Income level					
< 2.2 dollars per day	59 (24.9)	178 (75.1)	237 (59.3)	2.840	0.092
≥ 2.2 dollars per day	29 (17.8)	134 (82.2)	163 (40.8)		

In the current study, there was a statistically significant association between ASB and respondents with post-coital urination (p<0.001) (Table 4).

Table 4: Association between ASB and pregnancy-related factors (N = 400)

Variable	Asymptomatic Bacteria			Chi square	p-value
	Positive n (%)	Negative n (%)	Total (%)		
Parity					
Primigravida	24 (20.7)	92 (79.3)	116 (29.0)	0.163	0.686
Multigravida	64 (22.5)	220 (77.5)	284 (71.0)		
Trimester (EGA)					
First	9 (16.7)	45 (83.3)	54 (13.5)	2.099	0.350
Second	34 (25.8)	98 (74.2)	132 (33.0)		
Third	45 (21.0)	169 (79.0)	214 (53.4)		

Previous history of urethral catheterization					
Yes	21 (30.0)	49 (70.0)	70 (17.5)	3.165	0.075
No	67 (20.3)	263 (79.7)	330 (82.5)		
Previous history of Urinary Tract Infection					
Yes	27 (27.6)	71 (72.4)	98 (24.5)	2.331	0.127
No	61 (20.2)	241 (79.8)	302 (78.0)		
Post-coital urination					
No	48 (54.5)	40 (45.5)	88 (22.0)	69.639	**<0.001**
Yes	40 (12.8)	272 (87.2)	312 (78.0)		

Furthermore, there was a statistically significant association between ASB and respondents who had diabetes (p= 0.023), hypertension (p<0.033), and anaemic (p< 0.001), Table 5.

Table 5: Association between ASB and co-morbid conditions (N = 400)

Variable	Asymptomatic Bacteria			Chi square	p-value
	Positive n (%)	Negative n (%)	Total (%)		
Diabetes mellitus					
Yes	7 (46.7)	8 (53.3)	15 (3.8)	5.526	**0.019**
No	81 (21.0)	304 (79.0)	385 (96.3)		
Hypertension					
Yes	16 (44.4)	20 (55.6)	36 (9.0)	11.613	**0.001**
No	72 (19.8)	292 (80.2)	364 (91.0)		
HIV/ AIDS					
Yes	2 (40.0)	3 (60.0)	5 (1.3)	0.956	0.328
No	86 (21.8)	309 (78.2)	395 (98.7)		
Anemic status					
PCV ≤ 30%	50 (39.4)	77 (60.6)	127 (31.8)	32.718	**<0.001**
PCV > 30%	38 (13.9)	235 (86.1)	273 (68.3)		

In this study, after adjusting for possible confounders, the odds of being infected with ASB were 4.433 times (95% CI: 1.462-7.116) higher among pregnant women with the absence of post-coital urination, 2.468 times (95% CI: 1.300 – 4.684) higher among pregnant women with a history of diabetes mellitus, and 2.699 times (95% CI: 1.300 – 4.684) higher among the respondents with anaemia (Table 6).

Table 6: Multivariate logistic regression for the determinants of ASB in this study

Variable	+ve ASB	Total Examined	COR (95% CI)	p	AOR (95% CI)	P
Post-coital urination						
Yes	48 (54.5)	88 (22.0)	8.160 (4.779 – 13.933)	<0.001	8.982 (1.469 – 24.937)	**0.018**
No			1.000		1.000	
Diabetes mellitus						
Yes	7 (46.7)	15 (3.8)	3.284 (1.157 – 9.324)	**0.019**	3.372 (1.552 – 8.074)	**0.024**
No			1.000		1.000	
Hypertension						
Yes	16 (44.4)	36 (9.0)	3.244 (1.601 – 6.574)	**0.001**	1.722 (0.524 – 5.663)	0.371
No			1.000		1.000	
Anemic status						
PCV ≤ 30%	50 (39.4)	127 (31.8)	4.016 (2.450 – 6.582)	**<0.001**	2.642 (1.420 – 4.916)	**0.002**
PCV > 30%			1.000		1.000	

The gram-negative isolates were 100.0% sensitive to ceftriaxone, ceftazidine, and clindamycin but 100.0% resistant to ampicillin, erythromycin, and co-trimoxazole. Similarly, S. aureus was 100.0% sensitive to ceftriaxone, ceftazidine, and fosfomycin but 100.0% resistant to ampicillin, erythromycin, and amoxicillin-clavullate (Table 7).

Table 7: Antibiotics Sensitivity Pattern of Profile of Bacterial Isolates of Respondents with ASB

Bacterial Isolates	No of Isolated	CRO (%)	CTD (%)	AM-CL (%)	ETM(%)	A (%)	CPF (%)	COT (%)	CD (%)	FFM(%)	NIT (%)
E.Coli	52	52(100.0)	52(100.0)	26(50.0)	0(.0)	0(0.0)	20(38.5)	0(0.0)	52(100.0)	26(50.0)	16 (30.7)
Klebsiella Spp.	12	12(100.0)	12(100.0)	8(66.0)	0(0.0)	0(0.0)	10(82.5)	0(0.0)	12(100.0)	6(50.0)	8(66.0)
Proteus	12	12(100.0)	12(100.0)	10(82.5)	0(0.0)	0(0.0)	4(33.0)	0 (0.0)	12(100.0)	8(66.0)	6(50.0)
Pseud. Spp.	4	4(100.0)	4(100.0)	2(50.0)	0(0.0)	0(0.0)	2(50.0)	0(0.0)	4(100.0)	2(50.0)	2(50.0)
S. aureus	16	16(100.0)	16(100.0)	0(0.0)	0(0.0)	0 0.0)	4(25.0)	4(25.0)	12(75.0)	16(100.0)	12(75.0)
Total	96	96(100.0)	96(100.0)	46(81.3)	0(0.0)	0(0.0)	40(0.4)	4(31.3)	96(52.1)	58(31.3)	44(52.1)

CRO, Ceftriaxone; CTD, Ceftazidine; AM-CL, Amoxicillin-clavullate; ETM, Erythromycin; A, Ampicillian; CPF, Ciprofloxacin; COT, Cotrimoxazole; CD, Clindamycin, FFM, Fosfomycin; NIT, Nitrofurantoin.

Discussion

The overall prevalence of ASB in this study was 24.0%. This agreed with 23.9% reported in another Southwestern Nigeria (Olusanya et al., 1993). However, the result was higher than the 10.3% reported in Jos, North Central Nigeria (Banda et al., 2020). It was also higher than reported in other studies outside Nigeria, such as 16.7% in Lucknow, India (Sunkar et al., 2021) and 3.75% in Eastern Uganda (Nteziyaremye et al., 2020).

These other studies were carried out in the urban settings. Including respondents with co-morbid conditions in this study might also explain the higher prevalence of ASB compared with these other studies. On the contrary, the prevalence of ASB in this study was lower than the 29.5% reported in a study in Southeastern Nigeria (Izuchukwu et al., 2017), and the results from other countries such as Egypt, 29.0% (Nora et al.2017), and Southwest Cameroon 33.2% (Bisson et al., 2013). The differences between these studies and our study might be due to the sample size, geographical variations, prevalent social habits, and health-related practices (Tadesse et al., 2018; Ayoyi et al., 2017).

The current study showed that respondents who do not have a habit of post-coital urination were 4.433 times more likely to develop ASB. This finding was consistent with other studies that have found an association between a lack of post-coital urination and the risk of ASB (Edae et al., 2020; Schnar & Smail, 2008). These studies have linked the habit of post-coital urination to cleaning the urethra and preventing bacteria from entering the bladder during coitus.

The current study has revealed that respondents with diabetes mellitus were more likely to develop ASB when compared with their counterparts. The association between ASB and diabetes mellitus has been inconsistent in previous literature. The study in Southwestern Cameroon reported that diabetic patients were significantly at increased risk of ASB, which was consistent with the finding in this study (Bisson et al., 2013)). The increased risk of ASB in diabetes patients may be related to immune compromise and various genetic variants, such as C1q gene polymorphism (Van den Broek et al., 2020). However, another study found no significant association between ASB and patients with diabetes mellitus (Sentochnik & Eliopoglos, 2005).

The study showed that the presence of ASB was significantly associated with a packed cell volume of less than 30%. Pregnant women who were anaemic were more likely at risk of ASB when compared with their counterparts who were not. This agrees with findings in another study that linked a decrease in haemoglobin level to the occurrence of ASB (Cuttitta et al., 2014). This may be because pregnant women with iron deficiency are associated with a reduced immune system and are more likely to acquire infectious than those with normal iron levels (Tansarli et al., 2013).

This finding suggests that clinicians who provide antenatal care should screen pregnant mothers for anaemia to reduce the incidence of ASB.

In this study, the most common bacterial isolate was *E.coli*. This agreed with findings from a study in Nigeria (Banda et al., 2020), and studies in other countries (Sunkar et al., 2021; Edae et al., 2020). Reports from previous studies also indicate that *E.coli* possesses virulence factors that enhance their ability to colonize and invade the urinary tract (Tille et al., 2018). *E.coli* is also reported to be a common isolate in healthy pregnant mothers similar to the study population (Corgan et al., 2006). The presence of other members of the *Enterobacteriaceae* family, such as Klebsiella and Proteus species, which are predominantly of faecal origin, suggests poor personal hygiene in pregnant women.

The second most common isolated organism in this study was *S. aureus*, and this finding agreed with the reports from other studies where *S. aureus* was the second most common isolates (Banda et al., 2020; Bissong et al., 2013). However, it disagrees with a study reported in Uganda, where S. aureus was the most prevalent isolate (Fridreck et al., 2019) and a study reported in Ethiopia, where *S. pneumoniae* was the second most common isolated organism. The presence of *S. aureus* in the urine is due to poor genital hygiene by pregnant mothers (Nteziyaremye et al., 2020). The poor genital hygiene may be related to their low socio-economic factor and place of residence. The findings in this study call for continuous health education on improved personal and environmental hygiene to reduce the incidence of ASB due to the faecal-oral route.

In the current study, all the gram-negative isolates showed higher sensitivity (100.0%) to ceftriaxone, ceftazidine, and clindamycin but were resistant to ampicillin, erythromycin,and co-trimoxazole. This agreed with other studies (Tadesse et al., 2018; Edae et al., 2020).

Furthermore, *S. aureus* showed higher sensitivity (100.0%) to ceftriaxone, ceftazidine, and fosfomycin but was resistant to ampicillin, erythromycin, and amoxicillin-clavullate. Similar studies in Nigeria (Banda et al., 2020; Ezugwu et al., 2021) and other countries have reported majorly comparable findings (Tadesse et al., 2018; Tadesse et al., 2018).

Resistance to ampicillin, erythromycin, amoxicillin-clavullate, and co-trimoxazole, commonly used antibiotics, could result from overuse or misuse. These antibiotics are freely available for sale in Nigeria without a prescription (Banda et al., 2020; Ezugwu et al., 2021).

Limitations

The first limitation was that this research employed a cross-sectional design, which limited its ability to measure any causal association between ASB and other factors. The study was conducted in a hospital setting among respondents whose sample size was small, and thus, findings may not represent the general population. Notwithstanding these limitations, the study provides additional information regarding the burden and associated risk factors for ASB among pregnant women in rural Southwestern Nigeria.

Conclusion

The study showed that the prevalence of ASB among pregnant women in rural Southwestern Nigeria was 24.0%. The determinants of ASB were the absence of post-coital urination, diabetes mellitus, and anaemia. *E. coli* was the most isolated bacterial. Based on the urine culture and sensitivity results, the study suggests using ceftriaxone or ceftazidine as an empirical treatment. There may be a need to advocate for routine screening of pregnant women for ASB during the antenatal clinic to reduce the associated complications.

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A qualitative exploration of nurses' and midwives' experiences in designated COVID-19 healthcare facilities in rural and urban Tanzania

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Abstract

Background: Frontline healthcare providers, particularly nurses and midwives, are at higher risk of COVID-19 infection due to frequent patient contact. However, studies examining their experiences, particularly in low-income countries like Tanzania, are limited.

Objective: This study aimed to explore the experiences of nurses and midwives providing care in COVID-19-designated healthcare facilities in selected regions of Tanzania.

Methods: A qualitative descriptive approach was used to investigate the experiences of nurses and midwives in COVID-19 care. In-depth interviews were conducted with 20 purposefully selected participants from Dar es Salaam, Shinyanga, and Pwani regions. Data were coded with NVivo 12 software and analyzed using a descriptive phenomenology approach.

Results: Nurses and midwives in urban areas reported managing more patients and experiencing more deaths than peers in rural settings. Urban and rural participants demonstrated strong knowledge of COVID-19, including its symptoms, management, and preventive measures. Selection for COVID-19 care was based on Ministry of Health guidelines, prioritizing leadership and emergency care experience. Their roles included patient isolation, routine and specialized care, psychological support, health education, and post-mortem care. Despite this, most nurses and midwives reported feeling underprepared due to insufficient training, a lack of personal protective equipment, and limited medical supplies. Additionally, no risk allowances were provided. Nurses and midwives experienced key challenges such as patient stigmatization, abandonment by families, deaths resulting from oxygen shortages, burnout, and personal infection. Nurses and midwives recommended strengthening the healthcare system, providing ongoing training, offering risk allowances, and promoting community education and sensitization to improve future pandemic preparedness.

Conclusion: Nurses' and midwives' experiences in COVID-19 care facilities were surrounded by inadequate preparations, with health system deficiencies and societal fears significantly impacting their ability to provide effective care. Strengthening health sector readiness, including training and resource allocation, is essential for future pandemic and disaster response efforts.

Keywords: Nurses, midwives, experiences, COVID-19, rural, Tanzania

Background

Healthcare providers (HCPs) have been at the forefront of the COVID-19 pandemic, facing a wide range of challenges beyond the risk of infection. Evidence from high-income countries highlights the

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immense pressures faced by frontline HCPs during the COVID-19 pandemic, including inadequate protective equipment, excessive workloads, emotional exhaustion, and isolation, as well as having to manage patients experiencing heightened negative emotions (Kang *et al.*, 2020; Olesen *et al.,* 2020; Treibel *et al.*, 2020; Mattsson *et al.*, 2022). In addition to the physical and emotional toll, many frontline workers have expressed anxiety over insufficient protection despite using personal protective equipment (PPE), as reported in Denmark, for example(Olesen *et al.,* 2020). Literature also points to the heightened risk of mental health issues among those treating COVID-19 patients. In China, for instance, more than 3,000 HCPs were infected, with over 22 deaths reported (Adams & Walls, 2020), while in Italy, more than 10% of physicians and nurses contracted the virus (Thomas-Rüddel *et al.*, 2021). These findings suggest that the pandemic has disproportionately impacted nurses and midwives, representing the largest proportion of the global health workforce. Despite the wealth of research from high-income countries, there remains a notable gap in studies exploring the experiences of HCPs in Sub-Saharan Africa.

The COVID-19 pandemic significantly burdened the healthcare system in Tanzania, with widespread infections affecting the population and HCPs (Shayo *et al.*, 2023; Hamisi et al.,2023). Like many other low- and middle-income countries, Tanzania faced resource constraints, including limited access to personal protective equipment (PPE), testing supplies, and critical care facilities (Shayo *et al.*, 2023; Isangula *et al.*, 2023). The pandemic exacerbated existing challenges in the healthcare system, increasing strain on healthcare workers, especially nurses and midwives, who comprise a significant portion of the country's health workforce (Isangula *et al.*, 2023).

These frontline workers were central to the government's COVID-19 response, providing essential care under difficult circumstances (Isangula *et al.*, 2023). Initially, the Tanzanian government responded to the pandemic with minimal public health interventions, but over time, adopted more comprehensive measures (Hamisi, Dai, & Ibrahim,2023). These included establishing designated COVID-19 healthcare facilities for isolation, distributing PPE, and public health campaigns to raise awareness (Shayo *et al.*, 2023; Hamisi et al.,2023). Vaccination efforts were eventually rolled out, prioritizing vulnerable populations and healthcare workers (Mfinanga *et al.*, 2023).

However, despite these efforts, healthcare workers faced overwhelming challenges, particularly nurses and midwives. They not only bore the physical and emotional burden of managing patients but were also at heightened risk of infection due to shortages of PPE and inadequate workplace safety protocols (Isangula *et al.*, 2023). Nevertheless, nurses and midwives played a critical role in the pandemic response, as they are the backbone of the primary healthcare system in Tanzania. Their responsibilities extended from providing direct care to patients, including those with COVID-19, to delivering maternal and child health services amidst the crisis (Tani *et al.*, 2023).

There is a significant gap in the literature regarding their experiences. While studies have explored the general impact of COVID-19 on healthcare systems and the experience of HCPs on preventive and control measures (Tani *et al.,* 2023), there is limited evidence on the COVID-19 experiences and specific challenges faced by nurses and midwives in Tanzania. This lack of research leaves critical questions unanswered about the experiences and perspectives of nurses and midwives and their unique care experiences during the pandemic in the country.

Consequently, the findings from this study are expected to fill the gap and generate evidence to inform healthcare managers and policymakers on how best can the nurses and midwives at the frontline be prepared and supported to fulfil their professional role amid a crisis like COVID-19 or similar future disease outbreaks. The findings also identify the specific support-technical and psychosocial- that they need to better respond to epidemics. Finally, the study findings uplifted the nurses and midwives, allowing them to share their reality and have their voices heard.

Lessons drawn from nurses' and midwives' unique experiences facilitated the generation of recommendations on how to prepare the healthcare system during the crisis best and establish a safer environment to protect both the nurses and patients in similar situations.

Methods

Design

This qualitative descriptive design (Doyle, 2020) was used to explore the experiences of nurses and midwives who worked in COVID-19-designated healthcare facilities. This design was appropriate to answer a broad question about the lived experiences of COVID-19 patients during care provision in designated facilities.

Settings

The study was conducted across selected COVID-19-designated health facilities in Dar es Salaam, Pwani, and Shinyanga regions. These regions were chosen purposively based on several specific criteria. Firstly, the selection was guided by well-established and accessible COVID-19-designated facilities, which were crucial for ensuring that we could access and effectively study the nurses and midwives who were the key personnel in these facilities during the pandemic, particularly in the initial wave. Secondly, we aimed to triangulate our settings to encompass a range of contexts. Dar es Salaam represents an urban environment with high population density and advanced healthcare infrastructure.

Pwani is categorized as semi-urban, providing a middle-ground context with intermediate access to healthcare services and resources. Shinyanga, representing a rural setting, offers insights into healthcare challenges in less accessible and resource-constrained environments. This diversity allowed for a comprehensive exploration of the different experiences and responses to COVID-19 across varying healthcare contexts. Lastly, the selected regions were chosen due to their reported variable incidence of COVID-19 cases. This criterion ensured that the study addressed areas with high, median and low significant pandemic impact, allowing for a more robust examination of the healthcare response and challenges. By incorporating these diverse settings, we aimed to enhance the richness of our findings, capturing a broad spectrum of experiences and responses to the pandemic.

Study population, Sample size and sampling method

The participants were purposefully selected from COVID-19-designated healthcare facilities, with two facilities from each region included. The inclusion criteria for selecting nurses and midwives were: (i) Professional role: Participants needed to be registered nurses, midwives, or individuals holding both qualifications. This criterion was intended to ensure a focus on professionals directly involved in patient care and management within COVID-19-designated facilities. The inclusion was not limited by the level of education or gender, allowing for a diverse representation of clinical experiences and perspectives; (ii) Experience in COVID-19 care designated facilities: Participants had to have practical experience working in facilities designated for COVID-19 care.

Specifically, they needed to directly provide clinical care to patients with COVID-19 or manage such cases. This criterion was essential to gather insights from individuals with firsthand experience in handling the complexities and challenges posed by the pandemic, thereby enriching the study's understanding of the healthcare response. These criteria were designed to ensure that the study captures relevant and comprehensive insights from those actively engaged in frontline COVID-19 care, reflecting a broad range of experiences and professional backgrounds.

A minimum of five nurses and midwives were selected from each facility, comprising 20 participants. However, the principle of data saturation was used to determine the final sample size, as recommended by Faulkner and Trotter (Faulkner & Trotter, 2017). The sampling strategy considered variations in terms of gender, work experience, age, and professional qualifications to capture diverse experiences.

Data collection tools
Individual in-depth interviews (face-to-face or phone) were employed to collect data from nurses and midwives who worked in selected COVID-19-designated facilities. A semi-structured interview guide was developed through a peer review process involving experts at the School of Nursing and Midwifery (SONAM) and was used to guide the interviews. The English version of the interview guide was translated into Swahili, then back-translated to English, and conceptual equivalence was checked. A broad question in the interview guide asked to open the discussion was: *What was it like to be a nurse or midwife caring for confirmed or suspected cases of coronavirus patients in your facility*? This was followed by open-ended probing questions to understand better the nurses' and midwives' lived experiences.

Recruitment of participants
The nurses and midwives to be included in the study were recruited through facility managers of facilities designed for COVID-19 care. A list and contact information of nurses and midwives who had provided or previously provided direct care to suspected or confirmed cases of COVID-19 in the designated COVID-19 facilities were obtained. Initial phone contacts were made, and participants were provided information regarding the study before their consent was requested. All nurses and midwives contacted agreed to participate in the study, and the interviews were scheduled afterwards, considering time, location, and modality preferences.

Data Collection
Face-to-face interviews took place at a location and time chosen by the participants. Likewise, phone interviews occurred at the time preferred by the participants. Data were collected between June 2022 to August 2022. Before the interviews, participants were informed about the study's details, the risks, and the benefits of participating (outlined in an information sheet that was part of the interviews). Consent for the interview and voice recording was obtained in advance. Interviews were conducted with only those who provided verbal or written consent. Subsequently, approximately 30 to 60 minutes of interview sessions were conducted. For precautionary measures due to COVID-19 infection, all participants and research assistants who participated in face-to-face interviews were equipped with face masks and provided with hand sanitisers throughout the interview sessions.

Data management and analysis
All interview transcripts were securely stored and anonymized. The transcripts were provided with a code/anonymous ID that ensured no direct linkage to participant information, and the information was stored in password-protected Word files. Hard copies of interview transcripts, consent forms, and demographic information were stored in a locked cupboard at the Aga Khan University (AKU), Salama house in Tanzania. Data were only accessed by the investigators in the research team.

Research reports and publications only included quotes without identifying information for study participants. Data is kept and will be destroyed after five years, following Tanzania's standards that guide research conduct.

Data were analyzed using Colaizzi's descriptive phenomenology approach, as described by Morrow, Rodriguez, and King (2015). This approach followed the key seven (7) steps in data analysis using the NVIVO software as follows: (i) *Familiarization,* where the research team familiarized themselves with the data by individually reading through all the participant accounts several times; (ii) *Identification of significant statements;* the research team identified all statements in the accounts that were directly relevant to the phenomenon under investigation; (iii) *Formulating meanings;* the research team identified meanings relevant to the phenomenon that arose from a careful consideration of the significant statements while bracketing our pre-understanding to be able to examine the phenomenon as experienced by the informants closely; (iv) *Clustering of themes:* the research team clustered the identified meanings into themes that were common across all accounts.

A consensus-building session on the emerging themes among the research team members followed this. A consensus-driven method was employed to address arising conflicts and to determine whether to incorporate themes that diverged from the pre-established themes or dismiss them if they were subjectively or objectively deemed non-critical to the study; (v) *Developing an exhaustive description;* the research team jointly wrote a full and inclusive description of the phenomenon, incorporating all the themes produced in step four and the consensus building session; (vi) *Producing the fundamental structure;* The research team worked together to condense the exhaustive description down to short, dense statements that captured just those aspects relevant to the investigated phenomenon; (vii) *Seeking verifications of the fundamental structure*; the research team returned the key findings to a subset of few participants (two in each region) to ask whether these captured their lived experiences.

A broad consensus emerged among participants that the lived experiences were adequately captured. Subsequently, the data in Nvivo were transferred to Microsoft Word for analysis and report generation.

Results

Participants' demographics

Most participants were from rural (60%) of the female gender (80%), married (80%), worked at a hospital-level COVID-19 designated centre (75%), and had 1-2 children (50%). Table 1 summarizes these demographics.

Table 1: Participants Demographics

Category	Number	%
Geography		
Urban	**8**	**40**
Rural	**12**	**60**
Gender		
Male	**4**	**20**
Female	**16**	**80**
Age		
30-39	**7**	**35**
40-49	**8**	**40**
>50	**5**	**25**
Marital Status		

Single	1	5
Married	17	85
Widow	2	10
Level of Facility		
Hospital	15	75
Health Centre	5	25
Number of Children		
None	1	5
1-2	10	50
3-4	9	45
Level of nursing license		
Enrolled Nurse	7	35
Registered Nurse	13	65
Educational Qualification		
Certificate	7	35
Diploma	8	40
Bachelor's degree	5	25

Overview of the findings
About four (4) key themes that emerged from the data analysis. These included (i) Nurses' and Midwives' understanding of COVID-19, (ii) COVID-19 Patient care practices, (iii) challenges and lessons from offering COVID-19 care, and (iv) suggestions for improvement of preparedness to respond to pandemics. Each of these themes is examined in detail below.

Theme 1: Nurses' and Midwives' Understanding of COVID-19
Understanding of COVID-19 transmission, prevention and treatment
There was a broad consensus among nurses and midwives in both urban and rural healthcare facilities that COVID-19 is a viral infection transmitted through the airways, particularly by sneezing or coughing and presenting with various symptoms including fever, body ache, headache, runny nose, loss of appetite and problems with breathing depending on individual factor.
While few nurses and midwives linked COVID-19 to its origin in Europe in 2019 and Arusha in 2020 (a tourist destination in Tanzania), many agreed that it originated in China in 2019. Prevention measures included handwashing/sanitization, social distancing, face masks, and vaccination.
The risk factors for severe COVID-19 infection cited by most nurses and midwives included low immunity, old age, and chronic infections. There was a consensus among many nurses that COVID-19 has no definitive treatment; instead, supportive and symptomatic treatment, including immune boosters, Antibiotics and Oxygen therapy, depending on the severity, emerged among some nurses. COVID-19 vaccine as a preventive measure emerged in the description of some nurses/midwives. Some nurses commented:

> *Corona is a viral infection that originated in China, and it can be transmitted through air drops when sneezing, coughing, or talking. Things that put someone at risk of a severe infection include having chronic diseases for example, diabetes, HIV, hypertension, and old age (Nurse/Midwife, Urban Hospital)*

> *There is no cure for COVID-19, but management depends on the severity of the disease because if one has a runny nose or cough, one manages the symptoms. If one has a cough, you give antibiotics, and if someone has difficulty breathing, you give Oxygen (Nurse/Midwife, Rural Hospital)*

Understanding of services needed by COVID-19 patients.
The nursing and midwifery services needed by COVID-19 patients were threefold. First, _isolation from patients_ suffering from non-COVID-19 infections. Some nurses indicated that nurses were responsible for moving patients to designated COVID1-19 rooms. Second, _offering general support services_ for patients admitted to the wards. These included ensuring that patients take their prescribed medications promptly, providing assistance with feeding, giving oxygen therapy if needed, and checking and closely monitoring patient vitals.

Washing and turning to avoid bed sores (unconscious and seriously ill), assistance with simple exercises, and changing clothes and bedsheets. Third and final, _counselling, psychological support and health education_ to patients themselves, their families, and friends. Health education was also cited as being conducted in the patient waiting areas and communities. Some nurses commented:

> *A nurse is responsible for giving oxygen and other medications prescribed by doctors, changing the sleeping position, assistance with feeding and exercises and counselling and health education on preventive measures (Nurse/Midwife, Rural Hospital)*

> *A COVID-19 patient needs close monitoring because the situation may change anytime. So, the nurse needs to be close to monitor vitals, give medication, and provide psychological support because most who are dying are those with stress, and counselling helped a lot (Nurse/Midwife, Semi-urban Hospital)*

Theme 2: COVID-19 Patient CarePractices
Criteria for being selected to offer care to COVID-19 patients.
When COVID-19 designated centres were established in the country, some nurses and midwives were specifically selected to work there. Also, there was a broad consensus that most nurses and midwives feared caring for COVID-19 patients as it was a novel disease, and they had limited information. They feared taking the disease back home, and there were challenges with access to personal protective equipment (PPEs). We asked participants about why they were selected to join COVID-19 care teams.

Although few indicated being chosen just because they are nurses or midwives and have to offer care to any patient, the main reasons cited by many nurses and midwives were three. The first reason was a nurse or midwife who met the Ministry of Health's directives. Some indicated that the Ministry of Health stipulated directives on who should join COVID-19 care teams, including health nurses and midwives, not pregnant or breastfeeding, and not having chronic diseases such as Diabetes and Hypertension. The second reason was performing nursing or midwifery leadership roles or being members of pre-existing disaster response teams.

Some nursing and midwifery service leaders indicated being 'automatically selected' to coordinate nursing care services for COVID-19 patients because they are leaders. Some reported being selected because they have been members of facility district or regional disaster response teams. The third reason was having adequate work experience, particularly those engaged in hospital intensive care services. One nurse/midwife in a rural Hospital affirmed being selected because she has 10 years of work experience in the emergency care unit and intensive care department. For instance, citing the criteria for selection established by the Ministry of Health, one nurse commented:

> *There were directives from the Ministry that health care providers who are healthier and have no medical problems, for example, not being too old, pregnant, and not breastfeeding because they are required to take care of their children, and we worked in centres without*

going home for a long time. Also, people with no chronic diseases such as Diabetes, hypertension, and other diseases were selected (Nurse/Midwife, Rural Health Centre)

What a day looked like in a COVID-19 care facility.

Daily responsibilities performed by nurses and midwives in COVID-19 care centres ranged from routine nursing and midwifery care, specialized care, documentation, and reporting to leadership duties, depending on whether one performs clinical nursing and midwifery duties or coordination and leadership roles.

On the one hand, a day for a clinical nurse involved handing over a report from a nurse who just finished the shift, quickly inspecting the needs of each patient, taking oxygen saturation measures and vital signs, checking the availability of medical supplies and functionality of equipment (oxygen tanks), giving prescribed medications timely, receiving food from family members and assisting with feeding, cleaning the patient, monitoring vital signs and maintaining hygienic environment through cleaning. The day also involved the preparation of dead bodies for them to be sent to the mortuary when death occurs.

A day for coordinators and nursing and midwifery leaders involved checking the number of patients and their health status, including deaths, checking available medical supplies and the deficit, roster planning, and ensuring each shift has a nurse and midwife available, bearing on standby for support when needed and communicating and reporting to higher authorities. Some of these can be seen in the following quotes:

> *Upon changing the shift in the morning, I clean the room with my peers. Then, I would check each patient's vital signs, oxygen saturation, and temperature and give the prescribed medications. When the family members bring tea or food, I will receive it and take it to the patients and assist with feeding because family members were not allowed in. I would draw samples and send them where needed if an investigation is needed. These were some of my responsibilities before I handed over a shift to another nurse (Nurse/Midwife, Rural Health Centre)*

> *In the morning, you must check how many COVID-19 patients there are, if there is any death, their progress, and whether they received medications. You check whether there is Oxygen and whether patients receive the correct dose. I checked the ledger for medical supplies used and what was missing. Afterwards, the doctor comes, and you review every patient together; then, I continue with other non-COVID-19 duties. Before leaving for home, I go there to check what happened, and if there is any challenge, I find a solution and report it to my supervisors. (Nurse/Midwife leader, Rural Hospital)*

Preparedness for COVID-19 Patient care

Most nurses and midwives described caring for 50 -100 patients on average during the COVID-19 pandemic, depending on the facility level. Urban and hospital facilities received more patients and deaths than rural health centres.

However, we asked them how they prepared to offer care to COVID-19 patients. Opposing responses emerged regarding training among nurses selected to work in COVID-19 care facilities. Almost half of the nurses and midwives affirmed being weekly prepared to offer care to COVID-19 patients. Some nurses and midwives used phrases such as 'we were just selected' or 'we were just chosen' when describing non-preparedness.

Descriptions of being selected to work in COVID-19 without relevant information or training dominated in both urban and rural settings. On the contrary, some nurses and midwives (particularly leaders) affirmed receiving or the existence of online/distance learning training on how to care for COVID-19 patients. However, they have not specifically focused on the pandemic.

Some cited a three-day training organized by the region, and some cited on-the-job training mainly from senior and experienced doctors. Some indicated reliance on information from social media, radio, and other intra-facility discussions and meetings. However, even those who affirmed receiving training regarded them as inadequate. A participant commented:

> *Honestly, we were not prepared...we were just selected without a choice that 'you go to work in Covid-19 care'. It was up to you to explain why you should not go, but I had no sound reason. Nevertheless, we had no education or preparation for what to do once we reached there. We just found ourselves there, and we were just lucky that there were experienced doctors who were instructing us what to do (Nurse/Midwife, Rural Health Centre)*

Furthermore, we asked about the support they receive from supervisors and employers, family, and communities. A consensus was that they received no tangible support from supervisors and employers after being appointed to serve in COVID-19 care centres. Some indicated receiving 'instructions' on what to do, and a few indicated receiving a meal (lunch) from employers and nothing else. All nurses indicated they received no special allowances, incentives, or treatment besides medical equipment such as oxygen tanks and PPEs. One indicated receiving encouragement and promises of allowance from the district manager, but the promises were not fulfilled even after writing a request letter as instructed. Few indicated receiving words of encouragement from family and community members.

Some indicated receiving no support from both family and community members. One nurse indicated that even her children were afraid of her because she was dealing directly with COVID-19 patients. The community members were described as being afraid of getting diseases from nurses who care for COVID-19 patients. This suggests that nurses who care for COVID-19 patients may have faced stigma in some communities. One participant commented:

> *The employer initially offered us food for those working at the COVID-19 care centres, but we received nothing else. Family members encouraged me because we used to tell them stories of deaths when we went home. So, they encouraged us and insisted on protecting ourselves from getting the disease. The community did not support us because they were shocked and afraid of getting the disease from us. In short, they were very afraid of us' (Nurse/Midwife, Rural Health Centre)*

Memorable experiences when caring for COVID-19 patients.

Most nurses described both negative and positive experiences in COVID-19 care facilities. On the one hand, negative experiences that were dominant in nurses' descriptions included (i) stigmatization *and abandonment of COVID-19 patients by family* members rooted in fears of infection.

A nurse in a rural hospital described a tendency of family members to 'run away' from patients, leaving the burden of carrying the patient and care to nurses. Some indicated fear of taking the patient home after getting relief because of fear of infection; (ii) *witnessing patients dying from COVID-19*. Some nurses described negative experiences associated with witnessing a person struggling with life to death on oxygen without knowing what to do to help relieve the struggles.

Some discussed negative experiences of witnessing multiple deaths in one day, with some describing experiences of witnessing the death of fellow HCPs from COVID-19. Another nurse described witnessing the unforgettable death of two HCWs 'in her hand' while on duty; (iii) *experiences of getting infected by COVID-19 due to failure to adhere to protective measures*. Few nurses described suffering from COVID-19 after forgetting to put on a face mask or washing their hands when or after taking care of a COVID-19 patient offering care, and (iv) although most nurses expressed thankfulness with the availability of PPEs, some described experiences of stock out of other essential medical supplies/equipment.

For example, some nurses described their experience of running out of oxygen concentrators with patients struggling without any support (detailed in challenges). On the other hand, positive experiences included *witnessing very sick patients getting well*. Some nurses described rewarding experiences of assisting patients who were seriously sick to recover from COVID-19. One nurse narrated the experience of having lost faith in recovery for one adult patient who later recovered after massive efforts, including sleepless nights of offering care. Some participants commented:

> *There were some heartbreaking events. Family members were abandoning patients at the hospital. Even when you inform them that s/he has a relief and need to go home, they refuse to come the pick them up because of fear" (Nurse/Midwife, Rural Health Centre)*

> *One event that I will never forget is when we got three deaths in a single day. I was preparing a dead patient, but suddenly, a patient who was speaking to me a while ago changed his condition and died. I still have these images in my head (Nurse/Midwife, Semi-urban Hospital)*

Theme 3: Challenges and lessons from offering COVID-19 care.
Challenges encountered in COVID-19 care
There was a broad consensus on the availability of PPEs, including gowns, boots, aprons, gloves, face masks, hand sanitisers and handwashing facilities in COVID-19 care centres mainly due to the support of many stakeholders. While some indicated facing no major challenges, some cited several health system and personal challenges. A common health system challenge in rural and urban centres was an *inadequate supply of oxygen concentrators*. Stock out of oxygen tanks was largely linked to many patients, creating congestion in COVID-19 care centres. Another health system challenge was the *inadequate health workforce* compared to the number of patients. This was partly linked to strict criteria used in selecting nurses to work in COVID-19 centres, excluding those with pre-existing conditions, pregnant and old age.

Other health system challenges were inadequate support from the management and the absence of allowance or other incentives for nurses working in COVID-19 centres. A final health system challenge *was the inadequate preparedness of regions, districts, and facilities* for COVID-19 response regarding technical capacity and resources, resulting in reliance on development partners. Personal challenges included unpreparedness and fears of infection, burnout, and exhaustion because of overworking (up to 12 hours a day) and feeling uncomfortable with PPEs such as face masks and gowns (suffocation and sweating). Personal challenges extended to patients were described as harsh and stigmatized by nurses. A participant described a tendency of patients to think that they are being stigmatized when nurses and midwives take precautions when taking care.

Some nurses and midwives commented:

> *I faced burnout because of an inadequate supply of oxygen tanks. A patient comes with an oxygen saturation of 50 or 70; he is struggling, sweating, and shouting for help until he dies. You know you need to give oxygen, but no oxygen concentrators exist. This was very painful, and I will not forget it (Nurse/Midwife, Rural Hospital)*

> *My challenge was putting on PPEs, such as the gown, for a prolonged time. It was so suffocating. There is a gown that covers the whole body, and you add a face mask... after 20-30 minutes, you start sweating profusely, and you start facing problems with breathing (Nurse/Midwife, Rural Hospital)*

Key lessons from offering COVID-19 care.

Key lessons learnt from offering care to COVID-19 patients were closely related to the challenges encountered. For instance, a lesson that there is a need for disaster preparedness among nurses, midwives, and healthcare facilities. Preparedness was envisaged from the perspective of adequate training and resources, including human resources, medical supplies, and equipment. Another nurse described learning that pandemics and outbreaks require timely decision-making among healthcare leaders and HCPs so that patients receive timely care.

Given the experiences of witnessing HCPs dying from the disease, some nurses indicated learning about the need to adhere to infection prevention and control measures and standard operating procedures (SOPs) when offering nursing and midwifery care to patients. A nurse in a rural facility indicated that not taking things for granted or offering care without adhering to SOPs was a key learning from the pandemic. One nurse suggested that COVID-19 has strengthened the actions of disaster response and emergency teams and that response plans have been developed to be useful in future responses. A participant commented:

> *We learnt how to plan the response... disaster and emergency response teams have been strengthened through dealing with COVID-19; we now know what is needed, and we are now well-positioned to respond to future disasters (Nurse/Midwife, Urban Hospital)*

Theme 4: Suggestions for improving the preparedness for future pandemic/disaster response.

The sessions fell into three groups when asked about what could be done to improve preparedness for future pandemic responses. The first group is the health system strengthening, which includes improving the availability of resources. The dominant resources cited were medicines, medical equipment, PPEs, funds, and HCPs. PPEs emerged as particularly important as there were affirmations of nurses using facemasks for more than the recommended duration, for instance, 'more than two days' or using personal funds to purchase them (Nurse/Midwife, Rural Health Centre).

Rural participants indicated the absence of a specific building for emergencies and, therefore, recommended the construction of an emergency department. The need to strengthen existing disaster response teams at the facility, districts, and regions was cited, with an emphasis on technical capacity, composition, medical supplies, and financial resources. The second group involves building the capacity of nurses and other HCPs to respond to pandemics.

A dominant suggestion was to train HCPs through specific training on pandemics, on-the-job training, and continuous professional development on common pandemics. One participant suggested developing a special disaster response curriculum to be delivered in nursing schools and on the job.

There was also a suggestion for risk allowance for nurses and other providers who offer care to victims of pandemics. This was made amidst widespread concerns about not receiving any allowance when offering care to COVID-19 patients.

The third and final group was strengthening the preparedness of the communities. A dominant suggestion was continued community education on pandemics and disasters and what to do in case such events occur through multiple platforms with a greater focus on rural villages. Some participants commented:

> There is a need to educate healthcare providers about disease outbreaks and ensure the availability of medical supplies, especially PPEs. It reached a point where we were putting on masks for more than two days as there were times when they were unavailable, or sometimes you had to use personal funds to buy them. The government needs to ensure there is money to buy an adequate quantity of PPEs, medical equipment, and supplies (Nurse/Midwife, Rural Hospital)

> They need to consider the risks we are facing. When I offer care, they must remember that I have a family and am usually here at the centre. The Government must realize that we risk our lives to offer care to community members. Therefore, risk allowance needs to be provided (Nurse/Midwife, Urban Hospital)

> To be honest, the community has inadequate education on disasters and epidemics. There is a need to continue educating the community through Radio, Television, newspapers, and even social media. They need to be educated on what to do, for example, putting on a face mask, washing their hands, etc. A focus should be on the rural villages where most still believe the disease [COVDI-19] only affects people in urban areas (Nurse/Midwife, Rural Hospital)

Discussion

The current study explored the lived experiences of nurses and midwives providing care in COVID-19-designated healthcare facilities in Tanzania's Shinyanga, Dar es Salaam, and Pwani regions. Participants included healthcare professionals (HCPs) from rural and urban settings, with a majority being female. This aligns with a systematic review of 46 qualitative studies that found female dominance among HCPs and patients during the COVID-19 pandemic (Billings *et al.*, 2021). This highlights the crucial role female HCPs played during the pandemic and the predominance of women in the nursing and midwifery professions.

Our study reveals that nurses and midwives demonstrated commendable knowledge about COVID-19, which is consistent with findings from studies in Africa and other countries that also reported adequate understanding of transmission, symptoms, and preventive measures such as hand hygiene, social distancing, and PPE use (Adejumo *et al.*, 2021; Jemal *et al.*, 2021; Aryan & Ahmad, 2022; Panda *et al.*, 2023). However, some participants incorrectly believed in the efficacy of immune boosters for treatment, which contradicts WHO guidelines due to insufficient evidence supporting their effectiveness (WHO, 2019).

While this study aligns with research from India and Ethiopia, showing satisfactory knowledge among healthcare professionals (Jemal *et al.,* 2021), it also highlights persistent gaps in understanding disease management. These findings underscore the importance of continuous education and updates on evidence-based COVID-19 guidelines to ensure that healthcare professionals have the most current knowledge for optimal patient care.

An emphasis needs to be placed on implementing regular training sessions for healthcare workers to update their knowledge of emerging evidence and guidelines and developing and enforcing protocols based on the latest evidence to address misconceptions, such as the use of immune boosters.

Therefore, we recommend regularly revising and disseminating updated guidelines to healthcare professionals to reflect the latest research and best practices, establish mechanisms to monitor adherence to guidelines, and address any knowledge gaps identified in healthcare settings. These recommendations aim to enhance preparedness and response capabilities in future pandemics and ensure that healthcare practices remain aligned with current scientific evidence.

Several studies globally have underscored the multifaceted roles of nurses and midwives as frontline healthcare professionals (Küçüktürkmen et al., 2022; George et al., 2021; Clari et al., 2021; Fawaz et al., 2020; Bradfield *et al.*, 2021; Bolina et al., 2020; Tani *et al.*, 2023). Our findings align with these studies, revealing that their roles encompass three critical domains. The first domain involves patient isolation, which is crucial for minimizing cross-infection. Nurses and midwives have been pivotal in managing patient transfers to COVID-19 isolation areas, a role highlighted in previous research in other countries (Küçüktürkmen et al., 2022; George et al., 2021). This underscores their essential function in the initial management of COVID-19 cases and highlights the ongoing support needed to bolster their resilience in practice.

The second domain covers comprehensive support within hospital wards, including medication administration, oxygen therapy, and vital sign monitoring. This study confirms findings from earlier research (George et al., 2021; Bradfield *et al.*, 2021), which shows that nurses and midwives extended their roles to provide holistic care, such as skincare and physical exercises, demonstrating their broader impact beyond mere medical interventions. The third domain focuses on psychological and educational support. Our research found that nurses and midwives provided vital counselling and health education, extending their efforts to waiting for areas and communities, unlike some previous studies (George et al., 2021; Bradfield *et al.*, 2021).

This highlights a significant aspect of their role in addressing anxiety and information deficits among patients and their families, emphasizing the importance of community outreach during the pandemic. These findings underscore the need for robust support systems for nurses and midwives to enhance their resilience and effectiveness in managing pandemics. Recognizing and supporting their diverse roles in patient care, including isolation, comprehensive ward support, and community education, is essential. This could be achieved through regularly updating the training programs to address the evolving needs of nurses and midwives in patient management and community outreach and developing support systems to help healthcare professionals cope with the psychological and physical demands of the pandemic response.

We, therefore, recommend ensuring adequate resources and support are allocated to nursing and midwifery services to strengthen their roles during crises and incorporating comprehensive support roles into pandemic preparedness guidelines to ensure a holistic approach to healthcare delivery. These recommendations aim to strengthen nurses' and midwives' preparedness and response capabilities, ensuring they are well-supported in managing the multifaceted challenges of future pandemics.

Participants in our study reported that the selection of nurses and midwives for COVID-19 designated centres was primarily guided by Ministry of Health directives. Selection criteria included health status (free from chronic diseases such as hypertension and diabetes), years of work experience, leadership roles, disaster management experience, and critical care background.

This approach, which excluded vulnerable groups like pregnant, breastfeeding, and older healthcare professionals due to higher infection risks, is consistent with previous studies that highlight similar criteria for selecting healthcare workers (Fawaz et al., 2020; Aksoy & Koçak, 2020; Jackson *et al*., 2020; Han *et al*., 2023).

Most participants expressed significant fear of contracting COVID-19 and transmitting it to their families, a concern echoed in other studies (George et al., 2021; Clari *et al*., 2021; Jackson *et al*., 2020; Afshan *et al*., 2022). This fear was exacerbated by a lack of prior preparation, contrasting with recommendations by Shahil Feroz *et al*. (2021), emphasising the importance of training and preparedness for effective care provision. Only a few participants were positive about the opportunity to serve (Bradfield *et al*., 2021).

As noted in similar research (Fawaz et al., 2020; Han et al., 2023), the lack of preparatory training and the assumption that selected HCPs were fully prepared and willing may have negatively impacted patient care and worker morale. These findings underscore the critical need for comprehensive training and preparation for healthcare workers selected for pandemic response roles. Assumptions about their readiness and willingness, without adequate support, can undermine both patient care and worker safety.

Implementing robust training programs to prepare healthcare workers for pandemic situations is recommended. These programs should address clinical skills and psychological preparedness and allow healthcare professionals to volunteer for pandemic roles to ensure their willingness and readiness, enhancing their effectiveness and well-being.

Comprehensive preparatory protocols, including health assessments and readiness evaluations, must also be developed and mandated for healthcare workers assigned to pandemic response roles. The health sector must establish support systems to address healthcare workers' psychological and familial concerns, ensuring they are adequately prepared and supported before deployment. These measures aim to improve healthcare professionals' selection process and preparedness, enhancing their ability to provide effective care during pandemics.

Our research illuminates the diverse and multifaceted roles of clinical nurses and midwives in COVID-19 care facilities, encompassing direct patient care and supervisory/administrative duties. Key direct care responsibilities included conducting needs assessments, monitoring vital signs, administering medication, ensuring patient well-being, assisting with daily activities, and maintaining cleanliness.

Unlike other studies that focused primarily on these core roles (Billings *et al*., 2021; Bolina, Bomfim & Lopes-Júnior, 2020; Hosseini Moghaddam, Mohebbi & Tehranineshat, 2022; González-Timoneda *et al.,* 2021), our findings also revealed that nurses and midwives were involved in post-mortem care and body transfers—tasks that many found particularly challenging and uncomfortable. In their supervisory and administrative capacities, they coordinated patient care, compiled reports, tracked patient progress, documented incidents, addressed patient deaths, managed medical supplies, and ensured the functionality of critical equipment, consistent with previous studies (Clari *et al.,* 2021; Bolina et al., 2020).

These findings highlight the comprehensive and often uncomfortable nature of roles undertaken by nurses and midwives, which extends beyond what has been reported in other research. Including post-mortem care and body transfers underscores the need for targeted support and training for these challenging aspects of care. The diverse responsibilities affirm the critical role of nurses and midwives in managing both patient care and operational aspects of disaster response.

We, therefore, recommend implementing specialized training programs that include handling challenging tasks such as post-mortem care and body transfers to better prepare nurses and midwives for these roles and providing robust emotional and psychological support services to help healthcare workers manage the stress associated with their comprehensive roles.

There is a need to clearly define and support the diverse roles of nurses and midwives in disaster response, ensuring they receive adequate training and resources for all aspects of their responsibilities and ensuring sufficient resources and support systems are in place to address the physical and emotional demands of healthcare professionals during pandemics and other emergencies. These measures aim to enhance the preparedness and support for healthcare professionals, ensuring they are equipped to manage the full spectrum of responsibilities during future public health crises.

Our study revealed mixed responses regarding preparedness among healthcare professionals (HCPs) for COVID-19 patients. Approximately half of the participants felt unprepared, expressing sentiments of being "just selected" or "just chosen," indicating a lack of organization and readiness in COVID-19 patient care. This finding contrasts with a survey of nursing homes in the USA, where almost all nurses and midwives reported being well-prepared for COVID-19 patient care (Quigley *et al*., 2020). However, nurses with less than five years of experience or lower educational attainment in China felt less prepared (Han *et al*., 2023).

Some nurses and midwives in this study, particularly leaders, mentioned receiving online or distance learning training on COVID-19 patient care, though they found it insufficient. Others cited short training sessions organized by health authorities or on-the-job training from experienced doctors, yet still felt unprepared. Additionally, some HCPs sought information from informal sources like social media and intra-facility discussions. While these sources may offer some knowledge, they cannot replace structured, evidence-based training programs.

The lack of preparedness may impact the quality of care and HCPs' safety, affecting confidence, competence, and patient outcomes (Isangula *et al*., 2023). These findings align with a meta-synthesis involving 46 qualitative studies on frontline HCPs' experiences during pandemics, highlighting critical issues in preparedness, support, and social challenges faced during the COVID-19 pandemic (Billings *et al*., 2021). This may partly explain why Shahil Feroz *et al*.((2021) consider proactive measures as essential to support and protect HCPs during public health crises like COVID-19, enabling them to cope and provide quality care.

The experiences of nurses and midwives caring for COVID-19 patients in our study reflected a blend of positive and negative aspects, consistent with findings from various studies. Positive experiences included witnessing critically ill patients recover and being discharged, which were rewarding and motivating for the healthcare workers. They also valued the experience gained, which allowed them to extend care to their families and communities. Similar positive sentiments have been reported in other studies (Fawaz et al., 2020; Bradfield *et al*., 2021; Jackson *et al*., 2020; Ahmadidarrehsima *et al*., 2022), indicating a shared sense of fulfilment across different settings. This aligns with Clari *et al*. (2021), highlighting that nurses and midwives remain committed to achieving positive health outcomes for their patients despite the challenges.

Additionally, some healthcare workers expressed increased confidence in managing COVID-19, reflecting the learning opportunities presented by the pandemic (Aksoy & Koçak, 2020). Conversely, negative experiences included dealing with patient stigmatization and abandonment, which exacerbated emotional distress.

Witnessing patients suffer without adequate resources contributed to significant psychological strain, aligning with findings from other studies in low- and middle-income countries (Bolina, Bomfim & Lopes-Júnior, 2020; González-Timoneda *et al.,* 2021; Yörük & Güler, 2021).

Midwives, in particular, reported heightened fear, anxiety, and loneliness while caring for pregnant women with COVID-19, revealing gaps in emotional and psychosocial support. This correlates with reports of depression among nurses and midwives involved in COVID-19 care (Yörük & Güler, 2021). These mixed experiences underline the critical need for comprehensive support systems for healthcare workers.

Positive outcomes should be leveraged to bolster confidence and commitment while addressing the negative experiences is crucial for maintaining mental well-being and ensuring effective care. We, therefore, recommend implementing robust mental health and emotional support programs for healthcare professionals to manage stress and prevent burnout and developing training that includes psychological support and coping strategies to prepare healthcare workers for the emotional challenges of pandemic care.

There is also a need to establish policies integrating psychological support into the healthcare response, addressing both the emotional needs of healthcare workers and patients and developing initiatives to mitigate stigma and support patients and their families, reducing the emotional burden on healthcare professionals and improving overall care quality. These recommendations aim to enhance the resilience and effectiveness of healthcare workers during pandemics, ensuring that they are supported professionally and emotionally.

The COVID-19 pandemic has underscored various challenges in global healthcare systems, emphasizing the necessity of preparedness and responsiveness to manage infectious disease outbreaks effectively. Challenges faced by HCPs during the COVID-19 pandemic include insufficient PPE supply in Indonesia (Setiawan & Fitrianto, 2021) and oxygen shortages in Nepal (Bhatt *et al*., 2021). Common personal challenges include long working hours, burnout, exhaustion (De Leo *et al*., 2021; Youssef *et al*., 2022), fear of infection, and inadequate preparedness (Parthasarathy & Murthy, 2021; Hawari *et al*., 2021; De Kock *et al*., 2021).

 However, the diverse challenges HCPs face are often influenced by local contexts and healthcare systems. Chen *et al*. (2022) noted inadequate training in China, while Greenberg *et al*. (2020) highlighted communication issues in the UK. Despite variations, challenges appear consistent, and they emphasize the need for preparedness, resource allocation, and effective communication from healthcare authorities to support HCPs and enhance patient care quality (Lamberti-Castronuovo *et al*., 2022).

Numerous studies have examined lessons learned from caring for COVID-19 patients, highlighting critical aspects such as disaster preparedness, infection prevention, and healthcare system adaptability (Lamberti-Castronuovo *et al*., 2022; Ezzati et al., 2023; Liu & Liu, 2020; Hick *et al*., 2020). Research conducted in Italy and the United States emphasized the importance of disaster preparedness in ensuring healthcare professionals' safety and effective response to outbreaks (Lamberti-Castronuovo *et al.,* 2022; Liu & Liu, 2020; Hick *et al*., 2020; Kaye *et al.*, 2021). Similarly, studies from China highlighted the significance of infection prevention strategies in reducing virus transmission (Yang *et al*., 2020; Yang *et al.*, 2021).

Moreover, the pandemic underscored the need for healthcare systems to be flexible and adaptive to respond promptly to evolving circumstances and surges in patient numbers (Wyatt *et al*., 2021; Flynn *et al*., 2020; Henry Akintobi *et al*., 2020). Lessons learned from caring for COVID-19 patients are essential for policymakers and healthcare professionals in developing effective strategies for future pandemics. Additionally, studies have identified gaps in global pandemic preparedness,

emphasizing the importance of health system strengthening, healthcare worker capacity building, community engagement, and financial incentives (Jackson *et al*., 2020; Shahil Feroz *et al*., 2021; Isangula *et al.,* 2023).

Strengthening health systems, enhancing healthcare worker training, fostering community resilience, and providing financial incentives are crucial components of pandemic preparedness and disaster response efforts (Tumpey et al., 2019; Joo & Liu, 2021). For example, Joo & Liu (2021) suggested providing continuous education and training to healthcare professionals on emerging infectious diseases and pandemic preparedness, while Billings *et al.* (2021) and Shahil Feroz *et al*. (2021) emphasized the importance of risk allowances for healthcare professionals to encourage them to work in high-risk environments.

However, further exploration and consideration are needed before implementing such measures. Ultimately, the lessons learned from caring for COVID-19 patients offer valuable insights into effective pandemic and outbreak management, highlighting the need for proactive measures and ongoing improvements in healthcare systems globally to enhance preparedness and response capabilities for future pandemics and outbreaks.

Limitations
This study has several limitations. Firstly, the findings are presented when the global and Tanzanian burden of COVID-19 has decreased, potentially affecting their immediate applicability. However, we argue that these findings remain relevant for informing future pandemic responses, especially for frontline healthcare workers. Secondly, we focused solely on nurses and midwives, although other healthcare professionals were involved in COVID-19 care.

While this focus aligns with our institution's primary scope, the insights gained may have broader implications across the healthcare sector. Thirdly, our study targeted COVID-19-designated facilities, overlooking interactions with multidisciplinary teams in various healthcare settings before patients reached these facilities. Exploring experiences among diverse healthcare providers in different clinical settings could yield additional insights. Fourth, this study was conducted by healthcare workers, including a doctor and two nurses, actively involved in clinical responses during the COVID-19 pandemic.

Their professional experiences may have shaped the selection and interpretation of themes during the thematic analysis. As practitioners on the front lines, their proximity to the subject matter could have introduced both conscious and unconscious biases, potentially influencing the emphasis placed on certain themes, such as the pandemic's emotional toll or resource scarcity challenges. While their insider perspective provides valuable context and depth, it also necessitates a reflexive approach to ensure their personal experiences do not overshadow the broader findings.

To mitigate this, we engaged in regular reflexive discussions throughout the analysis process, critically examining how our roles as healthcare providers may have influenced our interpretation of the data. Despite these limitations, as the first study examining the lived experiences of nurses and midwives in Tanzanian COVID-19 care, we believe our findings could offer valuable insights applicable to diverse clinical contexts. Future research could broaden its scope beyond designated pandemic facilities to encompass broader healthcare settings.

Conclusion
In conclusion, our findings highlight the need for health system strengthening, capacity building for healthcare professionals, and community engagement as critical components of pandemic preparedness and disaster response.

Governments, public health organizations, and healthcare institutions must collaborate to implement proactive measures to enhance pandemic preparedness and disaster response. These findings may serve as a foundation for policy and practice improvements in healthcare systems to better prepare for future public health crises.

Declarations

Ethics approval and consent to participate.

The study received ethics clearance from the Aga Khan University Ethics and Review Committee and the National Institute for Medical Research (Certificate No: NIMR/HQ/R.8a/Vol. IX/3748), local approval from the regional and municipal medical officers in Dar Es Salaam, Pwani and Shinyanga.

Data Availability Statement

The data that support the findings of this study are available from the School of Nursing and Midwifery at Aga Khan University. However, restrictions apply to the availability of these data under the current study, and so are not publicly available. Data are, however, available from the corresponding author upon reasonable request and with permission of the School of Nursing and Midwifery at the Aga Khan University.

Conflict of interest

None declared.

Author contribution

K.I. participated in the study design and fund application and developed the initial draft of the manuscript. L.K. and L.M. participated in the data collection and management. All authors critically reviewed the manuscript and provided input for improvement.

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Mothers' Knowledge and Practices Towards Pneumonia to Children Under Five Years of Age in Makambako Town-Njombe

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Abstract

Background: Pneumonia is an acute respiratory infection caused by several infectious agents, such as viruses, bacteria, and fungi. It affects the lungs. This study aimed to assess mothers' knowledge and practices regarding pneumonia in children under five years of age in Makambako town. The study focused on exploring knowledge, awareness, practices, and the extent to which mothers understand the disease and measures taken to protect children to prevent and reduce the disease prevalence.

Methodology: A community-based descriptive cross-sectional study design was used, employing random and purposive sampling techniques to obtain 106 respondents in the study area who filled out the structured questionnaires. All questionnaires were checked for completeness and then entered into SPSS for analysis. The prevalence is high, as there were 2647 cases of pneumonia in 2017 compared to 1938 cases in 2016.

Results: Based on the study findings, the high prevalence of childhood pneumonia in Makambako town council is caused by low knowledge and poor practices of mothers concerning childhood pneumonia, as 70.8% of mothers do not know what pneumonia is about, 72.6% of mothers do not know health risk factors associated with childhood pneumonia, and 77.3% do not know how pneumonia is transmitted. Some mothers perform cultural and traditional beliefs, while others perform self-medication and take a child to the hospital when the conditions worsen. Most do not know if proper nutrition and immunization, as signified by 99% and 81%, respectively, are the most effective ways to protect a child against pneumonia.

Conclusion and recommendations: The study concludes that mothers' knowledge and practices associated with improper nutrition and immunization contribute much to children's pneumonia. Therefore, the study suggests proper nutrition and immunization education should be done appropriately to protect children from pneumonia.

Keywords: Knowledge, Practice, Pneumonia, Prevalence, self-medication, under-five

Introduction

Pneumonia is a form of acute respiratory infection that affects the lungs. Several infectious agents, including viruses, bacteria and fungi, cause pneumonia. The most common are _Streptococcus pneumonia_ (the most common cause of bacterial pneumonia in children), _Haemophilus influenzae_ type b [Hib] (the second most common cause of bacterial pneumonia), respiratory syncytial virus is the most common viral cause of pneumonia, in infants infected with

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HIV, *Pneumocystis jiroveci* is one of the most common causes of pneumonia, responsible for at least one-quarter of all pneumonia deaths in HIV-infected infants. Pneumonia is the number one infectious disease killer of children under five globally, killing more children than HIV, malaria, and TB combined (UNICEF & WHO, 2015).

Pneumonia is the leading cause of mortality in children aged less than five years worldwide (Sazawa & Black, 2023; Black, et al., 2010). The incidence of pneumonia in this group is estimated to be about 156 million episodes each year, of which approximately 151 million are in developing countries and 35 million are in Africa. Estimates indicate that 7-13% of these episodes are possibly life-threatening and require hospitalization (Rudan, et al., 2008). Pneumonia is responsible for about 1.6 million deaths among children aged 0 to 5 years of age. Pneumonia is the single largest infectious cause of death in children worldwide. Pneumonia killed 920,136 children under the age of 5 in 2015, accounting for 16% of all deaths of children under five years old. Pneumonia affects children and families everywhere but is most prevalent in South Asia and sub-Saharan Africa (UNICEF, 2015).

Tanzania is among the top 15 countries facing clinical pneumonia, with 1.9 million new cases predicted yearly. Childhood clinical pneumonia is caused by exposure to risk factors related to the host, the environment and infection. Among these are malnutrition, low birth weight, lack of measles immunization, parental smoking, zinc deficiency and indoor pollution (WHO, 2013). It is the leading cause of death in children under five. Pneumonia is the leading cause, accounting for 15% of others, such as diarrhoea, malaria and AIDS. Pneumonia contributes to over 20% of deaths in children under five. Only 22% of children with pneumonia receive antibiotics for treatment (Opendata.go.tz, 2013).

In Makambako district, there is a high prevalence of Pneumonia among children under five as the statistics trend shows that there is an increase in several children suffering from Pneumonia, accounting for 45% among other diseases (Ministry of Finance, National Bureau of Standards & Makambako Town Council, 2017). It is the top infectious disease which frequently affects children under 5 years of age. Indoor air pollution has been mentioned as the most common cause of disease in children in the Makambako district. Although some measures are undertaken by society to combat Pneumonia caused by indoor air pollution, the disease persists. There is a large number of childhood pneumonia occurring each year, and it has been a serious problem for children under 5 years.
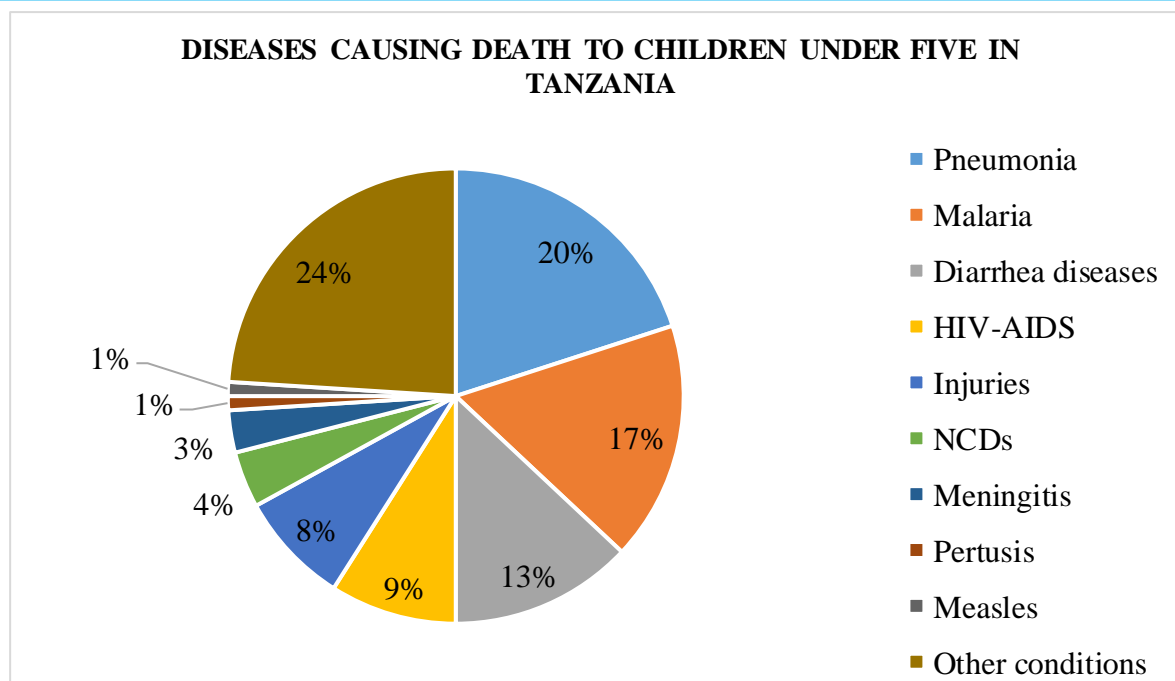
Figure 1. Pneumonia situation about other diseases (Source: UNICEF/WHO, 2013).

As observed above, pneumonia is the leading disease-causing death in children under five in Tanzania.

Materials and Methods

Research Design and Approaches

A research design is the arrangement of conditions for the collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure (Kothari, 2011). It is a conceptual structure within which research is conducted. Therefore, both cross-sectional study design and case study design were employed. Research approaches are plans and procedures that span the steps from broad assumptions to detailed methods of data collection, analysis, and interpretation (Bruce, 2000). The study used a mixed-method approach, using both qualitative and quantitative approaches.

Study Area

The study was conducted in Makambako town council. Makambako town council is a medium-sized town in the Njombe region of the Tanzanian Southern Highlands, located 40 miles north of Njombe city. It is located at the junction of the A104 and B4 roads between Njombe, Iringa, and Mbeya. According to the 2012 Tanzanian census, its population was 93,827, where males account for 44,031 and women account for 49,796. Makambako town council contains the settlements of Ubena, Mahongole, Utengule Kitandililo, Mlowa, Lyamkena, Mwembetogwa and Mjimwema. Makambako Plateau is one of three agroecological zones in the Njombe region, the other two being the Eastern Highlands and Njombe Plateau. Maize is commonly grown on plateaus, while Makambako is notable for tomato cultivation and trade as its economic activities.

The largest ethnic group in Makambako town is the Bena. Their living arrangements include large, polygamous, extended families and on average, there are more than five children in a

household. Farming responsibility is left to women, with almost all of them following an occupation.

Female-headed households depend more on subsistence food, operating as "street hawkers" or with mobile fast-food kitchens. The residents speak Kisovi, a variation of Kibena. Under the Archdiocese of Songea, there are two health services dispensaries in the Makambako District: The Makambako Dispensary in the town of Makambako and the Kitanewa Dispensary in the town of Kitanewa.

Study Population, Sample Frame and Sampling Procedure/Techniques
The study population refers to the people involved in the research. The study population was the community living in the Makambako district, specifically mothers with children under five years of age. The sample frame of the study included mothers with children under five years of age and healthcare workers. Both probability and non-probability sampling techniques/procedures were employed. In probability sampling, a researcher used simple random sampling where everyone was given an equal chance to be selected. In non-probability sampling, a researcher used purposive sampling, meaning that the researcher's judgement was used to select the cases that make up the sample, together with convenience sampling, where cases were selected randomly on the basis that they were easiest to obtain. This ensured maximum accuracy in obtaining needed information.

Data Collection Methods
Data collection methods involved Documentation and structured interviews/Questionnaires.
Documentation
Available data/documents concerning the cases of children affected and died of pneumonia diseases; both the current and past information was used.
Questionnaire
This refers to a set of printed or written questions with a choice of answers devised for a survey or statistical study. Questionnaires were distributed to mothers with children under five years of age.
Data Collection Instruments/Tools
Data collection instruments are tools for gathering information and data during research conduction. An interview schedule (questionnaire), a notebook for taking the available data/information, and a pencil, ruler and pen were used.
Data Analysis and Presentation
Data analysis refers to inspecting, cleansing, transforming, and modelling data to discover useful information, suggest conclusions, and support decision-making. Statistical Package for Social Science (SPSS) will analyze the obtained data as recommended by the Environmental Health Department at RUCU. Data in tables, charts, graphs and documents were presented.

Results and Discussion
Knowledge on Pneumonia
Several questions were asked of mothers with children under five years of age to assess their theoretical and practical understanding of childhood pneumonia and determine their knowledge level concerning it. The results of the knowledge assessment are presented below.

Information on the word pneumonia (n=106)

91 respondents (86%) have heard the word pneumonia, but 15 respondents (14%) have never heard it. Most respondents know the word pneumonia, but few do not, as presented in Figure 2 below.
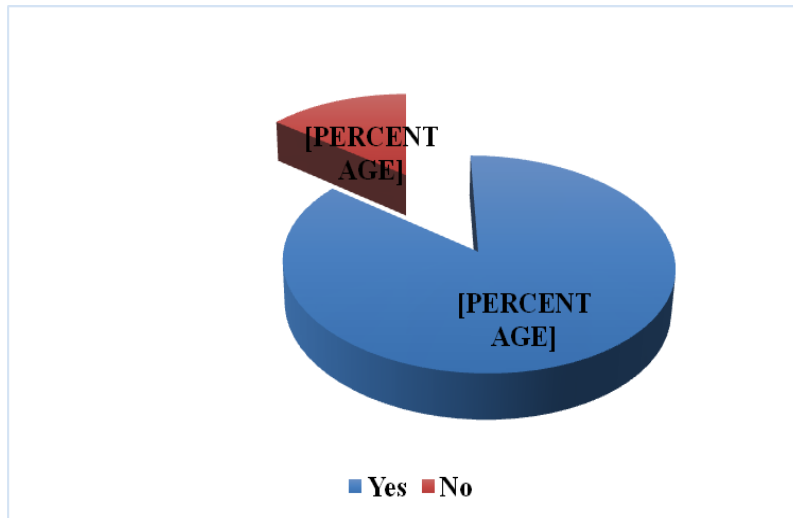
Figure 2. Understanding of pneumonia (Source: Researcher findings, 2018)

The study revealed that mothers are not aware of the disease, as some have never even heard the word pneumonia. It is difficult to prevent a disease if a person does not know. When the disease occurs, it will be new and may not know what to do and may result in death.

Of mothers aware of the disease, 12.3% do not understand what pneumonia is; this is dangerous since it is difficult to manage a disease that is not understood. Many say it is a disease caused by cold, which is not true; cold is just a contributing factor to the disease. This contradicts Black et al. (2010), who describe pneumonia as an acute respiratory infection affecting the lungs. The lungs comprise small sacs called alveoli, which fill with air when a healthy person breathes. When an individual has pneumonia, the alveoli are filled with pus and fluid, making breathing painful and limiting oxygen intake.

Children's hospital attendance (n=70)

Forty-three (43) respondents (61%) responded that a child was taken to the hospital when symptoms of pneumonia showed, but 27 respondents (39%) said that a child was not taken to the hospital. Those who said a child was not taken to the hospital proved that the child was taken to traditional healers and got treatment, and a few said that a child got home treatment and became well.
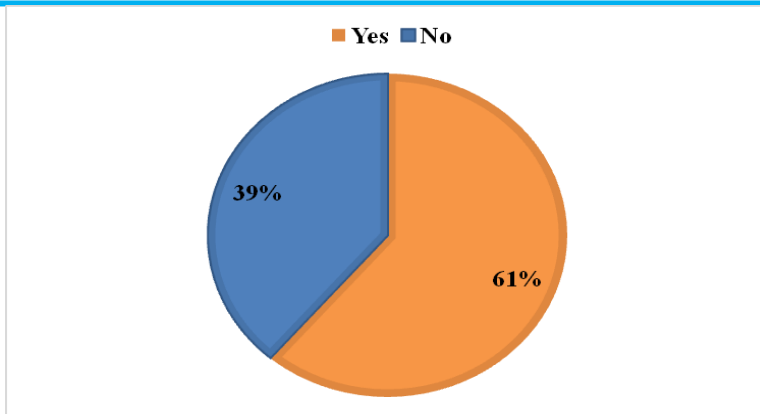
Figure 3. Hospital attendance (Source: Researcher findings, 2018)

As shown in Figure 3, 39% of mothers did not take a child to the hospital when they fell sick, and some performed home treatment by giving a child paracetamol, believing that it was a normal fever and taking the child to the hospital when the condition worsened. Some took children to traditional healers, believing that it is a wonderful disease and cannot be treated in a hospital. The study is like the one conducted in Iran by Farhad et al.(2014), who explain that most mothers (43% >) do not attend early hospitals to treat pneumonia in children under five children, signifying the positive association between high mortality rates and not attending on time at hospitals. This increases morbidity and mortality of children from childhood pneumonia since home treatment and traditional healing are not scientifically based and are not effective.

Understanding of risk factors of Pneumonia (n=91)
Thirty-nine (39) respondents (43.4%) said the health risk factor of childhood Pneumonia is cold, 18 respondents (19.8%) said it is indoor air pollution, such as parental smoking and the use of biomass fuel in cooking, 5 respondents (5.7%) said crowding, 2 respondents (1.9%) said malnutrition and 27 respondents (29.2%) said they do not know the health risk factors of childhood Pneumonia.
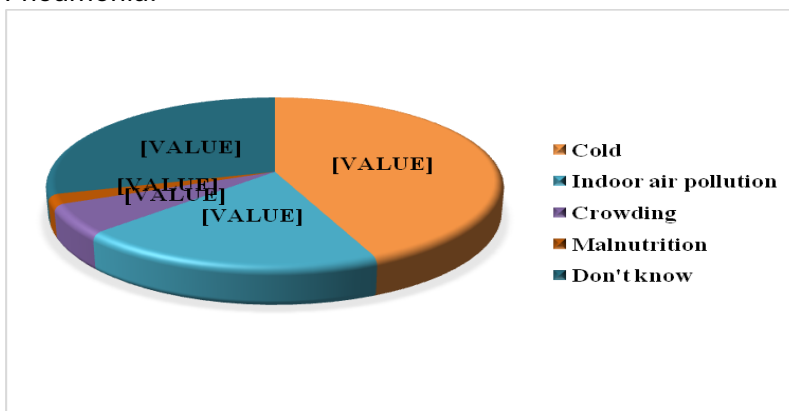
Figure 4. Risk factors of pneumonia (Source: Researcher findings, 2018)

76.2% of mothers do not understand the health risk factors contributing to Pneumonia, as 43.4% said it is cold, and 29.2% do not know anything; the major risk factors of childhood Pneumonia are Malnutrition, indoor air pollution and crowding. Most people do not know if crowding and malnutrition are health risk factors for pneumonia.

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The World Health Organization [WHO] explains that malnutrition decreases children's immunity, especially in infants not exclusively breastfed. However, other risk factors are pre-existing illnesses, such as symptomatic HIV infections and measles, also increase a child's risk of contracting pneumonia (WHO, 2018).

Understanding of Pneumonia transmission (n=91)
Twenty-one (21) respondents (22.6%) said Pneumonia is transmitted through air, 35 respondents (38.7%) said it is transmitted by cold, 9 respondents (9.4%) said it is by bacteria, and 26 respondents (29.2%) did not know how Pneumonia is transmitted.
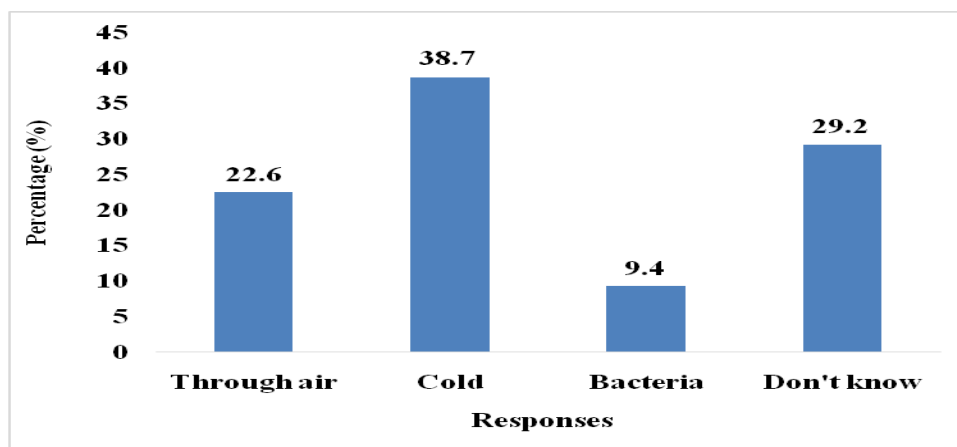
Figure 5. Pneumonia transmission (Source: Researcher findings, 2018)

67.9% of mothers do not know how Pneumonia is transmitted, whereas, among them, 38.7% said by cold, which is not true since coldness is a contributing factor, and 29.2% do not know anything about pneumonia transmission. Childhood Pneumonia can spread in several ways; the viruses and bacteria commonly found in a child's nose or throat can infect the lungs if inhaled. They may also spread via air-borne droplets from a cough or sneeze. In addition, pneumonia may spread through blood, especially during and shortly after birth. However, not all cases of pneumonia are caused by transmissible organisms. For example, WHO explains that pneumonia can occur when someone inhales an unwanted substance, like vomit, into their lungs (WHO, 2013). Generally, mothers' knowledge of Pneumonia disease is not enough, as some do not know anything about it. It is difficult to manage a disease that someone does not understand.

Practices on childhood pneumonia
Knowledge and practice must go together to manage childhood pneumonia. Several questions were asked of mothers with children under five years of age to assess their practices towards childhood pneumonia and determine if they have good practices concerning childhood pneumonia. The results of the practice assessment are presented and discussed below:

Cultural and traditional beliefs concerning childhood pneumonia (n=91)
Thirty-five (35) respondents (38.7%) said there are cultural practices regarding childhood pneumonia, such as taking a child to the traditional healer when the child shows symptoms of

pneumonia and believing that the disease cannot be treated in the hospital. Meanwhile, 56 respondents (61.3%) said no cultural or traditional beliefs concerning childhood pneumonia exist.
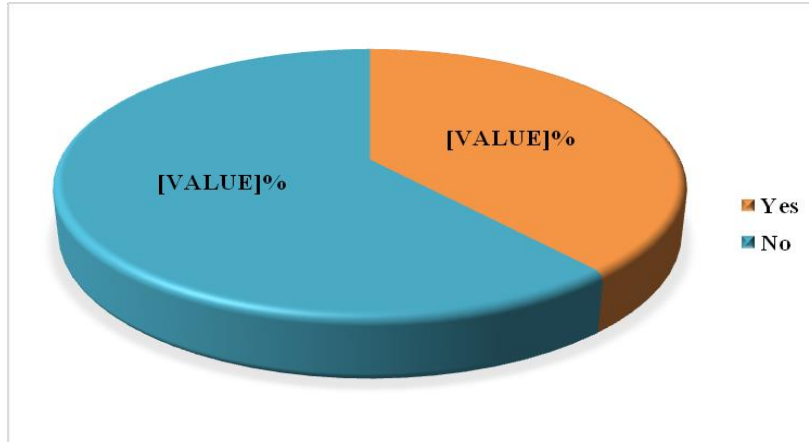
Figure 6. Cultural and traditional beliefs (Source: Researcher findings, 2018)

38.7% of mothers have bad practices towards childhood pneumonia as some perform cultural and traditional practices in order to treat the child, something which contributes in increasing morbidity and mortality since children do not get well through traditional healing. Also, other mothers said they prefer home treatment, meaning that they perform self-medication to the sick child. This is a bad practice as a child may fall sick or may even die since most mothers do not have any medical knowledge of childhood pneumonia. Even those who take children to hospitals mostly do so after self-medication, and the condition gets worse. Moreover, as failure to recognize symptoms of pneumonia may cause delays in care seeking, the World Health Organization has identified three essential steps to address pneumonia-specific mortality: ensuring that caregivers are aware of pneumonia symptoms, seeking appropriate care and treating suitably with antibiotics (WHO-Pneumonia Factsheet, 2018).

Preference for children treatment (n=91)

Fifty-two (52) respondents (57.5%) said they prefer to take a child to the hospital when he/she shows signs of Pneumonia, 17 respondents (17.9%) said they prefer home treatment, and 22 respondents (24.5%) said they prefer traditional healers. Most respondents said they prefer to take a sick child to the hospital, while some prefer home treatment and traditional healers.
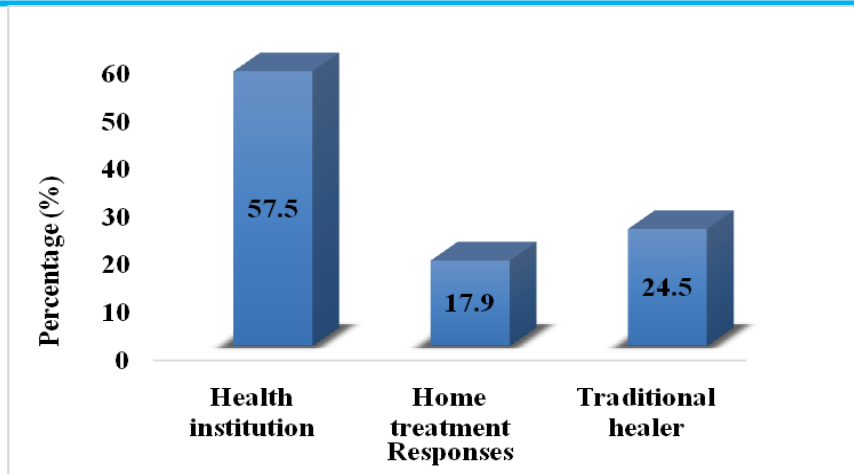
Figure 7. Children's treatment preference (Source: Researcher findings, 2018)

57.5% of mothers prefer to take their sick children to hospitals, but 17.9% prefer home treatment and 24.5% traditional healers, and those who prefer to take them to the hospital most do so after self-medication, and the condition worsens; this contributes to high morbidity and mortality to children.

Protection and prevention of a child against childhood pneumonia (n=91)

Forty-one (41) respondents (45.3%) said that to prevent and protect the child against pneumonia, they enclose children with thick clothes. One respondent (0.9%) said she would ensure a child gets proper nutrients for growth. Seventeen respondents (18.9%) said immunizing them, and 32 respondents (34.9%) said hygiene, such as keeping the indoor air clean and cleanliness in crowded homes, as shown in Figure 7 below.
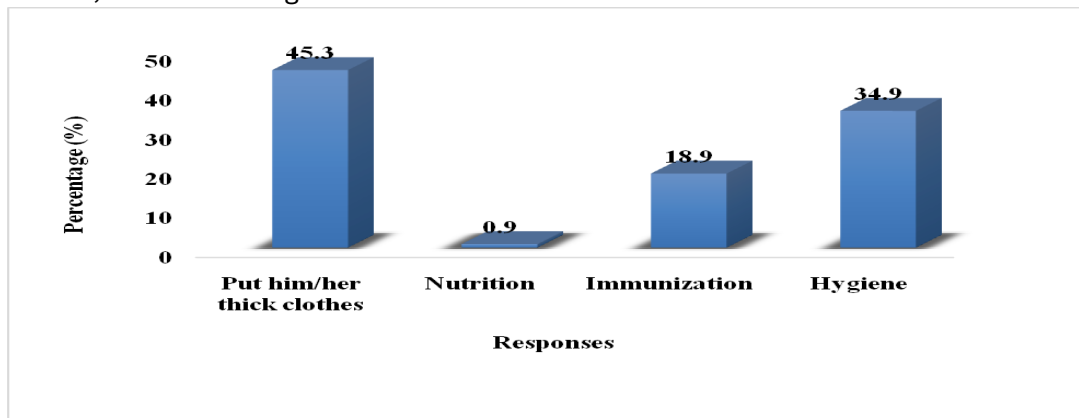
Figure8. Childhood pneumonia prevention and protection (Source: Researcher findings, 2018)

Based on the protection and prevention of a child from Pneumonia, 45.3% of mothers do not know effective ways to prevent and protect their children, many based on putting them in thick clothes. Putting on thick clothes is not an effective way of protecting a child against pneumonia since the disease has many transmission routes. Rudan et al. (2008) concurs with these findings by explaining that immunization against Hib, pneumococcus, measles and whooping cough (pertussis) is the most effective way to prevent pneumonia; adequate nutrition is key to improving children's natural defences, starting with exclusive breastfeeding for the first 6 months of life. In addition to being effective in preventing pneumonia, it also helps to reduce the length of the illness

if a child does become ill, addressing environmental factors such as indoor air pollution (by providing affordable clean indoor stoves, for example) and encouraging good hygiene in crowded homes reduces the number of children who fall ill with pneumonia, in children infected with HIV, the antibiotic cotrimoxazole is given daily to decrease the risk of contracting pneumonia.

Sleeping room of children under five years of age (n = 91)
The sleeping room of children was assessed by asking where a child under five years of age sleeps; 28 respondents (31%) said their children under five years of age sleep in a bedroom with their brothers/sisters, while 63 respondents (69%) said they sleep with their children under five years of age in their bedrooms.
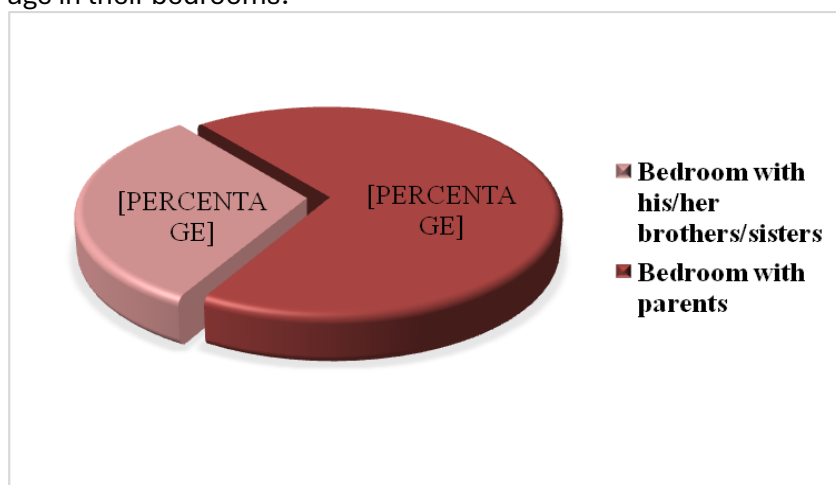
Figure 9. Sleeping rooms (Source: Researcher findings, 2018)
Regarding sleeping rooms, 69% of mothers said they sleep with their children, but 31% said they sleep with their brothers and/or sisters. Most of the children who sleep with their parents are under three years of age, and those above sleep with their brothers and sisters. Those under five who sleep with their brothers and/sisters who are 3 years and above are more likely to acquire pneumonia depending on how many children sleep in one room, how many beds they have, the clean level of the room and the age of a sister/brother who sleeps with a child. Most respondents said 3 children sleep in one room, and mostly, there are 1 to 2 beds. A crowded room results in the transmission of diseases, including childhood pneumonia. Similar findings were reported in studies conducted in Nigeria, Uganda, Albania, India and Pakistan, whereby fast breathing, coughing, fever and chest wall in-drawing were mentioned as commonly recognized complications resulting from the kind of sleeping rooms which favour the transmission of pneumonia disease(Aftab, et al.2018; Doracaj, et al.2015; Sougaijam, et al.2017; Tuhebwe, et al.2014 & Ukwaj, et al.2012).

Prevalence and incidence of childhood pneumonia
Incidence- refers to the number of new cases over a period or the extent to which something happens or has an effect. For example, how many new cases of pneumonia were diagnosed from January to June? Prevalence -is the proportion of individuals in the population who have a risk or disease at a point in time or the number of cases in time that are old and new existing now. Therefore, prevalence (P) is equal to the product of the incidence rate (I) and the average duration of the disease (D).

Number of children dying of childhood pneumonia (n=91)

Fifty-one (51) respondents (55.7%) said many children are dying of pneumonia in Makambako, 23 respondents (25.5%) said they do not know, and 17 respondents (18.9%) said few children are dying of Pneumonia in Makambako.
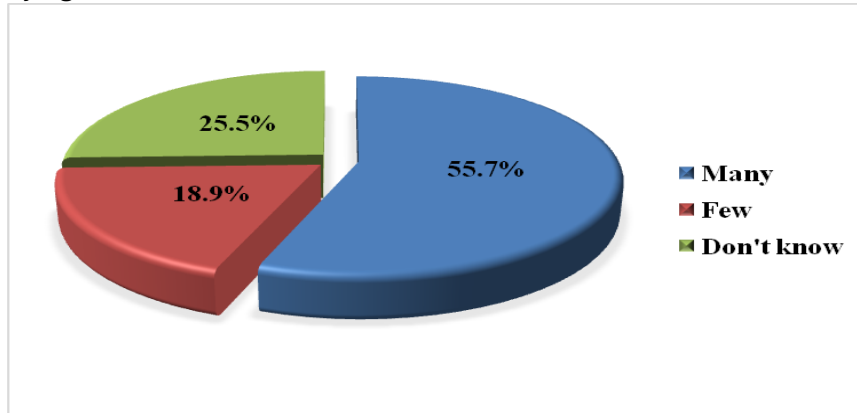
Figure 10. Pneumonic children death rate (Source: Researcher findings, 2018)

Reasons for high mortality rate

Forty-one (41) respondents (45.3%) said the reason for the high mortality rate is an environmental condition, meaning cold condition; 15 respondents (17%) said is caused by low knowledge of mothers concerning the disease and poor practices; 13 respondents (14.2%) said is caused by careless of healthcare workers, 15 respondents (16%) said indoor air pollution and the rest 7 respondents (7.5%) did not know.
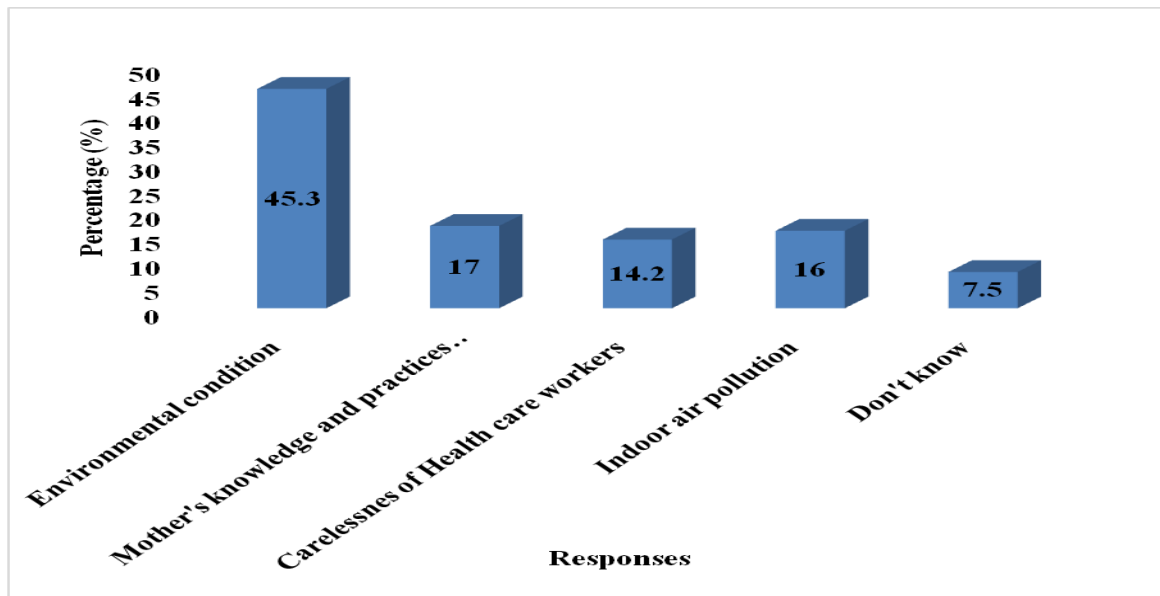
Figure 11.Reasons for high mortality rate (Source: Researcher findings, 2018)

There is a high incidence and prevalence of childhood pneumonia in Makambako town. The findings show that most respondents said that childhood pneumonia is a common illness in Makambako (figure 11), meaning that it exists for a long period. Many children are dying of childhood pneumonia, as per respondents' responses. This is associated with mothers' knowledge and practices. The majority of the respondents said cold conditions cause high morbidity and mortality. It might be true, but there must be other associated factors because other towns have colds, but there is no high prevalence and incidence of childhood pneumonia.

Childhood pneumonia cases treated from 2014 to 2017
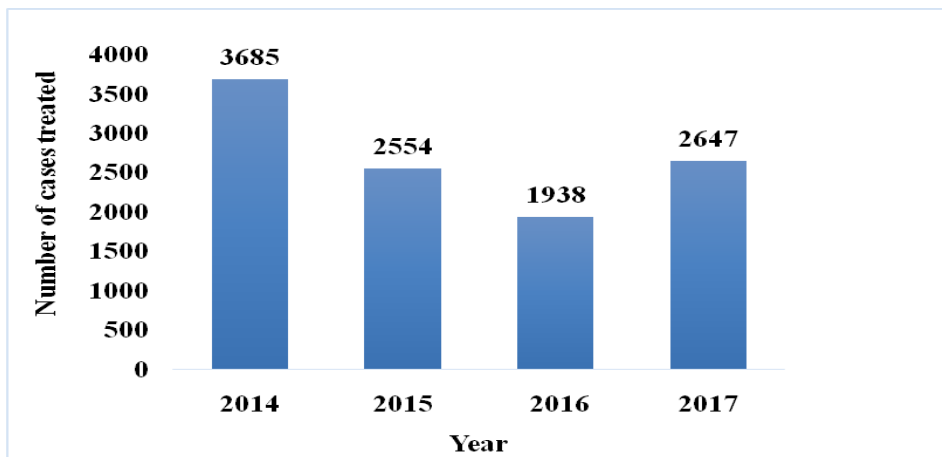
Figure 12. (Source: MTUHA Makambako Health Centre, 2018)

Figure 12 shows the number of pneumonia cases treated from 2014 to 2017. The number of cases was high in 2014, decreased to 1938 in 2016, and increased to 2647 in 2017. This indicates that childhood pneumonia is high in the study area.

Conclusion
Based on the study findings, the high prevalence of childhood pneumonia in Makambako town council is caused by low knowledge and poor practices of mothers concerning childhood pneumonia, as 67.9% of mothers do not know what pneumonia is. 72.6% do not know the health risk factors associated with childhood pneumonia. 77.3% do not know how pneumonia is transmitted. Some mothers perform cultural and traditional beliefs, and some perform self-medication and take a child to the hospital when the conditions worsen. Most do not know if proper nutrition and immunization are the most effective ways to protect a child against pneumonia.

Ethical Consideration
Ethical clearance to conduct the study was sought from Ruaha Catholic University; then, the Makambako Town Council Official provided a permission letter to collect data. The participants signed the agreement forms prior to responding to the questions. Also, verbal informed consent was given, and participant confidentiality and anonymity were clearly explained.

Conflict of interest: None.

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Review on Genetic Insights into Abnormal Uterine Bleeding and Leiomyoma Development

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Abstract
Background: Abnormal uterine bleeding is a prevalent issue among women of reproductive age, primarily stemming from hormonal imbalances. It is characterized by flow volume, duration, and frequency variations outside of pregnancy. Occurring frequently during perimenopause and menstruation, abnormal uterine bleeding is associated with several benign tumors within the female reproductive system, including leiomyomas and endometriomas. Leiomyomas, composed of smooth muscle cells originating from the uterine wall, are influenced by genetic and environmental factors.
Objective: This review explored the complications linked with abnormal uterine bleeding and identified crucial genes involved in developing leiomyomas.
Methods: The International Federation of Gynecology and Obstetrics (FIGO) has established a classification and terminology system for the causes of abnormal uterine bleeding (AUB). This standardization aims to enhance research efficiency, facilitate diagnosis, and improve the management of clinical cases. Articles in English were searched in the PubMed, Embase, Scopus, ScienceDirect, and MEDLINE databases using the terms abnormal uterine bleeding, leiomyomas, and genes. The selection included systematic reviews, meta-analyses, randomized controlled trials, and reviews. Data were searched from 2016 to May 2023.
Results: The research reveals that uterine leiomyomas affect a substantial percentage of females by age 50, underlining the need for a comprehensive understanding of their genetic underpinnings. The knowledge gained from this study contributes to the potential development of more targeted and efficient treatments for leiomyomas, offering hope for improved outcomes in managing these common gynecological disorders.
Conclusion
The findings underscore the complexity of abnormal uterine bleeding, emphasizing its connection with leiomyomas and the genetic factors influencing their development. By employing the FIGO classification system, researchers and clinicians can standardize their approach to diagnosis and management, paving the way for more efficient future research and diagnostics. Identifying critical genes associated with leiomyomas provides insights into the underlying mechanisms, particularly the involvement of hormones and genetic pathways.

Keywords: Uterine Bleeding, hormonal imbalance, menopause, estrogen, progesterone, non-malignant, leiomyoma

Introduction
Abnormal uterine bleeding is menometrorrhagia, bleeding between monthly cycles, persistent bleeding, or heavy menstruation. Fibroids, polyps, and hormonal shifts are all possible reasons. Women witness menstrual cycles from 11-12 to nearly 50 years; during these 40 years, a woman is likely to have a few episodes of bleeding that are not part of her normal cycle (Cheong et al.

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2017). An abnormal menstrual cycle is considered an AUB if it is characterized by irregularity, frequency, duration, and volume of flow that does not occur during pregnancy. An estimated one-third of women will experience abnormal uterine bleeding at some time; these abnormalities are most common during perimenopause and the menstrual cycle. Regular menstrual cycles last between 2 and 7 days, with a cycle period of 24 to 38 days and blood loss of 5 to 80 milliliters. An irregular uterine bleeding pattern occurs whenever there is a fluctuation in these four criteria, rather than using archaic terms such as oligomenorrhea, menorrhagia, or dysfunctional uterine bleeding to describe abnormal uterine bleeding.

A revised nomenclature was published in 2007, 2011, and 2018 by the International Federation of Obstetrics and Gynecology (FIGO). According to the FIGO systems, the most common aetiologies of abnormal uterine bleeding are alphabetized. These assertions can support chronic, nongestational AUB. The concept of irregular bleeding was added to intermenstrual bleeding in 2018, and hemorrhaging that falls outside the 75th percentile was defined as intermenstrual bleeding (Munro et al. 2018).

AUB is one of the most common conditions encountered in routine obstetrics and gynecology practice globally, affecting approximately 10%–30% of women of reproductive age over 35 years old (Sun et al., 2018). The percentage prevalence of AUB in females of various ages is classified as menarche (12.7%), reproductive age (82.9%), and postmenopausal (9.21%) in India (Faruqui et al. 2019). The prevalence of AUB in Brazil is 31.4% [4], India is 17.9% (Choudhury et al. 2020), and China is 57.7% (Sun et al. 2018).

Special attention must be given to abnormal uterine bleeding (AUB). The prevalence ranged from 5% to 65% among general population of Ethiopian women of reproductive age (Gerema et al. 2022), and AUB is most common between the ages of 20 and 34; however, the prevalence rate steadily dropped between the ages of 45 and 49, which may be connected to the fact that most women go through menopause around this time, along with a decline in ovarian function (sun et al. 2018) risk factors of abnormal uterine bleeding includes hemostatic disorders, genital tract pathology, infections, systemic diseases, endocrine disruption, obesity, and stress (Gerema et al. 2022). Among women of reproductive age, 14-25% suffer from AUB or heavy menstrual bleeding (HMB), which can impact their physical, social, emotional, and material well-being (Fraser et al., 2009; Shapley et al., 2004).

The number of women seeking treatment for AUB in the United Kingdom is approximately 800,000 annually. Significant economic and healthcare expenditures are associated with the incident and the immediate consequences for the woman and her family. The cost of lost work and home maintenance for every patient is more than $2,000 per year, according to a study conducted in the United States (Frick et al., 2009).

Identifying AUB requires a basic understanding of the normal menstrual cycle. Menstruation is controlled by the hypothalamic-pituitary-ovarian (HPO) axis, which secretes follicle-stimulating hormone (FSH) during the follicular phase of the menstrual cycle (Goldstein et al., 2017). Due to increased estrogen production, the granulosa cells produce more estrogen, and the endometrial lining thickens. Further, it increases LH levels and negatively influences FSH levels. It is expected that the surge in LH will result in ovulation. After ovulation, the corpus luteum secretes progesterone, which results in the secretory endometrium. During pregnancy, the corpus luteum and ovum degenerate if the ovum is not fertilized. This results in a decrease in estrogen and progesterone production. Women with anovulatory cycles are consequently subject to estrogenic endometrial stimulation, associated with irregular, excessively heavy bleeding that is longer than the required seven days (Jewson et al., 2020). During menstruation, the endometrium sheds due to the absence of progesterone. ESR1 has been identified as a tumour suppressor protein whose expression is adversely correlated with cancer development and stage.

An excess of estrogen or a deficiency of progesterone may cause heavy bleeding in many women. The presence of fibroids or polyps in the uterus may also result in bleeding.

There is a wide variety of monthly abnormalities (figure 1) among patients with polymenorrhagia (29%), menometrorrhagia (8%), menorrhagia (3%), oligomenorrhea (17%), hypomenorrhea (1%), and menorrhagia (3%) (Thakur et al., 2020). According to the FIGO classification, Leiomyomas are benign tumors forming in the uterus's smooth muscle and are common causes of irregular uterine bleeding. Leiomyomas of the uterus are the most prevalent benign tumors in women of reproductive age. Although they may appear asymptomatic, they can also create significant clinical symptoms (De La et al. 2017; Stewart et al., 2016). A fibroid is a lump of extracellular matrix containing collagen, fibronectin, and proteoglycan originating from the smooth muscle of the myometrium, which includes these components (Khan et al., 2014; Stewart et al. 2017). The frequency of fibroids varies according to study populations and diagnostic procedures. Approximately 25% of women of reproductive age develop clinically evident fibroids, which may result in unpleasant symptoms. A prevalence of 24% is reported in urban areas in India, whereas 37.65% is reported in rural areas (Munusamy et al., 2017).

Methods

In conducting our literature review, we comprehensively searched multiple electronic databases, namely PubMed, MEDLINE, Scopus, EMBASE, and ScienceDirect, spanning from January 2016 to May 2023. We employed the search terms "uterine leiomyomas," "abnormal uterine bleeding," "genes," and "pathophysiology." Papers were required to be in English without geographic restrictions. Additionally, we reviewed the reference lists of identified articles to identify relevant studies not captured in our initial searches. Three authors (KJG, IBK, and RV) independently assessed the search results and study eligibility. Inclusion criteria encompassed randomized clinical trials, retrospective studies, literature reviews, case reports, and series involving patients with uterine leiomyomas. Out of 219 studies reviewed, 104 met the inclusion criteria for our research. Any discrepancies were resolved through discussion to achieve consensus.

Major Complications associated with abnormal uterine bleeding

Various adverse effects may be related to AUB, and the treatment for these side effects will depend on the specific cause and intensity of the bleeding. AUB has severe impacts, including anaemia, endometrial cancer, and infertility.

Anemia

The World Health Organization (WHO) classifies anaemia as a public health issue in which the quantity of red blood cells or haemoglobin concentration is below the physiological range (Bursac et al., 2022). Gynecologic causes of Iron deficiency symptoms include menorrhagia and hypermenorrhea, iron deficiency anemia brought by irregular uterine bleeding can be dealt with ferric carboxymaltose (FCM) (Hagras et al. 2022). AUB patients develop iron deficiency anaemia (IDA) as a response to recent or ongoing blood loss; anaemia is one of the most typical diseases in India among every age group; women who lose more than 80ml per menstrual cycle are prone to iron deficiency anaemia which affects their regular activity. Prolonged bleeding can reduce iron stores, which results in anaemia and can cause chronic illness, fatigue, and depression. Menstrual disorders account for 5% - 10% of women with IDA (Mishra et al. 2018).

Iron deficiency (ID) is the most frequent micronutrient deficiency worldwide, affecting more than 20% of women during their reproductive years (Percy et al. 2017). The most common adverse effect of irregular uterine bleeding is anaemia, which can occur in women with abnormal uterine bleeding when it is severe or prolonged. Research indicates that anaemia may harm women's health, including fatigue, weakness, cognitive impairment, reduced productivity at

work, and a decreased quality of life. The authors also discuss how anaemia may exacerbate diabetes, chronic kidney disease, and cardiovascular disease. Anaemia should be screened in women with irregular uterine bleeding by their healthcare providers, and iron supplements, transfusions, or other necessary therapies should be administered as required. To minimize complications and improve women's overall health, the authors emphasize the importance of treating the underlying cause of bleeding (Agrawal et al. 2020).

Endometrial cancer

Endometrial cancer is a type of cancer in which tumor cells grow on the lining of the uterus (endometrium) and is also known as uterine cancer. Most women experience early symptoms of endometrial cancer; abnormal vaginal bleeding is the most prevalent sign of endometrial cancer. Around 90% of EC occurrences are preceded by premenopausal or perimenopausal uterine bleeding or postmenopausal bleeding (Clarke et al. 2020); the two most familiar causes of bleeding disturbance include primary endometrial abnormalities and cysts (Brennan et al. 2018); endometrial thickness of 8 mm or less is related to a lower risk of malignant diseases in premenopausal uterine hemorrhage (Getpook et al. 2006).

Cancer of the endometrium is a common adverse effect of AUB. Postmenopausal bleeding and heavy, prolonged, and irregular periods are all associated with endometrial cancer. Irregular uterine bleeding may be a sign of endometrial cancer, but not all cases are caused by it. Fibroids, uterine polyps, hormonal imbalances, and infections can cause irregular uterine bleeding. Detecting and treating endometrial cancer early can improve outcomes (Sung et al. 2022). According to a study published in 2018, irregular bleeding is one of the most common symptoms of endometrial cancer. The results of these studies suggest that detecting and treating AUB as soon as possible may result in a better outcome due to AUB's risk of recurrence and its poor prognosis due to early detection and treatment (Suh et al. 2018).

Infertility

Non-ovulating women may experience prolonged estrogen exposure without adequate progesterone levels to cause the endometrium to shred completely. Eventually, this could lead to irregular bleeding or significant bleeding. Infertility patients are more likely to develop uterine fibroids, the most common tumors in women. According to the study, fibroids may be responsible for 2-3% of infertility cases. Clinical manifestations include abnormal bleeding, pelvic pain, infertility, pelvic masses, and obstetric complications (Donnez et al. 2016 & Freytag et al. 2021).

Irregular uterine bleeding may be associated with infertility. In general, abnormal uterine bleeding is any bleeding that does not occur during a regular menstrual cycle. Various conditions, including polycystic ovarian syndrome, endometriosis, fibroids, adenomyosis, and thyroid disorders, can cause abnormal uterine bleeding. There may be a relationship between infertility and these concerns and other factors such as age, weight, and lifestyle. The same underlying condition can cause irregular uterine bleeding and infertility (Matthews et al. 2015)

AUB is not usually associated with fertility problems in women. Even though no study has specifically addressed AUB rates in the infertility population, to our knowledge, intracavitary abnormalities are present in approximately 16% of premenopausal women with infertility, and ovulatory dysfunction is present in approximately 20% to 40% of these women (Tur-Kaspa et al. 2006; Practice. 2015). A result of structural causes of AUB, such as polyps or submucosal fibroids, as well as possible systemic causes, such as anovulation and endometrial changes that affect gene expression, growth factors, and cellular immunity, may cause subfertility or infertility among women of reproductive age.

It remains unclear how endometrial disorders and structural abnormalities may affect fertility. This is despite widespread recognition of the impact of systemic causes of AUB, such as ovulatory dysfunction. AUB women's reproductive outcomes will need to be investigated in the

context of structural abnormalities and their treatment. By understanding how hormonal and structural abnormalities affect the uterine environment, we can better understand the relationship between abnormal uterine bleeding and infertility (Sacha et al. 2017).

FIGO Classification of abnormal uterine bleeding

AUB diagnostic and therapy keywords were integrated into the International Federation of Gynecology and Obstetrics' unique category system (FIGO) 2011 (Kahveci et al. 2021). The FIGO has developed a classification system based on the underlying causes of abnormal uterine bleeding. According to the FIGO classification system, AUB may be classified into three categories: structural, nonstructural, and ad hoc. An acronym PALM may be used to refer to a structural cause, while COEIN may be used to refer to a nonstructural cause.

Structural causes – PALM

Women with structural abnormalities may have several underlying causes and may, for various reasons, be asymptomatic. The PALM-COEIN classification system acknowledges that several causes can contribute to these structural abnormalities. These changes cause structural variations in the uterus. Endometrial polyps and abnormal uterine bleeding is known for the epithelial growth comprising various components like vascular, fibromuscular, glandular, and connective tissues, primarily asymptomatic in women (Munro et al. 2018) or the most common symptom is abnormal uterine bleeding (Tanos et al. 2017). These groupings correspond to possible underlying causes that may contribute to AUB. Patients may benefit from the PALM-COEIN classification to diagnose and treat their condition. Figure 3 illustrates the anatomical factors contributing to abnormal uterine bleeding.

Adenomyosis (AUB-A)

It is defined as an abnormal growth of endometrial tissue within the smooth muscles of the uterus (Diffuse or focal). The primary indications are dysmenorrhea, heavy menstrual bleeding, pelvic pain, and reduced fertility (Bourdon et al. 2021). They are associated with a 28% reduced clinical pregnancy rate and a double chance of miscarriage in women having IVF with autologous oocytes (Harmsen et al. 2019). Other gynecological conditions, including uterine fibroids and endometriosis, usually occur with adenomyosis (Vannuccini et al. 2019).

Magnetic resonance imaging (MRI) and transvaginal ultrasound (TVUS) are commonly used for diagnosis, and the presence of lesions is usually verified histologically when a surgical specimen is available (Chapron et al. 2020). There is no 'adenomyosis medicine,' but many off-label pharmaceuticals have been utilized over the years (Vannuccini et al. 2019). The prognosis for adenomyosis is usually favorable with the correct treatment, and in most cases, women can manage their symptoms and lead a normal, healthy lifestyle after being diagnosed. However, if you suffer from severe cramps, heavy or prolonged menstruation, or pain during sex, you should seek the advice of a physician.

Leiomyoma (AUB-L)

Uterine leiomyomas are benign uterine tumors that can be submucous, subserous, or intramural and induce abnormal uterine bleeding and (AUB-L) and bulk symptoms caused by fibroid size and the force they create on nearby organs (Wright et al. 2022). Leiomyoma is a benign soft tissue that develops from smooth muscle cells (Pulgar et al. 2021). Heavy menstrual flow and pain are the two most typical symptoms of uterine leiomyoma, leading to a hysterectomy or other medical or surgical intervention. Up to 80% of women by age 50 have been reported to have the most prevalent gynecological and pelvic tumor uterine leiomyomas (Bajaj et al. 2022).

A study published in 2020 examined the therapeutic benefits of different approaches to treating AUB-L. Patients with abnormal uterine bleeding typically undergo hysterectomy or

myomectomy to reduce bleeding and improve quality of life. The study indicated that hormone therapy and non-hormonal medical treatment may prove beneficial in certain situations, particularly for women who wish to preserve their fertility or not undergo surgery (Wu et al., 2020).

Malignancy and hyperplasia (AUB-M)

The abnormal growth of endometrial glands with an increase in the gland-to-stroma ratio compared to proliferative endometrium, along with the detection of atypical cells, is known as endometrial hyperplasia; this can cause endometrial malignancy if left untreated (Singh et al. 2022). Endometrial hyperplasia often presents as abnormal uterine bleeding, including intermenstrual bleeding, postmenopausal bleeding, and bleeding during hormone replacement therapy. The rate of endometrial hyperplasia is believed to be three times the number of instances of endometrial cancer. An early diagnosis of endometrial hyperplasia can prevent the progression of the disease to endometrial cancer (Siegal et al. 2018). The therapeutic efficacy of AUB-M depends on a variety of factors, and treatments range from conservative to aggressive. The use of progestin therapy may be a viable option for some women undergoing treatment for atypical hyperplasia and early-stage endometrial cancer. However, hysterectomy is often used to treat these conditions.

Non-structural classification-COEIN

Abnormal uterine bleeding (AUB) is classified based on its underlying causes according to the FIGO, also known as the COEIN classification. Figure 4 illustrates the possibility of abnormal uterine bleeding by non-structural causes (COEIN). It is an inconvenient procedure that causes bleeding, ovulatory dysfunction, endometritis, and iatrogenic disorders of the uterus, none of which affect the uterine structure.

Coagulopathy (AUB-C)

Systemic ataxias of hemostasis lead to heavy menstrual bleeding, for example, von Willebrand disease and hemophilia (Bacon et al. 2017). This condition affects the clotting factors, resulting in more or unstoppable bleeding during surgery, injury, and menstruation. Coagulation factor deficiencies can be caused rapidly if a considerable volume of blood is lost during serious surgery or trauma that would prompt fluid restoration treatment and an array of blood component treatments leading to haemodilution (Hofer et al. 2021). AUB-C's effectiveness as a treatment agent depends on the underlying cause of coagulopathy. The treatment of coagulopathy can include hormone therapy, tranexamic acid, desmopressin, or platelet transfusions, depending on the underlying cause. A study in 2018 assessed the effectiveness of various AUB-C therapeutic techniques. The study concluded that a personalized approach is essential for AUB-C to achieve maximum results, and the specific underlying cause of coagulopathy determines the appropriate treatment (James et al. 2011).

Ovulatory (AUB-O)

Ovulatory dysfunction is unusual, irregular (with 9 menstrual cycles per year), or absent ovulation or egg release (Jones et al. 2022). Abnormal uterine bleeding due to ovulatory dysfunction generates irregular or often heavy menstruation. The most prevalent cause of AUB throughout adolescence is anovulation. Growing menarche age is associated with prolonged ovulatory dysfunction Deligeoroglou et al. 2018). Obesity and polycystic ovarian syndrome (PCOS) are two conditions that might induce irregular ovulation (Anitha et al. 2020). Imaging and histological examinations can figure out structural reasons. AUB-O can be treated using various effective treatment options, such as hormone therapy, NSAIDs, tranexamic acid, and surgical

procedures, depending on the underlying cause of the bleeding, the patient's preferences, and the patient's treatment goals.

Endometrial (AUB-E)

The condition when the endometrium (womb lining) does not function well since it sheds and heals during menstruation is referred to as endometrial dysfunction, which further leads to symptoms like heavy and prolonged menstrual bleeding, which impacts almost one-third of women.

However, variations in cycle length and intermenstrual bleeding may also occur (Brennan et al. 2018). No particular medicines are currently available to address endometrial dysfunction (Whitaker et al. 2016). The treatment of AUB-E caused by endometrial causes depends on the underlying cause and the severity of the symptoms. Treatment goals include reducing bleeding, preventing complications, and improving patient quality of life. AUB-E is treated with hormonal therapy, including oral contraceptives, progestins, or gonadotropin-releasing hormone agonists, to regulate the menstrual cycle and reduce bleeding.

Iatrogenic (AUB-I)

Abnormal uterine bleeding brought on by treatments, devices, or medications that affect the endometrium, such as the Copper intrauterine device, which influences ovulation or interferes with clotting mechanisms, steroids, hypothalamic depressants, anticoagulants, digitalis, phenytoin, and intrauterine contraceptive devices is iatrogenic causes of AUB (Motta et al. 2017). Unscheduled endometrial bleeding associated with the use of hormonal contraceptives is one of the symptoms. To rule out different causes of bleeding, medical history and gynecological examination (including transvaginal ultrasound) should be performed (Maas et al. 2015). The effectiveness of AUB-I treatment depends on the cause of the disease, the extent of bleeding, and the response of each patient to the medicine. Therefore, it is imperative to consult with a healthcare professional to determine the best course of treatment for AUB-I.

Not otherwise classified (AUB-N)

This covers situations where pregnancy does not bring on abnormal uterine bleeding, structural pelvic changes, chronic illness, hormone imbalance, hormonal imbalance, or contraception (Grzechocinska et al. 2017). Myometrial hypertrophy, arteriovenous malformations, and uterine isthmocele caused by the uterine scar from a prior cesarean section are a few possible conditions; this category covers all other causes of problematic periods, including rare causes or conditions where bleeding may not be the main symptom. AUB-N may have a poor prognosis when caused by benign conditions, such as fibroids, polyps, or hormonal imbalances. It may typically be treated effectively with medication, hormone therapy, or minimally invasive procedures such as hysteroscopy or endometrial ablation (American College of Obstetricians and Gynecologists. 2018). In the case of endometrial or cervical cancer, the prognosis may depend on the cancer stage and the patient's response to treatment. Several types of cancer might have a better prognosis if detected early and treated.

An environmental factor can cause abnormal uterine bleeding.

AUB-N is associated with exposure to toxic chemicals, such as polychlorinated biphenyls (PCBs), dioxins, and phthalates, that cause the disease (Havelock et al. 2019). According to some reports, there is also evidence that exposure to air pollution increases the risk of AUB-N development. There has been evidence that chronic stress affects the menstrual cycle and increases the likelihood of developing AUB-N (Hu et al. 2020). People living sedentary lifestyles are likelier to develop AUB-N infections (Kaya et al. 2012) than those who lead active lifestyles. Research indicates that AUB-N risk may be related to the deficiency of certain nutrients,

including iron and vitamin D, that contribute to the development of the disease. Several environmental factors may influence the development of irregular uterine bleeding. It is essential to understand that several factors may cause irregular uterine bleeding and that each case is unique. Environmental factors like exposure to pollutants, toxins, or chemicals may also contribute to AUB (Wouk et al. 2019; Munro et al. 2011).

Abnormal uterine bleeding with leiomyoma

Fibroids in the uterus are sometimes known as leiomyomas or myomas, which develop in uterine myometrial cells and lead to proliferation and differentiation due to various genetic factors and conduct to myometrial hyperplasia by ECM deposition, addition, and angiogenesis through gonadal steroids, estrogen, and progesterone which finally results in the development of uterine leiomyoma (Noel et al.2019) (figure 5). Among these nine classifications, we are primarily concerned with leiomyoma development since it is believed that several factors may contribute to the association between leiomyoma and abnormal uterine bleeding, including changes in angiogenic, environmental, gene-associated, vasoactive substances, and mechanical changes to the uterus (Lasmar et al. 2017).

The role of fibroids (leiomyomas) in the development of AUB

Fibroids and AUB do not appear to interact in a well-understood manner. Fibroids are commonly found in women with perfectly normal bleeding patterns, which is strange. Furthermore, fibroids are more prevalent in female AUB patients. Previous hypotheses include an engorged vasculature associated with a perimyoma environment and an enhanced endometrial surface area (Munro et al. 2012). These enlarged arteries may result in increased circulation, counterbalancing the activity of platelets (Stewart et al. 1996).

Fibroids are associated with various cellular and molecular changes that influence angiogenesis, modulate vasoactive substrates and growth factors, and disrupt coagulation. Myomas affect the endometrium in a broad sense as opposed to being limited to the area containing the myoma. AUB may also be impacted by these changes and the endometrium's receptivity to implantation (Doherty et al. 2014; Sinclair et al. 2011). The matrix metalloproteinases (MMP) -2 and -11 levels are higher in fibroids (Palmer et al. 1998; Bogusiewicz et al. 2007), but it is unclear whether this increases endometrial bleeding. The effect of VEGF, bFGF, PDGF, and PTHrP on the endometrium in fibroids is still unknown, even though all these substances have the potential to be angiogenic. Women with fibroids have higher plasma interleukin (IL)-13, IL-17, and IL-10 in their blood (Wegienka et al. 2013).

Endometrial degeneration and repair have both been associated with immune systems and inflammation. There is no information regarding these polymorphisms. The prevalence of HMB was believed to be higher in women with SM fibroids, particularly those with distorting cavities. A significant degree of cavity distortion in women is widely debated as to whether it poses additional therapeutic challenges.

Genetics of leiomyoma

A uterine fibroid or leiomyoma is a benign tumor that grows in the smooth muscles of the uterus. Leiomyomas are inherently hereditary, although their exact cause is unknown. A variety of genetic factors, including estrogen and progesterone receptors, are capable of influencing leiomyoma development. We have reviewed several potential genes, among which are listed a few. The growth of leiomyomas can be attributed to mutations in genes such as ESR1, PRs, IGF1, TGF-β, FGF, IL-6, and FH, which are responsible for regulating the proliferation of smooth muscle cells.

Role of estrogen and progesterone in leiomyoma and genes associated
Estrogen receptor 1

Numerous cellular functions, including growth, differentiation, and reproductive system operation, are regulated by estrogen. There is a transcription factor encoded by this gene that is activated by ligands and an estrogen receptor encoded by this gene. In many non-reproductive tissues, this gene encodes a protein that regulates the transcription of several estrogen-sensitive genes involved in growth, metabolism, sexual development, gestation, and other reproductive functions. This gene has been associated with breast cancer, endometrial cancer, and osteoporosis. ESR1 (estrogen receptor 1) gene is a protein-coding gene positioned on chromosome 6, the band - 6q25.1-q25.2. Estrogen receptor-alpha (ESR-α), which the estrogen receptor 1 encodes (ESR1), is mainly expressed in uterine tissues.

This receptor is vital in estrogen in premenopausal and menopausal women (tyan et al. 2023). Two significant forms of intracellular estrogen receptors designated ER-α and ER-β have been encoded by distinct genes (Bharathi et al. 2019). Accordingly, several genes have been linked to the development of leiomyomas, and both estrogen and progesterone play key roles in the development and progression of these cancers. The development of innovative treatment methods for leiomyomas may be made possible by understanding the molecular pathways that lead to the development of leiomyomas.

Progesterone receptor

Progesterone receptors (PRs) are nuclear hormone receptors of the NR3C family, containing mineralocorticoid, glucocorticoid, and androgen receptors. They exist as homodimers with Hsp90 or HMGB proteins that are removed upon activation. PR binds to thousands of DNA regions in uterine myomas' smooth muscles, regulating many genes and promoting survival, proliferation, and inappropriate ECM synthesis. Which occurs primarily during childbearing age, whereas insignificant hormone levels cause tumour degeneration due to menopause or GnRH analogue therapy (Maruo et al. 2004; Sabry et al. 2012). At the tissue level, a high standard of progesterone receptor expression in the smooth muscle is also linked to an expanding risk of developing uLM (Omar et al. 2019). However, progesterone is required for uLM development and perpetuation (Ishikawa et al., 2010).

Indeed, progesterone receptors are one of the most popular therapeutic targets in uterine leiomyoma therapy due to using particular progesterone receptor modulators such as ulipristal acetate (UPA) or mifepristone, which can promote apoptosis, suppress proliferation, and decrease tumor development and manifestation (Engman et al. 2009; Murji et al., 2017). The role of estrogen and progesterone in leiomyoma is shown in Figure 6. Proteins activated by progesterone receptors are known as "progesterone receptors." There is an increase in progesterone receptor expression in leiomyomas, suggesting that progesterone plays a critical role in their development. Developing customized treatments for leiomyomas may be possible by understanding the activity and relationship between these genes and progesterone signalling.

Other genes that are associated with leiomyoma development include

Even though mutations in these genes have been associated with developing leiomyomas, not all individuals with these mutations will develop leiomyomas. Leiomyomas are likely to grow depending on hereditary and environmental factors.

Insulin-like growth factor 1 (IGF1)

The IGF system is a combination of the biological system made up of peptide hormones such as insulin-like growth factor-1 and -2 (IGF-I and IGF-2) cell surface receptors and IGF binding proteins (IGFBPs) that synchronize a variety of critical biological processes such as cell migration, differentiation, proliferation, and smooth muscle cell survival. Insulin-like growth

factor-I (IGF-I) is probably one of the growth factors involved in the pathogenesis of fibroids (Swartz et al. 2005). Growth hormone can boost IGF-I synthesis, and its functions include cell proliferation and apoptosis inhibition (Jones et al. 1995). IGF-I promotes cell proliferation in uterine leiomyoma (fibroid) tissue (Jones et al. 1995).

Human myometrium and myoma tissues contain significant levels of extractable IGF-I, far more than other peptide growth factors (Eshet et al. 2004). When steroid hormones are absent, IGF-1 stimulates leiomyoma development, suggesting it is directly involved in leiomyoma pathogenesis. Steroid hormones have a crucial role in the molecular pathophysiology of tumor development as they interact with their receptors to enhance fibroid development (Andersen et al. 1996).

Furthermore, several leiomyoma-related genes regulate IGF1 expression and are believed to be involved in the onset and development of uterine leiomyomas. Additional research is necessary to understand these cancers' molecular mechanisms and identify potential therapeutic targets.

Transforming growth factor-beta

TGF-β signaling has a complicated function in the formation of UFs. TGF-β isoforms and their receptors are expressed in human myometrium and UF malignancies. TGF-β is a potent tumor suppressor in normal smooth muscle cells by inhibiting proliferation and stimulating apoptosis (Ciebiera et al. 2017). On the other hand, overexpression of TGF-β in uterine fibroids has been identified and appears to play a vital role in their growth and disease progression (Ciarmela et al. 2011; Bulun et al. 2013). TGF-β influences the formation of uterine leiomyoma directly or indirectly by modifying environmental estrogen interactions (Shen et al. 2018).

TGF signaling causes molecular alterations that aid in the genesis of leiomyomas. A variety of chemicals or medicines have been linked to the increased TGF signaling in the pathogenesis of leiomyomas, such as genistein (Di et al. 2012), halofuginone (Grudzein et al. 2008), asoprisnil (Ohara et al. 2007), relaxin (Roggero et al. 2009), gonadotropin-releasing hormone-analogs (GnRH-a), and tibolone (De et al. 2006). Although a relationship between TGFB overexpression and leiomyoma has been shown, the underlying mechanisms of TGF signalling in leiomyoma remain elusive (Li et al. 2014). There is strong evidence that TGF-signaling and its downstream targets are essential in developing and progressing leiomyomas. Novel therapeutic methods may be developed for these diseases if we can understand the molecular mechanisms underlying TGF-signaling.

Fibroblast growth factor

FGFs are a cytokine class that serves essential regulatory functions in development, tumourigenesis, hematopoiesis, and wound healing (Wolanska et al. 2006). It is well understood that neoplastic malignancies, including uterine leiomyomas, comprise neoplastic cells and stromal connective tissue. It is involved in tumor growth but also performs in typical cell growth, survival, differentiation, and angiogenesis (Korc et al. 2009). FGF stimulates cell division in endothelial cells expressing the FGFR, directly affecting tumor angiogenesis (Korc et al. 2009).

It has been shown that fibroblasts can interact with neoplastic cells, generates the extracellular matrix (ECM), and stimulate tumor cells to produce/secrete a range of soluble factors and proteins into the ECM, such as growth factors. Furthermore, fibroblasts and the ECM in tumours may benefit tumour progression (Moore et al. 2010). Numerous growth factors in the fibroblast growth factor family are essential to cellular migration, proliferation, differentiation, and growth. Liomyomas, a benign tumour from smooth muscle cells in the uterus, have been linked to FGF.

Interleukin-6

Interleukin-6 is a cytokine that performs a significant role in the communication of cells by the body's defence mechanism. The expression of this can activate the production of cellular components of blood and stimulate immune responses. Lately, it has been studied that cytokines such as IL-6 and tumor necrosis factor-α (TNF-α) contribute to the progression of uterine leiomyoma leading to anemia (Ohta et al. 2020). Along with IL-6, several other growth elements, including transforming growth factor-α, heparin-binding epidermal growth factor, and epidermal growth factor, induce leiomyoma by enhancing the growth of fibrous tissues. The proliferation of cells in the uterus is accelerated by reactive oxygen species and unbound ions (Amballi et al. 2017).

Lately, it has been observed that there is a link between IL-6 and adiponectin. Adiponectin is an inflammatory mediator secreted by adipocytes, whose levels get reduced significantly when there is an increase in the levels of IL-6. It has a higher accumulation of fat, which has a more significant effect on the myometrium and intensifies uterine leiomyomas' growth (Adediji et al. 2019). Figure 7 shows the mechanism of the IL-6 gene. While there is evidence that IL-6 may play a role in the etiology of leiomyomas, more research is required to understand its role in this condition. This gene family regulates various biological processes, including extracellular matrix remodelling, inflammation, and cell proliferation.

Fumarate hydratase gene
Fumarate hydratase (FH) gene mutations are commonly observed in hereditary leiomyomatosis and Reed syndrome. It is sometimes seen in uterine leiomyoma in younger people with a higher rate of incidence (Zhang et al. 2018). It is often associated with the pathogenesis of leiomyoma with bizarre nuclei (LBN), a rare variant of the endometrial neoplasm in the uterus (Gregova et al. 2020). Uterine leiomyomas that are FH-deficient are characterized by the stimulation of the NRF2 mechanism that includes upregulating the NRF2 target gene AKR1B10. The most common features typically observed are perivascular hypercellularity and cellular histopathology (Mehine et al. 2022).

In the case of hereditary leiomyomatosis and renal cell carcinoma, the FH gene is involved in tumor suppression. Biallelic inactivation of the gene causes higher levels of ATP, which is necessary for increased cell proliferation. Later revealed that women of African origin are highly susceptible to uterine leiomyoma (Mochado et al. 2021). The FH gene is responsible for the development of leiomyomas. Patients suffering from these tumors may experience severe clinical outcomes if this gene is changed. The molecular mechanisms underlying leiomyomas must be better understood to identify potentially effective therapeutic strategies for this often debilitating condition.

Conclusion
This review, focusing on leiomyomas, summarizes the prevalence, complications, genetic associations, and hormonal changes related to AUB and its various patterns. The FIGO PALM-COEIN categorization system is crucial for accurate diagnosis and treatment guidance.

Genetic insights into AUB are used to design personalized therapy techniques, identifying mutations affecting hormone control and coagulation pathways. Because genes such as FH, IL-6, FGF, TGF-β, IGF-1, PR, and ESR1 play a role in the pathogenesis of leiomyoma in various ways, such as cell proliferation and matrix remodelling, it may be possible to treat these tumours with targeted therapies. Future research should focus on identifying more complex genetic and environmental connections to improve diagnostic and treatment results. Explore biomarkers for early detection and diagnosis of leiomyomas, given their impact on women's health and quality of life. Collaboration among medical professionals is essential to develop effective treatments for uterine leiomyomas, considering their high prevalence and clinical impact.

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Abbreviations
AUB   abnormal uterine bleeding; FIGO - The International Federation of Gynecology and Obstetrics; PALM polyps adenomyosis leiomyoma malignancy and hyperplasia; COEIN - coagulopathy, ovulatory dysfunction, endometrial, iatrogenic; HPO - hypothalamic pituitary ovarian; FSH - follicle-stimulating hormone; HMB - heavy menstrual bleeding; FCM - ferric carboxymaltose; ID - iron deficiency; IDA - iron deficiency anemia ; TVS - transvaginal ultrasonography; MRI - magnetic resonance imaging; TVUS - transvaginal ultrasound; PCOS - polycystic ovarian syndrome ; ECM - extracellular matrix; EDC - endocrine disrupting chemicals ; ESR - estrogen receptor 1; PR - progesterone receptor; IGF1- insulin-like growth factor 1; TGF-β - insulin-like growth factor beta; FGF - fibroblast growth factor; IL-6 - interleukin-6; TNF-α - tumor necrosis factor alpha; FH - fumaratee hydratase; GWAS - genome-wide association studies.

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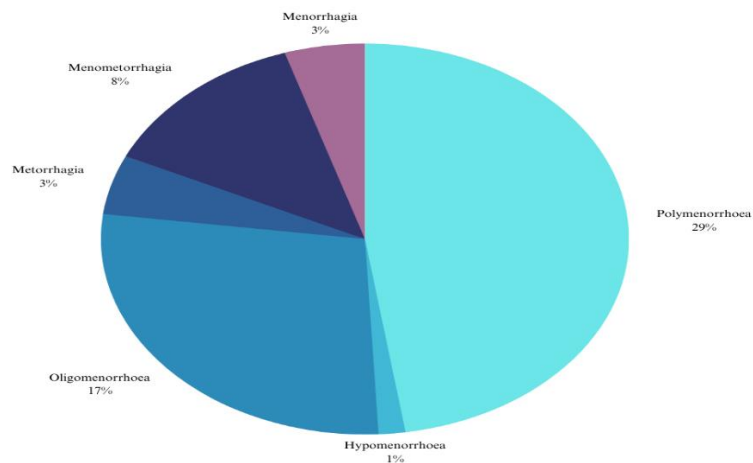
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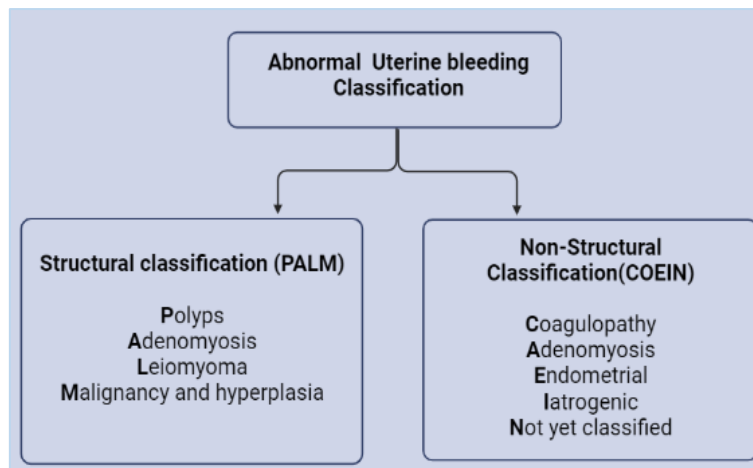
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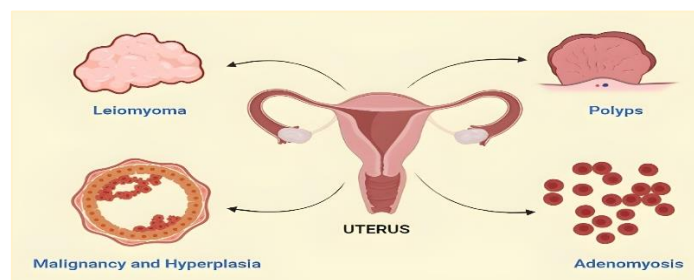
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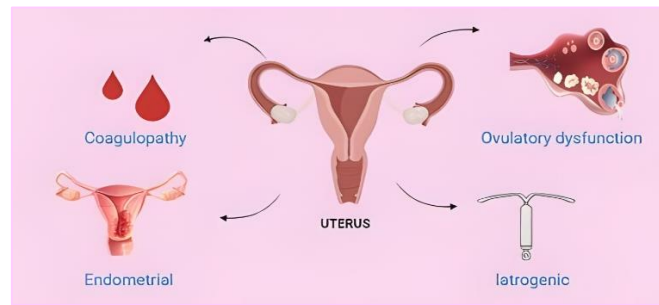
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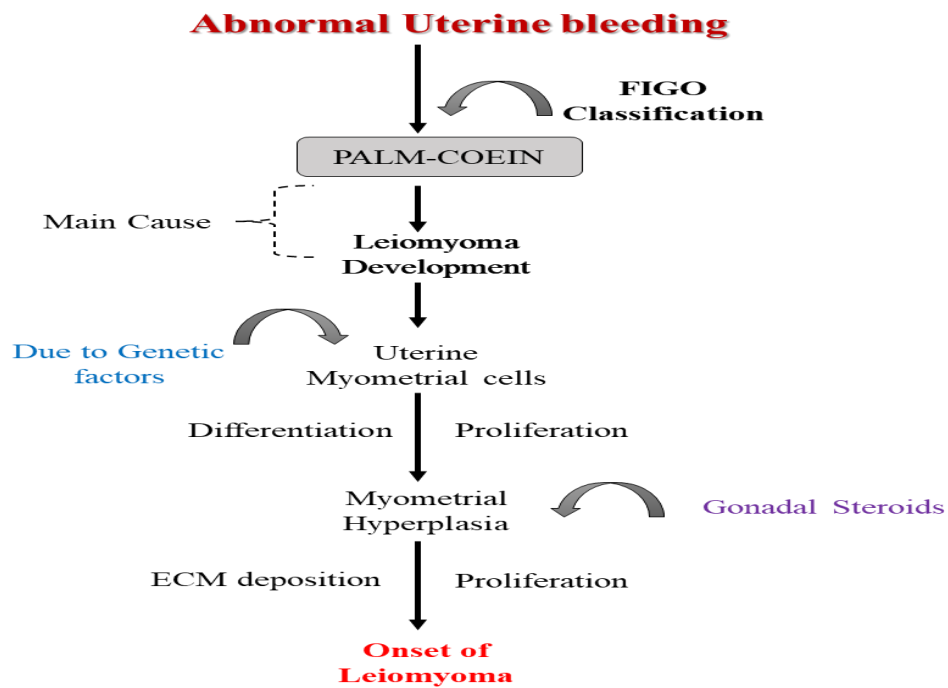
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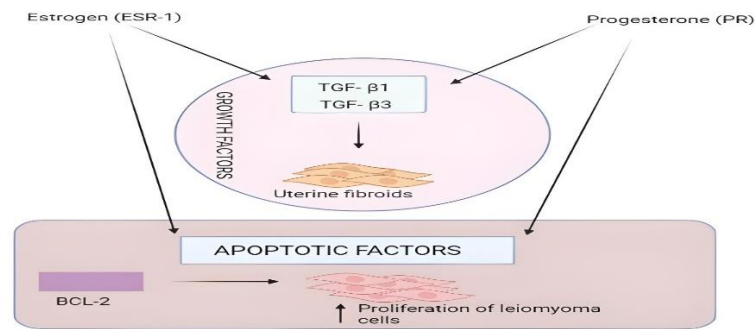
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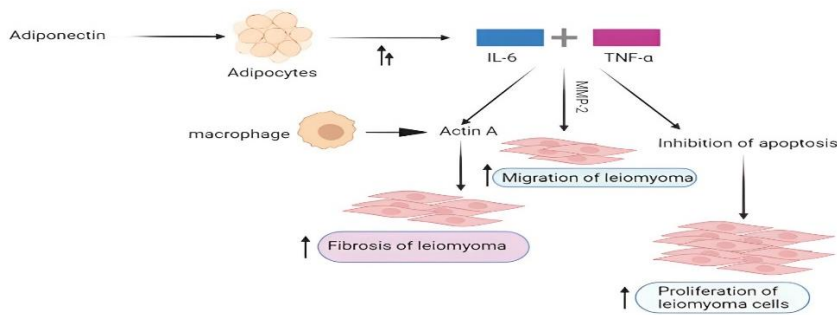
Figure 7. Mechanism of interleukin 6 gene in leiomyoma development

Table 1. An overview of the function, location, amino acids, and exons associated with leiomyoma development and hormones

Name	Gene	Location	Exon	Amino Acid	Function	References
Estrogen receptor-1	ESR1	6q25.1-q25.2	22	595	The ligand-activated transcription factor and the protein encoded by this gene control the transcription of numerous genes. In addition to growth, metabolism, pregnancy, sexual development, estrogen-inducible genes affect several reproductive processes.	[78]
Progesterone receptor	PR	11q22.1	10	933	As a member of the superfamily of steroid receptors, the encoded protein mediates progesterone's physiological effects. This hormone is predominant in reproductive events such as the onset and upkeep of pregnancy.	[80, 81]
Insulin-like growth factor-1	IGF-1	12q23.2	7	195	In terms of structure and function, this protein is similar to insulin. It belongs to a family of proteins that regulates growth and development. A precursor protein is processed, bound by a specific receptor, and secreted. Insulin-like growth factor I deficiency occurs due to mutations in this gene.	[87]
Transforming growth factor-beta	TGF-β	19q13.2	7	390	The TGF-beta superfamily of proteins' secreted ligand is encoded by this gene. These ligands bind to various TGF-beta receptors, causing the recruitment and activating of transcription factors as a result. from the SMAD family that control gene expression which regulates cell proliferation, differentiation, and growth factors such as tumour necrosis factor-alpha and interferon-gamma	[91]
Fibroblast growth factor	FGF	4q28.1	3	822	The protein encoded by this gene is a member of the immediate family of fibroblast growth factors (FGF). Several FGF family members have strong and broad mitogenic and angiogenic properties and can bind heparin. This protein modulates several biological processes, including the growth of the nervous system and limbs, the healing of wounds, and tumour growth.	[101]
Interleukin -6	IL-6	7p15.3	5	212	This gene produces a cytokine that activates the interleukin 6 receptor alpha to trigger transcriptional inflammation at acute and chronic inflammation sites. Additionally, it has been demonstrated that the encoded protein functions as an endogenous pyrogen that can cause fever in persons with autoimmune disorders or infections.	[105]
Fumarate hydratase	FH	1q43	10	510	A gene that produces an enzyme that assists cells in the body in using oxygen and producing energy. Cells with mutated (modified) fumarate hydratase genes may lose their capacity to utilize oxygen. As a result some cells particularly cancer cells and abnormal cells may develop more rapidly.	[108]

Secondary School Food Environment and Purchase Choices of Adolescents in Mbeya City

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Abstract

Background: Increasing levels of overweight and obesity among adolescents are quite alarming worldwide. Among the depicted causes is poor diet, in which the food environment plays a major role in contributing. Still, little is known about adolescents and the school food environment they are exposed to in Tanzania.

Objective: This study aimed to explore the secondary school food environment and document food and drink mostly purchased by secondary school adolescents

Methodology: This cross-sectional study involved 8 secondary schools in Mbeya City, 384 secondary school adolescents and 35 food outlets. Aspects of the food environment studied were under the external domain, food availability, price and promotion and policy and guideline. Personal domain: accessibility, affordability and desirability. Direct observation was used in food outlets with the help of an observation tool adopted from the Nutrition Environment Measure Survey. Structured interviews were done with the school administrators or teachers responsible for nutrition issues in school with the help of a questionnaire designed based on WHO Nutrition Friendly Schools Initiative. Also, a student purchased a recall questionnaire designed based on the Nutrition Environment Measure Survey, which also helped identify the adolescents' demographic characteristics. Descriptive statistics and ordinal logistic regression were used to establish prevalences and associations between variables.

Results: Most available food outlets outside the school were retail shops and canteens inside the schools. The foods most purchased by adolescents are sweets, fried snacks, and sugar-sweetened beverages. Most adolescents purchase their food and drinks in school shops and canteens. Cereal-based foods are most available, while fruit and vegetables are least available inside and outside school. Adolescents care most about taste and least about nutrition and weight control while purchasing food and drinks. Demographic characteristics like age, level of education, and the type of school adolescents attend are associated with purchasing certain foods.

Conclusion: Secondary schools have weak policies and guidelines on the food environment, and they are filled with ultra-processed foods, fried snacks, and sugar-sweetened beverages. Adolescents respond to their environment by purchasing what is most available. Adolescents' responses depend on their age and the school type, either public or private. This situation calls for effective planning and interventions from the national to the institutional/school levels to ensure a nutrition-enabling environment is created in secondary schools.

Introduction

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Increasing levels of overweight and obesity among adolescents are quite alarming worldwide, where one in five adolescents is either obese or overweight (WHO, 2020). The scenario is similar

in Sub-Saharan countries, except that this area also struggles with undernutrition, making it double the burden of malnutrition among children and adolescents (Berhane *et al.,* 2022).

A major contributing factor causing the rise, especially among adolescents, is the shift from consuming fresh and minimal processed foods to ultra-processed foods (Venurs *et al.,* 2021). Among the factors that have been recognized to influence the consumption of these foods is the food environment, which affects societal and individual food choices (FAO, 2022). This, in turn, affects adolescents' dietary behaviours and diets (Beck *et al.,* 2019).

The food environment is built on the understanding and acknowledgement that people are exposed to various choices in obtaining and consuming food. (Pacific *et al.,* 2020)It has been defined as the interface that mediates people's food acquisition and consumption within the wider food system. This system encompasses external dimensions such as availability, prices, vendor and product properties, and promotional information, as well as personal dimensions such as the accessibility, affordability, convenience, and desirability of food sources and products (Turner *et al.*, 2017).

It has been reported that a significant part of the diet of millions of adolescents is consumed at schools during school hours. (FAO, 2022). At the same time, adolescents in different countries have been reported to be exposed to high-fat, high-sugar, high-salt, energy-dense, and micronutrient-poor foods, which has contributed to the rise of obesity (WHO, 2021). This can be explained as a response to the two-way relationship between food environment and dietary behaviour(Pacific *et al.,* 2020)In different countries, some secondary school adolescents eat lunch prepared and sold within schools (Stevens et al., 2013). Other adolescents bring food and drink from home to consume at school, whereas some purchase and consume food or drink from local retailers around school. Some go home to eat lunch, while others do not eat or drink during school hours (Tugault-Lafleur & Black, 2020).

School food environment is the spaces, infrastructure and conditions within and beyond school premises where food is available, obtained, purchased and consumed (FAO, 2019). School Food environment consists of several types of retail food establishments present within and around schools. Characteristics of the school food environment include targeted marketing, availability and access to unhealthy food, which contribute to the school environment being unhealthy. This, consequently, influences the nutritional status of adolescents. (da Costa Peres *et al*., 2020; Gewa *et al.*, 2021).

For adolescents, these elements of the food environment led to a greater preference for foods with low nutritive value and ultra-processed foods (Popkin & Reardon, 2018). At the same time, these dietary patterns are believed to underlie the nutrition transition and double the burden of malnutrition in many Low-middle-income countries (International Food Policy Research Institute, 2017). That is why, in different countries, it has been suggested that comprehensive interventions should be conducted to improve the school food environment to prevent the double burden of malnutrition (Mukanu *et al.,* 2022; High-Level Panel of Experts, 2017; WHO, 2016).

However, the degree of choices adolescents experience means that policymakers and program planners must understand the food purchased and consumed inside and outside schools and the factors relating to these practices. This will develop effective intervention strategies and improve the nutritional status of the adolescents (Wills *et al.,* 2019). Therefore, this area of research has established a gap in many countries (Franca *et al.,* 2022). Research topics concerning adolescents are still evolving in Tanzania because little is known about them. Although there is information on food consumption and nutrition status (John *et al.,* 2021), information on the food environment is scarce, especially about the secondary school food

environment. Therefore, this study aimed to explore the school food environment and document foods and drinks mostly purchased by secondary school adolescents.

Methodology
Study design, area and participants
A cross-sectional study was conducted in Mbeya City. Mbeya City covers a total area of 222 sq. Km, 46.4% of this area is under agriculture, and 53.6% is used for other uses, which include settlements, forestry, valleys, and mountain ranges. Mbeya City Council has a total population of 385,279 inhabitants, of which 182,620 (47%) are male and 202,659 (53%) are female. The city is considered a highland characterized by a mode climate and sufficient rainfall, with major economic activities such as commerce and trade, agriculture and livestock keeping, small-scale and large-scale production, and service provision (MCC, 2018). It has 36 wards and 51 secondary schools (23 private schools). It is in the region with high levels of stunting and among leading regions with high levels of overweight and obesity among adolescents (John *et al.,* 2021).

The study involved male and female adolescent students, ages 14 to 19 years (WHO, 2016), who attended ordinary-level (From 1 to 4) secondary schools in private and public schools. Multistage sampling was conducted, and four wards in Mbeya city were purposively selected to have both private and public schools on both days. Schools in each selected ward were clustered into private and public schools. One private and public day school was randomly selected in each ward, which resulted in 8 schools being recruited in the study. 48 students were stratified and randomly selected from form one to form four in selected schools by considering forms/grades and sex. Kothar's formula (kothar, 2004) was used to calculate the sample size. A total of 384 students participated in the study. Participating schools and subjects were given codes to maintain anonymity and confidentiality.

Data collection
Socio-demographic and food environment characteristics were assessed using structured interviews and direct observation.

Food environment
Two domains of the food environment, external and personal domains, were explored in this study.

External domains of the food environment
The availability of foods, prices, marketing, and regulations were explored in this domain, including the availability of different food groups and varieties of food items under each food group sold in food outlets. Another aspect is the price of food items under the food groups. Also, promotional activities and advertisements to promote food purchasing. This was observed inside and outside schools and food outlets. Google Earth was used to find approximate coverage of 800m from the selected schools (Figure 1), and the physical survey was done to recruit the food outlets around the school by considering that they are visited frequently by students of the neighbouring participating schools. A total of 35 food outlets located inside and outside 8 participating schools were studied. Food 'outlets' were defined as any shop/place selling foodstuff, including grocery stores, food vendors of take-out foods, minimarkets, supermarkets,

bakeries, milk kiosks or restaurants. Then, structured observation was done with the help of the store observation tool adapted from the Nutrition Environment Measures Survey (NEMS, 2010). This was used to assess availability, prices and promotion.

The last aspect under external domains was policy and guidelines governing the food environment inside and around schools. Three aspects were considered. First was the recommended package of school-based nutrition services. In this aspect, food vendor guidelines/regulations, physical activities packages, WASH infrastructure/ practice packages, School feeding program packages and dietary guidelines availability were considered. The second aspect was whether nutrition is taught in school or not. Then, Nutrition and WASH Services, whereby this study focused on school feeding services, clean water availability, toilet cleanliness and repair services. Also, are the services offered daily, per term, when needed, or never? Data were collected with the help of structured interviews with the school's nutrition teacher or a teacher who is an expert or responsible for nutrition issues. The questionnaire was designed based on the WHO Nutrition Friendly Schools Initiative (WHO, 2020).

Personal domains of the food environment
The domains in focus were accessibility, affordability and desirability. The aspects studied were as follows: a place where food outlets are located either inside or outside the school and purchasing power, assessed using student allowances. Lastly, attitude on taste, nutrition, cost, convenience and weight control when purchasing food. This was done with the help of structured interviews guided by purchasing a recall questionnaire designed based on the Nutrition Environment Measures Survey (NEMS, 2010). Also, participants were given a list of 54 foods normally sold in food outlets to assess food items most purchased among students. Whereby during interviews, Nutrition was defined as the study of nutrients in food, how the body uses nutrients, and the relationship between diet, health and disease (Beauman *et al.,* 2005). Convenience was defined as a quality of food that makes it easy to be consumed by reducing amount of time and work required to consume or prepare it.
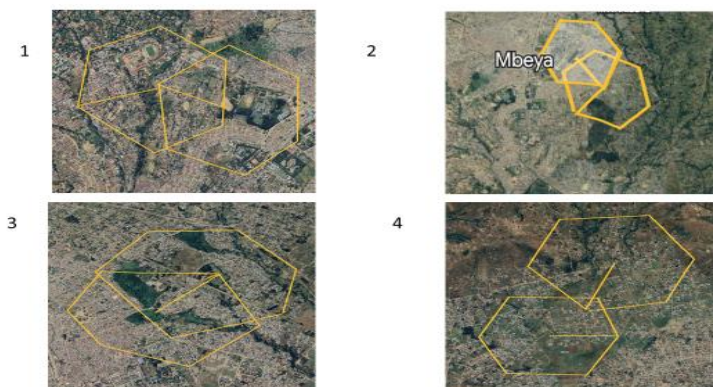
Figure 1: Approximate Coverage Area (800m) Around school obtained from Google Earth

Data analysis

A statistical package for social sciences (SPSS version 21) was used for the data analysis. Data were presented as numbers, frequencies and percentages. Descriptive statistics were used to analyse the food environment's demographic characteristics and external and personal domains. Ordinal logistic regression was used to test the association between socio-demographic characteristics (independent variable) and most food and drink purchases (dependent variable) among adolescents. All p-values were significant at p<0.05

Ethical clearance
Ethical clearance was sought from the National Health Research Ethics Sub-Committee (NatHREC) of the National Institute for Medical Research (NIMR), Tanzania, with the reference number NIMR/HQ/R.8a/Vol.IX/4315. Permission to conduct this study was also sought from relevant authorities, including the Regional Administrative Secretary to District Executive Directors and respective school authorities. The purpose of the study was well explained to the school administrators, students, and caregivers (staff or teachers responsible for meals) before commencement. Assent was sought from students, and their caregivers signed the consent form. The school administrators signed consent forms for their schools and caregivers' consent for the students under 18 years, while students aged 18 years and above signed their consent forms after they all agreed to participate in the study. Consent was sought from food vendors, and they signed consent forms after the study was explained to them well. Confidentiality of the information obtained was assured, and participation was voluntary.

Results
384 students from eight secondary schools (four private and four public schools) participated in this study. Of these, 195 (50.8%) were female and 189(49.2%) were male. The age of respondents at recruitment ranged between 14 and 19 years, with a mean (±SD) of 15.5(±1.2). Half (50%) of the participants were from private schools and the other half (50%) from public schools. On the level of education, 101 (26.3%) students were in form one, 88(22.9%) were in form two, 98(25.5%) were in form three and 97(25.3%) were in form four. Food purchasing among adolescents was characterised by deep-fried buns being the most (100%) bought food among adolescents, being in the top ten list of most bought foods, and potato chips being last in the list (51.4%) **(Table 1).**

Personal domains of the food environment
Three aspects were studied. First, affordability, where most adolescents (70.8%) had school allowances ranging from 500-1500TZS. Another aspect was desirability; it was observed that among adolescents' taste was the most somewhat or very important considered (84.9%) factor while purchasing food items, and the least considered factors were nutrition (48.4%) and weight control (40.0%) **(Table 2)**. In the case of accessibility whereby, there was a difference in the availability of food outlets inside and outside schools. Canteens are the most available food outlets (42.1%) inside schools, and retail shops are the most available food outlets (38.9%) outside schools **(Table 3)**. Most students accessed food from the school canteen and shops **(Figure 2)**.

External Domains of Food Environment
Under the availability domain, results showed that cereal-based foods were the most available food items (74.2%) in food outlets, and vegetables and fruits were the least since 80.0% and 82.9% of food outlets were not selling vegetables and fruits, respectively. Another aspect was price, where the food group with the highest price was drinks (3500TZS), and the lowest was

snacks and fruits, with a price of 50TZS. Regarding Advertisement and promotion, the only promotion activities done among food outlets was to provide an option to ask for ½ portion or reduced portions for reduced value **(Table 4).**

The last aspect of external domains studied was policy and guidelines. We focused on three aspects studied: firstly, a recommended package of school-based nutrition services, and in this aspect, all schools had food vendor guidelines/regulations, physical activities packages, WASH infrastructure/ practice packages, and school feeding program packages. However, none had a dietary guideline. The second aspect is that all schools taught nutrition, and the topics covered were physical activities, hygiene, and healthy eating practices. However, no topics related to unhealthy foods and beverages were covered. Third, in all schools' clean water was available daily, and toilets were cleaned daily and repaired when needed; however, none provided school feeding services **(Table 5).**

Association between demographic characteristics and most purchases among adolescents
The relationship between demographic characteristics and most food and drink purchases among adolescents was explored by testing the association between personal domains of food environment, demographic characteristics and food purchasing. Where age had a positive association with purchasing of bags ($\beta=0.518$, $p=0.002$), Chapati ($\beta=0.625$, $p\leq0.001$), fried cassava ($\beta=0.540$, $p=0.002$), potato chips ($\beta=0.615$, $p\leq0.001$) and Sweets ($\beta=0.369$, $p=0.020$). Level of education had a positive association with purchasing foods like chapati ($\beta=1.607$, $p=0.004$), fried cassava ($\beta=1.913$, $p=0.002$), potato chips ($\beta=1.381$, $p=0.011$) and sweets ($\beta=1.210$, $p=0.019$). At the same time, public schools had a negative association with purchasing of some foods like bagia ($\beta=-0.872$, $p=0.001$), kachori ($\beta=-0.994$, $p\leq0.001$), potato chips ($\beta=-0.899$, $p\leq0.001$) and processed juice ($\beta=0.65$, $p=0.005$) **(Table 6).**

Table 1: Socio-demographic information of the adolescents

Characteristics	N	%
Mean age (standard deviation)	15.5(±1.2)	
Type of the school of the respondent		
Public	192	50
Private	192	50
Age of the respondent		
14	109	28.4
15	96	25.0
16	95	24.5
17	61	15.9
18	22	5.7
19	2	0.5
Level of Education		
Form one	101	26.3
Form two	88	22.9
Form three	98	25.5
Form four	97	25.3

Gender of the respondent		
Male	189	49.2
Female	195	50.8
Most bought foods and drinks among adolescents		
Deep fried buns		
Bought	358	100
Not bought	0	0
Chapati		
Bought	241	67.3
Not bought	117	32.7
Bagia		
Bought	240	67.0
Not bought	118	33.0
Kachori		
Bought	213	59.5
Not bought	145	40.5
Deep fried Cassava		
Bought	279	77.9
Not bought	79	22.1
Potato chips		
Bought	184	51.4
Not bought	174	48.6
Sweets		
Bought	294	82.1
Not bought	64	17.9
Carbonated drinks		
Bought	220	61.5
Not bought	138	38.5
Energy drinks		
Bought	191	53.4
Not bought	167	46.6
Processed juices		
Bought	217	60.6
Not bought	141	39.4

Table 2: Personal domains of food environment		
Food environment aspect	n	%
AFFORDABILITY		
Purchasing power		
None	26	6.8
500-1500TZS	272	70.8
1600-2500TZS	60	15.6
>2500TZS	23	6.0
DESIRABILITY		
Attitude when purchasing food		
Taste importance	34	8.9
Not at all important	138	35.9
Somewhat important	188	49.0

Very important		
Nutrition importance	174	45.3
Not at all important	124	32.3
Somewhat important	62	16.1
Very important		
Cost importance	79	20.6
Not at all important	174	45.3
Somewhat important	107	27.9
Very important		
Convenience importance	84	21.9
Not at all important	163	42.4
Somewhat important	113	29.4
Very important		
Weight control	203	52.9
Not at all important	94	24.5
Somewhat important	63	16.4
Very important		

Table 3: Food outlets inside and outside schools

	Type of food outlet available	(n)	(%)
	School canteen/ cafeteria	7	41.2
inside	Retail shop	2	11.8
school	School shop	4	23.5
	Food vendors (mixed foods)	1	5.9
	Food vendors (deep fried snacks)	3	17.6
	Milk kiosk	1	5.6
	Retail shop	7	38.9
outside	Food vendors (mixed foods)	2	11.1
school	Food vendors (deep fried snacks)	6	33.3
	Food vendors (fruits)	2	11.1

Table 4: external food environment in school

FOOD ENVIRONMENT ASPECTS	Number of outlets(n)	%
FOOD AVAILABILITY IN STORES		
Cereal based foods		
1-5 varieties	26	74.2
5-10 varieties	1	2.9
0	8	22.9
Starchy roots and tubers		
1-5 varieties	17	48.6
0	18	51.4
Fruits		
1-5 varieties	3	8.6
5-10 varieties	3	8.6
0	29	82.9
Vegetables		
1-5 varieties	6	17.1

0	29	80.0
Snacks		
1-5 varieties	5	14.3
5-10 varieties	6	17.1
10-15 varieties	6	17.1
>20 varieties	1	2.9
0 varieties	17	48.9
Prepared dishes		
1-5 varieties	11	31.4
5-10 varieties	1	2.9
0	23	65.7
Beverages		
1-5 varieties	1	2.9
5-10 varieties	6	17.1
10-15 varieties	8	22.9
0 varieties	20	57.1
FOOD PRICE IN FOOD OUTLET(TZS)		
Cereal based foods		
Highest prices	3000	-
Lowest prices	100	-
Starchy roots and tubers		
Highest prices	2000	-
Lowest prices		-
Fruits		
Highest prices	1000	-
Lowest prices	50	-
Vegetables		
Highest prices	500	-
Lowest prices	200	-
Snacks		
Highest prices	3000	-
Lowest prices	50	-
Prepared dishes		
Highest prices	2500	-
Lowest prices	200	-
Beverages		
Highest price	3500	-
Lowest price	100	-
ADVERTISEMENT AND PROMOTION		
Visual advertising encouraging the purchase of sugar-added drinks or soft drinks	0	0
Yes	35	100
No		
Visual advertising encouraging the purchase of fruits, legumes and vegetables	0	0
Yes	35	100
No		
Visual advertising encouraging the	0	0

purchase of biscuits, balls and snacks Yes	35	100
No	0	0
Other advertisement within and outside the store yes	35	100
No	0	0
Nutritional information about the products offered on the wall/or in folders available to customers	35	100
Yes	0	37.1
No	35	62.9
Option to ask for ½ portion or reduced portions for reduced value		
Yes		
No		

Table 5: **Policy and Guideline Environment**

	Yes (n (%))	No (n (%))
Recommended package of school based nutrition services		
Food vendor guidelines/regulation	8(100)	0(0)
Physical activities	8(100)	0(0)
School feeding program	3(37.5)	5(62.5)
WASH infrastructure/ practice	8(100)	0 (0)
Dietary guideline	0(0)	8(100)
Mandated guidelines for nutrition studies	8(100)	0(0)
Do you teach nutrition or nutrition related topics in this school?	8(100)	0 (0)
Topic covered		
Health eating practices	8(100)	0 (0)
Physical activity	8 (100)	0 (0)
Unhealthy foods and beverages	0 (0)	8(100)
Hygiene	8(100)	0 (0)
Nutrition and WASH Services		
School feeding services		
Daily	-	-
Per term	-	-
When needed	-	-
Never	8 (100)	0(0)
Clean water		
Daily	8(100)	0(0)
Per term	-	-
When needed	-	-
Never	-	-
Toilet cleaned		
Daily	8(100)	0(0)
Per term	-	-
When needed	-	-

Never	-	-
Toilet repaired		
Daily	-	-
Per term	-	-
When needed	8(100)	0(0)
Never	-	-

Figure 2: Source of food among secondary school adolescents
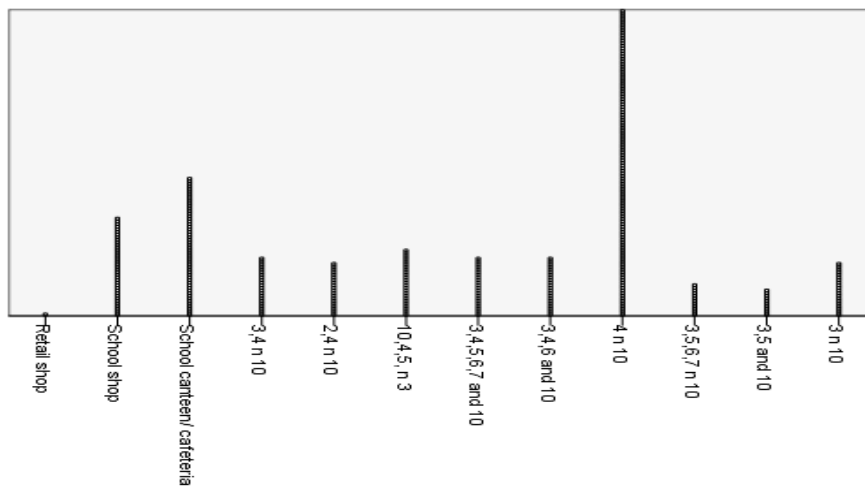
*1-supermarket, 2-minisupermarket, 3-retail store, 4- school shop, 5- food vendors (mixed foods), 6- food vendors selling deep fried (snacks), 7- food vendors selling fruit, 8- ice cream vendors, 9-milk kiosk and 10- school canteen/cafeteria

Table 6: Association between most bought food items and demographic characteristics and personal domain of food environment

Characteristics	Bagia	Chapati	Fried cassava	Kachori	Potato chips	Sweets	Carbonated drink	energy drink	Processed juice
Demographic Characteristics	β (CI)	β (CI)	β (CI)	β (CI)	β (CI)	β (CI)	β (CI)	β (CI)	β (CI)
Type of school									
public school	**-0.872*** **(-1.396-0.375)**	-0.180 (0.666-0.307)	-0.193 (-0.737-0.351)	**-0.994*** **(-1.455-0.533)**	**-0.899*** **(-1.364-0.434)**	-0.380 (-0.824-0.064)	-0.358 (-0.811-0.095)	-0.419 (-0.865-0.027)	**-0.651*** **(-1.109-0.193)**
private school	ref	ref	ref	ref	ref	ref	ref	ref	ref
level of education									
form 1	0.736 (-0.336-1.808)	**1.607*** **(0.509-2.706)**	**1.913*** **(0.686-3.139)**	0.321 (-0.972-1.313)	**1.381*** **(0.319-2.443)**	**1.210*** **(0.201-2.219)**	-0.413 (-1.398-0.572)	0.688 (-0.289-1.665)	-0.102 (-1.099-0.895)
form 2	**1.257*** **(0.348-2.166)**	**1.165*** **(0.233-2.097)**	**1.167*** **(0.119-2.214)**	0.187 (-0668-1.042)	**1.332*** **(0.420-2.243)**	**0.932*** **(0.065-1.799)**	-0.396 (-1.244-0.452)	0.467 (-0.373-1.307)	0.040 (-0.820-0.899)
form 3	-0.221 (-0.963-0521)	0.547 (-0.187-1.280)	0.787 (-0.053-1.628)	-0.041 (-0.724-0.642)	0.579 (-0.120-1.278)	0.370 (-0.295-1.035)	-0.269 (-0.937-399)	0.082 (-0.582-0.746)	0.130 (-0.554-0.814)
form 4	ref	ref	ref	ref	ref		ref	ref	ref
Age	**0.518*** **(0.194-0.843)**	**0.625*** **(0.299-0.951)**	**0.540*** **(0.191-0.888)**	0.080 (-0.219-0.378)	**0.615*** **(0.284-0.946)**	**0.369*** **(0.059-0.680)**	-0.101 (-0.042-0.199)	0.065 (-0.232-0.361)	-0.174 (-0.478-0.130)
Gender									
male	ref	ref	ref	ref	ref	ref	ref	ref	ref
female	0.259 (-0.0936-0.079)	-0.353 (-0.846-0.141)	-0.055 (-0.601-0.492)	-0.182 (-0.646-0.281)	-0.164 (-0.633-0.306)	0.256 (-0.194-0.707)	-0.049 (-0.508-0.411)	0.163 (-0.290-0.616)	0.276 (-0.189-0.741)

Ordinal logistic regression, p<0.05, B-Coefficient, CI-Confidence interval. Deep fried buns could not be involved since it cannot provide any results statistically since it was consumed by all adolescents.

Discussion

The study focused on exploring the secondary school food environment in Mbeya city, where external and personal domains of the food environment were studied, including accessibility, availability, prices, marketing and regulation, affordability and desirability. Retail shops mainly surrounded schools, but adolescents' leading food sources were canteen and school shops, consistent with what has been reported in other places (Pauuvale *et al.,* 2022; Londoño-Cañola *et al.,* 2023). In terms of food purchasing, the study found that adolescents purchase mostly fried snacks, sweets and sugar-sweetened beverages like what has been reported in other studies exploring food purchasing among adolescents (da Costa Peres *et al*., 2020; Leite *et al.,* 2022; Mukanu *et al.,* 2022).

This study's external domains of the food environment have shown how much students are exposed to cereal-based food and less fruits and vegetables, as other studies have reported (França *et al.,* 2022; Mukanu *et al.,* 2022). Most of these foods were ultra-processed foods and fried foods, and they are found within school premises, which is different to what has been reported in other places where foods like these were found outside school (Wills *et al.,* 2019; França *et al.,* 2022), which shows weak policies and dietary guideline in secondary schools. That has been evident in this study since all the participating schools had food vendor guidelines; they were not specifically tailored to support a nutritious environment in schools, like what has been reported in other places (Bassi *et al.,* 2021). Also, although the schools taught nutrition-related topics, they were only in biology studies and never included healthy and unhealthy food and drinks (Reeve *et al.,* 2021).

This is because schools have guidelines for nutrition studies at the regional level but no actual mandated curriculum for nutrition studies in the country. This showed immediate effects on the adolescents by showing pictures of the top ten list of food items purchased among students, which was made of snacks, oily foods and sugar-sweetened beverages, which have also been reported by other studies (Bassi *et al.,* 2021). Results showed advertisement and promotion inside and outside the school, and food outlets was almost not existing, which shows that promotion activities in the school environment may not affect the purchasing of food around the school environment; this report different from what other studies have reported (Bassi *et al.,* 2021; Reeve *et al.,* 2021). However, it could be explained by the fact that this study did not involve promotion activities and advertisements, such as social media and Television advertisements, that happen away from the school environment but only focused on the promotion activities done inside and outside schools and food outlets.

Results also showed adolescents cared less about nutrition and weight control but taste while purchasing foods, which was also reported in other studies (Wills *et al.,* 2019; Leite *et al.,* 2022). Also, cost and convenience were some factors that were somewhat considered necessary by many adolescents, as other literature has reported (Wills *et al.,* 2019). Demographic characteristics showed an important role in food purchasing, where purchasing of some foods like bags, fried cassava, chapati, potato chips, and sweets increased with age. Bags, kachori, potato chips and processed juice were not likely to be purchased in public schools, which is unlike what has been reported that public school adolescents are exposed to more fast foods and, therefore, tend to purchase and consume unhealthy foods more than private school adolescents (França *et al.,* 2022).

This study could be explained by the variations in purchasing power among private and public-school adolescents. This is similar to what has been reported in other studies (Carmo *et al.,* 2018). Also, purchasing of chapati, fried cassava, potato chips and sweets was higher among

lower grades/ forms compared to those in upper grade/forms, which shows their preference for some foods compared to their fellow older adolescents, which is like what has been reported (Will *et al.,* 2021).

Limitations of the study

As much as this study's novelty is relevant in the country, it has covered most aspects of the food environment and can provide a representative picture of the secondary school food environment. However, some aspects could have been captured better by incorporating more qualitative methods in data collection, especially in finding factors influencing students' food purchasing. This would enhance the view of what happens as adolescents access and consume food inside and around schools.

Conclusion and recommendation

Ultra-processed foods, fried snacks, and sugar-sweetened beverages characterise the secondary school food environment. Adolescents respond depending on their age and the type of school they attend, either public or private; they respond to their environment by purchasing what is most available. Also, schools have a weak policy environment to support an excellent nutrition-enabling environment.

     Limited information about the school environment is still a hindrance in planning and executing interventions and policies that could help solve the problem of malnutrition among adolescents in Tanzania. Therefore, more research is needed to explore this area in the country. Not only that, but also, at the organisation/school level, teachers should be capacitated to deliver nutrition education and communication messages to students so they may be aware of unhealthy and healthy foods and the consequences to their nutrition and health status. This could begin with creating a mandated curriculum for nutrition studies for secondary schools and other education levels. Promotion/modification of school food policy/environment at national and school levels are obliged to set policies and laws that will guide types of foods that should be available in schools and hence promote the creation of an excellent nutrition-enabling food environment.

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Antibacterial Activity and Synergism of Sapium ellipticum (Hochst.) Pax and Harungana madagascariensis (Lam. Ex Poir) Stem bark Extract against Methicillin Resistant Staphylococcus aureus

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Abstract

Background: The increase in infections involving anti-microbial resistant (AMR) bacteria like Methicillin-resistant Staphylococcus aureus (MRSA) has limited therapeutic options and has been consistently found to be among the top causes of threats to global health. Combining antibacterial agents and/or medicinal plants has minimized this AMR crisis worldwide.

Aim: This study aimed to investigate *in vitro* synergistic antibacterial activity of *Sapium ellipticum* (Hochst.) Pax and *Harungana madagascariensis* (Lam. Ex Poir) stem bark extracts against Methicillin resistant *Staphylococcus aureus* (MRSA).

Methods: The MRSA clinical isolates were identified phenotypically and genotypically before being used as test microorganisms. Stem bark plant extracts of S. ellipticum and H. madagascariensis were prepared using methanol and dichloromethane solvents. Screening of antibacterial activities of plant extracts was done using the agar-well diffusion method, and minimum inhibitory concentration (MIC) determination was done by serial microdilution technique.

Results: The MIC for individual extracts ranged from 1.56 - 6.25 mg/mL, while MIC for combined extracts ranged from 0.2 - 0.8 mg/mL. Combined extracts were significantly more active than individual extracts. The study discovered synergistic interaction when combining methanol or dichloromethane extracts of *S. ellipticum* and *H. madagascariensis* against MRSA isolates. The suitable combination ratio for methanol and dichloromethane extracts was 1:1, though a 3:1 ratio also resulted in synergistic interaction in the methanolic combination.

Conclusion: The differences in MIC range between the individual and combined extracts might be attributed to the concentration and composition of the extracts. These results provide promising information for using methanol or dichloromethane crude extracts of *S. ellipticum* and *H. madagarscariensis* stem barks in synergism against MRSA isolates.

Keywords: Synergistm, Antibacterial activity, Plant extracts, and Methicillin-resistant *Staphylococcus aureus*

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Introduction

Medicinal plants possess drug-comparable properties and thus have been used throughout the history of mankind as substantial sources for modern drugs (Kumar Shakya and Arvind Kumar Shakya 2016). Early drugs discovered from plants include aspirin isolated from willow bark and morphine isolated from opium poppy (Anand et al. 2019). Currently, drugs produced from medicinal plants include artemisinin, used as an antimalarial, bicyclol in the treatment of hepatitis and albicidin as an antibiotic (Anand et al. 2019).

Sapium ellipticum is a jumping seed tree (Macdonald et al. 2016). Scientific studies that have been carried out on *S. ellipticum* extracts showed significant anti-plasmodial, anti-oxidant, antifungal, antibacterial and anti-human immunodeficiency virus activities (Masalu et al 2020; Masalu and Mpinda 2021). *Harungana madagascariensis* is a bushy tree, and its fruits, stem bark, roots, and leaves have been reported in the literature as having antibacterial, antifungal, antiprotozoal and antioxidant activities (Oe and Me 2020). Literature reported these plants' phytochemical composition of different morphological parts (Mouthé et al. 2019, Oe and Me 2020 and Abogo Mebale et al. 2022). Other reports show these plants' use and status in managing opportunistic infections (Kisangau et al. 2007, Kisangau et al. 2009, Amenu 2014 and Mpinda et al. 2018).

Rising of infections involving anti-microbial resistant (AMR) bacteria like methicillin-resistant Staphylococcus aureus (MRSA) have limited therapeutic options and have been consistently found to be among the upper source of threat to human health globally, with WHO estimating about 70% of AMR-related deaths globally (Kehinde Peter et al. 2020). MRSA alone caused more than 100,000 deaths globally, according to a recent systematic analysis in the Lancet in 2019 (Masimen et al. 2022).

Normally, *Staphylococcus aureus* exhibits resistance to methicillin by expression of the mecA gene, which marks in production of modified penicillin-binding proteins (PBP2a) (Reichmann and Pinho 2017). Another gene known for its resistance to drugs is FEMA (Lozano et al. 2016). The resistance of bacteria to antibiotics may arise through different mechanisms, such as inhibiting membrane absorptivity to antibiotics and producing enzymes that neutralize antibiotics (Cheesman et al. 2017). For enzyme mutation example, the β-lactamase enzyme cleaves the β-lactam ring and inhibits it from attaching to the PBPs, such as peptidoglycan transpeptidase (Reichmann and Pinho 2017). Also, increasing the efflux of antimicrobial compounds and altering drug accessibility could offer the development of resistance to antimicrobials (Vestergaard et al. 2019). No report presented resistance of methicillin-resistant *Staphylococcus aureus* to medicinal plants, though it had been reported to be resistant to all beta-lactam and multiple antibiotics (Sharaf et al. 2021). Hence, developing new antibacterial agents that block resistance mechanisms is an urgent issue (Sharaf et al. 2021).

A combination of antibacterial agents and /or medicinal plants has become an effective option to minimize this crisis of AMR worldwide (Thereza et al. 2015; Donkor et al. 2023). Examples of fixed-dose combined (FDC) antibiotics currently known are trimethoprim-sulfamethoxazole, amoxicillin-clavulanate and ampicillin cloxacillin for bacterial infections treatment in several human body parts (Pallett et al., 2023). Varieties of strategies are offered by antibacterial combination, and they are interested in treatment, for example, stopping the development of antibiotic resistance, refining the efficacy, attaining high specificity for target pathogens or the rise of target spectrum and reviving target antibiotics (Gideon and Ladan 2023). Some studies reported that combining plant extracts produces a greater effect than their individual extracts (Feng et al. 2023; Duremdes et al. 2023; Masalu and Mpinda 2021).

Synergism is the most desired combination interaction in treatment, and it can result in a significant extra beneficial effect by evading resistance mechanisms and reducing toxicity to the host. However, the effect can sometimes be antagonism, either by reducing the activity or causing toxicity (Victor Nyangabo Mbunde et al. 2019).

The present study aims to investigate the antibacterial activity and synergism of crude extracts from *Sapium ellipticum* (Hochst.) Pax and *Harungana madagarscariensis* (Lam. ex Poir) stem bark extracts against Methicillin resistant *Staphylococcus aureus* (MRSA).

Materials
Plant Material

Plant materials of *Sapium ellipticum* and *Harungana madagascariensis* collected October 2018 from Bukoba rural and Misenyi districts in Kagera region, Tanzania were used. The plant materials were identified, and voucher specimens were coded and kept in the herbarium of the Department of Botany at UDSM as *Sapium ellipticum* stem bark (SN03) and *Harungana madagascariensis* stem bark (SN05) (Masalu et al 2020). These plants were selected based on their wide use by traditional medicine healers in Bukoba, Tanzania and their potential antimicrobial activities as well as its widely use by indigenous communities reported in different studies done in Africa especially Tanzania, Zambia, Burundi, Ethiopia, Cameroon, Nigeria and Kenya (Kisangau et al. 2007, Kisangau et al. 2009, Amenu 2014, Macdonald et al. 2016 , Mpinda et al. 2018 and Oe and Me 2020).

Test Bacteria.

The Methicillin-resistant *Staphylococcus aureus* (MRSA) clinical isolates used in this study were obtained from the Department of Microbiology and Immunology, Muhimbili University of Health and Allied Sciences (MUHAS). These bacteria had been isolated from wounds of the patient from Muhimbili hospital and then identified as Methicillin-resistant *Staphylococcus aureus* (MRSA) by different phenotypic approaches and preserved well as a reference microorganism.

Methodology
Preparation of Plant Extracts

Plant stem barks were ground into fine powder by using a mixer grinder. Solvents used were methanol (Fluka Chemie GmbH (Sigma-Aldrich®, Zwijndrecht, Netherlands) and dichloromethane (Merk KgaA, Darmstadt,German). During extraction of methanolic crude extract, stem bark powder (300g) was soaked into 1000 mL methanol solvents and maintained at room temperature for 72 hours with twice daily homogenization. The solution was then filtered using Whatman no.1 filter paper (pore size: 11 µm). During extraction of dichloromethane crude extract, stem bark powder (300g) was soaked in 1000 mL dichloromethane for 72 hours with twice daily homogenization. The solution was then filtered using Whatman no.1 filter paper (pore size: 11 µm). Thereafter, the extracts were concentrated using a rotary evaporator (R-210 BUCHI, Switzerland) at 55 °C, 100 m bar pressure. Then, all crude extracts yielded were weighed and stored in a refrigerator (4 °C) pending the day of use.

Identification of MRSA Clinical Isolates
Phenotypic Identification
Gram Staining

Each slide smeared with pure colonies was applied with crystal violate, then iodine, decolourized by ethanol, and counterstained with safranin. The isolates were identified based on their morphological shapes and colours, as seen in the microscope.

Biochemical Tests

A catalase and coagulase tests were done to the pure culture of the suspected MRSA isolate as follows:

Catalase Test

A small amount of bacteria isolate was smeared on a clean glass slide using a wire loop and then dried. A drop of hydrogen peroxide was placed on top of the isolate.

Coagulase Test

A small amount of bacteria isolate was smeared on two clean glass slides with a drop of normal saline using a wire loop, and then the slides were dried. A drop of human plasma was added to one of the slides, smeared with bacterial suspension, and mixed gently.

Antibiotic Resistance

Antibiotic resistance was determined by disc diffusion method and standards according to Clinical Laboratory Standard Institute (CLSI-2015) guidelines. A pure culture of MRSA confirmed by Gram's staining and biochemical tests identification procedures was grown in a nutrient agar plate 24 hours before being used as the test microorganism in the antibiotic resistance test. The antibiotic resistance test used standard oxacillin discs (1 μg/mL) and methicillin discs (1 μg/mL) as the reference. The positive control was vancomycin disc (2 μg/mL).

The pure colonies of MRSA detected by Gram's staining and biochemical test identification procedures were grown in a nutrient agar plate 24 hours before being used as the test microorganism. The test organism's suspension approximated to 0.5 McFarland standards, was prepared in a test tube using sterile normal saline water. 20 mL of fresh sterile nutrient agar was poured into a sterilized plate and allowed to solidify at room temperature. The test organism was spread aseptically on solidified nutrient agar by a decontaminated cotton swab. Oxacillin (1 μg) standard discs were aseptically placed in a solidified nutrient agar plate, and 6 mm vancomycin discs (2 μg) were placed as the positive control. Another plate with standard discs of methicillin (1 μg) was used as a reference. Then, plates were incubated for 24 hours at 37°C. Inhibition zones were measured in millimeter and interpreted according to (CLSI) guidelines.

Genotypic Identification
Extraction of DNA

DNA was extracted by Zymo-Research kit protocol procedures with minor modifications. The MRSA culture was transferred into a Spin-Away™ Filter1 in a collection tube and then centrifugated at 10,000x g for 15 seconds. After centrifugation, Spin-Away Filter1 was placed in a new collection tube, 400 μL of DNA Prep buffer was added to the column, allowing for centrifugation, and then the flow was discarded. 700 μL of DNA wash buffer was added to the column, allowing centrifugation, and then the flow was discarded. A 400 μL of DNA wash buffer was added to the column and then centrifuged for 2 minutes to ensure the wash buffer was obliterated, then the column was transferred into a nuclease-free tube. During DNA elution, 100 μL of DNase-free water was added to the column matrix; then, it was allowed to remain standing for 5 minutes, followed by centrifugation. Lastly, the DNA sample was stored in the refrigerator (-20 °C) before being used in PCR reactions.

Polymerase Chain Reaction (PCR)

The reactions were attained in a final volume of 25 μL containing 4 μL of DNA sample (template), 12.5 μL of Taq 2X master mix (New England Biolabs), 1 μL of specific primer set and 7.5 μL of nuclease-free water (Water for Molecular biology, Bio Concept). PCR amplification cycle for 16S rRNA primer started with an initial denaturation step at 95 °C after 24 minutes, then 35 cycles of denaturation at 95 °C for the 30 s, annealing at 55 °C for 35 s, extension for 50 s at 72 °C and a last extension at 72 °C for 7 minutes.

The amplification cycle for detection of mecA was performed beginning with a denaturation step at 95 °C for 4 minutes, then 40 cycles of denaturation at 95 °C for 30 s, annealing at 56 °C for 1 minute, and a final extension step at 72 °C for 7 minutes. Forward and reverse primers for the mecA used were.

MRSA1 - 5' AAAATCGATGGTAAAGGTTGGC 3'
MRSA2 - 3' AGTTCTGCAGTACCGGATTTGC 5'

Amplified products were verified by electrophoresis in agarose gels (1%) stained with Safe view™ and classic dye visualized in the gel. LUMINAX Gel documentation System—BioZEN Labs (Nagar, India). The Quick-load 1500 bp and 533 bp amplicons were used as the molecular weight markers for 16S rRNA and mecA primers, respectively.

Antibacterial Activity of Individual Plant Extracts
Screening Antibacterial Activity of Individual Plant Extracts
The agar well diffusion antibacterial assay of methanol and dichloromethane of *Sapium ellipticum* and *Harungana madagascariensis* crude extracts was determined according to the Clinical Laboratory Standard Institute (CLSI-2015). Inoculum containing 1×10^6 CFU/mL of MRSA bacterial culture was spread on Muller Hinton agar plates with a sterile cotton swab moistened with the bacterial suspension. Subsequently, wells of 6 mm diameter were punched into agar medium, filled with 20 μL of each desired concentration of each plant extract, and allowed to diffuse at room temperature for 2 hours. Positive control wells filled with 20 μL vancomycin (2 mg/mL) and negative control wells filled with 10% DMSO (Dimethyl sulfoxide) were used. The plates were incubated at 37 °C for 24 hours. Different concentrations of plant extracts (200, 100, 25 and 1.56 mg/mL) were tested during antibacterial screening to simplify the approximation of concentrations that would be used for MIC determination.

Diameters of the zone of growth inhibition were measured using a transparent ruler calibrated in millimetres. Results were presented as means and standard deviations mean ± SD from the three independent experiments. Then, the activity Index (AI) was calculated by using this formula.

AI = *ZOI of sample/ZOI of positive control*

Minimum Inhibitory Concentrations of the Individual Plant Extracts
The minimum inhibitory concentration (MIC) of plant crude extracts that exhibited antibacterial activities was determined by using the broth microdilution method in the 96-well microtiter plate according to (Mpinda et al. 2018) with minor modification. The MRSA inocula used were prepared from 24 hours-grown cultures. A 50 μL of sterile Muller Hinton broth was put in each well, and 50 μL of 50 mg/mL of crude extract was diluted by serial dilution to obtain the following concentrations along the column: 25, 12.5, 6.25, 3.12, 1.56, 0.8, 0.4 and 0.2 mg/mL as explained below. To each well of the first row, 50 μL of the crude extracts were added to the 50 μL broth. After thorough mixing, 50 μL of the mixture was drawn and transferred to the second well. This procedure was repeated until the last well in each column.

Then, 50 µL of the mix was discarded from each previous well of the column. Then 50 µL of inoculated bacteria approximated to 0.5 McFarland test organisms were added to each well to make 100 µL per well. Microtiter plates with the same scheme but with no test organisms inoculated in Muller Hinton broth were included as a reference. Then, microtiter plates were incubated at 37 °C for 24 hours. The positive control column contained vancomycin (6 µg/mL), broth and inoculated bacteria, the negative control column contained broth and inoculated bacteria and the blank (sterility control) column contained broth only. The MIC endpoints were determined using a SPECTRO star Nano® plate reader (BMG LABTECH) at 560 nm. The overall results were taken from three independent experiments and were interpreted by the relationship between the absorbance and concentration.

Investigation of Synergism
Screening for Antibacterial Activity of Combined Plant Extracts
The agar well diffusion assay screened the antibacterial activity of combined extracts of *Sapium ellipticum* and *Harungana madagascariensis*. Inoculum containing 1 x 10^6 CFU/mL of MRSA bacterial culture was spread on Muller Hinton agar plates with a sterile cotton swab moistened with the bacterial suspension. Subsequently, wells of 6 mm diameter were punched into agar medium and for the case of combining the extracts, the total 20 µL of extracts were filled in each well by 1:1 v/v (*Sapium ellipticum*: *Harungana madagascariensis)* combination ratio for each desired concentration. They were allowed to diffuse at room temperature for 2 hours. Positive control wells filled with 20 µL vancomycin (2 mg/mL) and negative control wells filled with 10% DMSO (Dimethyl sulfoxide) were used. The plates were incubated at 37 °C for 24 hours.

Minimum Inhibitory Concentration of Combined Plant Extracts
The minimum inhibitory concentration assay for combined plant extracts was accomplished using 96 wells of a microtiter plate by broth microdilution method as previously described. Extracts combination was performed so that methanol crude extracts were mixed in pairs among themselves. The same was done among dichloromethane crude extracts. A sterile 50 µL of Muller Hinton broth was put in each well. To each well of the first row, 50 µL of crude extract was added to 50 µL of broth. 50 µL of crude extract was put in combination, and the suggested (v/v) ratios were 3:1, 1:1 and 1:3 (*S. ellipticum*: *H. madagarscariensis*) for methanol and dichloromethane extract combinations. After thorough mixing, 50 µL of the mixture was moved to the next well.

In each column, the procedure was constant to the last well. 50 µL of the mixture was drawn and discarded to the previous well. The extracts were serially diluted to obtain 25, 12.5, 6.25, 3.12, 1.56, 0.8, 0.4 and 0.2 mg/mL concentrations. Serial dilution of crude extract concentrations was done along the columns in triplicate for the combined crude extracts. Then 50 µL of inoculated MRSA approximated to 0.5 McFarland test organisms were added to each well to make a total of 100 µL per well. Microtiter plates used as a reference were prepared with the same filling profile but with no inoculation of test MRSA. All plates were put in an incubator at 37 °C for 24 hours. The positive control column contained vancomycin (6 µg/mL), broth and inoculated bacteria, the negative control column contained broth and inoculated bacteria and the blank (sterility control) column contained broth only. The MIC endpoints were determined using the SPECTRO star Nano® plate reader (BMG LABTECH) at 560 nm. The overall results were taken from three independent experiments and were interpreted by the relationship between the absorbance and concentration. The suggested combination ratios have also been used in the study reported by Johnson and Ayoola (2015).

Fractional Inhibitory Concentration (FIC)

The synergistic antibacterial activity of plant extracts was determined by the checkboard method. The equations below calculated the Fractional activity index from the minimum inhibitory concentration (MIC) of the individual and combined crude extracts of the two selected plants.

$FIC_1 = (MIC_{1+2} / MIC_1)$

$FIC_2 = (MIC_{1+2} / MIC_2)$

$FIC = FIC_1 + FIC_2$

MIC_1= minimum inhibitory concentration of *H. madagascariensis* alone, MIC_2= minimum inhibitory concentration of *S. ellipticum* alone, MIC_{1+2}= minimum inhibitory concentration of combined crude extract, FIC_1= fraction inhibitory concentration of *H. madagascariensis* alone, FIC_2= fraction inhibitory concentration of *S. ellipticum* alone and FIC = fraction inhibitory concentration of the combined extract. The criteria used in the interpretation of the FIC Index concerning the mode of plant extract interactions were.

≤ 0.5 Synergism, > 0.5 to 1 Additive, > 1 to ≤ 4 Indifference and > 4 Antagonism.

Statistical Analysis

Antimicrobial susceptibility of plant crude extracts data obtained from agar well diffusion assay was represented by mean ± standard deviation. One-way ANOVA analyzed the comparisons in activeness of extracts; $p < 0.05$ were considered statistically significant. The MIC values in the tables are interpreted according to standard breakpoints described by Clinical and Laboratory Standard Institute (CLSI) criteria for antibacterial agents. FIC values were analyzed by checkboard data analysis depending on the model of deviations from theories of synergism, additive, no interaction and antagonist interactions.

Results

Identification of MRSA Clinical Isolates

Purple-coloured and cocci-shaped bacterial cells were observed on the slides spread with pure bacteria colonies. The bacteria isolates were catalase-positive and coagulase-positive. The results of antibiotic resistance showed that the tested bacteria were resistant to oxacillin and methicillin while were intermediate to vancomycin as shown in (Table 1).

Table 1: Antibiotic Resistance Inhibition Zone Diameters (ZOI) and Interpretation

Antibiotics	ZOI (mm)	Interpretation
Oxacillin (1µg/mL)	6.5 ± 0.1	Resistant
Methicillin (1µg/mL)	9.0 ± 0.5	Resistant
Vancomycin (2µg/mL)	20.0 ± 0.0	Intermediate

In this study the DNA sample of MRSA isolate were positively detected as bacteria by 16S rRNA PCR amplification as shown in (figure 1). The mecA resistant genes detection was used to confirm if the bacterial sample was methicillin resistant. The DNA sample of the MRSA clinical isolate tested was found to be mecA positive as shown in (figure 2).
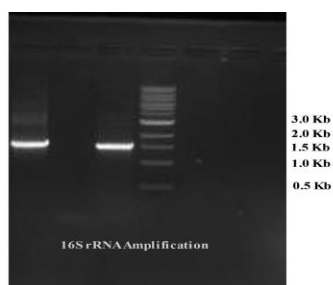
Figure 1:   **Figure 2:**

Agarose Gel for 16S rRNA Gene Amplicon (Figure 1) and for mecA Resistant Gene (Figure 2) Observed for MRSA Isolate in which there was positive genotypic/phenotypic concordance. M: Molecular Marker (1kb+DNA ladder). Lane 1: PCR amplicon of 16S rRNA gene (1500 bp) in (Figure 1) and of mecA (533 bp) in (Figure 2). NC: Negative control and PC: Positive control.
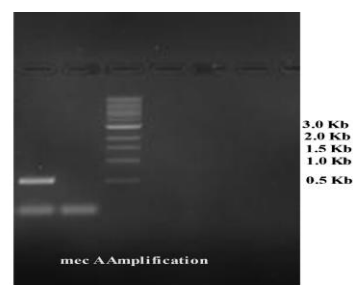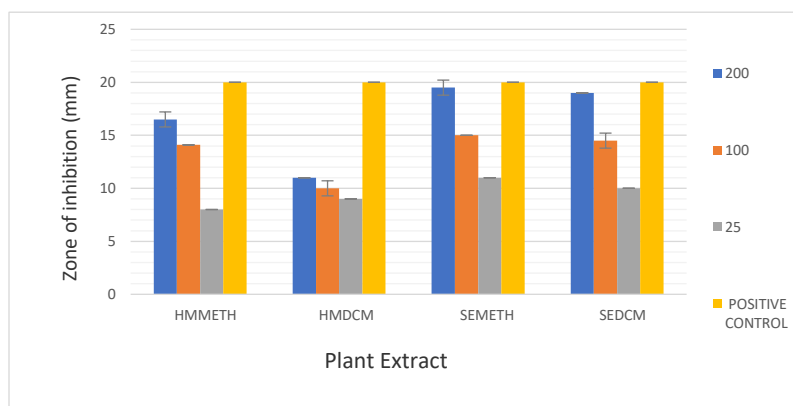
Antibacterial Activity of Individual Plant Extracts

All extracts at different concentrations exhibited antibacterial effects against MRSA isolate. Generally, the values of the zone of inhibition decreased with the decrease in concentrations of the extracts. ZOI was measured and represented in mean ± SD (mm) for triplicate data and the results were analyzed by using a graph chart presented in (Figure 3).

The concentrations of plant extracts tested were 200, 100, 25 and 1.56 mg/mL. For the individual extracts, there was no clear ZOI when concentration was 1.56 mg/mL. The values of ZOI for individual extracts ranged from (8 mm - 19.5 mm) for the concentrations of (200, 100 and 25 mg/mL) as shown clearly in the following clarification: At 200 mg/mL ZOI were; SEMETH= 19.5mm, SEDCM= 19mm, HMMETH= 16.5mm and HMDCM= 11mm. At 100 mg/mL ZOI were; SEMETH= 15mm, SEDCM= 14.5mm, HMMETH= 14mm and HMDCM= 10mm. At 25 mg/mL, *ZOI were SEMETH= 11mm, SEDCM= 10mm, HMMETH= 8mm,* and HMDCM= 9mm. *S. ellipticum* methanolic extract showed the highest effect in concentrations tested while *H. madagascariensis* dichloromethane extract showed less effect in almost all concentrations tested.

Figure 3: Zones of Inhibition (mm) for Individual Extracts in Different Concentrations against MRSA Isolates by Agar Well Diffusion. Error Bar Implies Standard Deviation for Triplicate Experiments. HMMETH and SEMETH are *H. madagascariensis* and *S. ellipticum* methanolic extracts while the HMDCM and SEDCM are *H. madagascariensis* and *S. ellipticum* Dichloromethane extracts

Determination of the AI values as presented in (Table 2) formed the foundation of distinguishing antibacterial activeness of the plant extracts used in this study. Generally, the results shown in (Table 2) provide the information that the activeness of the plant extract was increased by increase in concentration and differences in activity of plant extracts was depending on the extract composition and type of solvent used. Results for determination of activity index (AI) for individual extracts showed that *S. ellipticum* methanolic extract was more active than other individual extracts for all concentrations tested while the least active extract was *H. madagascariensis* dichloromethane extracts for the concentration of 200 mg/mL and 100 mg/mL except for concentration of 25 mg/mL where *H. madagascariensis* methanolic extract showed less activity than its Dichloromethanolic counterpart. Methanolic extracts showed to be more active than dichloromethane extracts but not significantly (p > 0.05) in almost all concentrations except for the concentration of 25 mg/mL where *H. madagascariensis* methanolic extract showed less activity than all extracts. *S. ellipticum* extract showed to be active than *H. madagascariensis* but not significantly (p > 0.05).

Table 2: Activity Index (AI) of Individual Extracts against MRSA Isolate

Concentration (mg/mL)	HM METH	HM DCM	SE METH	SE DCM
200	0.83	0.55	0.98	0.95
100	0.7	0.5	0.75	0.73
25	0.4	0.45	0.55	0.5

HM METH= *H. madagascariensis* methanolic extract, HM DCM= *H. madagascariensis* dichloromethane extract, SE METH= *S. ellipticum* methanolic extract and SE DCM= *S. ellipticum* dichloromethane extract.

Minimum inhibitory concentrations for individual extracts against MRSA isolate were determined and the average results for triplicate experiments were recorded in (table 3). The MIC values ranged from 1.56 - 6.25 mg/mL for individual extracts. MIC values for all single extracts showed that *S. ellipticum* methanolic extract was very active extract (MIC = 1.56 mg/mL) while *S. ellipticum* dichloromethane extract was least active (MIC = 6.25 mg/mL).

Table 3: Minimum Inhibitory Concentration M(mg/mL) for Individual Plant Extracts

Extracts	HMMETH	HMDCM	SEMETH	SEDCM
MIC (mg/mL)	3.125	3.125	1.56	6.25

HM METH= *H. madagascariensis* methanolic extract, HM DCM= *H. madagascariensis* dichloromethane extract, SE METH= *S. ellipticum* methanolic extract and SE DCM= *S. ellipticum* dichloromethane extract.

Investigation of Synergism.

The zone of inhibition (ZOI) for the concentrations of 200, 100, 25 and 1.56 mg/mL ranged from 25 mm - 8 mm for combined extracts as shown in (Figure 4). In combined extracts 1.56 mg/mL concentration showed the inhibition zone diameter. Methanolic combined extract showed the greater value of inhibition zone diameter than dichloromethane extracts in all concentrations tested and at 200mg/mL the methanolic combined extract (ZOI=25 mm) showed to be larger than even the positive control (ZOI=20mm).

Figure 4: Zones of Inhibition (mm) for Combined Plant Extracts in Different Concentrations Against MRSA
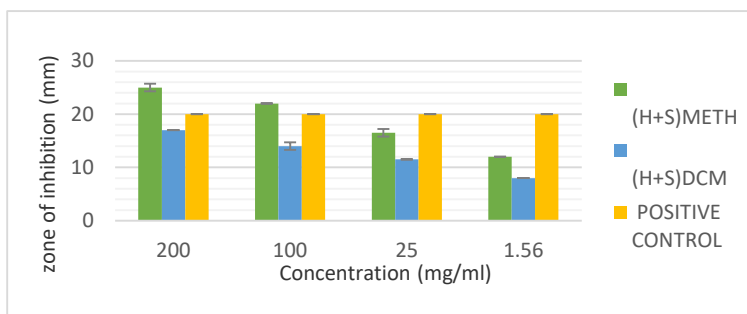
Isolates. Error Bars Represent Standard Deviation for Triplicate Experiments.

Determination of activity index (AI) for combined extracts shown in (Table 4) showed that methanolic combined extract has the higher AI value than dichloromethane combined extracts (but not significantly) in all concentrations tested. Using one way ANOVA test the results concluded that: The combined extracts were statistically significant active than the individual extracts ($p < 0.05$).

Table 4: Activity Index (AI) of Combined Extracts against MRSA Isolate

Concentration(mg/mL)	200	100	25	1.56
(H+ S) METH	1.75	1.35	0.95	0.7
(H + S) DCM	1	0.8	0.58	0.5

Minimum inhibitory concentration (MIC) for combined extracts ranged from 0.2 - 0.8 mg/mL. MIC for combined extracts showed that methanolic combination ratio 3: 1 (*S. ellipticum*: *H. madagascariensis*) was the most active with MIC of 0.2 mg/mL while methanolic combination ratio 1: 3 (*S. ellipticum*: *H. madagascariensis*) and dichloromethane combination ratio 1: 1 (*S. ellipticum*: *H. madagascariensis*) were the least active with MIC of 0.8 mg/mL as shown (Table 5).

Table 5: Minimum Inhibitory Concentration (mg/mL) of combined plant extracts against MRSA.

Combined Extract	Ratios	MIC (mg/mL)
	3: 1	0.2
S + H METH	1: 1	0.4
	1: 3	0.8
	3: 1	0.4
S + H DCM	1: 1	0.8
	1: 3	0.4

By using a one-way ANOVA test, MIC values of combined extracts were significantly lower than those of the individual extracts ($p < 0.05$), as shown in the comparative analysis (Table 6). This analysis concluded that combined extracts showed higher activity than individual extracts.

Table 6: Comparative Analysis between the MIC (mg/mL) of Combined Extracts and that of Individual Extracts

Individual extracts	MIC (mg/mL)
SE METH	1.56
SE DCM	6.25
HM METH	3.125
HMDCM	3.125
Combined Extracts	
S + H METH (3: 1)	0.2
(1: 1)	0.4
(1: 3)	0.8
S + H DCM (3: 1)	0.4
(1: 1)	0.8
(1: 3)	0.4

In this study the synergism among methanol and dichloromethane extracts of *S. ellipticum* and *H. madagascariensis* was successfully investigated against MRSA clinical isolate. The results showed a synergistic effect in these combinations as follows; methanolic combination ratio 3:1 (*S. ellipticum*: *H. madagascariensis*) (FICI= 0.192) and 1:1 (*S. ellipticum*: *H. madagascariensis*) (FICI= 0.384) as well as in dichloromethane combination ratio 1:1 (*S. ellipticum*: *H. madagascariensis*) (FICI= 0.384). The 1:1 ratio showed synergistic effect in both methanol and dichloromethane combinations while with the other combinations, additive effect and non-interactive interactions were observed as shown in (table 7). In all combinations, no antagonism interaction was observed.

Table 7: FIC Index of Combined Plant Extracts in (v/v) Ratio against MRSA Isolates.

Extract	Ratio	FIC- Index	Interpretation
S + H (METH)	3: 1	0.192	Synergistic
	1: 1	0.384	Synergistic
	1: 3	0.768	Additive
S + H (DCM)	3: 1	3.589	Non-interactive
	1: 1	0.384	Synergistic
	1: 3	3.589	Non-interactive

The results of this study showed that the combination of *S. ellipticum* and *H. madagascariensis* has a synergistic effect as the beneficial antibacterial activity against MRSA, and the suggested ratios in this study observed no antagonism (reduction of activity). By using the test for association, there was a significant association (r = 0.801) in antibacterial activity screened (AI) with the results of FIC Index (p < 0.05)

Discussion
Identification of MRSA Clinical Isolates
In the present study, gram staining, catalase, coagulase and antibiotic resistance tests were the important phenotypic identifying markers of *S. aureus* as similarly reported (Karmakar et al. 2016). Clinical isolate isolated from the patient's wound was catalase positive and coagulase positive,

which are among the characteristics of S. aureus, as similarly reported by (Guan et al. 2022). The antibiotic resistance test used oxacillin disc diffusion as the sensitive method for MRSA detection and the result showed that the isolate was resistant to oxacillin. This is similarly reported by (Salas et al. 2020). PCR for 16 rRNA specific primer assisted to confirm if the bacterial species was *S. aureus* before performing the mecA gene detection (Guan et al. 2022) .

In this study, phenotypically identified MRSA possessed mecA gene during PCR for mecA specific primer. It has been reported that the resistance in MRSA is commonly conferred by mecA gene encoding a modified penicillin-binding protein (PBP2a) with reduced affinity for methicillin and other beta-lactam antibiotic (Singh et al. 2023). mecA gene carried horizontal transfer of MGE known as staphylococcal cassette chromosome mec (SCCmec) (Singh et al. 2023). Molecular and phenotypic identification result was in concordance as similarly reported that the clinical strains of *S. aureus* from infected wounds might be MRSA (Koupahi1 et al. 2016). Confirmation of the addressed clinical isolate as the MRSA approved using the isolate as the intended microorganism in this study.

Antibacterial Activities of Individual Plant Extracts
In this study, the selected plant extracts employed were found to be susceptible to MRSA isolate. The antibacterial activity increased with increased concentrations, as Odongo et al. (2023) reported. Determination of AI established the base for describing the activeness of extracts. In the present study, S. ellipticum methanolic extract was more active (AI= 0.98) than other individual extracts.

The activity index (AI) for *H. madagarscariensis* dichloromethane extract at 200 mg/mL against MRSA isolate in this study was (AI= 0.55) comparable to that of methanol leaf extract of *H. madagascariensis* at 25 mg/mL against *Escherichia coli* reported by (B et al. 2020). In contrast, (Onajobi et al. 2020) reported the activity (AI=0.51) for *H. madagascariensis* ethanol stem bark extract against *S. aureus*.

The AI of *S. ellipticum* dichloromethane extract at 200 mg/mL was (AI=0.72) similar to that shown by *Beta vulgaris* aqueous extract against *P. aeruginosa* reported by (Kousar et al. 2023). In contrast, a study reported by (Octavie Merveille 2017) showed (AI=0.84) of *S. ellipticum* methanol extract against *Staphylococcus saprophiticus* at 50 mg/mL. These differences of activity index possibly were due to the difference in sensitivity of tested microorganisms, environmental influences to the used plant, the plant part used, type of solvent used in extraction as well as the methods used (Ugboko et al. 2020). The susceptibility of MRSA to the selected plant extracts in this study correlates with other studies which have reported the presence of antibacterial activity on single or combined plant extracts and/or antibiotics against MRSA (Anyanwu and Okoye 2017, Aqil et al. 2006 (Voravuthikunchai and The Kitpipit The 2005). However, no study has been reported on synergistic effect between *S. ellipticum* and *H. madagarscariensis* against the MRSA.

Minimum Inhibitory Concentration of the Individual Extracts
In the present study, the range of MIC (1.56 - 6.25 mg/mL) for individual extracts was comparable to that exhibited by *Psidium guaja* against *Staphylococcus aureus* reported by (Qaralleh et al. 2020). This was in contrast with the range of MIC (6.2 – 100 mg/mL) for aqueous extracts of *S. ellipticum* and *H. madagarscariensis* stem barks against *Streptococcus lactis* reported by (Mpinda et al. 2018). However, the MIC value range (0.02 - 1.56 mg/mL) is shown in findings reported by (Jatin Chadha et al. 2021).

The MIC value (6.25 mg/mL) of *S. ellipticum* dichloromethane extract in the present study was comparable that of *P. mirabilis* methanol extract against *Klebsiella pneumonia* and *Escherichia*

coli reported by (Ahmed et al. 2023). Also, was nearly comparable with the MIC (6.3 mg/mL) of *S. ellipticum* dichloromethane stem bark extract against *Aspergillus niger* reported by (Kisangau_2009). In contrast, activity of *S. ellipticum* methanol extract (MIC < 1 mg/mL) against *S. saprophiticus* was reported by (Octavie Merveille 2017).

Results showed the activity of *H. madagascariensis* was (MIC=3.125 mg/mL) comparable with that of *Croton macrostachyus* and *Calpurina aurea* methanol extract reported by (Teshale et al. 2023). In contrast, *H. madagascariensis* aqueous leaf extract showed (MIC=1.56 mg/mL) against Salmonella (Kengni et al. 2013).

The results explored that methanol extracts were more active against MRSA isolate than dichloromethane extracts (intermediate). Differences in MIC range might be attributed to the solvent used, a starting concentration during serial microdilution and the sensitivity of test microorganisms. *S. aureus* has been reported to be the most inhibited isolate by plant crude extracts (Dahiya and Purkayastha et al. 2021). Also, reports showed that MRSA is more susceptible to different plant extracts than other microorganisms (Amenu 2014 and Zakaria et al. 2014).

Based on the report described by (Octavie Merveille 2017), the antimicrobial potential of the various extracts is categorized as follows: MIC < 1 mg/mL; very active, 1 ≥ MIC ≤ 8 mg/mL; moderately active, 8 > MIC ≤ 64 mg/mL; less active or negligible and MIC > 64 mg/mL; not active. Therefore, in this study, the results of MIC ranges (1.56 - 6.25 mg/mL) showed that all individual extracts were moderately active.

Investigation of Synergism

Zones of inhibition for combined extracts in a particular concentration exceeded those obtained from individual extracts. This is related to what has been reported by (Kehinde Peter et al. 2020). The AI of the methanolic combination at 200 mg/mL (AI=1.75) and 100 mg/mL (AI=1.35) in the present study showed its activity exceeded that expressed by a positive control (AI=1). The information revealed here is that, combination of extracts as well as an increase in concentration improves the effectiveness of extracts as similarly reported (Odongo et al. 2023).

Comparison analysis between MIC for combined and individual extracts revealed that all combined extracts were active against MRSA, and there was a significant difference in ($p < 0.05$). The range of MIC (0.2 - 0.8 mg/mL) for combined extracts in this study was not comparable to the range of MIC (3.125 – 25 mg/mL) for two combined extracts reported by (Teshale et al. 2023) and that of MIC range (0.5 – 1 mg/mL) for three combined extracts reported by (Donkor et al. 2023). There was no significant difference between methanolic and dichloromethane extract in their activeness ($p > 0.05$). The study showed the methanolic combination has higher activity in the 3:1 and 1:1 ratios, which was in contrast with the results with higher activity in the methanolic combination in 1: the 3 and 3:1 ratios reported by (Johnson and Ayoola 2015).

FIC Indices in this study discovered the novel information that there is a potential synergism interaction among combined extracts of *S. ellipticum* and *H. madagascariensis* stem bark extracts, which had not yet been reported in the literature before. Therefore, it validates the relevance of combining these plants in treating MRSA infections by traditional medicine practitioners and explores the information of discovering new and effective antibacterial agents using a combination of these plants.

Methanolic combinations showed two ratios with synergistic interaction and one ratio with additive interaction. Dichloromethane combinations showed only one ratio with synergistic interaction and two ratios with non-interactive effects. This indicates that in combinations of

extracts, polar compounds like methanol interact more synergistically than non-polar compounds, as reported by Johnson and Ayoola (2015; Odongo et al., 2023).

In this study, the best ratio that possessed a synergistic effect in both methanol and dichloromethane combination was 1:1. Many studies done on the combination of plant extracts have reported a synergistic effect in a 1:1 combination ratio (Karmegam et al. 2019, Donkor et al. 2023). However, there is insufficient reported information about the extract–extract combination effect for comparison.

Conclusion

The results demonstrate that combined extracts from selected plants exhibit significantly higher antibacterial activity than individual extracts. This study revealed a synergistic interaction when methanol or dichloromethane extracts of *S. ellipticum* and *H. madagascariensis* were combined against MRSA isolates. The optimal ratio for achieving this synergism in both methanol and dichloromethane combinations was 1:1. In conclusion, these findings provide promising evidence for the potential use of methanol or dichloromethane crude extracts of *S. ellipticum* and *H. madagascariensis* stem barks in synergistic treatments for MRSA infections.

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Indonesia Measles Immunization Program Monitoring: An Analysis of 5 Years Measles Surveillance Data

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Abstract

Background: Measles remains a leading cause of death among young children. Maintaining high coverage of routine immunization should be a top priority to achieve the elimination target in 2020. This study aims to determine the progress of the national measles immunization program.

Method: We analyzed the measles surveillance data from January 2008 to December 2013. A measles case is a clinical measles case with a positive measles virus infection through a serology test (measles IgM positive) and no measles vaccination 4-6 weeks before the rash appears.

Results: We found that 115,105 measles cases were reported. During that period, a series of measles immunization campaigns were conducted from 2009 – to 2011. There was a decrease in laboratory-confirmed measles cases, from 10 per 100,000 population in 2008 to 4.6 in 2013. From 2010 to 2013, the proportion of suspect measles cases tested in the laboratory increased from 16 to 37% of the total suspect cases. Among those tested specimens, we found the increasing number ranged from 12 to 26% measles positive and 24 to 44% rubella positive.

Conclusion: These findings indicate that the measles immunization program in Indonesia has effectively reduced the number of measles cases.

Keywords: immunization, Indonesia, measles, surveillance

Introduction

Measles is a highly contagious disease that causes morbidity and mortality among young children in the world. Measles remains a leading cause of death among young children. The data shows that measles with complications killed approximately 139,300 children in 2010 and 145,700 in 2013 (Simon *et al.*, 2010). Almost 400 deaths occur every day, or 16 deaths occur every hour (WHO, 2015). Recognizing the vital contribution of measles to child mortality, the world is committed to eliminating measles (WHO, 2009). High vaccination coverage of 95% attained via routine immunization and supplementary immunization activities (SIAs) is key to bringing the world closer to eliminating measles (WHO, 2009). Maintenance of progress towards elimination is being carried out at the regional level. The WHO Region of the Americas achieved regional measles elimination in 2002.

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The other WHO regions have also established elimination goals: Eastern Mediterranean (2010), Europe (2010), Western Pacific (2012), Africa (2020), and Southeast Asia (2020) (WHO, 2009).

Indonesia has set the target of elimination with the following strategies: 1) to achieve the first dosage of measles immunization coverage >95% nationally and >80% in all districts; 2) to decrease measles incidence rate to less than 5 per million population; 3) decrease measles case fatality rate at least 95% from baseline data by the year 2000; and 4)to increase the sensitivity of measles surveillance with CBMS, including conduct laboratory confirmation. Measles elimination is defined as no endemic area for more than 12 months and no evidence of measles transmission (zero transmission) through the implementation of an adequate surveillance system (WHO, 2013).

Indonesia has over 250 million people and about 9.6 million square kilometres of landmass. It is the second largest country among the SEAR countries. Measles is endemic in Indonesia, but Indonesia is committed to eliminating the disease by strengthening routine immunization and conducting Supplementary immunization Activities (SIAs). From 2009 to 2011, SIAs were conducted in all provinces gradually: 4 provinces in 2009, 8 provinces in 2010, and other provinces were conducted in 2011, with coverage reaching more than 70% of the population target (WHO, 2015).

Despite the great efforts to eliminate measles from Indonesia in recent years, the measles virus continues to circulate and cause morbidity and mortality across the country. The progress of the measles immunization program in Indonesia should be monitored through analysis of surveillance data. The measles surveillance system in Indonesia was developed before 1980 to track measles cases and deaths due to measles. Measles surveillance is also used to inform the development and improvement of immunization programs. In 2010, the sensitivity of the measles surveillance system was increased by implementing laboratory Case-Based Measles Surveillance (CBMS) throughout provinces.

The individual data collected from CBMS, including information on age, sex, immunization status, and laboratory test results of clinical measles cases (suspected measles cases), completes the aggregate data available previously in the surveillance system, including outbreak data. The individual data in CBMS comes from Primary Health Centers, while aggregate data comes from sub-national (district, province) and national levels. This study aims to provide an overview of the achievement of the measles immunization program in Indonesia, especially after a series of measles immunization campaigns conducted from 2009 to 2011.

Methods

We used laboratory Case-Based Measles Surveillance data collected from January 2008 to December 2013 to monitor the progress of the measles elimination program. A clinical measles case has fever and maculopapular rash symptoms with coryza and conjunctivitis. A measles case is a clinical measles case with a positive measles virus infection through a serology test (measles IgM positive) and no measles vaccination 4-6 weeks before the rash appears. The clinical measles case has an epidemiological link to another laboratory-confirmed measles case (CDC, 2002).

A discarded measles case is a clinical measles case with negative evidence of measles virus infection through the laboratory test (measles IgM negative). Since 2000, genotypes have also been carried out on urine or throat swab specimens during

an outbreak. Specimens with a negative laboratory result (measles IgM negative) are subsequently tested for rubella virus infection.

The study was a surveillance data analysis from sub-directorate surveillance under the Directorate of Surveillance, Immunization and Matra Health, Directorate General of Disease Control and Environment Health, Ministry of Health (Approval Number: TU.01.01/D.3/II.2/2227/2015).

Results

Between January 2008 and December 2013, about 115,105 clinical measles cases were reported. The reported data show a decrease in the incidence rate from 10 per 100,000 population in 2008 to 4.6 per 100,000 in 2013. The number of clinical measles cases in 2013 was 11,521, lower than in 2012, with 18,798 cases. Figure 1 shows a similar seasonal pattern per year from 2008 to 2013, with the peak mostly occurring in the first three months. The clinical cases tend to decrease at the end of the year.
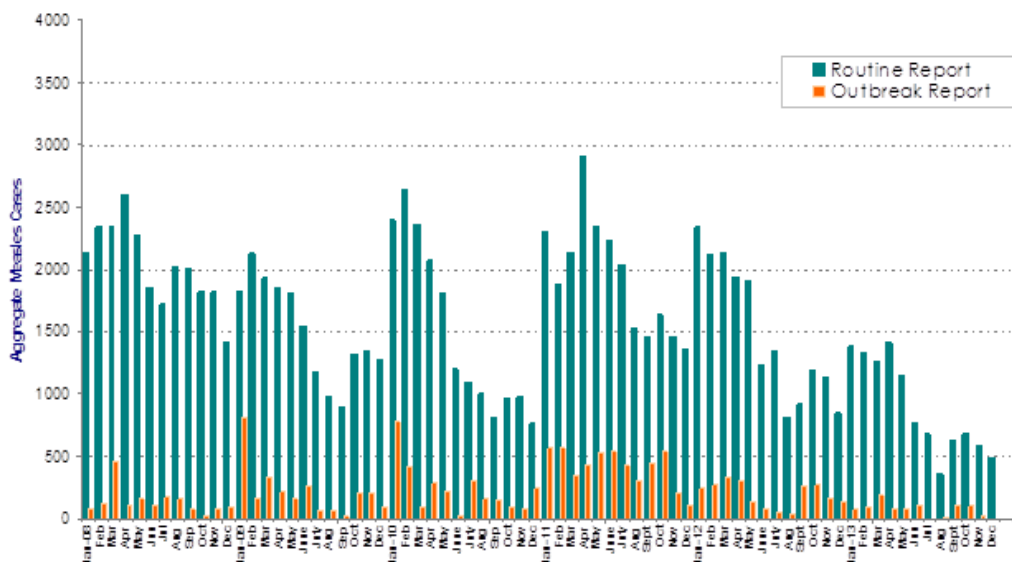
Figure 1. The number of clinical measles by month in 2008-2013

Every year, the highest proportion of measles cases occur in the 5-9 and 1-4 year age groups. Figure 2 shows that there was no significant decrease in these two age groups, which were targeted during the measles immunization campaign from 2009 to 2011. The trend of cases in children 10-14 and >14 does not significantly change over time either.
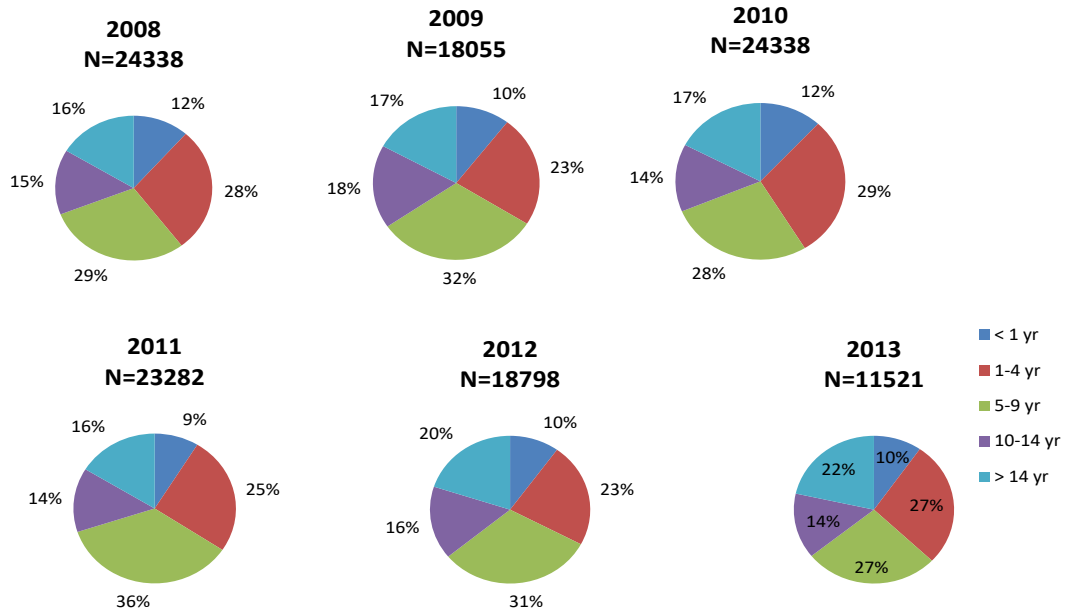
Figure 2. The distribution of clinical measles cases by age, 2008-2013
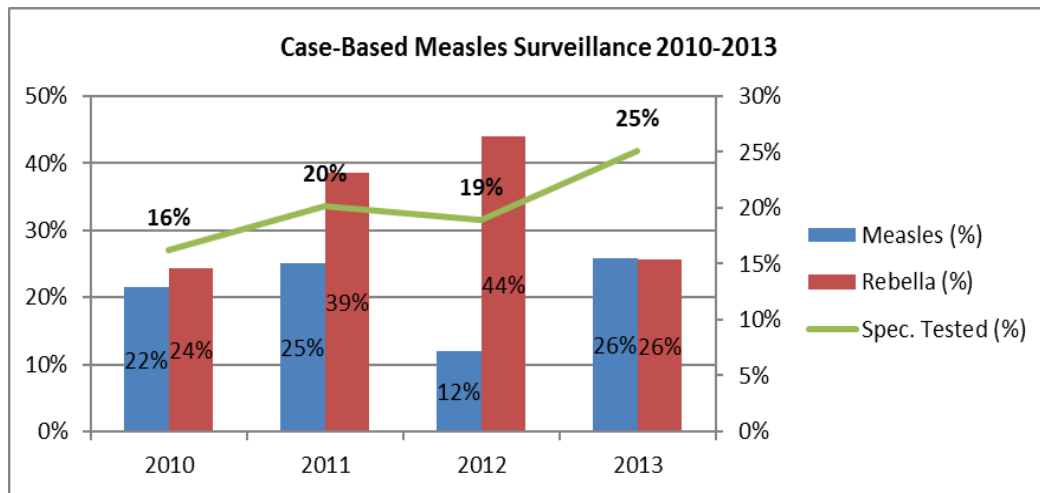
Figure 3. Case Base Measles Surveillance Indonesia, 2010-2013

Nationally, measles diagnosis confirmation by laboratory examination started in 2010. In Figure 3, from 2010 - to 2013, the proportion of measles cases conducted in laboratory tests ranged from 16 to 37% of the total cases per year. Specimens with measles tested positive ranged from 12 to 26%, while rubella positive ranged from 24% to 44% and 36-54% measles discarded. The proportion of cases with laboratory tests increased from 16% in 2010 to 25% in 2013.
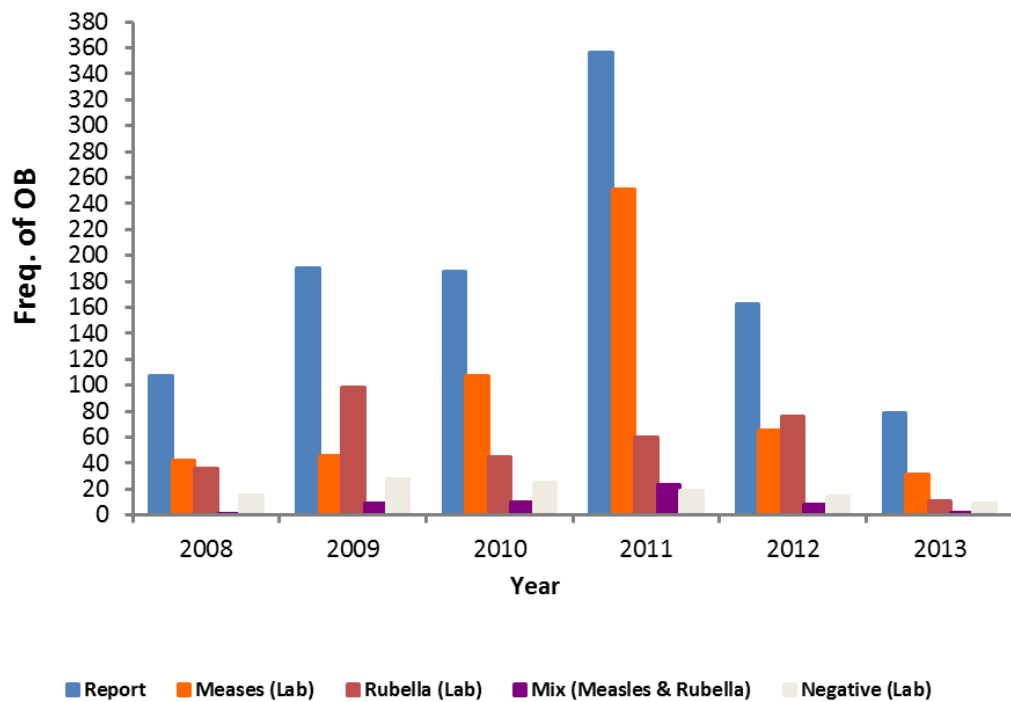
Figure 4. The Measles Outbreaks in Indonesia, 2008-2013

In Figure 4, measles outbreaks were reported in several areas. The frequency of outbreaks from 2008 to 2013 ranged from 42 to 251. The highest outbreak frequency was 251 times and was reported in 2011.

Discussion

Measles control in Indonesia was initiated in 1982. The National Immunization Program was expanded, and it was started to apply the standard of the routine immunization schedule to give a dosage of measles vaccine for 9-month-old children. The measles immunization coverage increased to over 90% in 1990 (WHO, 2014). In 2000, to overcome the measles outbreaks and to provide a second chance of immunization for children or those who have not yet gotten immunity, three measles control strategies have been arranged as follows: measles programs for all children 5 years old and under in high-risk areas; measles catch-up campaign for school children; introducing the second dosage of measles vaccines through immunization program for school children called Bulan Imunisasi Anak Sekolah or BIAS as routine activities for the first grade of primary school students in the following year after the catch-up campaign program (WHO, 2007).

The catch-up campaign program started gradually. The national coverage of measles immunisations in children aged less than 12 months from 1990 - to 2004 ranged between 58 - and 76%. This measles immunization coverage is slightly higher than in the SEA Region, 59 – 69% (WHO, 2017). To accelerate the measles elimination goals, measles immunization campaigns were conducted for children aged 9-59 months from 2005 to 2007, and a follow-up campaign from 2009 to 2011 resulted in targeted coverage levels ranging from 94.5% to 97.5%. In 2014, to increase the children's

immunity, there was a policy to give a booster immunization against measles to 24-month-old children. In addition, advanced immunization for school-age children is still ongoing. These efforts lowered the number of measles cases in Indonesia, although not as expected. These efforts should be conducted continuously to achieve the elimination target by 2020.

The seasonal pattern shown in Figure 1, with increasing measles cases at the beginning of the year and decreasing at the end of the year, can be influenced by some factors, such as the circulation pattern of the measles virus and the descent of surveillance officer performance at the end of the year, which is always overcrowding by so many kinds of health program activities.

Every year, the highest proportion of measles occurs in the 5-9 years and 1-4 year age groups. From Figure 2, it can be seen that there was no significant decrease. Logically, after the measles immunization campaign in 2009 - 2011 at 9-59 months, there should be a substantial decline in cases in those age groups. However, the data did not show this declination as expected. This might happen because not all targeted groups of ages have received immunizations (outreach), aside from the limitation of measles-containing vaccine efficacy.

Besides the effort to strengthen measles immunization, strengthening measles surveillance has also been carried out. Indonesia began to implement measles case-based surveillance of individuals (Case-Based Measles Surveillance / CBMS) in 2008 in two provinces (Bali and Jogjakarta). Strengthened CBMS was started in 2010 by gradually implementing laboratory tests throughout the provinces in Indonesia. At first, the test was carried out for 20% of suspected measles cases, and the proportions improved from year to year.

Measles laboratory tests are conducted in four national reference laboratories accredited by WHO, including Bio Farma, National Institute of Health Research and Development (NIHRD), BBLK Surabaya, and BLK Jogjakarta (Subangkit *et al.*, 2017). When CBMS started in 2008, the number of specimens examined was only 2%. From 2010 to 2013, the number of examined specimens ranged between 16% - and 37%. Measles reporting cases from 2010 to 2013 ranged between 40% and 70%. This rate is lower than the estimated number of measles cases, about 10 / 100.000 population. Meanwhile, the discarded rate, used to measure the sensitivity of case findings, is a targeted minimum of 2/100.000 population; the accomplishment in 5 years is still around 0.5/100.000 population. It was reported that 12-25% are measles IgM positive, and about 24-43% are rubella IgM positive.

Besides strengthening measles surveillance to decrease measles transmission, each measles outbreak should be thoroughly investigated to ensure a prompt response. In 2008, it was reported that 926 clinical measles outbreaks occurred, consisting of 584 measles outbreaks and 342 rubella outbreaks. After 2008, the outbreak frequency decreased to less than 200. The highest measles outbreak during the study period after 2008 occurred in 2011, with 251 outbreaks (Kemenkes, 2014).

One of the activities conducted during an outbreak investigation is active measles case finding by tracking from one house to another, taking notes of the cases individually, and examining 5 serum specimens (WHO, 2008). Public health response measures will be taken based on the findings from the outbreak investigation, including if there is a need for Outbreak Response Immunization (ORI) to stop further transmission. Not all outbreaks were reported to health authorities, and public health

responses could not be taken promptly. This matter has some constraints, including limited human resources and operational costs.

Conclusion

The measles immunization program in Indonesia has reduced the number of measles cases. However, measles is still endemic in Indonesia, and some outbreaks occur sporadically. At a certain time, immunization campaigns should be conducted regularly to decrease the number of susceptible populations caused by outreach targets and the limited efficacy of the measles-containing vaccine. To ensure the validity of measles surveillance data, the sensitivity of the measles surveillance system should be increased by strengthening Case-Based Measles Surveillance (CBMS). A full investigation of all measles outbreaks is important as evidence to ensure a prompt public health response is being taken timely to stop further transmission.

Conflict of Interest

The authors declared they have no conflicts of interest. Authors' contributions: Conception and design of the study as the main contributor: RBH, VS. Acquisition of data: CK, DA, S, M, NM, R. Analysis and interpretation of data: RBH, CK, N, R. Drafting the article or revising it critically for important intellectual content and final approval of the version to be submitted: VS, RBH, and CK. All authors have read and agreed to this manuscript's final version and contributed equally to its content and case management.

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Factors related to attitude-associated stigma among caregivers of mentally ill patients in Tanzania

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Abstract
Background: Attitude-associated stigmas towards patients with mental illness affect most patients. However, the factors related to attitude-associated stigma among caregivers remain unknown. This might lead to the disruption of family relationships, low self-esteem, lack of socialization and other adverse effects. Therefore, the current study aimed to determine the associated stigma among caregivers of a patient with a mental illness

Methods: A quantitative approach, with a cross-sectional study design, was used, involving two standardized questionnaires: Community Attitudes Towards the Mentally Ill (CAMI) Scale and Modified Consumer Experiences of Stigma Questionnaire (MCESQ), which were used to measure attitudes associated with stigma towards mentally ill patients, experienced stigma and discriminations among caregivers of patient with mental illness. Data were analyzed using SPSS version 20, and descriptive and appropriate inferential statistics such as Chi-square test, Pearson correction and logistic regression were used.

Results: 422 caregivers living with mentally ill people attending Mirembe National Mental Hospital participated in the study. The overall prevalence of attitude-associated stigma towards mentally ill patients among caregivers was 95.3% in all four dimensions. However, in those who experienced stigma and discrimination, the overall prevalence was 63.3%. Factors that were statistically significantly associated with experiencing stigma and discrimination against mental disorders were age, education, occupation, place of residence, relationship and frequency of admission.

Conclusion: Attitudes associated with stigma towards mentally ill patients among caregivers are associated with admissions, relationships and some demographic characteristics. Thus, the current study suggests that social support should be provided to caregivers with a family member having a mental illness. However, future studies with longitudinal study design might provide the risk factors that predispose caregivers to attitude-associated stigma.

Keywords: Stigma, Mental illness, Attitude, Discrimination, Caregivers

Introduction
Mental health problems are among the most prevalent non-communicable diseases worldwide. Although various interventions towards the prevention and treatment of mental illness exist in the public, mentally ill people are still surrounded by several challenges, including stigma (Tawiah *et al.*, 2015). It is estimated that more than 50% of people with mental illness have poor access to mental health care due to stigma (Kaaya, 2014).

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Stigma can be categorized into self-stigma, public stigma, and label avoidance. Public stigma, also known as enacted stigma, occurs when the general population endorses prejudices and discriminates against individuals with mental illness, such as losing a job due to disclosing one's mental health status.(Gervas *et al.*, 2022; Koschorke *et al.*, 2021; Subramanian & Santo., 2021; Subu *et al.*, 2021).Stigma presents with broad detrimental effects on the lives of people living with mental illness; it contributes to disrupted family relationships, low self-esteem, lack of employment and adverse effects on the ability to socialize, obtain housing and access to education in the community (Subu *et al.*, 2021).

Numerous theories are attached to the stigma. For example, intersectionality theory postulates that societies within communities tend to evaluate and shape people to fit them into societal norms, which disadvantages individuals with multiple social stigmas. (Oexle & Corrigan., 2018).The current study applied this theory to mental illness because, historically, individuals with mental illness have been viewed as having a personality or ethical defect within their communities.(Overton & Medina., 2008).To effectively address the implications of the intersectionality of stigma, it is important to provide flexible and targeted support to individuals with mental illness rather than adopting a universal approach.

Previous studies have indicated that both caregivers and individuals with mental health problems suffer from negative attitudes and stereotypes of their human rights (Shibre *et al.*, 2001; Sommer., 1990; Drew *et al.*, 2011; Lauber & Rossler., 2007). Mental health problems are still perceived and viewed as threatening and uncomfortable in the community (Gervas *et al.*, 2022; Subramanian & Santo., 2021). Different attitudes within the communities view mental health problems as threatening and uncomfortable, and these attitudes frequently enhance stigma and discrimination towards people living with mental health problems. (Girma *et al.*, 2013).Stigma poses significant barriers to the treatment and prevention of mental illness. It is a major reason why Individuals who are experiencing mental health issues may be at an increased risk of violence, exploitation, malnutrition, drug abuse, and even suicide and death due to their failure to recognize their illness.(Girma, 2013, Patel et al., 2018). Further, it is stated that stigma may influence mental health care seeking in the community. (Corrigan *et al.*, 2012).Thus, attitude-associated stigma leads to more adverse effects on people with mental illness and their families.

In sub-Saharan Africa, particularly in Tanzania, despite the existence of some studies on stigma (Bengtsson-Tops & Tops., 2005; Li et al., 2019), most of them concentrated on individuals with mental illness and their relatives (Bengtsson-Tops & Tops, 2005; Li *et al.*, 2019). Therefore, this study assessed the public attitudes towards stigma among caregivers of people with mental illness attending the National Consultant Hospital in Tanzania.

Materials and Methods
Study Area
The study was conducted at Mirembe National Mental Hospital in Tanzania. This hospital is the only specialized hospital in the country for mental health services. It has a total bedding capacity 630 and is in the country's capital city, Dodoma. Dodoma is among the top seven regions in Tanzania with more than 20,000 mentally ill individuals, and males are the most affected group (Kaaya, 2014). Dodoma Region is the national capital of Tanzania, which has a population of about 3 085,625 (National Bureau of Statistics. 2022). Mirembe National Mental Hospital was chosen purposefully. It is the only government hospital in Tanzania that provides mental health care services to patients with mental illness from all over the country because it receives patients from different regions in Tanzania.

Study population
The study population was caregivers of patients with mental illness who were aged 18 years and above who escorted the mentally ill patients to the mental hospital for health care services.

Inclusion and Exclusion Criteria
Inclusion criteria
The study included caregivers of over 18 years of age of mentally ill patients at Mirembe National Mental Hospital. These patients had been diagnosed with mental illness for at least a year and were willing to participate in the study.
Exclusion criteria
Caregivers of patients with difficulty communicating, with a mental disability or who are seriously sick and with experience of less than one year in caring for mentally ill patients.

Study design
A survey with a quantitative approach using a cross-sectional study design was conducted among caregivers of patients with mental illness. The study was a cross-sectional design, where exposure and outcomes were measured at the same time among individuals. The advantage of a cross-sectional study design is that it is a quick study that provides estimates of the prevalence and associated factors at a single point in time.

Sample size
The estimated sample size was based on the Kish formula.(Usha *et al.*, 2018)The prevalence of stigma toward people with mental illness has been estimated to be 50%. This prevalence was used to calculate the sample size, which was 384. Ten per cent of the calculated sample size was added for attrition rate and non-response, making a total sample of 422 participants.

Sampling Technique
The systematic random sampling technique was used. A sample frame was established daily, and the 2 was used to make the intended sample within two months, deemed feasible for getting the calculated sample. Participants were selected randomly from the sample frame.

Data Collection Techniques / Methods and Tools
Data collection technique
Before data collection, two research assistants were trained in the data collection procedures and ethical considerations and given an orientation on the data collection tools. The researcher and the research assistants conducted face-to-face interviews at the Outpatient Department (OPD) and in the wards.

Data Collection procedures
Before signing the consent form, eligible participants received comprehensive information regarding the study, including its significance, ethical considerations, privacy and confidentiality measures, potential risks of participation, and the consequences of declining participation. Participants were educated about the informed consent form and were free to decide whether to sign it for their participation in the study. The participants underwent an interview in which they were asked about their demographic details and their attitudes towards people with mental illness as caregivers. Additionally, the interview aimed to measure the level of perceived stigma and discrimination towards patients with mental illness.

Data Collection Tools

The attitude associated with stigma towards mental illness among caregivers was measured using standardized tools known as Community Attitudes towards Mental Illness (CAMI)scale, which consisted of 40 total items using a 5-point Likert scale ranging from strongly agree to strongly disagree. The measurement comprised four-dimensional subscales used as dependent variables in this study. Each dimension comprised 10 items to be measured, and an equal number were worded positively and negatively. The dimensions are Authoritarianism, social restrictiveness, benevolence, and community mental health ideology. A Likert-type scale measures attitudes on a scale of five points, from "strongly agree" (1) to "strongly disagree" (5); a higher score indicates a high stigma, while a lower score indicates a low stigma.

On each dimension, the reverse-coded items were done; these values are opposite. Therefore, among 10 items for each of these dimensions, 5 items ofthese10 are reverse-coded. Then, items for each dimension are summed together to provide one score ranging from 10-50; this tool was developed. (Taylor & Dear., 1981) and used in different countries. Another standardized tool is the Modified Consumer Experiences of Stigma Questionnaire (MCESQ), a self-report scale survey designed to measure the experience of stigma and discrimination toward mentally ill patients. The tools were developed and re-tested in China. (Yin et al., 2014), it was not validated in Tanzania, but it was validated in African countries like Ethiopia; MCESQ complies with 18 items, while one item was excluded due to the nature of the question and environment when the tools were pre-tested; the score was on the five-point Likert scale whereby (1 = never, 5 = very often) and is divided into two subscales: the Stigma Experiences Scale nine (9) items which measured the scope to caregivers on how if dealt with negative attitudes from others of their relative with mental disorders.

For example, "I have worried that others will view me unfavourably because my family member receives psychiatric treatment". Also, the discrimination Experiences Scale has (8) items, which measure whether the caregiver experienced discrimination in working, the house, participation in social activities and other activities in the community because they have been caring for a relative with a mental disorder. So, one of the examples was, "I have been avoided, indicating on written applications (for jobs, licenses, housing, school, etc.) that my family received psychiatric treatment, for fear that information would be used against me or my family". The above explanation tools were also translated into Swahili to make participants and research assistants understand.

Data Management and Analysis

Data were coded and entered SPSS, cleaned, and checked for normality using graphs such as histograms and Q.Q plots before data analysis. Descriptive and inferential statistics were analyzed and presented in frequencies, percentages, tables, and figures. Inferential statistics such as the Chi-square test, Pearson correction and logistic regression were used to test the relationship between the outcome variable and independent variables. The logistic regression model was used to find predictors and to determine the effects of attitude associated, stigma and experienced discrimination against mentally ill patients among caregivers of persons with mental disorders at Mirembe National Mental Hospital Dodoma. Confidence intervals at 95% with $P<0.005$ were considered statistically significant.

Ethical Consideration

The study obtained ethical clearance from the institutional review board of the University of Dodoma (UDOM). Participants received a consent form written in Swahili and English before continuing the study. Interviewers received special training on how to handle the attitudes, experienced stigma, and discrimination associated with mentally ill patients among caregivers of patients with mental illness. Both participants and interviewers were assured of their safety and protection. Confidentiality was maintained to ensure the interviewer and interviewee's safety and the data's quality. Participants

were informed about ethical considerations, privacy, and confidentiality regarding their information. They were also informed of the potential risks associated with participating in the study and the effects if they decided not to participate before signing the consent form. Data collection was done anonymously to protect participants' information.

Results
Sample characteristics
The participant's socio-demographic characteristics

A total of 422 participants were included in the study; of the total participants, 422 (57.8%) were males. The minimum age of participants was 18 years, and the maximum was 68 years, with a mean age of 38±3.6 years. 283 (67.1%) were from urban residence area and 139 (32.9%) rural. Most of them were married, which accounts for 321 (76.1%), 59 singles (14.0%) separated/divorced, and widows accounted for 42 (10.0%). About 277 (65.6%) were Christians, while 145 (34.4%) were Muslims by their religion. Most of the participants, 235 (55.7%), were unemployed. On education, 200 (47.4%) had a primary education. Almost 260(61.6%) lived with mentally ill patients together. Apart from that, it has been shown that 133 (31.5%) of the primary caretakers for patients with mental illness in the community were sons/daughters. In comparison, 124(29.4%) were cared for by siblings, 78 (18.5%) were cared for by parents, 64 (15.2%) were cared for by their spouses, and 23 (5.5%) cared for others, like religious institutions. Other socio-demographic characteristics of the participants are described in Table 1 below.

Table 1: Socio-demographic characteristics of the participants (n= 422)

Socio-demographic characteristics	Frequency (n)	Percentage (%)
Age group responded		
15-19	4	0.9
20-29	124	29.4
30-39	110	26.1
40 and above	184	43.6
Gender of respondents		
Males	244	57.8
Females	178	42.2
Marital Status		
Married	321	76.0
Singles	59	14.0
Divorced, separated and widow	42	10.0
Religion of respondents		
Christians	277	65.6
Muslims	145	34.4
Level of education		
None	91	21.6
Primary	200	47.4
Secondary	93	22.0
Collage	38	9.0
Occupational status of respondents	82	19.4
Employed		
Un employed	235	55.7
Self employed	105	24.9
Residence area		
Rural	139	32.9
Urban	283	67.1
Relationship with mental ill patient		
Parents	78	18.5
Son/daughter	133	31.5
Sibling	124	29.4

Spouse	64	15.2
Other relative	23	5.4
Living together with mental ill in the same house		
Yes	260	61.6
No	162	38.4
Head of house who are taking carethe family		
Father		
Mother	356	84.4
	66	15.6
Duration diagnosed mental disorder		
0-6 monthly	128	30.4
7-12 monthly	58	13.7
13-18 monthly	46	10.9
19 and above	190	45.0
Frequency of admission		
Less or equal to 2 per year	138	32.7
More than twice per year	284	67.3

The prevalence of attitude associated stigma towards mentally ill patients
Descriptive statistics analysis of attitude associated stigma towards mental ill patients among care givers of patents with mental illnessCAMI
The Table4.2; shows the CAMI scale score for each item. The mean score for the CAMI scale were as follows; 96.27 ±15.03 of overall score with range of 43-126; 27.11± 5.87 for AU with range 10-43; 25.28 ± 5.07 for BE with the range of 10-40; 23.54 ± 4.87 for SR with the range 10-35; and CMHI had mean score of 20.34 ±4.21 with the range score of 11.30.

Table 2: Descriptive statistics analysis of CAMI Scale (n= 422)

Measure	Prevalence n (%)		Mean score (Sd)	Range
	Low	High		
CAMI	20 (4.7)	402 (95.3)	96.27(sd 15.03)	43-126
Authoritarianism (AU)	36 (8.5)	386 (91.5)	27.11 (sd 5.87)	10-43
Benevolence. (BE)	39 (9.2)	383 (90.8)	25.28 (sd 5.07)	10-40
Social Restriction (SR)	66 (15.6)	356 (84.4)	23.54 (sd 4.87)	10-35
Community Mental Health Ideology (CMHI)	239 (56.6)	183 (43.4)	20.34 (sd 4.21)	11-30

The overall prevalence of attitude-associated stigma among caregivers
In this study, the cutoff point for low attitude-associated stigma was less than 12.5, the median ranged from 13 to 25, and a high attitude-associated stigma towards mentally ill patients was rated above 26 scores. Thus, this study's findings have been reviewed: the Overall prevalence of attitude-associated stigma towards mentally ill patients among caregivers of patients with mental illness was 95.3% with (95% CI, 2.80-6.90) as indicated in Figure 1.
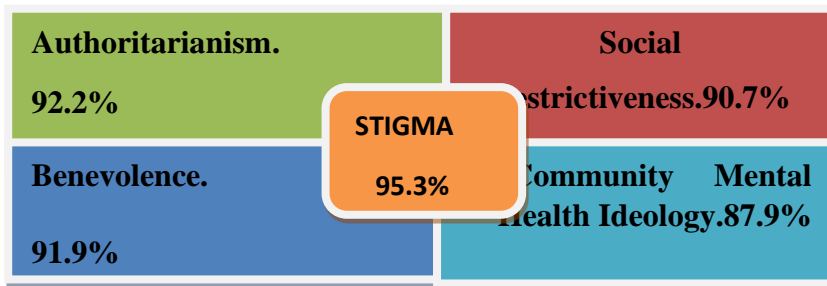
Figure 1: Overall prevalence of stigma score for CAMI Scale

Factors related to attitude associated stigma towards mentally ill patients among caregivers of patients with mental illness, by four dimensions for CAMI Scale

Authoritarianism (AU)

Table 3, Authoritarianism (AU): Even though the age group was not associated with AU, the age group 20-29 years was 94 (75.8%) and was shown to have a high prevalence compared to others. There was a high stigma among males 189 (77.5%). Attitudes associated with stigma score for AU were found to be 51 (86.4%) for single marital status, 73 (80.2%) for those none educated people, 184 (78.3%) for the unemployed, which also was statistically significantly associated with AU of X_2, (2) 11.698, P<0.05.

Table 3: Factors related to attitude associated stigma towards mental ill patients among caregivers of patients with mental illness, Authoritarianism (AU) (n=422)

Variable	Low	Median	High	X^2	*p*-value
Age group					
15-19	0 (0.0)	0 (0.0)	4 (100.0)		
20-29	8 (6.5)	22 (17.7)	94 (75.8)		
30-39	9 (8.2)	21 (19.1)	80 (72.7)		
>40	16 (8.)	30 (16.3)	138 (75.0)	2.244	0.896
Gender					
Males	16 (6.6)	39 (16.0)	189 (77.5)		
Females	17 (9.6)	34 (19.1)	127 (71.3)	2.271	0.321
Marital status					
Marriages	27 (8.4)	59 (18.4)	235 (73.2)		
Single	2 (3.4)	6 (10.2)	51 (86.4)		
Separated/devoiced and widow	4 (9.5)	8 (19.0)	30 (71.4)	5.045	0.283
Level of education					
None	6 (6.6)	12 (13.2)	73 (80.2)		
Primary	12 (6.0)	30 (15.0)	158 (79.0)		
Secondary	12 (12.9)	20 (21.5)	61 (65.6)		
Collage	3 (7.9)	11 (28.9)	24 (63.2)	12.097	**0.030**
Occupation status					
Employed	8 (9.8)	24 (29.3)	50 (61.0)		
Unemployed	18 (7.7)	33 (14.0)	184 (78.3)		
Self employed	7 (6.7)	16 (15.2)	82 (78.1)	11.698	**0.020**
Residence area					
Rural	9 (6.5)	28 (20.1)	102 (73.4)		
Urban	24 (8.5)	45 (15.9)	214 (75.6)	1.512	0.470
Relationship with mental patient					
Parents					
Son/daughter	5 (6.4)	17 (21.8)	56 (71.8)		
Sibling	13 (9.8)	20 (15.0)	100 (75.2)		
Spouse	11 (8.9)	14 (11.3)	99 (79.8)		
Other relative	3 (4.7)	19 (29.7)	42 (65.6)		
	1 (4.3)	3 (13.0)	19 (82.6)	13.416	0.098
Living together with mental patient					
Yes	17 (10.5)	24 (14.8)	121 (74.7)		
No	16 (6.2)	49 (18.8)	195 (75.0)	3.393	0.188

Variable	Low	Median	High	X²	p-value
Duration of illness since diagnosed					
0-6 monthly	10 (7.8)	27 (21.2)	91 (71.1)		
7-12 monthly	3 (5.2)	9 (15.5)	46 (79.3)		
13-18 monthly	4 (8.7)	8 (17.4)	34 (73.9)		
19 and above	16 (8.4)	29 (15.3)	145 (76.3)	2.735	0.841
Frequency of admission					
≤ 2 per year	12 (8.7)	29 (21.0)	97 (70.3)		
> per year	21 (7.4)	44 (15.5)	219 (77.1)	2.415	0.299

Benevolence (BE)

Table 4.4 indicates the association between attitude-associated stigma and Benevolence (BE): High attitude-associated stigma towards mentally ill patients was found between the age of 20-29. The level of education, duration of illness since diagnosis, and frequency of admission due to mental disorder showed a statistically significant association with BE, $P<0.05$.

Table 4: Factors related to attitude-associated stigma towards mentally ill patients among caregivers of patients with mental illness on Benevolence dimensions (BE) (n=422)

Variable	Low	Median	High	X²	p-value
Age group					
15-19	0 (0.0)	2 (50.0)	2 (50.0)		
20-29	8 (6.5)	40 (32.3)	76 (61.3)		
30-39	12 (10.9)	34 (30.9)	64 (58.2)		
40>	14 (7.6)	62 (33.7)	108 (58.7)	2.588	0.858
Gender					
Males	19 (7.8)	79 (32.4)	146 (59.8)		
Females	15 (8.4)	59 (33.1)	104 (58.4)	0.105	0.949
Marital status					
Marriages	28 (8.7)	107 (33.3)	186 (57.9)		
Single	2 (3.4)	17 (28.8)	40 (67.8)		
Separated/devoiced and widow	4 (9.4)	14 (33.3)	24 (57.1)	3.052	0.549
Level of education					
None	7 (7.7)	22 (24.2)	62 (68.1)		
Primary	12 (6.0)	64 (32.0)	124 (62.0)		
Secondary	12 (12.9)	41 (44.1)	40 (43.0)		
Collage	3 (7.9)	11 (28.9)	24 (63.2)	15.39	**0.017**
Occupation status					
Employed	9 (11.0)	33 (40.2)	40 (48.8)		
Un employed	18 (7.7)	69 (29.4)	148 (63.0)		
Self employed	7 (6.7)	36 (34.3)	62 (59.0)	5.54	0.236
Residence area.					
Rural	10 (7.2)	55 (39.6)	74 (53.2)		
Urban	24 (8.5)	83 (29.3)	176 (62.2)	4.44	0.109
Relationship with mentalpatient					
Parents					
Son/daughter	7 (9.0)	35 (44.9)	36 (46.2)		
Sibling	10 (7.5)	49 (36.8)	74 (55.6)		
Spouse	9 (7.3)	29 (23.4)	86 (69.4)		
Other relative	6 (9.4)	19 (29.7)	39 (60.9)		
	2 (8.7)	6 (26.1)	15 (65.2)	13.24	0.104

Living together with mental patient					
Yes	16 (9.9)	52 (32.1)	94 (58.0)		
No	18 (6.9)	86 (33.1)	156 (60.0)	1.176	0.556
Duration of illness since diagnosed					
0-6 monthly	13 (10.2)	58 (45.3)	57 (44.5)		
7-12 monthly	3 (5.2)	23 (39.7)	32 (55.2)		
13-18 monthly	2 (4.3)	12 (26.1)	32 (69.6)		
19 and above	16 (8.4)	45 (23.7)	129 (67.9)	22.61	**0.001**
Frequency of admission					
≤ 2 per year	14 (10.1)	59 (42.8)	65 (47.1)		
>2 per year	20 (7.0)	79 (27.8)	185 (65.1)	12.59	**0.002**

Social Restrictiveness (SR)

Table 5 indicates the relationship between attitude-associated stigma and Social Restrictiveness (SR): Attitude-associated stigma had a high prevalence in ages between 20-29 years 62 (50.0%) in SR, the level of education, living with mentally ill patients was found to have statistically significant difference with SR, with P<0.05.

Table 5: Factors related to attitude-associated stigma towards mentally ill patients among caregivers of patients with mental illness, Social Restrictiveness (SR) (n=422)

	Low	Median	High	X²	P-Value
Age group					
15-19	0 (0.0)	3 (75.0)	1 (25.0)		
20-29	6 (4.8)	56 (45.2)	62 (50.0)		
30-39	13 11.8)	51 (46.4)	46 (41.8)		
>40	20(10.9)	85 (46.2)	79 (42.9)	6.498	0.370
Gender					
Male	18 (7.4)	104 (42.6)	122 (50.0)		
Female	21(11.8)	91 (51.1)	66 (37.1)	7.643	**0.022**
Marital status					
Marriage	34 (10.6)	148 (46.1)	139 (43.3)		
Single	0 (0.0)	32 (54.2)	27 (45.8)		
Separated/devoiced and widow	5 (11.9)	15 (35.7)	22 (52.4)	8.94	0.063
Level of education					
None	8 (8.8)	36 (39.6)	47 (51.6)		
Primary	17 (8.5)	84 (42.0)	99 (49.5)		
Secondary	11 (11.8)	54 (58.1)	28 (30.1)		
Collage	3 (7.9)	21 (55.3)	14 (36.8)	13.017	0.043
Occupation status.					
Employed	9 (11.0)	47 (57.3)	26 (31.7)		
Un employed	21 (8.9)	103 (43.8)	111 (47.2)		
Self employed	9 (8.6)	45 (42.9)	51 (48.6)	6.871	0.143
Residence area.					
Rural	11 (7.9)	72 (51.8)	56 (40.3)		
Urban	28 (9.9)	123 (43.5)	132 (46.6)	2.642	0.267
Relationship with mental patient.					
Parents	7 (9.0)	38 (48.7)	33 (42.3)		
Son/daughter	12 (9.0)	66 (49.6)	55 (41.4)		
Sibling	10 (8.1)	48 (38.70	66 (53.2)		

Spouse	8 (12.5)	35 (54.7)	21 (32.8)		
Other relative	2 (8.7)	8 (34.8)	13 (56.5)	9.745	0.283
Living together with mental. patient					
Yes	19 (11.7)	62 (38.3)	81 (50.0)		
No	20 (7.7)	133 (51.2)	107 (41.2)	7.097	0.029
Duration of illness since diagnosed.					
0-6 monthly	13 (10.2)	59 (46.1)	56 (43.8)		
7-12 monthly	5 (8.6)	26 (44.8)	27 (46.6)		
13-18 monthly	3 (6.5)	22 (47.8)	21 (45.7)		
19 and above	18 (9.5)	88 (46.3)	84 (44.2)	0.658	0.995
Frequency of admission.					
≤2 per year	12 (8.7)	69 (50.0)	57 (41.3)		
>2 per year	27 (9.5)	126 (44.4)	131 (46.1)	1.189	0.552

Discussion

The objective of this research was to establish the occurrence rate of attitude-associated stigma and discrimination among caregivers of patients with mental illness. In this study, it was shown that the overall prevalence of attitude-associated stigma among caregivers of people with mental illness was high in all four dimensions. Factors strongly associated with attitude-associated stigma among caregivers are education, age, occupation, place of residence, the relationship of caregivers with the patient and the frequency of admission.

The overall Prevalence of attitude-associated stigma among caregivers of people living with mental illness in this study was 90%, which is in line with the study done in Morroco, which had a prevalence of 86.7% (Kadri *et al.*, 2004). However, the prevalence in this study was higher than the prevalence reported in the United States (43%) and Ethiopia (75%) (Struening et al., 2001; Catthoor *et al.,* 2015). The difference might be attributed to factors like variation in context and social culture of this study compared to others and the study participants' socio-demographic characteristics. In addition to this, the attitude associated with stigma in our study might be due to a misperception about mental illness and most of the time, people believe that mental illness is happening because of supernatural punishment in authoritarianism. This emphasizes the urgent need for culturally tailored mental health education and awareness programs that can address these misconceptions and reduce stigmatizing attitudes.

There was a high prevalence of attitude-associated stigma in males as compared to their counterparts. This finding agrees with findings from India and Nigeria, which also revealed that males were seen to show stigma towards people with mental illness (Abayomi *et al.*, 2013; Salva *et al.,*2013). The possible explanation for this finding could be that most participants were males. However, this is contrary to (Venkatesh *et al.,*2015) Who showed a higher stigma among females than males. Previous literature on attitudes associated with stigma in authoritarianism is inconsistent. Gender roles can explain this, as gender is a complex social construct determined by culture, behaviour and practice, which may differ from place to place (Inhorm& Whittle., 2001). The high proportion of male caregivers which was seen did not want to live and accompany patients when attending Mirembe National Mental Hospital to seek treatment and other health services. Their low education may probably account for this as most of them had a primary school level and may misconceive that it was a waste of time to take care of mentally ill patients; it also can be attributed to poor knowledge of mental disorders. Lack of education shown to associate with AU attitude associated with stigma (Li *et al.*, 2014).

In this study, it has been revealed that the high score attitude associated with stigma to mental illness among caregivers in Benoverance (BE), and in Social Restrictiveness (SR) was shown in

none education people with 68.1 % in BE and 51.6% in SR than those who attended to school, this result is consistent with another study showing that people with education presented a positive attitude toward people with mental disorders (Aznar *et al.*, 2016). However, this is contrary to (Bedaso *et al.*, 2016) Who reported a high prevalence score of attitude-associated stigma among college-level students. In contrast, one study pointed out that education level was not significantly associated with positive attitudes toward mental disorders (Chiles et al., 2017). When caregivers lack education and training, they may hold misconceptions and misunderstandings about the mental health condition. This can lead to stigmatizing attitudes and behaviour towards the individuals they are caring for, such as viewing them as dangerous or unpredictable or as being responsible for their illness. Often, family, friends and relatives don't have enough knowledge about mental illnesses and eventually, they end up blaming the individual and/or their family for their problems (Kutcher *et al.*, 2016).

The current study found that employed caregivers were more likely to display attitudes related to stigma towards individuals with mental illness than their unemployed counterparts. This finding is in line with previous research, such as a study conducted by Cohen-Mansfield and colleagues (2010), which found that employed caregivers reported higher levels of burden and depressive symptoms compared to those who were unemployed. This study suggests that the demands of both work and caregiving responsibilities can contribute to negative psychological outcomes, which may, in turn, lead to stigmatizing attitudes. However, other studies suggest that employment can positively impact caregivers' mental health and well-being. For example, a study by Lee and colleagues (2019) found that employed caregivers reported better mental health outcomes than those who were not. This study suggests that employment may give caregivers a sense of purpose and social connection, which can positively affect their mental health. In conclusion, the finding that employed caregivers may exhibit more stigma towards individuals with mental health issues is a complex issue that several factors, including the demands of work and caregiving responsibilities, social support, and access to mental health resources, may influence. Further research is needed to understand the factors contributing to stigma among employed caregivers and develop effective interventions to reduce stigma and improve the well-being of caregivers and their loved ones.

According to the current study, a significant number of caregivers exhibited stigmatizing attitudes towards individuals with mental illness who had experienced frequent hospitalizations and prolonged periods of mental illness symptoms. This finding is consistent with a previous study conducted by Corrigan *et al.* (2014), which found that repeated hospitalizations for mental illness may contribute to stigmatization among caregivers by perpetuating the belief that mental illness is not a serious condition and that recovery is unlikely. Moreover, frequent hospitalizations may be viewed as a lack of progress or treatment failure, which can further reinforce negative stereotypes, burnout, frustrations and attitudes towards individuals with mental illness. However, Reavley and Jorm (2014) found that contact with individuals with mental illness, including those who had been hospitalized multiple times, was associated with reduced stigma among the general population. The authors suggest that contact may help to reduce fear and misconceptions about mental illness, leading to more positive attitudes. The findings across studies may be due to differences in study design, population characteristics, and cultural factors. Overall, these conflicting findings highlight the need for further research to understand better the relationship between repeated hospitalizations and stigma among caregivers and to develop effective interventions to reduce stigma and promote more positive attitudes towards individuals with mental illness.

Stigma towards people with mental illness is a local issue shaped by the experience of mental illness in a variety of social contexts. Through this study, it has been observed that attitudes and actions that have been consistently promoting stigma among individuals with mental illnesses and made people perceive mental illness as threatening and uncomfortable are the attitudes of stereotyping mental illness and projecting ideas about blaming, discriminatory behaviour, perceiving dangerousness, and incompetence among individuals with mental illnesses. For example, the public

is hesitant to employ or rent property to people with mental illness (Fekih et al., 2021). Therefore, it's extremely important to raise the level of awareness and contact regarding positive attitudes toward caregivers among mentally ill individuals and the importance of taking the patients to the available health services.

The findings of this study have important implications for policy and practice. Policies that promote mental health education and awareness campaigns are critical to addressing the high levels of stigma among caregivers. Healthcare providers should receive training to help them support caregivers and reduce stigmatizing attitudes. Public awareness initiatives are also needed to challenge stereotypes and promote a more inclusive approach to mental health.

Interpretations of these findings need to consider the following limitations. The study was purely quantitative and did not explore the participants' perceived feelings about stigma. This study was conducted in one clinical setting; this might limit the generalization of the study outcomes to the whole country. However, the sample was selected randomly, and Mirembe Psychiatric Hospital is a consultant hospital that receives patients from the whole country. Moreover, the study employed a cross-sectional study design to evaluate the attitude associated with stigma; such a study design cannot provide the causal relationship between stigma and mental illness.

In conclusion, findings from this study have shown that the occurrence of attitude-associated stigma among caregivers of people with mental illness attending Mirembe National Referral Hospital in Dodoma, Tanzania, was significantly widespread. Factors that were highly associated with stigma were being a male caregiver and having a low level of education, age, relationship and frequency of admission. Therefore, it is important to raise the level of awareness regarding positive attitudes toward caregivers among mentally ill individuals and the importance of taking the patients to the available health services.

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Socio-cultural and religious factors influencing menstrual hygiene management among schoolgirls in Tanzania. A literature survey

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Abstract

Background: Menstruation is a natural phenomenon for adolescent girls and women as part of their reproductive life. It is associated with social and cultural values among schoolgirls and women. This study aimed to identify and discuss several socio-cultural and religious elements that influence menstruation among Tanzanian schoolgirls.

Methods: The study is a literature survey based on relevant papers published in Tanzania. It was conducted utilising a seven-step methodology, in which relevant themes from several prospective bibliographic databases, such as Google Scholar, PubMed, and institutional repositories, were methodically identified, collated, and analysed using descriptive methods.

Results: The survey found sociocultural and traditional factors influencing menstrual hygiene management among Tanzanian schoolgirls. These elements include religious beliefs, impurity, witchcraft, local superstitions, menstruation associated with fear, shame, and secrecy, male involvement, awareness, knowledge, abilities, and relationships with family, teachers, and peers.

Conclusion: The government and other stakeholders should work together to address the socio-cultural and religious concerns that affect menstrual hygiene management among schoolgirls in the country.

Keywords: Menstrual hygiene management; Menstruation; Religious factors; Socio cultural factors; Tanzania

Background

Menstruation is a natural phenomenon for adolescent girls and women as part of their reproductive life (Panda et al., 2024). It is estimated that menstruation is experienced by about one-quarter of the global population, or about 1.8 billion women and girls of

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reproductive age between 15 and 49 years (Jain, 2013). Girls start menstruating between 11-14 years. Poor hygiene during menstruation has been associated with serious ill health, ranging from reproductive tract infections to urinary tract infections (Bobhate & Shrivastava, 2011).

Menstrual Hygiene Management (MHM) involves clearly understanding the basic facts of the menstrual cycle and how to handle it comfortably. Globally, 2.3 billion girls and women do not manage their menstruation properly due to a lack of MHM facilities, high costs, and ignorance (Mulugeta Demmu et al., 2023). This leads to the use of unhygienic menstrual material (such as old clothes) that cause infections, a threat to their well-being and growth. The study conducted in sub-Saharan African countries revealed that, on average, 49% of the school girls missed four school days monthly due to menstruation (Tamiru et al., 2015). About 200 million women and girls from developing countries struggle to access clean water for personal hygiene and private places (Crofts & Fisher, 2012). Schools have inadequate handwashing facilities, dirty toilets that are not private, and a lack of places to dispose of menstrual materials. Menstruating girls' school life becomes uncomfortable and difficult.

Similarly to other developing countries, MHM is among the challenges that schoolgirls in Tanzania face. Sociocultural and religious factors generate hurdles for teenagers and impede the reception of crucial, sufficient information concerning proper MHM. Tanzania has a huge variety of socio-cultural issues that impede MHM practices. Besides, MHM practices among schoolgirls can affect multiple areas across the sustainable development goals (SDGs) agenda, including health, education, gender equality, and women's empowerment (Mohammed Gena, 2020). Poor MHM in schools lead to absenteeism, dropping out, diminished dignity, and a variety of sexual and reproductive health concerns, all of which can have serious and long-term health and socioeconomic consequences for adolescent girls not only in Tanzania but in other countries (Canon, 2021; Van Eijk et al., 2016).

For instance, in schools, adolescent girls' ability to manage their menstruation is hampered by a variety of factors, including low knowledge level of menstruation, insufficient access to safe and private toilets, a lack of clean water and soap for personal hygiene, and limited access to affordable and sanitary materials and disposal options (Patel et al., 2022; Sharma et al., 2022). Moreover, sociocultural myths, norms and religious beliefs impose restrictions on girls during menstruation. All these factors make it difficult for all girls to manage their menstruation in a safe and sanitary manner.

Hence, it is crucial to identify the social-cultural and religious issues in order to intervene correspondingly. However, no comprehensive study or review provides information on how socio-cultural and religious factors affect school life and the general well-being of schoolgirls in Tanzania. Therefore, this survey highlights and discusses socio-cultural and religious issues that influence MHM among schoolgirls in Tanzania.

MHM Situation in Tanzania

Proper MHM is crucial for Tanzanian schoolgirls and women. However, the Tanzanian government increasingly recognises menstrual health and hygiene but has not fully mainstreamed them (Lila et al., 2022). Most girls in rural primary and secondary schools who have reached puberty do not have sufficient materials and facilities during their monthly menstrual cycle (Magayane & Meremo, 2021) and face other sociocultural and religious challenges. However, the government and stakeholders have given MHM issues the attention it deserves.

In the past 10 years, the government and local and international organizations have launched MHM initiatives, as presented in Table 1. All these initiatives aim to improve MHM among women and girls in Tanzania.

Table 1: MHM initiatives in Tanzania

Initiative	Core function	References
Girls in Control	It is a multi-country project that aims to increase school attendance for adolescent schoolgirls through improved MHM in schools and a value-chain business model that facilitates access to safe, affordable, and sustainable sanitary materials.	(SNV, 2024)
Empowering girls through WASH	Through the Foreign, Commonwealth, and Development Office-funded project, Save the Children recognized the urgent need to address MHM challenges girls face. The project focused on constructing latrines, providing disposable sanitary pads, and building handwashing stations to combat absenteeism and promote safety during menstruation.	(Save the Children Tanzania website, 2023)
Maji Safi Group's Menstrual Hygiene Program	Is recognized as a founding member of the nationwide menstrual hygiene management coalition in Tanzania. The coalition is committed to improving the supply chain of menstrual products, educating girls and women on feminine hygiene, and breaking the silence of the barriers women face during menstruation.	(Maji Safi Group website, 2023)
Improving menstruation hygiene management and sanitation conditions in Tanzanian schools	The project's main objectives include girl-friendly sanitation infrastructures, public acceptance of menstruation, and improved school capabilities for good practices.	(Alstom Foundation website, 2023)
'Sauti ya Binti' (Daugter's Voice)	An initiative to promote better healthcare and education for girls in Tanzania (awareness of the changes they go through as they grow).	(The Tanzanian Citizen newspaper website, 2018)

The nation's decision to promote menstrual hygiene as a public health concern is a significant milestone (Gabrielsson, 2018). In 2018, the members of the parliament of Tanzania gave a value-added tax (VAT) exemption for sanitary pads. A year later, it reinstated the VAT exemption as it was ineffective in cutting costs and boosting girls' and women´s access to sanitary pads. The Ministry of Health, other sectoral ministries such as the Ministry of Environment and Local Government and MHM stakeholders such as NGOs and international organizations have partnerships to improve MHM by providing human and financial resources. Despite these efforts, there is still poor MHM among schoolgirls in Tanzania. Tanzania scores low in knowledge, attitude and practice on MHM, with some differences between rural and urban areas (Okello et al., 2022).

While MHM issues are generally expressed in the national guidelines for water, sanitation, and hygiene in health care facilities (URT, 2017), and the Water, Sanitation, and Hygiene (WASH) guidelines were issued in 2016, no specific guidelines provide clear and specific recommendations or instructions on how to perform a task, decide, or achieve MHM issues in Tanzania. More evidence is needed to adequately incorporate MHM issues in future policy documents for planning purposes and MHM resource allocation.

Methods

A literature survey was conducted to appraise MHM among Tanzanian schoolgirls. The utilization of literature surveys has increased consideration in recent years. (Bryman, 2012). This survey includes pertinent research used as secondary data, as well as evaluation and assessment information published in various databases, to examine the socio-cultural and religious aspects impacting MHM among Tanzanian schoolgirls. It reproduces prior and current research findings to provide a general overview of the pertinent topic. (Owusu & Vaaland, 2016).

This study was conducted through the Seven-Step paradigm, replicating the exploration, interpretation, and communication phases commonly used in a complete literature review (Onwuegbuzie & Frels, 2016). First, researchers investigated global perceptions about MHM among schoolgirls in Tanzania and highlighted its associated influential factors. The key terms such as 'menstrual hygiene', 'MHM', 'schoolgirls', 'traditional beliefs, taboos and rituals concerns', 'fear', 'shame', 'secrecy', and 'awareness, knowledge and skills' were selected to explain deeply the MHM among schoolgirls. Second, researchers prepared an initial list of relevant studies, identified through Google Scholar, Web of Science, institutional repositories, and grey literature documents, and then completed the list through snowball sampling (Waters, 2015).

Each keyword search produced a high number of hits. Each hit was narrowed down to relevant research in journal papers, book chapters, reports, media and speech articles, or working papers containing the keywords in the main text and connected to socio-cultural and religious aspects impacting MHM among Tanzanian schoolgirls. All hits in each list were checked, and the resulting list was analysed for prospective selections. The second screening reduced the list to 105 studies from 234. The selection procedure found that certain research was unsuitable owing to a lack of precise information about the

sociocultural and religious factors that influence MHM. As shown in Table 2, 76 studies were chosen from 105.

Table 2: Potential studies relevant to socio-cultural and traditional factors influencing schoolgirls in Tanzania

No.	Variable	Number of relevant studies	Per cent
1.	Traditional beliefs, taboos and rituals	11	14.9
2.	Religious beliefs	05	6.8
3.	Impurity, witchcraft and local superstitions	15	20.3
4.	Restrictions associated with menstruation	16	21.6
5.	Menstruation is associated with fear, shame and secrecy	13	17.6
6.	Male involvement	04	5.4
7.	Awareness, knowledge and skills	07	9.5
8.	Relationships with family, teachers and peers	02	2.7
9.	School/gender-related policies	01	1.4
	Total	**74**	**100**

The selected studies identified potential themes consistent with the study's premise. Extensive reading, analysis, and synthesis were performed to verify the data's reliability and validity and determine the relationship between the emerging themes from relevant research and the study's objectives. The researchers developed and carefully collated theme summaries using descriptive methods to prevent plagiarism (Williams, 2018). The final step was to communicate the final results through thorough discussion. The model for this study is indicated in Figure 1.
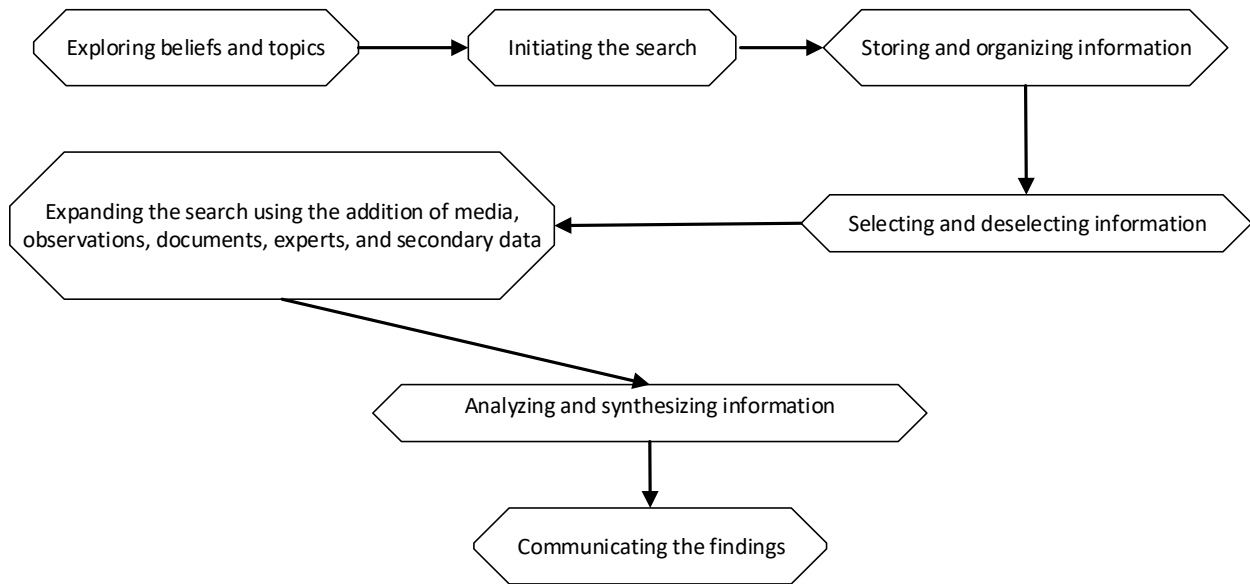
Figure 1: The Seven-Step Model used in the study for an extensive literature survey, as adopted and modified from Williams (2018)

Results

The study of sociocultural and religious factors influencing MHM among schoolgirls is complex and requires a deep understanding and identification from people with different experts in public health, sociology, and religion. After examining the selected papers in this survey, we identified eight main factors that influence individual and community behavioural change regarding environmental health (Table 1). These factors differ among individuals, communities, nations, and generations.

Table 1: Main themes socio-cultural and religious factors influencing MHM among schoolgirls in Tanzania that were identified after a literature review

No.	Theme	Implications to MHM among the schoolgirls	References
1	Traditional beliefs, taboos and rituals	Menstrual blood is believed to be a private matter that is often associated with impurity in Tanzania	Stoilova et al., (2022)
		Tribes believe that they can shorten the days of menses for girls who get their periods for more than 5 days in Rorya district in Mara region	(Grevstad., 2022)
		Menstruating girls are not supposed to hit a dog as it believed that the dog will stop being brave behaviour on environmental sanitation and solid waste management in the societies in Muleba district, Kagera region	(Grevstad., 2022)
		Traditional rituals that are done when a girl experiences her first period some areas such Namtumbo district in Ruvuma region and Mufindi district in Iringa region	

2	Religious beliefs	The community perceive that Islam is stricter with practices related to menstruation than Christianity in most parts of Tanzania.	(Njee et al., 2021)
		When menstruating, girls may be expected to stay away from their peer group, avoid male community members, and not visit certain locations, such as churches	(Tamiru et al., 2013)
		Girls or women are not allowed to preach because they are considered dirty, unholy and weak when they are in menstruation, in Mkoma Ward in Mara region.	(Grevstad., 2022).
3	Impurity, witchcraft and local superstitions	Menstrual materials are handled with care because of witchcrafts beliefs that if someone takes your menstrual blood you won't have children, you will over-bleed or lose your womb, in Mufindi district in Iringa region.	Sommer et al., 2015; Tamiru et al., 2013
		Reusable menstrual material are not hanged outside as the girl can be bewitched. Many girls and women hang reusable menstrual materials indoors and not under direct sunlight that facilitates proper drying to avoid infections of wearing damp ones, in Mpwapwa district in Dodoma region	Kim & Choi, 2020; Torondel et al., 2018
		Also, some are scared to be married, especially Wafipa in Rukwa region, Wasafwa in Mbeya region and Waluo in Mara region. Their mothers also keep the secret because they will be bewitched to death if they refuse to marry off their daughters.	Stoilova et al., 2022
		There is a belief that If a used menstrual material is not disposed of well and it is picked by bad people, the girl can be bewitched hence she won't get kids, or might make her go crazy or she can be killed in Rorya district in Mara region.	Njee et al., 2021
4	Restrictions associated with menstruation	Menstruating girls are not supposed to eat mangoes lime and green vegetables, in Rorya district in Mara region.	Kumar & Maity, 2022
		The Kine and Luo (tribes in Mara region), menstruating girls are not supposed to harvest vegetables it is believed that the leaves will dry up or rot (eg; tomatoes, pumpkin leaves, spinach, "sukuma wiki" and the local greeen vegetable "mgagani"); and they are not supposed to weed and harvest groundnuts. They are also not suppossed to slaughter a chicken when they are in their menses.	Njee et al., 2021
		Girls are not supposed to walk into a groundnuts farm as the plants will dry up, if she has to walk into the farm	NIXON, 2007

		she has to throw sand on the plants first, in Mpwapwa district in Dodoma region	
		Girls are not suppossed to eat sugarcane or drink tea as they are both sweet and it is believed that the sugar will cause heavy bleeding in Lushoto district in Tanga region.	Sugita, 2022
		School girls from the Wamang'ati community in Arusha region are not allowed to attend school when menstruating, they stay home under observation; and they sleep on a hide during menstruation.	NIXON, 2007
		Parents and teachers encourage schoolgirls in Temeke district in the Dar es Salaam region and Namtumbo district in the Ruvuma region not to attend school during their menses.	Njee et al., 2021
		Likewise, menstruating schoolgirls in Msalala district in Shinyanga region, Igunga district in Tabora region, Rorya district in Mara region and Mpwapwa district in Dodoma region are not allowed to cook as they are considered to be dirty.	House et al., 2012
		In Rorya district in the Mara region, menstruating girls are not supposed to fetch water or walk across a fishing net.	House et al., 2012
5	Menstruation is associated with fear, shame and secrecy	Teasing, especially of primary school girls, is common in urban areas of Mbeya region and in Mufindi, Iringa region. One acute manifestation of boys' negative attitudes is period teasing—harassment linked directly to girls' menstruation.	Benshaul-Tolonen et al., 2020
		Boys engage in period teasing because they perceive periods as embarrassing, especially visible markers of periods (odor or stains).	Benshaul-Tolonen et al., 2020; Chinyama et al., 2019; Girod et al., 2017
		In addition, male peers are the most commonly feared perpetrators of period teasing among this sample of girls.	Benshaul-Tolonen et al., 2020
6	Male involvement	In most of the rural areas in Tanzania, especially in the districts of Mpwapwa, Pemba, Karatu, Rorya and Kibondo, males are socio culturally prohibited to deal with menstrual issues, as it is considered a dirty thing, hence shameful to involve them; and it is also	Njee et al., 2021

		considered as a women issue, hence discussing it is like talking about the nakedness of a woman.	
		Also, culturally, in West Tanzania especially in the districts of Kibondo, Msalala and Butiama, men are not supposed to know that their daughters are menstruating.	Njee et al., 2021
7	Awareness, knowledge and skills	Most of the schoolgirls with and without disabilities appear to have a fair awareness of menstruation.	Bishoge et al., 2022; Njee et al., 2021
		The lack of awareness and education as well as sociocultural conditioning around menstruation were cited as major contributors to male disengagement from menstruation generally.	Njee et al., 2021
8	Relationships with family, teachers and peers	While most of the males (parents, family members, teachers and peers) play a significant role in educating girls about menstruation, their influence is limited by entrenched misconceptions and a lack of systematic guidance.	Njee et al., 2024
9	MHM related policies	There is no standalone MHH policy in Tanzania. Menstruation is a subtopic of adolescent reproductive health guidelines and school curricula on similar topics and a subcomponent of SWASH guidelines.	Njee et al., 2021

Discussion
Traditional beliefs, taboos and rituals

Traditional belief is the passing down of cultural information from one generation to another. Taboo is a social or religious custom restricting a particular practice, person, place or thing (Chakrabarti & Chakrabarti, 2019). A ritual is a religious ceremony of actions performed in a certain order. Traditional beliefs, taboos, and rituals impact and reinforce the behaviour of girls and women during menstruation in different parts of the world. The sociocultural beliefs and perceptions of menstruation are due to multiple factors evolving from cultural beliefs of girls' and women´s fertility and impurity. During menstruation, girls and women are considered impure, untouchable and undesirable, especially in developing countries (Garg & Anand, 2015; Joshy et al., 2019; Mukherjee et al., 2020; Rothchild & Piya, 2020; Syed Abdullah, 2022).

In some areas, especially developing countries, menstrual taboos and norms direct girls and women to avoid cooking or eating certain foods and, in some cases, avoid bathing and isolate themselves during menstruation (Australian Department of Foreign Affairs and Trade, 2016). For instance, culturally, menstruation is still considered to be dirty and impure in India, leading to the isolation of girls and women who are in their menstrual period (Garg & Anand, 2015). Moreover, in India, during menstruation, some women aren't allowed to enter

the kitchen and temples, sleep in the daytime, bathe, wear flowers, have sex, touch other males or females, talk loudly, and touch pickles (Bhartiya, 2013).

In Tanzania, there are a lot of cultural beliefs or myths that influence girls during menstruation. For instance, according to Stoilova et al., (2022), menstrual myths and taboos exist, and in most communities, menstrual blood is believed to be a private matter that is often associated with impurity in Tanzania. Some communities believe girls and women can spread misfortune during menstruation (Stoilova et al., 2022). Numerous myths and social norms impose restrictions on girls and women to participate in community issues, hence causing difficulties and impeding their freedom. For instance, in many parts of Tanzania, girls and women are told that they should not touch tomatoes, mushrooms and sweet potatoes (they will rot or die), touch eggs (they will rot), touch neonates (they will get rashes), harvesting a fruit and eating it (will cause severe stomachache) or harvest pumpkin leaves (they will dry out).

Social norms or informal rules and practices about managing menstruation and interacting with menstruators exist. Most cultures have ways to deal with beneficial or harmful myths about girls and women. For instance, the Simbiti tribe in Rorya district, Mara region, believes that they can shorten the days of menses for girls who get their periods for more than 5 days. This is done by the girl lying on the floor of a house made of sticks, and she counts a few sticks laid horizontally; her menses will be shortened according to the number of sticks she has counted (For example, if she counts 3 of them her menses will be shortened to 3 days) (Grevstad., 2022).

Moreover, menstruating girls in the Muleba district, Kagera region, are not supposed to hit a dog as it is believed that the dog will stop being brave (Grevstad., 2022); and in Rorya, Mara region, it is believed that if a used pad is disposed of carelessly, a dog eats it, and the individual won't have a child. The positive side of the fear of not having a child is that it facilitates proper disposal of menstrual materials among some girls (Njee et al., 2021).

In some cultures, menarche signifies readiness for sexual activity and marriage, with particular implications for sexual and reproductive health as well as educational attainment (Ibitoye et al., 2017; Sommer et al., 2017). In some parts of Tanzania, such as Namtumbo and Mufindi districts, traditional rituals are done when a girl experiences her first period. During the rituals "kuchezwa", girls are taught how to manage menstruation hygienically, how to appear as a grown woman and are prepared for marriage wifely duties; and some are married off after the rituals when they are teenagers (Njee et al., 2021). "Kuchezwa" is a traditional ritual that is done once a girl reaches menarche. Likewise, in some tribes in Tanzania, once a girl starts her menses, she is considered old enough to get married. The ritual, at times, also leads to teenage pregnancies, abortion, and transmission of sexually transmitted diseases. This ritual also leads to some girls keeping it a secret, leading to difficulties in getting MHH materials and not getting medical help for girls with painful menses. Those who are married off end up being housewives, fueling more male dominance, and this prevents girls' personal development academically and economically.

Furthermore, males are not supposed to have sexual intercourse with menstruating girls and women as it is believed they will get hydrocele in Mufindi district, Iringa region,

(Grevstad., 2022). This promotes hygiene and prevents infections in men and women, but unfortunately, the community is deprived of the correct cause of hydrocele.

Subsequently, menstrual taboos facilitate gender inequality by depriving girls and women of sufficient healthcare, education and work.

Religious beliefs

Many religions have practices that impact the relations, activities, and participation of menstruators in daily activities (Ganguly & Satpati, 2023). Religious and local leaders are influential in communities, impacting MHM within the community. Abstinence from sex, exclusion and isolation from religious activities are the usual restrictions of most religions.

In Tanzania, there is a difference in how Christian and Muslim girls or women conduct and handle themselves during menstruation. In most parts of Tanzania, the community perceive that Islam is stricter with practices related to menstruation than Christianity (Njee et al., 2021). When menstruating, girls may be expected to stay away from their peer group, avoid male community members, and not visit certain locations, such as churches (Tamiru et al., 2013).

During her menses, an Islamic girl or a woman is considered ritually impure. She is supposed to stop certain forms of worship. For example, the five daily prayers, fasting during Ramadan (she fasts for an equivalent number of days later) or sitting in a mosque. She is also not allowed to touch the Holy Qur'an – "juzuu" or "msahafu" (recitation is allowed if she does not physically touch the Holy Qur'an and recites it from memory or, a recent adaption, reads it from an electronic device). ´The restrictions are rooted in the notion that menstrual products such as blood are `dirty´ - "najisi" or "haram" (House et al., 2012).

Conversely, Christianity is perceived to be easier going with practices related to menstruation. Some restrictions still exist for denominations, such as some of the Roman Catholic and Sabbaths in the Mbeya Region; women are not allowed to preach or to become priests because of menstruation (they are considered dirty, unholy and weak). In the Mara region, menstruating girls are not supposed to go to church (the Sabbath church is in the Mkoma ward). Ladies are advised not to receive Holy Communion, to preach and to sing as church choir members when they are in their menses, and they are supposed to stay outside the church because they're dirty (Grevstad., 2022).

While religions have core doctrines, perspectives, values, and teachings, this study intends to how religions in Tanzania influence menstruation and not undermine or support any religion.

Impurity, witchcraft and local superstitions

Impurity is the state of not being pure. Witchcraft is a practice of evil magic. Superstition is an irrational belief in supernatural influences of good or bad luck. Socio-cultural norms and religious taboos are associated with impurity, witchcraft and superstitions. Studies have revealed that erroneous knowledge of the menstrual cycle, hygiene, and self-care practices is less widespread than superstitions, illogical beliefs, and misunderstandings (Adika, 2013).

Menstruating girls and women (Sharma et al., 2022) and menstrual blood are considered impure and should be washed off in some developing countries especially in South Asia and Africa (Caruso et al., 2017;Chebii, 2018;Seyed Hosseini, 2020;Wall et al., 2018). The same case happens in Tanzania. For instance, menstrual materials are handled with care because of witchcraft beliefs that if someone takes the menstrual blood, the woman/girl is likely to over bleed or loses womb or cannot have children (Sommer et al., 2015; Tamiru et al., 2013). Hence, girls and women bury their menstrual materials to avoid being bewitched.

Likewise, reusable menstrual materials are not hung outside as the girl can be bewitched in Mpwapwa district, Dodoma region. Many girls and women hang reusable menstrual materials indoors and not under direct sunlight, which facilitates improper drying to avoid infections from wearing damp ones (Kim & Choi, 2020; Torondel et al., 2018). The positive side of the fear of being bewitched is that it facilitates the proper disposal of menstrual materials among some girls and women.

Menstruation is a secret among individuals as girls fear witchcraft (being bewitched after someone finds out that they are bleeding, the menstrual blood; once taken by a witch, the individual may not get a child in Rorya district, Mara region (Umeora & Egwuatu, 2008). In Rorya, there is a belief that if a used menstrual material is not disposed of well and bad people pick it, the girl can be bewitched; hence, she will not get kids, or it might make her go crazy, or she can die (Njee et al., 2021).

Menstruation is a topic that falls underneath the broader category of sexuality issues; thus, in order to change knowledge, attitudes and beliefs regarding menstruation, comprehensive sex education is essential (Joshi et al., 2015). Primary school girls try to keep their MHM issues secret. They are scared to be sexually harassed, bullied, segregated by their peers in plays and other common activities because they are considered as grownups.

Restrictions associated with menstruation
Poor knowledge of menstruation leads to misconceptions that perpetuate stigma and cultural restrictions, as well as poor hygiene (Mahon & Fernandes, 2010). Restrictions may include diminished mobility, seclusion, dietary restrictions, or being prevented from fully participating in community life (State & Monitoring, 2012). Cultural perceptions and restrictive practices associated with menstruation can serve to isolate and stigmatize girls and women. (Winkler & Roaf, 2015). Where this is the case, stigma and silence around menstruation can contribute to gender inequality that discriminates against women and girls throughout the lifecycle (Geertz et al., 2016). Such restrictive practices can also influence MHM and the extent to which menstruation can be managed effectively and with dignity (House et al., 2012).

The following are restrictions on girls during their menses in many parts of Tanzania. menstruating girls are not supposed to eat mangoes, lime and green vegetables in Rorya district, Mara region (Kumar & Maity, 2022). There is a belief that green vegetables can make them bleed daily or after every 2 weeks and end up bleeding thrice within the same month. Families that practice dietary restrictions may have effects on girls´ nutrition. Menstruating

girls are also not supposed to eat hot food as it is believed that it will cause heavy bleeding, and they are not supposed to take certain pills such as panadol as it is believed that this might stop the menses. The negative side of this belief is that girls with unbearable pain will not take painkillers to ease their pain so that they can study and carry out their daily routines.

Moreover, in the Kine and Luo (tribes in the Mara region), menstruating girls are not supposed to harvest vegetables such as tomatoes, pumpkin leaves, spinach, 'sukuma wiki' and the local green vegetable 'Pagani', as it is believed that the leaves will dry up or rot They are also not supposed to weed and harvest groundnuts. They are also not supposed to slaughter chickens when they are in their menses (Njee et al., 2021). Likewise girls are not supposed to walk into a groundnut farm as the plants will dry up; if she has to walk into the farm, she has to throw sand on the plants first in Mpwapwa district, Dodoma region (NIXON, 2007). Moreover, girls are not supposed to eat sugarcane or drink tea as they are both sweet, and it is believed that the sugar will cause heavy bleeding in Lushoto district, Tanga region (Sugita, 2022).

School girls from the Wamang'ati community in the Arusha region are not allowed to attend school when menstruating; they stay home under observation, and they sleep on a hide during menstruation (NIXON, 2007). Likewise, parents and teachers encourage schoolgirls in Namtumbo district in the Ruvuma region not to attend school during their menses (Njee et al., 2021). Moreover, schoolgirls who are in menstruation in most rural areas of Tanzania do not participate in sports' activities to avoid heavy bleeding and abdominal pains and to prevent menstrual materials from falling off or staining their clothes. This is due to the lack of durable and effective menstrual materials in rural areas.

As the cooking or preparing food is essential at household level, most of schoolgirls are not allowed to cook or prepare food while they in menstruation as they are considered dirty in some rural areas such as Msalala district in the Shinyanga region, Igunga district in the Tabora region, Rorya district in Mara region, Marangu district of the Kilimanjaro region and Mpwapwa district in the Dodoma region (House et al., 2012).

Bad enough, menstruating girls are not supposed to sit on a well as it will dry up in the Kibondo district, Kigoma region and menstruating girls are not supposed to fetch water and walk across a fishing net in Rorya district, Mara region (House et al., 2012). All of these events stigmatize girls when they are in menstruation.

Menstruation is associated with fear, shame and secrecy.
MHM is a common challenge, especially for poor rural girls and women, due to their standards of living. Public menstrual hygiene accidents are embarrassing and shameful to adolescent girls. A growing body of evidence suggests that girls commonly report feelings of embarrassment and shame related to menstruation. Often, these emotions are borne from both internalized and externally imposed constraints (Benshaul-Tolonen et al., 2020; Mason et al., 2013; Rheinländer et al., 2019). Another cause for school absenteeism, as reported by Rajbhandari et al., (2018), is fear of leakage and staining during menstruation. Similarly, Benshaul-Tolonen et al. (2020) reported that menstruation was a source of shame, pain, and fear of leakage and odour, as well as teasing from boys in Northern Tanzania.

In Tanzania, boys have phrases they use to tease girls when they see menstrual stains. Phrases like '*slaughtering chicken', 'without a knife', 'breaking a pot', 'shedding water', 'going to wete',*and *'receiving a salary'* are used by boys across the country. Some girls are roughed when they are in menstruation. For instance, an adolescent girl is laughed at in school if her skirt accidentally gets stained with menstrual blood (they also tell her that she has slaughtered a chicken – in Swahili, 'amechinja kuku' in Rorya district, Mara region. Such incidents may lead to harassment by boys, teasing, and making fun of girls. Hence, girls miss school during their menses or drop out of school. Teasing, especially of primary school girls, is common in Mbeya and Mufindi, Iringa urban areas. One acute manifestation of boys' negative attitudes is period teasing-harassment linked directly to girls' menstruation (Benshaul-Tolonen et al., 2020).

Some girls avoid sitting around people due to the fear that others can smell menstrual blood. In most parts of Tanzania, menstruating girls do not want to sit around and mix with other people as they think they are smelling. In addition, male peers are the most commonly feared perpetrators of period teasing among this sample of girls (Benshaul-Tolonen et al., 2020). Boys engage in period teasing because they perceive periods as embarrassing, especially visible markers of periods (odour or stains) (Benshaul-Tolonen et al., 2020; Chinyama et al., 2019; Girod et al., 2017).

Male involvement

While Preliminary boys and men, families, and communities are essential to combat stigmas and taboos to girls who are in menstruation (Benshaul-Tolonen et al., 2020; Mahon & Fernandes, 2010; Mason et al., 2013), in most of the rural areas in Tanzania, especially in the districts of Mpwapwa, Pemba, Karatu, Rorya and Kibondo, males are socio-culturally prohibited from dealing with menstrual issues. It is considered a dirty thing, hence shameful to involve them. It is also considered a women's issue; hence, discussing it is like talking about the nakedness of a woman (Njee et al., 2021).

Most men in the Karatu district, Arusha region, never involve themselves in taking care of the girl's menstrual issues and cannot even attend meetings discussing menstrual health among women and girls. Girls cannot sit near or even talk about menstrual issues with their male parents. Since in rural areas, men are usually the breadwinners and the ones with a final say concerning family resources; girls face difficulties in getting money to purchase MHH materials (Njee et al., 2021).

Likewise, it becomes difficult for some girls to discuss menstrual issues with their male parents. Girls find it difficult to share their menstruation challenges because of the belief that it is not a men's issue and it is a shame. Financial constraints give a loophole for 'sugar daddies' to cater for MHH materials needs, among other needs and wants, leading to teenage pregnancies, abortions and transmission of sexually transmitted diseases. Also, culturally men are not supposed to know that their daughters are menstruating in West Tanzania, especially in the districts of Kibondo, Msalala and Butiama districts (Njee et al., 2021).

Awareness, knowledge and skills

Globally, girls often lack accurate knowledge regarding menstruation and menstrual health and hygiene (Unicef, 2022). Parents, teachers, and health practitioners may also be misinformed, preventing girls from getting the necessary knowledge and skills for healthy well-being. Most of the school girls with and without disabilities appear to have a fair awareness of menstruation (Bishoge et al., 2022).

There is an expectation that higher levels of education are associated with greater awareness regarding MHM, which will result in better hygiene practices during menstruation. (Afiaz & Biswas, 2021). The lack of awareness and knowledge of menstruation is one of the challenges facing the male disengagement from menstruation in Tanzania (Method et al., 2024).

While there are some initiatives for improvement of MHM, Tanzania scores low in knowledge, attitude and practice on MHM, with some differences between rural and urban areas (Njee et al., 2024). Girls in rural areas of Tanzania face more challenges in managing menstruation than those in urban areas.

Relationships with family, teachers and peers

Schoolgirls get guidance and supplies from family, teachers, and peers. Female family members (mothers, aunties, sisters, and grandmothers) usually guide and help schoolgirls get supplies. They also inform schoolgirls about signs of puberty and how to handle menstruation and provide them with materials to use during menstruation. Teachers impact knowledge of menstruation and provide menstrual materials to schoolgirls. Schools and teachers are important in how girls navigate menstruation during adolescence (Phillips-Howard et al., 2016).

Their peers at school and home also provide guidance. It is easy for schoolgirls to talk to fellow girls of their age group. A few fathers help of supplies and guidance during menstruation. Fathers are usually the financial providers to families; hence, they give money to their daughters to purchase sanitary pads. While most of the male parents, brothers or guardians support their schoolgirls by providing financial assistance to purchase, there is still insufficient support to schoolgirls when they are in menstruation from families and at school, which impedes hygiene and health.

Generally, females (parents, family members, teachers and peers) are socio-culturally responsible for educating and supporting girls during menstruation. While most of the males (parents, family members, teachers and peers) play a significant role in educating girls about menstruation, their influence is limited by entrenched misconceptions and a lack of systematic guidance (Njee et al., 2024).

MHM related policies

There is no standalone MHM policy in Tanzania. Menstruation is a subtopic of adolescent reproductive health guidelines and school curricula on similar topics and a subcomponent of SWASH guidelines. There is a need for an MHM policy in Tanzania whereby menstruation will be mentioned to normalize it and thereafter influence social norms. The policy will catalyze discussions of MHM issues, facilitating menstrual health. Gender-sensitive MHM

interventions are crucial for menstrual health. Interventions such as training teachers on MHM and providing necessary menstruation information should be part of the MHM policy. Female-friendly water and sanitation facilities in schools and trained teachers supporting students are two examples of gender-responsive measures that could be implemented within the education sector. (Sommer et al., 2017). The MHM policy will facilitate overcoming the taboo around menstruation and fast-track prioritization of implicit MHM in schools.

Conclusion and Recommendations

MHM among schoolgirls is influenced by sociocultural and religious factors, which affect school attendance, complete school involvement, and class attention. Consequently, the schoolgirls' education is jeopardised. Sociocultural interventions should be implemented in society through education to increase awareness and attitudes towards MHM. Knowledge will aid in the debunking of falsehoods. Influential people of society should be urged to promote MHM in order to help girls overcome superstitions. Social and cultural issues must be given the attention they deserve and handled convincingly in MHM interventions so that schoolgirls can achieve academically and reach their full potential.

Competing Interests

On behalf of all authors, the corresponding author stated that there was no conflict of interest.

Availability of Data

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

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Barriers to HIV prevention among adolescents in Njombe, Tanzania: Knowledge gaps and accessibility of sexual and reproductive health services

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Abstract

Background: HIV remains a significant global public health issue, claiming 36.3 million lives worldwide. In 2020, approximately 1.75 million adolescents aged 10-19 were living with HIV globally, with sub-Saharan Africa accounting for 88% of these cases. Tanzania has a national HIV prevalence of 4.8% among individuals aged 15-49, with the Njombe region reporting the highest prevalence at 11.4%. Despite efforts to combat HIV, adolescents often receive less focus in intervention programs, resulting in inadequate adolescent-friendly services and low HIV testing coverage. This study aimed to assess the barriers to HIV prevention among adolescents in Njombe, focusing on their knowledge and access to Sexual and Reproductive Health Rights (SRHR) services.

Methods: A descriptive research approach was used, targeting adolescents aged 15-19 from Agnes Trust and Mpechi secondary schools in Ramadhani and Mji Mwema wards. A total of 155 students were selected through purposive sampling. Data was collected using structured questionnaires and analyzed using STATA version 17.

Results: The study revealed that 67.1% of adolescents had good knowledge of HIV prevention, with females demonstrating slightly better knowledge (70.11%) than males (63.24%). However, only 69.68% had access to SRHR services, with counselling and testing (31.61%) and health education (30.97%) being the most common services received. Despite this, condom use remained low, with only 3.7% taking condoms during SRHR service participation.

Conclusion: While adolescents in Njombe have a good understanding of HIV prevention, there are significant gaps in the consistent use of preventive measures like condoms. Enhanced community awareness, better access to SRHR services, and targeted interventions for male adolescents are recommended to address these gaps and reduce HIV prevalence among adolescents in the region. Further research is needed to explore additional factors contributing to the high HIV prevalence in Njombe.

Keywords: HIV Prevention, adolescents, Njombe Region, sexual and reproductive health rights (SRHR), knowledge gaps, condom use

Introduction

HIV remains a formidable global public health challenge, responsible for approximately 36.3 million deaths worldwide. Despite notable progress in the development of antiretroviral therapies and preventive measures, the epidemic continues to affect vulnerable populations, particularly adolescents, disproportionately. In 2020, about 1.75 million adolescents aged 10-19 were living with HIV globally, with sub-Saharan Africa accounting for a staggering 88% of these cases (WHO, 2020).

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This demographic shift is concerning, as it highlights the increasing burden of HIV among young people. Adolescents face unique risks and vulnerabilities contributing to this growing epidemic, including biological susceptibility, behavioral risks, and socioeconomic challenges (Bossonario et al., 2022; Lewis et al., 2022). Additionally, adolescent girls are six times more likely to contract HIV than their male peers, primarily due to gender-based inequalities and limited access to education and health services (UNICEF, 2021). These disparities underscore the urgent need for targeted interventions tailored to the specific needs of adolescents in HIV prevention efforts.

In Tanzania, the national HIV prevalence among individuals aged 15-49 was reported at 4.8% in 2019, with the Njombe region exhibiting the highest prevalence at 11.4% (UNAIDS, 2020). Despite concerted efforts by the government and various non-governmental organizations to curb the spread of HIV, adolescents remain a largely neglected demographic in intervention programs. Most initiatives tend to focus on children through programs such as Prevention of Mother-to-Child Transmission (PMTCT) and adults through Antiretroviral Therapy (ART) treatments, leaving a significant gap in adolescent-specific services. (Nel et al., 2020). As a result, adolescents often have limited access to youth-friendly health services, including HIV testing and counselling, leading to lower rates of HIV status awareness and treatment uptake among this age group.

Addressing the HIV epidemic among adolescents requires a comprehensive understanding of the barriers they face in accessing preventive and treatment services. (WHO, 2013). This study focuses on the Njombe region, known for its high HIV prevalence, to assess adolescents' knowledge of HIV and their access to Sexual and Reproductive Health Rights (SRHR) services. By identifying gaps in knowledge and service provision, this research aims to inform more effective intervention strategies tailored to the needs of adolescents. Previous studies have highlighted the importance of SRHR services in reducing HIV transmission among young people, yet many adolescents in Tanzania still struggle to access these essential services due to social stigma, lack of awareness, and inadequate healthcare infrastructure (Ivanova et al., 2019).

This study is significant as it provides critical insights into the barriers to HIV prevention among adolescents in Njombe and informs policy and practice to enhance SRHR service delivery. The findings will contribute to the broader body of knowledge on adolescent health and HIV prevention, offering evidence-based recommendations for improving service accessibility and effectiveness. By addressing the specific needs of adolescents, stakeholders can develop targeted interventions that not only increase HIV awareness and testing rates but also promote safer sexual behaviors and better health outcomes. Ultimately, this research aims to support the global goal of ending the AIDS epidemic by 2030 by ensuring that no adolescent is left behind in the fight against HIV.

Methods
Study area
This study was conducted in the Njombe region in the Southern Highlands of Tanzania. Njombe is bordered by Makambako town and Mufindi district to the north, Morogoro region to the east, and Njombe town to the south. The study focused on the Ramadhani and Mji Mwema wards, two urban areas within the Njombe region (Figure 1). According to the 2012 Population and Housing Census (PHC), Ramadhani ward has a population of 16,305, while Mji Mwema ward has a population of 13,929 (URT, 2022). The region's high HIV prevalence, reported at 11.4%, makes it a critical area for studying barriers to HIV prevention among adolescents.
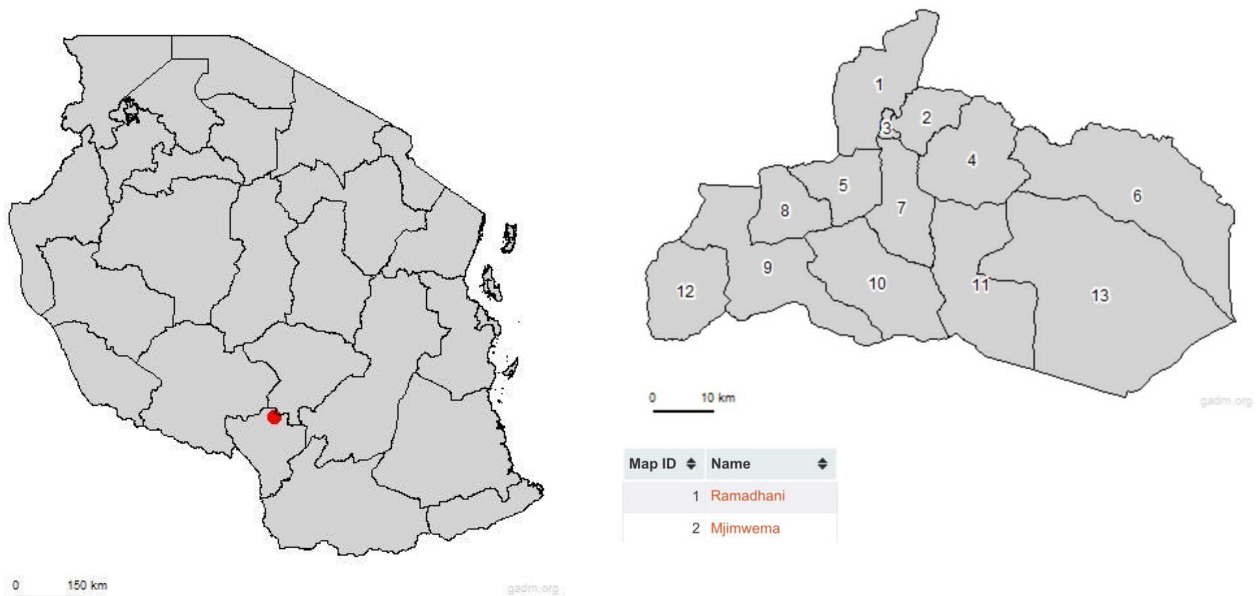
Figure 1: A map of Tanzania and Njombe region. Ward 1 is Ramadhani ward and Ward 2 is Mji Mwema ward

Study population

The study population consisted of adolescents aged 15-19 from Agnes Trust and Mpechi secondary schools in the Njombe urban district. These schools were selected to provide a representative sample of the adolescent population in the region. The inclusion criteria were adolescents aged 15-19 who were residents of the Ramadhani and Mji Mwema wards and provided informed consent to participate in the study. Adolescents below 15 or above 19 were excluded from the study.

Study design

A descriptive cross-sectional research design was employed to gain insights into the barriers to HIV prevention among adolescents in Njombe. This design is suitable for obtaining a snapshot of the current status of knowledge, attitudes, and practices related to HIV prevention and access to SRHR services among the target population.

Sampling procedure and sample size

Purposive sampling was used to select the study participants. The sample size was calculated using the formula for determining sample size for a population proportion with a 95% confidence level and a 5% margin of error (Charan & Biswas, 2013). Based on the estimated HIV prevalence of 11.4% in Njombe (UNAIDS, 2020), the sample size was determined as follows:

$$n = \frac{z^2 * p\,(1-p)}{e^2}$$

Where n=sample size

  p=estimated proportion in the study obtained from the previous study, for Njombe P =11.4% (UNAIDS, 2020)

  Z=standard normal deviation set at 1.96, which corresponds with a 95% confidence interval

e=standard error set at 0.05(5%) marginal error

$$n = \frac{1.96^2 \times 0.114\,(1-0.114)}{(0.05)^2} = 155$$

Therefore, the required sample size for this study was 155 participants.

Data collection

The primary data for this study were gathered through a structured questionnaire administered to the sampled population, focusing on three key areas: general demographics, knowledge and experience, and access to SRHR services. Demographic information included age, gender, school, and ward of residence. The knowledge and experience section assessed participants' understanding of HIV prevention methods, their sources of HIV-related information, and personal experiences with HIV prevention. Finally, the questionnaire explored the accessibility and utilization of SRHR services, including the types of services received and the methods of service provision. This comprehensive approach aimed to provide a holistic view of the participants' backgrounds, knowledge, and experiences related to HIV prevention and SRHR services.

Questionnaire design

The questionnaire was structured into three parts and utilized multiple-choice and open-ended questions to collect quantitative and qualitative data. Part A focused on general demographics, gathering information such as age, gender, school, and ward of residence. Part B delved into knowledge and experience, assessing participants' understanding of HIV prevention, their sources of information, and personal experiences related to the topic. Part C addressed SRHR services, examining access to these services, the types of services received, and the methods of service provision. This comprehensive design allowed for thoroughly exploring the participants' backgrounds, knowledge, and experiences regarding HIV prevention and SRHR services.

Data analysis

Data were checked for completeness, entered, cleaned, and analyzed using the Statistical Package for Social Sciences (STATA) version 17. Descriptive statistics summarised the data, including means for numerical variables and frequencies and percentages for categorical variables. The relationship between variables, such as knowledge of HIV prevention and gender, was analyzed using chi-square tests. Results were presented in tables, figures, and narrative form.

Ethical considerations

Ethical approval for the study was obtained from the University of Dar es Salaam – Mbeya College of Health and Allied Sciences (UDSM-MCHAS) ethical review board. Permission to conduct the research was also obtained from the Njombe region administration. Informed consent was obtained from all participants after explaining the study's aim, procedures, benefits, and risks. Participants were assured of their right to withdraw from the study at any time without any consequences. Confidentiality of the information was maintained by using codes instead of participants' names and ensuring that data were used solely for research purposes.

Results
Participant demographics

The study enrolled 155 adolescents aged 15-19 from Agnes Trust and Mpechi secondary schools in the Njombe urban district. The mean age of the participants was 16.42 years. The sample comprised

56% females (87 participants) and 44% males (68 participants). Most participants were from Agnes Trust Secondary School, representing 54% (83 participants), while 46% (72 participants) were from Mpechi Secondary School. The participants were almost evenly distributed between the two wards: 54% from Ramadhani (83 participants) and 46% from Mji Mwema (72 participants) (Table 1).

Table 1: Background characteristics of participants from our study

Variable	n	%
DISTRICT		
NJOMBE URBAN	155	100
WARD		
RAMADHANI	83	54
MJI MWEMA	72	46
SCHOOL		
AGNES TRUST SECONDARY SCHOOL	83	54
MPECHI SECONDARY SCHOOL	72	46
AGE GROUP (MEAN AGE 16.42)		
(15-16)	89	57
(17-18)	58	37
(19-20)	8	5
SEX		
MALE	68	44
FEMALE	87	56

Knowledge of HIV/AIDS

Basic knowledge of HIV/AIDS

The study found that 67.1% (104 participants) of adolescents had good knowledge of HIV/AIDS prevention, while 32.9% (51 participants) had poor knowledge. This was determined based on their ability to correctly answer five key HIV knowledge questions: understanding what HIV is, recognizing that consistent condom use reduces the risk of HIV, knowing that healthy-looking individuals can have HIV, acknowledging that mosquito bites cannot transmit HIV, and knowing that HIV cannot be spread by sharing food (Table 2).

Table 2: Knowledge of adolescents on HIV/ADS

Basic Knowledge	n	%
GOOD KNOWLEDGE	104	67.10
POOR KNOWLEDGE	51	32.90
TOTAL	**155**	**100.00**

Relationship between knowledge and gender

The relationship between knowledge of HIV/AIDS and gender was statistically significant ($p < 0.05$). Among the female participants, 70.11% (61 out of 87) had good knowledge compared to 63.24% (43 out of 68) of male participants. This indicates a higher level of knowledge among female adolescents in the study (Table 3).

Table 3: Relationship between knowledge and gender

Basic Knowledge	Sex		Total	Key	
	Female	**Male**		**Key**	
Good Knowledge	61	43	104	Frequency	
	58.	45.6	104.0		
Poor Knowledge	26	25	51	Expected Frequency	
	28.6	22.4	51.0		
Total	87	68	155		
	87.0	68.0	155		

Pearson chi2 (1) = 0.8183   Pr = 0.0366

Sources of knowledge
The primary sources of HIV knowledge among the participants were mass media (television, newspapers, radio), at 48%, followed by schools, at 29.68%. Other sources included parents and the community (18.71%), books (3.23%), and conferences (0.65%) (Figure 2).
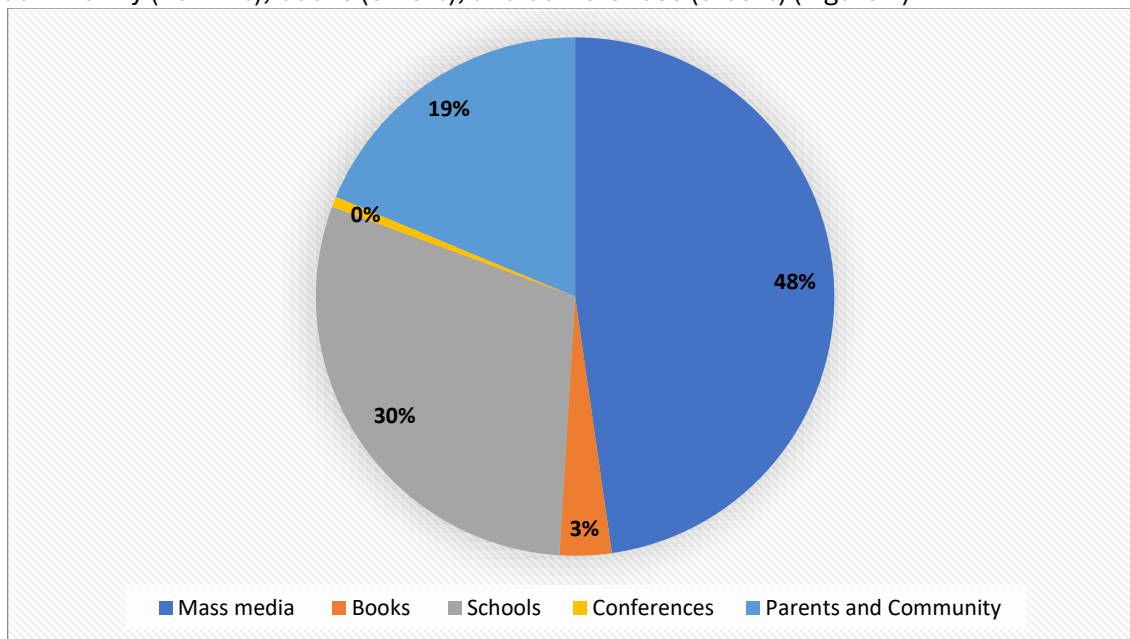
Figure 2: A pie chart showing Sources of knowledge

Sexual debut and condom use
Among the 155 participants, 16.6% (26 participants) reported being in sexual relationships. Of those, 30.7% (8 participants) had initiated sexual intercourse. However, only 37.5% (3 out of 8) of these sexually active adolescents reported using condoms during intercourse. The relationship between sexual debut and condom use was statistically significant ($p < 0.05$) (Table 4).

Table 4: Relationship between sexual debut and condom use

Sexual debut	Condom use		Total
	No	**Yes**	
No	11	7	18
	1.6	1.4	18.0
Yes	3	5	8
	0.7	0.6	8.0
Total	14	12	26.0
	14.0	12.0	

Key	
Frequency	
Expected Frequency	

Pearson chi2 (4) = 162.4066   Pr = 0.000

Access to SRHR services
General Access to SRHR Services
Regarding access to SRHR services, 69.68% (108 participants) reported having accessed these services, while 30.32% (47 participants) had not. This indicates that a significant portion of adolescents still lack access to essential SRHR services (Figure 3).
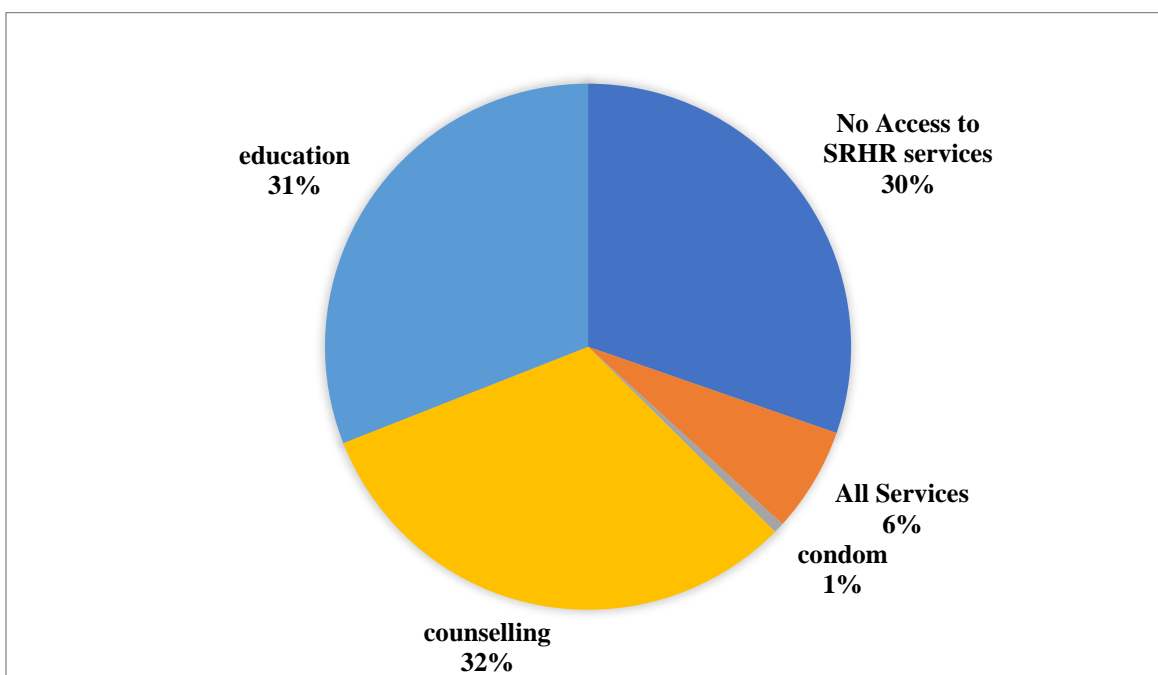
Figure 3: A pie chart showing access to SRHR services and types of services received.

Types of SRHR services received

The most common SRHR services received by adolescents were counselling and testing (31.61%) and health education (30.97%). A notably low percentage (0.65%) reported receiving condoms. This suggests a gap in the provision of comprehensive SRHR services, particularly in promoting and distributing condoms.

Methods of provision of SRHR services

Adolescents received SRHR services primarily through seminars (53.7%), followed by all sources combined (25%). Other methods included journals (10.19%), youth clubs (9.26%), and posters (1.85%). This reflects a reliance on group-based educational approaches over individual or media-based methods (Table 5).

Table 5: Method of provision of SRHR services

Method of provision	N	%
Journal	11	10.19
Seminars	58	53.7
Youth clubs	10	9.26
Posters	2	1.85
All sources	27	25

Participation in SRHR services

Participation Rates

A significant majority, 85% (132 participants), reported participating in SRHR services, while 15% (23 participants) did not. This indicates a relatively high level of engagement with available SRHR services among the study population.

Ways of participation

Among those who participated in SRHR services, 53.7% were willing to test for HIV, 29.63% attended conferences, and 3.7% took condoms. A combined approach involving multiple methods of participation was reported by 12.96% of the participants. These findings suggest that while there is good participation in some SRHR activities, condom uptake remains low (Figure 4).
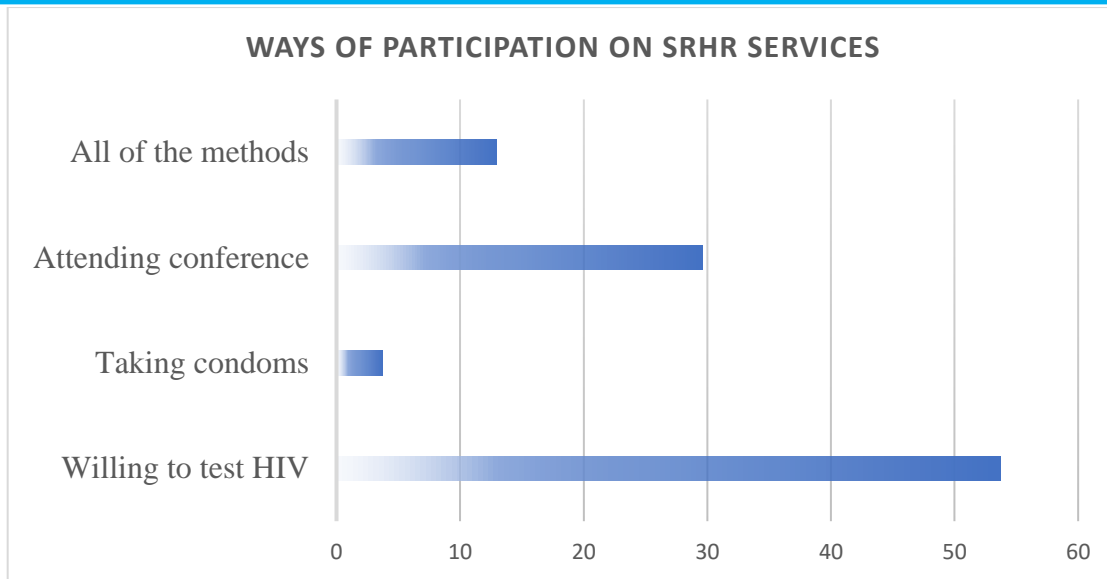
Figure *4*: A bar chart showing a percentage of ways of participation of adolescents to SRHR services

Discussion

The findings of this study reveal a significant level of knowledge about HIV prevention among adolescents in Njombe, with 67.1% demonstrating a good understanding. This aligns with other studies that highlight the positive impact of education on HIV awareness. (UNICEF, 2021). However, the gender disparity in knowledge, where females exhibited slightly higher knowledge levels than males, suggests that targeted educational interventions for males might be necessary. This gender difference in HIV knowledge has been documented in various contexts, emphasizing the need for gender-sensitive approaches in health education. (UNAIDS, 2020). By addressing these gaps, health programs can better equip all adolescents with the necessary knowledge to prevent HIV.

Despite the high level of knowledge, the study uncovered critical gaps in behaviour, particularly concerning condom use. Among sexually active adolescents, only 37.5% reported using condoms, highlighting a significant risk for HIV transmission. (Conserve et al., 2012; Guiella & Madise, 2007). This finding is consistent with other research indicating that knowledge alone cannot change behaviour. (Ivanova et al., 2019). Effective HIV prevention requires not only awareness but also access to preventive tools and consistent behaviour change. Programs need to focus on practical strategies to increase condom use, such as making condoms more accessible and promoting their use through targeted campaigns.

Access to SRHR services was relatively high, with 69.68% of adolescents having accessed these services. However, the types of services received varied, with counselling and testing being the most common. (Ninsiima et al., 2021; Wakjira & Habedi, 2022). The notably low provision of condoms (0.65%) is concerning and points to a gap in comprehensive SRHR services. Effective HIV prevention requires a holistic approach that includes education, testing, counselling, and access to preventive tools like condoms. (Nel et al., 2020). Enhancing the availability of condoms and integrating their distribution into SRHR services could significantly improve prevention efforts.

The study also highlighted the preferred methods of SRHR education among adolescents. Seminars were the predominant method, suggesting that group-based educational approaches are effective in this context. However, relying on seminars indicates that other methods, such as individual counselling, media campaigns, and peer education, might be underutilized. Diversifying the methods of SRHR education could enhance reach and impact, ensuring that all adolescents, including those who might not attend seminars, receive accurate and comprehensive information. (Ngilangwa et al., 2016). Future programs should consider a multi-faceted approach to SRHR education.

This study had several limitations. First, the reliance on self-reported data may introduce bias, as participants might not accurately recall or may underreport sensitive behaviors. Second, the study was conducted in only two wards of Njombe, which may limit the generalizability of the findings to other regions. Third, the cross-sectional design provides a snapshot in time but cannot establish causality. Despite these limitations, the study provides valuable insights into the barriers to HIV prevention among adolescents in Njombe, highlighting critical areas for intervention and further research.

Conclusion
This study highlights the significant knowledge adolescents in Njombe possess about HIV prevention, yet it underscores the persistent gaps in actual preventive behaviours, particularly condom use. Despite a high level of awareness, with 67.1% of adolescents demonstrating good knowledge, this did not translate into consistent condom use, revealing a critical disconnect between knowledge and practice.

The findings indicate that while access to SRHR services is relatively high, there are notable deficiencies in the comprehensive provision of these services, especially in the distribution of condoms. Addressing these gaps requires a multi-faceted approach that combines enhanced education, increased accessibility to preventive tools, and targeted behavioural interventions. Additionally, the study emphasizes the need for gender-sensitive educational programs, as females exhibited higher knowledge levels than males. To ensure broader reach and impact, future interventions should focus on diversifying SRHR education methods, including individual counselling, media campaigns, and peer education. Despite the study's limitations, including the reliance on self-reported data and its limited geographic scope, the insights gained are invaluable for informing policy and programmatic efforts aimed at reducing HIV prevalence among adolescents. By addressing these identified barriers and implementing targeted strategies, stakeholders can significantly improve HIV prevention efforts and support the global goal of ending the AIDS epidemic by 2030.

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Author contributions
JDS and VC designed the study. JDS and VC conducted and contributed to data analysis. JDS and CNM interpreted the data. JSD and CNM prepared the original manuscript. All co-authors contributed to subsequent revisions. All authors read and approved the final manuscript.

Conflict of interest
The authors declare that they have no competing financial and non-financial interests.

Availability of data and material
All data generated or analyzed during this study is included in this published article.

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Understanding Practice and Associated Factors of Implementers on Fidelity Implementation of Prime Vendor System: A Case Study of Tanzania Mainland

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Abstract

The practice of Supply Chain Management is an application of the process view, focusing on delivering health commodities to clients and transitioning from functions to processes. The Prime Vendor system has been implemented through the existing institutional structures at various levels of government and funded exclusively by complementary funds. The availability of quality medicines in low-income and middle-income countries is often limited, especially in peripheral health facilities. This study provides a comprehensive understanding of the actual practice and associated factors of implementers on fidelity implementation of the prime vendor system.

Materials and Methods: Data was collected from June to September 2023 using the ODK application from 356 respondents in the Dodoma, Morogoro, Mtwara, and Mwanza regions in Tanzania. They were analysed using SAS version 9.4. Statistical significance was determined at a 95% confidence level."5% confidence level.

Results: In the study, 98.60% of health facility respondents reported procuring health commodities from prime vendors only when they received out-of-stock notifications from the Medical Stores Department. However, 85.67% disagreed with the practice of quarterly procurement. Additionally, 50.56% of respondents agreed they incurred costs upon consignment receipt, and 58.15% disagreed with health facility overseers being responsible for prime vendor preparation. The study revealed that 90.45% of respondents acknowledged the Health Facility Governing Committee/Medicine and Therapeutic Committee's role in approving orders and funds for health commodities procurement through the prime vendor system. Regarding payment timelines, 65.17% of respondents were uncertain about settling invoices within seven days. Most respondents (86.80%) disagreed with using online payment platforms when traditional banking services were unavailable. Furthermore, 88.76% relied on supplementary funds for procurement, while 73.60% disagreed with using in-kind receipts as a source of funds in implementing the prime vendor system. Regarding order submission and delivery, 73.60% did not support health facilities directly submitting their orders to prime vendors, and 56.18% were unaware of the delivery timelines used by the prime vendor to supply various destinations.

Conclusion: The study elucidates the issues surrounding the procurement practices and procedures of health commodities through the prime vendor system, revealing significant variations in implementation fidelity among respondents. Factors influencing implementers' practices underscore the complex interplay between individual characteristics and systemic factors. Addressing these challenges requires targeted interventions, which are essential in enhancing smooth and consistent fidelity in the implementation of the prime vendor system, which will ensure equitable access to health commodities across healthcare facilities.

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Introduction

The practice of Supply Chain Management in the world applies the process view. (Mentzer et al., 2008) It focuses on dispensing health commodities to clients and from functions to process (MOH, 2017).

In the United Republic of Tanzania, the Local Government Authorities (LGAs) and CHMTs are among the Institutions responsible for budgeting and planning, conducting supportive supervision, and mentoring lower-level health facilities. (MoHCDGEC, 2021) That enhances the implementation fidelity of the prime vendor system.

The practice of the Prime Vendor system shall have been implemented through existing institutional structures embedded in the various government administrative levels and will be financed exclusively by complementary funds. (PORALG, 2022) (Kumurya, 2015)The Tanzania Prime Vendor System National Implementation Manual guides and supports the available institutional structures in day-to-day operations. (Bernstein, 1995).

The availability of quality medicines in low-income and middle-income countries is often limited, especially in peripheral health facilities. (Kuwawenaruwa et al., 2020), and can only be resolved by the complementary practice of the prime vendor system (Mganga et al., 2024).
Despite being knowledgeable, prime vendor system implementers highly accept it (Mganga et al., 2024). (Kuwawenaruwa et al., 2021 and 2020), (Wiedenmayer et al., 2019a) and often perceived it (Mganga et al., 2024) Yet PORALG administrative reports show some notable differences in actual practice across the key PVS actors, leading to shortages and stockouts of health commodities at the facility level. (MoHCDGEC, 2021).

The Medical Stores Department (MSD) was established by Act of Parliament No. 13 of 1993 (MSD, 1993) as an autonomous department under the Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) responsible for developing, maintaining and managing an efficient and cost-effective system of procurement, storage, and distribution of approved medicines and medical supplies required for use by all public health facilities (Durand & Paolella, 2013). The challenges of inaccurate bottom-up quantification of health commodities needed at facility levels, a low number of pharmaceutical personnel at the health facility level, and ineffective systems for fulfilling back-ordered items at MSD and prime vendors need immediate interventions to ensure commodities' availability. (Mathew et al., 2013) (Kuwawenaruwa, 2021).

Furthermore, the effectiveness of any activity is influenced mainly by the actual practice of the key implementers involved. (MOH, 2017). While previous studies have not examined the actual/real practice of the Prime Vendor System in Tanzania, this study provides a comprehensive understanding of the actual practice and associated factors of implementers on fidelity implementation of the prime vendor system. (PORALG, 2022).

Materials and Methodology
Study Design
The research adopts a quantitative cross-sectional design, focusing on four regions in Mainland Tanzania: Dodoma, Morogoro, Mtwara, and Mwanza. Within these regions, the study encompasses thirteen diverse local government authorities, including Dodoma (Dodoma City Council, Kondoa District Council, Kongwa District Council), Morogoro (Morogoro Municipal Council, Mvomero District Council, Kilosa District Council), Mtwara (Mtwara District Council, Mtwara Municipal Council, Newala

Town Council, Masasi District Council), and Mwanza (Magu District Council, Nyamagana District Council, Ukerewe District Council).

Study Population

The study population consisted of purposively selected members from various levels of health facilities, including in-charges, pharmaceutical personnel/storekeepers, laboratory personnel, and health secretaries directly involved in health commodities' supply chain management system. (Fossey et al., 2002).

Sample Size and Sampling

The sample size for this study was determined using Yamane's formula (1967), which considers the study population, marginal error, and confidence level. With a total study population (N) of 3,203 individuals and a chosen marginal error (e) of 0.05, the calculated sample size (n) is 356. Applying the formula, $n = N/[1 + N(e)^2]$, the calculated sample size (n) is 356. Regarding sampling strategy, regions were purposively selected based on their relevance to the research objectives, including regions with and without medical store department zonal offices and areas with facilities with high health commodity consumption rates. From these regions, councils were chosen randomly, ensuring the representation of rural and urban settings to capture diverse perspectives. This random selection of councils enhances the study's representativeness. Facilities and individuals were also randomly chosen within these councils, contributing to the inclusivity and generalizability of the study findings. This comprehensive approach ensures that a wide range of experiences and characteristics are represented within the selected regions and councils, thereby improving the validity and reliability of the research outcomes.

Study Approach

The study deployed a quantitative research approach. Data collection utilised both prospective methods. For the prospective approach, face-to-face interviews were conducted with all respondents using a guided and constructive questionnaire containing both open and closed-ended questions. Structured questionnaires, including open and closed-ended questions, were utilised to gather information from the selected participants. Before data collection, tools were pre-tested at Chamwino District Council Hospital, Mlowa Barabarani Health Center, and Manzase Dispensary to find the tool's reliability and practicability. Informed consent was obtained, and strict confidentiality protocols were followed. Ethical clearance was secured from the Institutional Review Board (IRB) of the University of Dodoma.

Study Area.

Yellow-colored district councils are Dodoma City Council, Kondoa District Council, Kongwa District Council, Morogoro Municipal Council, Mvomero District Council, Kilosa District Council, Mtwara District Council, Mtwara Municipal Council, Newala Town Council, Masasi District Council, Magu District Council, Nyamagana District Council, Ukerewe District Council are areas the research was conducted.
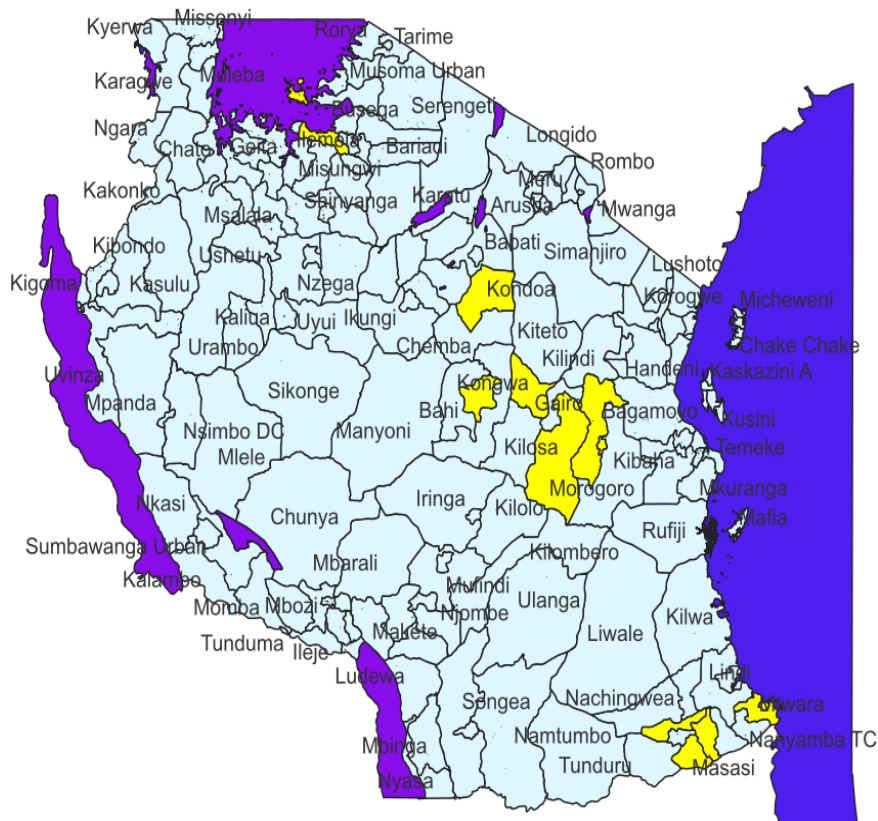
Data collection, and data processing

A face-to-face interview was conducted with all purposefully selected respondents, with a prepared questionnaire. All quantitative data was electronically collected using the ODK application, where data collectors entered the information/data collected directly into the Tablet using the electronic tool. The ODK application allowed online and offline data entry with GPS coding (Hartung et al., 2010).

Dependent variable

The dependent variable of this study (Practice) was obtained from the set of fourteen 14 questions. Each of the questions had a response whether Yes, No, or Don't know. Those questions were divided into four areas which are procurement of health commodities through prime vendors, procurement procedures under the prime vendor system, approval of the orders and payment of health commodities, and lastly submission of orders and delivery of health commodities.

Independent Variables

The independent variables in this study encompass various factors: demographic indicators such as sex, age, and education level; professional attributes such as position within the health facility and years of experience; and contextual elements including the type of health facility, region, and mobility-related factors (such as having been transferred from one working station to another).

Data Analysis

The basic descriptive statistics were used to compute and elucidate the respondent's baseline characteristics, including frequency and percentage for categorical variables and mean and standard deviation for non-categorical variables. Since the outcome variable (practice) score demonstrated an approximately normal distribution and is non-categorical, a binary logistic regression model was used to assess factors associated with the practice of implementers on the prime vendor system. The model results are presented in the form of regression parameter estimates and estimated odds ratios (OR). The data analysis was conducted using SAS version 9.4, and the significance of all statistical tests was established at a 5% level of significance (Khademi, 2018).

Ethical Considerations

The University of Dodoma Ethics Committee granted ethical approval and registration for the study. In addition, the Office of the President of the Local Government Regional Administration and the Ministry of Health in the United Republic of Tanzania granted permission for access to all facilities supporting/implementing the Prime Vendor System within the Regional Secretariat and Local Government Authorities as well as four regional referral hospitals (Mwanza, Dodoma, Morogoro, and Mtwara). Finally, informed consent was obtained from respondents during data collection, and confidentiality was maintained throughout the study.

Results

The study was conducted in all four regions Dodoma, Morogoro, Mtwara, and Mwanza. A total of 356 respondents were interviewed from health facilities visited, huge numbers of respondents were from Mwanza (27.81%) and Morogoro (27.81%) followed by Mtwara (26.40%) and with a few participants from Dodoma (17.98%). Figure 1 shows that most respondents are from dispensaries (45.79%) and health centres (39.89%). A smaller percentage of participants were associated with District hospitals (10.67%), and the fewest were from Regional Referral Hospitals (3.65%).
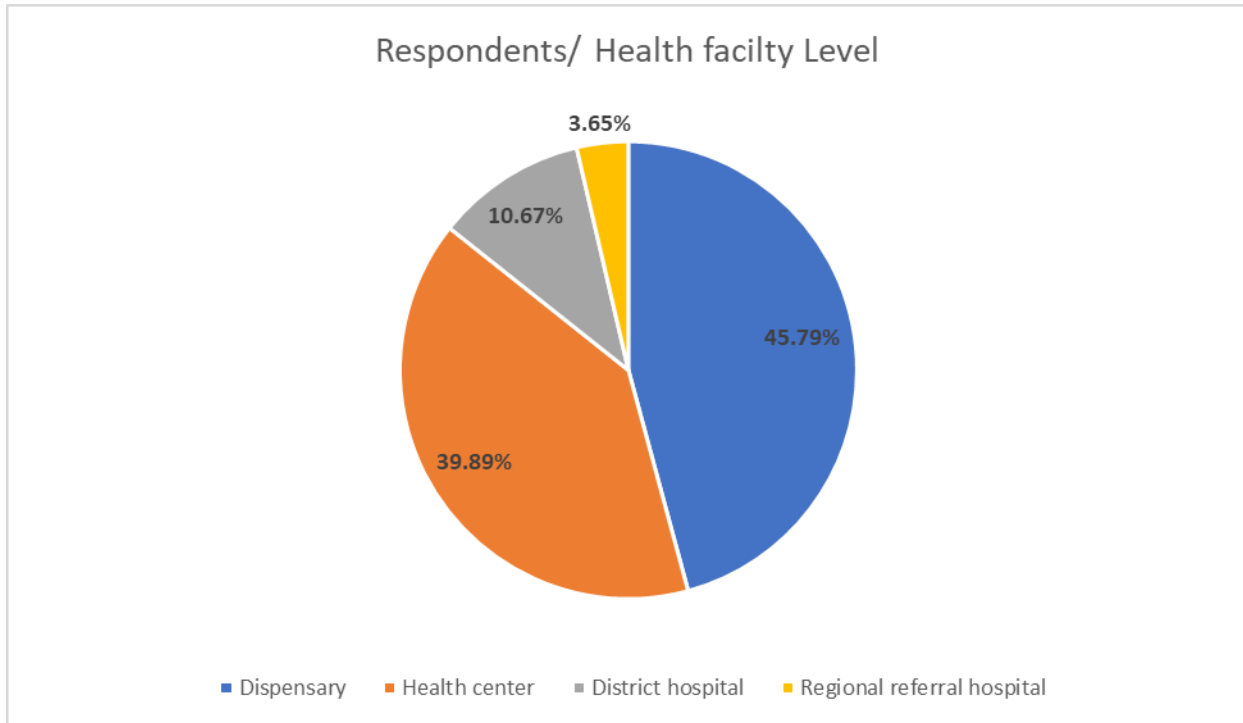
Figure 1: Respondents Interviewed per Health Facility Level

Demographic Results of Respondents

All 356 intended respondents (100% of the sample) participated throughout the data collection process. Notably, a substantial proportion of the participants were females, accounting for 181 (50.84%), while males constituted 175 (49.16%) in the study. Age-wise categorically, the majority of respondents fell within the 30-34 age range, comprising 33.71% of the total. Subsequently, individuals aged 35-39 constituted 20.79%, and those above 45 accounted for 19.10%. In contrast, a smaller % of participants, 8.71%, belonged to the 40-44 age group.

During data collection, we aimed to conduct interviews with the Health Facility in charge, storekeeper, and Laboratory personnel at each health facility. The findings across all visited health facilities revealed that 41.85% were Health Facility In charge, followed by Storekeepers at 32.58%. A smaller percentage, 25.56%, represented Laboratory personnel, as many of the observed dispensaries lacked standard laboratories. From the results, it was noted that most of the respondents had no upper level of education; only 3.37% had a master's degree, 14.61% had a first degree meanwhile, many of them had a diploma 55.06%, and 26.97% of them had a certificate. (See Table 1).

Table 1: Demographic results

Demographic Results			
Variable	**Frequency**	**Percentage (%)**	**Mean ±SD**
Sex			
Male	181	50.84	
Female	175	49.16	

Total	356	100.00	
Age category			36.74±8.33
<30	63	17.70	
30-34	120	33.71	
35-39	74	20.79	
40-44	31	8.71	
45+	68	19.10	
Education level			
Certificate	96	26.97	
Diploma	196	55.06	
Degree	52	14.61	
Master	12	3.37	
Position in this health facility			
Health Facility In charge	149	41.85	
Storekeeper/ Store In - Charge	116	32.58	
Laboratory Personnel	91	25.56	

General Information of Respondents

Table 2 shows that among the interviewed respondents, the majority had experience of 5 – 9 years (40.17%) as Government officials working as health care workers. During their working period, half of the interviewed respondents (59.27%) had transferred from one working station to another, the majority of them transferred once (56.40%) or twice (22.27%), while 40.73% had never transferred to any station since their employment.

Table 2: General Information of respondents Interviewed.

General Information of Respondents			
Variable	**Frequency**	**Percentage (%)**	**Mean ±SD**
Experience			9.72±7.30
<5	66	18.54	
5-9	143	40.17	
10-14	85	23.88	
15+	62	17.42	
Ever transferred from one working station			
No	145	40.73	
Yes	211	59.27	
How many Times? (n=211)			
1	119	56.40	
2	47	22.27	
3	17	8.06	
4	28	13.27	

Throughout the data collection process, the study aimed to assess the practices of implementers on the Prime Vendor system. This study aimed to evaluate implementers' practices within the Prime Vendor system across various domains, including the procurement of health commodities, procurement procedures, order approval, and payments, as well as order submission and delivery processes.

Procurement and procurement procedures of health commodities through prime vendor system

According to the study, 98.60% of respondents from health facilities indicated that they procure health commodities from prime vendors upon receiving notifications of out-of-stock items from the medical store department. However, the majority of respondents (85.67%) disagreed with the notion of procuring health commodities from prime vendors quarterly. (PORALG, 2022). Half of the respondents (50.56%) acknowledged incurring some costs upon receiving consignments from prime vendors in their respective regions. Moreover, 58.15% of respondents disagreed that health facility overseers are responsible for prime preparation upon receiving notifications of out-of-stock items from the Medical Store Department. These findings suggest that most respondents were familiar with the procurement procedures associated with prime vendors. (Ruhago et al., 2023).

Variable	Frequency (Percent %)		
	No	**Yes**	**I don't know**
Procurement of Health commodities through the prime vendor system			
Health facilities procure Health commodities from the Prime Vendor upon receipt of the Stock (OS) notice of Health commodities from the Medical Store Department (MSD)	2(0.56)	351(98.60)	3(0.84)
Currently, health facilities procure health commodities from prime vendors every quarter.	305(85.67)	30(8.43)	21(5.90)
Incurring any cost for receiving the consignment from the Prime vendor	129(36.24)	180(50.56)	47(13.20)
Procurement Procedures under the Prime Vendor System The health facility in charge is responsible for preparing an order of health commodities indicated in the out-of-stock notification from MSD within 14 days	207(58.15)	117(32.87)	32(8.99)

Approval of the orders and payments of health commodities
Most respondents, accounting for 90.45%, agreed with HFGC/MTC's role in approving orders and funding for procuring health commodities through the prime vendor. Furthermore, 62.92% concurred that the council health service board authorizes payment to the prime vendor upon delivering health commodities at the health facility level. (United Republic of Tanzania, 2017).

65.17% of participants were uncertain whether health facilities must settle invoices within seven days of placing an order. Most respondents (86.80%) disagreed with using online payment platforms like Tigopesa and Mpesa when traditional banking systems are unavailable. Moreover, 88.76% of survey participants concurred that health facilities rely on supplementary funds for procurement through the prime vendor system. In comparison, 73.60% expressed disagreement with the utilization of receipts in-kind for procurement within the prime vendor system. (URT, 2009).

Variable	Frequency (Percent %)		
	No	**Yes**	**I don't know**
Approval of the order and payments of Health Commodities HFGC/ MTC approves orders and funds for the procurement of health commodities to the Prime Vendor	20(5.62)	322(90.45)	14(3.93)
Health facilities are required to pay for the consignment within 7 days of sending the order	84(23.60)	40(11.24)	232(65.17)
When the banking system is not working, health facilities can	309(86.80)	12(3.37)	35(9.83)

also make payments to prime vendors online such as TIGO Pesa, M-Pesa			
The Council Health Service Board approves payment for the Prime Vendor after delivery of health commodities at HF level	29(8.15)	224(62.92)	103(28.93)
Health facilities can utilize complementary funds to procure Health Commodities to Prime Vendor System	3(0.84)	316(88.76)	37(10.39)
The Prime Vendor System utilizes the receipt in kind fund for health commodities	262(73.60)	27(7.58)	67(18.82)

Submission of orders and delivery of health commodities
From the study, 73.60% of respondents did not agree that health facilities send their orders directly to the prime vendor after approval by MTC /HFGB and half of the respondents 56.18% were not aware of the agreed time for delivery of health commodities.

Variable	Frequency (Percent %)		
	No	Yes	I don't know
Submission of orders and delivery of Health Commodities Health facilities send their orders directly to the Prime Vendor after approval by MTC/HFGB	262(73.60)	63(17.70)	31(8.71)
Delivery lead time of health commodities from Prime vendors is within 21 working days	91(25.56)	65(18.26)	200(56.18)

Factors affecting the practice of implementers on Prime vendor System.
In this section, we wanted to assess factors affecting the practice of implementers on the prime vendor system regarding several variables mentioned below.

Variable	Inadequate	Adequate	Unadjusted analysis		Adjusted analysis	
	n (%)	n (%)	OR [95%CI]	p-value	AOR [95%CI]	p-value
Sex						
Male	81(44.75)	100(55.25)	1.09[0.72, 1.65]	0.6902		
Female	82(46.86)	93(53.14)	ref			
Age category						
<30	25(39.68)	38(60.32)	ref		ref	
30-34	55(45.83)	65(54.17)	0.78[0.42, 1.45]	0.4259	0.72[0.37, 1.43]	0.3507
35-39	34(45.95)	40(54.05)	0.77[0.39, 1.53]	0.4609	0.61[0.28, 1.31]	0.2032
40-44	18(58.06)	13(41.94)	0.48[0.19, 1.14]	0.0951	0.43[0.16, 1.13]	0.0863
45+	31(45.59)	37(54.41)	0.79[0.39, 1.57]	0.4951	0.59[0.27, 1.28]	0.1798
Education level						
Certificate	42(43.75)	54(56.25)	ref		ref	
Diploma	85(43.37)	111(56.63)	1.02[0.62, 1.66]	0.9506	0.68[0.38, 1.21]	0.1934
Degree	33(63.46)	19(36.54)	0.45[0.22, 0.89]	0.0232	0.28[0.12, 0.68]	0.0048
Master	3(25.00)	9(75.00)	2.33[0.59, 9.16]	0.1246	3.01[1.61, 14.88]	0.0475
Position in health facility						
Laboratory	64(55.17)	52(44.83)	ref		ref	
In charge	59(39.60)	90(60.40)	1.88[1.15, 3.07]	0.0120	2.25[1.21, 4.17]	0.0105

Storekeeper	40(43.96)	51(56.04)	1.57[0.90, 2.73]	0.1099	1.76[0.95, 3.27]	0.0737
Experience						
<5	29(43.94)	37(56.06)	ref			
5-9	59(41.26)	84(58.74)	1.12[0.62, 2.01]	0.7153		
10-14	45(52.94)	40(47.06)	0.69[0.37, 1.33]	0.2731		
15+	30(48.39)	32(51.61)	0.84[0.42, 1.68]	0.6140		
Type of health facility						
Dispensary	69(42.33)	94(57.67)	ref		ref	
Health center	67(47.18)	75(52.82)	0.82[0.52, 1.29]	0.3953	0.93[0.54, 1.59]	0.7939
District hospital	19(50.00)	19(50.00)	0.73[0.36, 1.49]	0.3919	1.02[0.44, 2.35]	0.9693
RR hospital	8(61.54)	5(38.46)	0.46[0.14, 1.46]	0.1879	0.41[0.09, 1.79]	0.2340
Region						
Dodoma	21(32.81)	43(67.19)	3.02[1.56, 5.83]	0.0010	2.49[1.22, 5.06]	0.0120
Morogoro	44(44.44)	55(55.56)	1.84[1.05, 3.24]	0.0336	1.95[1.04, 3.67]	0.0379
Mtwara	39(41.49)	55(58.51)	2.08[1.17, 3.69]	0.0124	1.65[0.88, 3.08]	0.1173
Mwanza	59(59.60)	40(40.40)	ref		ref	
Ever transferred						
No	72(49.66)	73(50.34)	ref			
Yes	91(43.13)	120(56.87)	1.30[0.85, 1.99]	0.2249		
Knowledge						
Inadequate	84(53.85)	72(46.15)	ref		ref	
Adequate	79(39.50)	121(60.50)	1.79[1.17, 2.73]	0.0072	1.45[1.19, 2.36]	0.0383
Perception						
Negative	78(60.47)	51(39.53)	ref		ref	
Positive	85(37.44)	142(62.56)	2.55[1.64, 3.98]	<.0001	2.56[1.57, 4.17]	0.0002

Discussion

Procurement and Procurement Procedures of Health Commodities through Prime Vendor System:
Most respondents knew the procurement procedures required from the prime vendor system. Specifically, 85.67% of respondents disagreed that procurement is conducted every quarter, noting that they utilize a redesigned eLMIS system instead. Through this system, they typically procure from the Medical Stores Department (MSD) bimonthly, with procurement from prime vendors occurring only when there is an out-of-stock notification from MSD after the primary procurement.

All consignments from prime vendors must be delivered to the district hospital. This arrangement causes some health facilities to incur additional costs for picking up consignments from the district hospital or selected health facilities. In contrast, facilities near the highway to the district hospital benefit from direct deliveries. Some councils have a budget allocation for distributing consignments to health facilities, resulting in no additional costs. This variability creates different responses based on several factors.

In dispensaries and health centres, the absence of pharmaceutical personnel means that tasks such as procuring from medical stores and prime vendors often fall to a designated member of the health facility in charge, who acts as the pharmaceutical personnel. This situation partly explains why 58.15% of respondents disagreed, while 32.87% agreed that health facility staff are responsible for preparing orders of health commodities upon receiving an out-of-stock notification from MSD.

The findings are consistent with other studies on the prime vendor system. For instance, the Jazia Prime Vendor System (PVS) in Tanzania has demonstrated improvements in the availability of

health commodities, yet challenges persist in order fill rates and delivery lead times. Training and transparent standard operating procedures (SOPs) are crucial for the effective implementation and operation of the PVS. (Wiedenmayer et al., 2019b) (Pyuza et al., 2023) (Mganga et al., 2024)

Approval of the orders and payments of health commodities:

The study observed that all implementers interviewed knew the procurement procedures necessary when procuring health commodities from a prime vendor. This included Council Health Management Team (CHMT) members, where the district pharmacist and laboratory technologist supervise all prime vendor activities at the council level. The approval of procurement to prime vendors is overseen by the Medical Therapeutic Committee (MTC) or the Health Facility Governing Committee (HFGC). This operational protocol was confirmed by examining meeting minutes from HFGC/MTC sessions held at the visited health facilities. Various challenges were noted despite the conduct of these meetings, including inconsistent participation from committee members, the absence of standardized procurement documentation for prime vendors, and the lack of meeting minutes in the invoices issued by prime vendors to some health facilities.

During data collection, it was noted that a significant portion of procurements from prime vendors occur following notifications of out-of-stock items from the medical store. Approval of orders by the MTC/HFGC within health facilities is contingent upon the urgent need for out-of-stock health commodities from the Medical Store Department and the available funds for payment. Most respondents (73.60%) indicated that receipts in-kind are not employed in prime vendor procurements, while 88.76% reported using complementary funds by health facilities for procurement from prime vendors. Additionally, all payments were observed via the banking system, with prime vendors receiving payments through bank checks. However, many implementers, including prime vendors, expressed dissatisfaction with this method due to lengthy approval procedures at the council level, rejection of bank checks by banks, and insufficient knowledge among some implementers regarding the process of using bank check slips.

Similar findings have been reported in other studies investigating the implementation and challenges of the prime vendor system in Tanzania. For example, the performance evaluation of the Jazia Prime Vendor System highlighted issues such as inconsistent order fill rates and delayed delivery times, which impact the availability of health commodities at the facility level. (Pyuza et al., 2023). A study on the Jazia Prime Vendor System by USAID also noted that while the system improved the availability of medicines, challenges such as the complexity of financial transactions and approval procedures remain significant hurdles.

Moreover, research published in the Tanzania Journal of Health Research identified similar challenges in implementing the prime vendor system, including the need for better training of health facility staff, standardized documentation, and streamlined financial processes to enhance the efficiency and reliability of the supply chain. (Mganga et al., 2024). These studies underscore the necessity of addressing procedural and systemic issues to optimize the procurement and supply of health commodities in Tanzania.

Recommendations

Since the study did not examine whether regional Prime Vendors have storage warehouses for specific regions, it is recommended that further studies be conducted to focus on storage and

improve the best practices for health commodities and Regulatory Authority practices after starting implementation compared to during due diligence.

Conclusion

In conclusion, the study sheds light on health commodities' procurement and procurement procedures through the prime vendor system, revealing a variation in practice among most respondents. Challenges arise concerning the delivery of consignments, with varying costs incurred by different health facilities based on their proximity to health facilities. Moreover, Factors influencing the practices of implementers, such as education level, position in health facilities, regional differences, knowledge, and perception, highlight the complex interplay between individual characteristics and systemic factors. Addressing these challenges necessitates targeted interventions to enhance procurement efficiency and ensure equitable access to health commodities across healthcare facilities.

Acknowledgements

Authors contributions

MM developed the proposal and study design and participated in planning, data collection, and interpretation. MM was the principal investigator in all four regions visited and supervised the data collection process. MM contributed to the training and managing data collection, and SK supported planning and organizing logistics. MM drafted the manuscript for input by the other authors. All authors read and approved the final manuscript.

Competing interests

None.

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Perceived COVID-19 Vaccine Uptake and Effect on Delivery of Health Services in Tanzania: A Qualitative Study of Community and Health Workers

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Abstract

Background: The World Health Organization (WHO) declared the novel coronavirus a worldwide pandemic in March 2020. Since the coronavirus (COVID-19) is highly contagious, the number of confirmed cases and death rates has increased dramatically. The COVID-19 pandemic has caused significant morbidity and mortality throughout the world, as well as major social, educational and economic disruptions. Studies conducted in other low- and middle-income countries showed that health workers perceived the vaccine as beneficial; the benefits include preventing infection and limiting the severity of the disease. Despite myths and misconceptions which are reported to contribute significantly towards vaccine hesitancy in several African countries, there is a scarcity of systematic documentation of health workers and community perceptions on how the COVID-19 vaccine impacted the delivery and uptake of other services in Tanzania.

Objective: This study assessed and documented health workers' and community perceived uptake and impact of COVID-19 vaccination on the delivery of other services in Tanzania.

Methods: A phenomenological cross-sectional study among 632 healthcare workers at all levels and community leaders was conducted using interview guides for key informants, in-depth interviews, and Focus Group Discussions. The collected data were analyzed using a thematic analysis approach.

Results: In this study, six themes emerged, namely COVID-19 vaccine uptake, hesitation and awareness, COVID-19 transmission and prevention, and the effect of COVID-19 vaccination on the delivery and uptake of other services. Most study participants indicated that they were aware of COVID-19 and could understand the mode of COVID-19 transmission. Participants identified several factors that contribute to vaccine hesitation in the country. Such factors included receiving mixed information on the COVID-19 vaccine, family influence and secretive manner of vaccine delivery. Participants indicated that a shortage of resources affected the delivery of other services. Nevertheless, other participants indicated that the COVID-19 vaccination program did not affect the delivery of other health services. Based on the participants' views, the country was unprepared to respond effectively to the pandemic.

Conclusion: The Ministry of Health, under the communication section, should raise awareness of COVID-19 and its means of transmission. Using community leaders and champions to deliver appropriate information on COVID-19 vaccination may increase vaccine uptake and prevent misconceptions among community members.

Keywords: COVID-19, perception, health workers, community, impact, Tanzania

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Introduction

The World Health Organization (WHO) declared the novel coronavirus a worldwide pandemic in March 2020 (Cucinotta & Vanelli, 2020). Since the coronavirus (COVID-19) is highly contagious, the number of confirmed cases and death rates have increased dramatically. (Cucinotta & Vanelli, 2020). The governments took several preventative measures to reduce the spread of the virus, including mandatory mask-wearing, social distancing, and national curfews. (Deressa et al., 2021; Jang et al., 2020) Furthermore, the governments worldwide have pinned their hopes on developing COVID-19 vaccines. (Dal-Ré et al., 2021; Joseph Becker, Landry Tsague, 2009).

Immunization against vaccine-preventable infections is considered the most cost-effective way of preventing morbidity and mortality caused by such infections. Global data shows that about 2.5 million child deaths are averted annually through immunization against common childhood infections like diphtheria, tetanus, pertussis and measles. (MacDonald et al., 2020).

The Tanzania IVD Programme, formerly the Expanded Immunization Programme, was established in 1975. The programme procures, stores, and delivers safe vaccines for vaccine-preventable diseases to children under two years of age, adolescent girls, and women of reproductive age. The IVD programme has occasionally added new antigens to the immunization schedule to reduce the number of unvaccinated Tanzanians and under-vaccinated children, especially those living in hard-to-reach areas, through routine immunization. (TDHS-MIS, 2016; USAID & MSCP, 2019). The Tanzania routine immunization schedule includes BCG (birth dose), OPV (birth, 6, 10, 14 weeks), PCV(6, 10, 14 weeks), Rota (6 weeks,10 weeks), DTPHepBHib(6, 10, 14 weeks), MR(9, 18 months), and HPV(9 years) for children and adolescents. Women of Reproductive age and pregnant women are offered TT (1st contact; +1, +6 months;+1, +1 year). (Banks et al., 2020). According to TDHS-MIS 2015-2016, the proportion of children with all basic vaccination coverage ranged from a high of 83 per cent in Central, Southern Highlands, and Eastern zones to a low in Southwest Highland zone (67 per cent) and Western zone(66 per cent). (TDHS-MIS, 2016).

The COVID-19 pandemic has caused significant morbidity and mortality throughout the world, as well as major social, educational and economic disruptions. Globally, as of 6th December 2021, there were 265,194,191 confirmed cases of COVID-19, including 5,254,116 deaths, reported to WHO[1]This virus, which causes respiratory disease, was identified as belonging to the Coronavirus family, and it rapidly spread to many other countries worldwide. (MoHCDGEC, 2021). Common symptoms of COVID-19 include a high temperature, continuous dry cough, and loss or change in the sense of smell and taste. About 80% of infected people have no or mild symptoms, and one in six people who get COVID-19 becomes seriously ill. (MoHCDGEC, 2021). Older people and those with underlying medical problems are more likely to develop serious illnesses or die from COVID-19.
Coronavirus control measures include social distancing measures, travel restrictions, closure of public spaces, washing hands with soap and running water or using sanitizers, and wearing face masks. (Hager et al., 2020). Scientists around the world are continuing to develop many potential vaccines for COVID-19. These vaccines teach the body's immune system to recognize and block the COVID-19 virus safely. As of December 2020, over 200 vaccine candidates for COVID-19 were being developed. Of these, at least 52 candidate vaccines were in human trials. WHO has approved nine COVID-19 vaccines in the Emergency Use Listing (EUL). They include Pfizer BioNTech, Moderna,

AstraZeneca, Sinopharm, Sinovac, Janssen, and Serum Institute of India Pvt.Ltd, Sputinik, and Bharat. Biotech (WHO, 2021). Five of these vaccines were recommended for introduction in Tanzania. They include Pfizer BioNTech, Moderna, Sinopharm, Sinovac, and Janssen (MoHCDGEC, 2021).

A stuy conducted in Zambia revealed that Health workers perceived the vaccine as beneficial; the benefits included preventing infection and limiting the severity of the disease. Moreover, FGD participants from urban sites expressed a negative attitude towards the vaccine. They believed the vaccine conferred no benefits. By contrast, participants from rural communities had mixed views; they needed more information about the vaccine benefits. Participants' attitudes seem to have been influenced by personal or family experience with the COVID-19 disease or vaccination; those who had experienced the disease had a more positive attitude. (Mashoto et al., 2024). In contrast, most young people believed they were not at risk of the COVID-19 disease. Misinformation from social media influenced their attitude. (Sialubanje et al., 2022).

The effectiveness of vaccines depends on vaccine availability and uptake and vaccine hesitancy; the latter can range from simple indecisiveness/doubt to outright anti-vaccination beliefs. (Dhama et al., 2021; Jairoun et al., 2022; Puri et al., 2020; Sialubanje et al., 2022). The WHO listed vaccine hesitancy as one of the top ten threats to global health in 2019. It is a critical barrier to preventing vaccine-preventable diseases. (Macdonald, 2015). Vaccine hesitancy is an important barrier to achieving high vaccination coverage and has been reported among various socio-demographics from educated populations (Dhada et al., 2021), who failed to appreciate the science of vaccines, to refugees in the USA. (Dhada et al., 2021). Despite the volume of literature on vaccine hesitancy, it has remained an elusive topic, particularly because of its complexity and the myriad factors affecting it. Some of the prominent reasons centre around the concerns of safety, potential adverse effects, and disconcerting rumours about vaccine's impact on fertility and pregnancy. (Chemali et al., 2022). Understanding how vaccines are perceived in a particular context and the factors affecting their acceptance (or absence) can offer a window to the potential success of vaccine rollout.

Vaccine hesitance has been reported both in Zambia and other countries and is an important obstacle to the fight against COVID-19. (Quinn et al., 2021; Thapar et al., 2021). Lack of knowledge about different types of vaccines is among the factors that influence vaccine hesitancy. (Larson et al., 2021). Low vaccine coverage has been attributed to the delay in accepting or refusing vaccination despite the availability of vaccination services.

Studies conducted in WHO regions indicated that the existence of COVID-19 affected access to other health services for HIV, malaria, routine vaccination, non-communicable diseases, and mental health. (Al-Zalfawi et al., 2021; Ciardi et al., 2021; Jairoun et al., 2022). Attention directed to COVID-19 worsened the health system challenges, which impacted the quality of care, hindered patients from accessing care due to the lockdown, and resulted in increased patient default.

In most countries, vaccine hesitancy, negative attitudes, and perceptions about COVID-19 vaccines have influenced vaccine hesitancy, leading to low immunization rates. (Al-raeei, 2020; Ali et al., 2024; Paul et al., 2021). A shift of social mobilization towards COVID-19 prevention may affect the uptake of routine immunizations and negatively impact routine vaccination. (Ali et al., 2024; Hager et al., 2020).

Materials and Methods
Study designs
A cross-sectional study was conducted using qualitative phenomenological approaches to collect data. (Hunter et al., 2019).

Data collection tools
Interview guides were used to collect data during Key informant interviews, In-depth interviews and Focus Group Interviews.

Study settings and population
The study covered all eight health sector zones in Tanzania and targeted community members, national-level IVD programme staff, regional health management teams (RHMTs), members from DHMTs, healthcare providers, and ward and village leaders.

Data collection and sampling procedures
In each selected region, two councils were randomly selected, and from each council, two wards stratified by rural-urban were randomly selected. In each ward, four villages/streets were selected; hence, 128 villages were sampled for the entire study. Thus, at each respective level (national, region, council, ward and village), the following key informants were interviewed: logistic supply chain officer RIVO, RMO and RRCHCO; DMOs, DRCHCOs and DIVOs; WEOs, W-EHOs, WECs; and VEOs and CHWs (Table 1).

This study was part of a larger study conducted country wide. The heterogeneity of FGD groups was women and men, with women aged 25+ and Men aged 25+. Purposive sampling was chosen to select participants due to their rich information as representatives of health workers about the study. Furthermore, women and men in FGD groups were chosen to represent the community based on their experience and age (Manera et al., 2019).

One village from each zone was randomly selected from the respective region for focus group discussions. In each selected village, four FGDs were purposively selected (young boys, young girls, men and women) were conducted giving a total of 32 FGDs (Saunders et al., 2018).

Table 1. Number of Interviewed Key Informants

Level	Proposed Sample	Interviewed
National	2	2
Region	24	20
Council	48	38
Ward	192	134
Village	384	173
FGD participants	384	256
All	**826**	**623**

Data analysis
The interviews were conducted in Kiswahili. Research assistants and note-takers Verbatim transcribed the FGDs and KIIs sessions. The qualitative personnel verified all transcriptions to ensure accuracy by listening to the audio and ensuring that what was written was the same as what was in the audio.

Four researchers reviewed transcripts, and interviews were coded using thematic analysis. The analysis involved multiple transcript readings by researchers to identify recurring themes. The authors then revised versions of the codebooks according to emerging themes. The codebooks were reviewed, and themes were redefined over several meetings until a consensus was reached on defining all themes. New themes that emerged during this process were defined and added to the codebooks.

All study team members coded all interviews and FGD transcripts and compared them for inter-coder reliability. The transcripts were re-coded, a new theme emerged, a definition was redefined, and a consensus was reached.

The transcribed and translated transcripts were then exported to NVIVO 12 software to support the analysis and process of qualitative data, particularly in grouping the subthemes based on the developed codes.

Trustworthiness of the data

Several criteria are used to evaluate the trustworthiness of qualitative papers: credibility, transferability, dependability and confirmability. (Guba E.G, 1981; Hager et al., 2020). In this paper, credibility was ensured by purposive sampling when selecting the study participants who were eligible for participation. These participants were key to our research question, "How does COVID-19 vaccination affect work performance?" Using IDs assisted in meeting the credibility of the study. Transferability was attained through the description of the context, and the findings of this study are expected to be implemented in other similar contexts. Dependability was attained based on the availability of quotations to support the description of the findings, indicating that the findings emerged from the participants' voices.

Ethical considerations

This study was approved by the National Health Research Ethics Committee of Tanzania (Certificate reference number NIMR/HQ/R.8a/Vol.IX/3981). Study participants provided verbal informed consent before the interviews and Focus Group Discussions. In addition, all ethical issues were considered during the study.

Results

Demographic characteristics of participants

We interviewed 623 (75.4%) of the planned informants. The majority (24.3%) of the participants were aged 20-24, with a mean age of 34. More than half (52%) were male. More than half (68.1%) were from rural settings. 14.9% worked as community health workers.

COVID-19 Awareness

The theme conveys how participants were aware of the disease and knew that it is a dangerous disease with no cure but can be prevented through vaccination. As expected, health workers, by their positions, were well informed and affirmed that vaccination greatly reduces the severity of the disease. They also acknowledge that vaccines are good for the people as per the informants' narration here under:

> The truth is that the disease is dangerous. We have not been infected until now, but if we need to protect ourselves from COVID-19, we should vaccinate. Through vaccination, you can get antibodies that can protect you against COVID-19. If you get infected with the virus, antibodies act as soldiers that protect the body by fighting back the viruses while you continue doing your activities; you will not be severely affected *(KII Number 1).*

Anha, this is because I am a health personnel. The vaccine helps, and it is good. It has greatly reduced the harm that COVID-19 might cause, and transmission has been reduced greatly. Therefore, the vaccine is important and helps a lot **(KII Number 2***).*

Transmission of COVID 19

Participants in this study showed that they understand how COVID-19 is transmitted. They also mentioned that it is transmitted through droplets, coughing, sneezing, and contact with contaminated hands, saliva, and sputum.

It is transmitted by coughing, sneezing, and messing up your hands with saliva and sputum. Shaking hands is also another way a person can get infected. (**KII Number 2***)*

Most of the transmission methods are through droplets that come out through the nose, so when an infected person sneezes, nearby people are exposed to the virus and get the infection. Eventually, that virus can cause harm to respiratory organs. Also, viruses can be transmitted through contaminated surfaces such as benches, plastic metals or anything. So, it is not always from a coughing person and spitted sputum (**KII Number 3***)*

I do not know exactly how this disease is transmitted. I cannot yet tell how the disease is transmitted because I do not fully understand how... I heard that viruses come from birds known as bats and are transmitted through the respiratory tract, but it is also dangerous to touch and share utensils with an infected person. **(FGD_Males 25+ years**)

Prevention of COVID 19

Participants in this study indicated that they have ideas on preventing COVID-19. They mentioned social distancing, avoiding shaking hands, hand washing with soap using running water and sanitizers, and wearing masks to prevent the spread of the infection.

Some preventions, especially for businesspeople, include social distancing and not touching each other. Other preventions include using soap and running water, sanitizer, and avoiding crowding **(KII Number 4**).

Firstly, protect your mouth and nose when sneezing using your elbow. Wear masks, wash hands using running water and soap, and use sanitizers. Those measures are used to prevent the spread of COVID-19 **(KII Number 2***).*

*Many methods have been used to prevent COVID-19, especially avoiding congestion, travelling unnecessarily, washing hands frequently with clean running water and soap, and vaccina*tion (**KII Number 5**).

We are avoiding congestion, like sitting in groups, we are washing our hands frequently with clean water and soap, and we are wearing masks (**FGD_Women 25+ years**)

Availability of COVD 19 vaccines

The theme conveys that participants acknowledge the availability of the COVID-19 vaccine and that people who need it get it. In most of the study sites, mobile clinics for COVID-19 are conducted in areas such as churches and other places where people are congested. Furthermore, in collaboration with stakeholders such as WHO and JEPIEGO, vaccination campaigns are conducted in villages or

on the streets. Since COVID-19 vaccines are available, and uptake is low, healthcare providers visit households to educate on the importance of vaccines and vaccinate those willing to receive the vaccine. However, other participants reported a shortage of vaccines, as it was narrated by participants here.

> *We do not have problems securing vaccines. All the time, our facilities are stocked with the vaccine. Whenever clients need the vaccine, they get it easily. Secondly, we have mobile clinics to serve the communities, and when we visit them for other services, we also offer COVID-19 vaccine education and services. We also visit congested areas like churches and other religious places to provide vaccine information and services. Our visits extend to other institutions which harbour so many people. So, we go there to offer both vaccine information and services. In addition, we conduct vaccination campaigns in collaboration with other stakeholders such as WHO and JEPIEGO* (**KII Number 3***).*
>
> *Aaah, I can say it is difficult to reach all people because there is a shortage of resources. We get a few dosages of vaccine. But when obtaining the dosage, the issue is how to deliver the vaccine to people who need it the most. We do not have the budget for household visits to provide the vaccine. On the other hand, you can be asked how you can stay with expired vaccines. Therefore, there is no way but to visit the households to increase access to the vaccine. I can say there is a shortage, but at the same time, accessibility is a challenge (***KII Number 3****).*
>
> *COVID-19 vaccines are readily available... They are in the street, but we are not making follow-ups of them as there are no seminars. That is why people are unwilling; you do not know if they are fake or original. Education is needed. Vaccines are available, and healthcare providers make visits to households to provide vaccine information and services* (**FGD Males 25+ years**)

Reasons for noncompliance to COVID-19 vaccines

The low uptake of the COVID-19 vaccine is partly attributed to people's beliefs and perceptions. The study's findings indicated that participants were not well informed about how the disease is transmitted and spread and had different perceptions and beliefs, which leaders influenced, as some leaders' statements came with confusion on vaccine issues.

> *Mmh, For the already infected individuals, we are afraid of vaccinating them for fear that they can become seriously sick. We are still learning about this disease; we are not sure how and where the disease came from*. (**KII Number 4***)*
>
> *The community was confused by the opinions of different leaders regarding COVID-19 vaccination. Hence, when you approach people, some are against the vaccine, and others are against it. They tell you, "Can't you see that our leader said the vaccine is not safe? How come you are saying it is safe now?" Our initial response to COVID-19 was not right, and now we pay the consequences—high vaccination refusal (***KII Number 3****).*

Some participants reported that proper vaccine information and education were not provided to people in the initial response to the pandemic. People are being informed and educated on the importance of the COVID-19 vaccine, and there is hope that positive changes will be achieved. Other

participants reported that vaccination hesitancy is due to family influence, and COVID-19 vaccination is treated as a secret issue. There have been reports by participants as indicated here:

> *Those who hesitate to be vaccinated do not have adequate and appropriate information on the vaccine. Continuously providing appropriate vaccine information will change the status quo. It is not easy, but people will eventually change their negative perspective on vaccines*

> *If they receive appropriate information, people have started to change; the difficult ones have become good ambassadors* **(KII Number 1***)***.

> *I have not received vaccine information from the right people, so I am not vaccinated because I am unsure of the vaccine's safety. I am waiting for what will happen to those who have received the vaccine. You know the vaccination exercise is kept secret, and a family decides whether their relatives should be vaccinated. People do not want to be stigmatized for being vaccinated, so they prefer not to admit that they have been vaccinated openly.* (**FGD_Males 25+ Years)**

Effects of COVID-19 vaccination on delivery of other services

The findings from this study indicated that there is ambivalence regarding the effects of COVID-19 vaccination on the delivery of other services. Participants in this study indicated mixed perspectives. Some participants said that COVID-19 vaccination did not affect the delivery of other services as they were running as usual. According to the narration, others mentioned that COVID-19 vaccination activities added an extra load to already overworked health workers.

> *It does not harm anything [COVID-19 vaccination]. People continue with their usual activities. Some health workers continue their routine work, while others deliver the COVID-19 vaccine. Therefore, Kazi Inaendelea [the work continues]* **(KII Number 4).**

> *COVID-19 vaccination did not affect the delivery of other health services. When we provide mobile clinics, we ensure that other services continue as usual at the health centre* **(KII Number 3).**

> *You know, the COVID-19 vaccination was not included in the plan, so we are trying to fix its activities in our plan. We cannot afford not to implement COVID-19 vaccination activities; the disease is dangerous. But we cannot say that we have not been affected. Some planned activities were not implemented to accommodate COVID-19 vaccination activities* **(KII Number 2).**

> *The same health workers were supposed to implement COVID-19 vaccination activities. That means health workers had to perform their routine duties and implement COVID-19 vaccination activities. Since there was pressure to reach vaccination targets, the focus was directed to COVID-19 vaccination, and thus, the time for other routine vaccines was consumed by COVID-19 vaccination. So, coupled with the shortage of human resources, you will realize that routine services were largely affected.* **(KII Number 2).**

*I can say that COVID-19 vaccination has affected other routine services. As you increase the pace of providing the COVID-19 vaccine, you slow down or disrupt the provision of other routine services (***KII Number 6***).*

Discussion
In this study, most participants were aware of COVID-19 and knew how it is transmitted. When asked about preventing the disease, they knew how to prevent it. Vaccine hesitance was also one of the issues among participants. Participants also mentioned the effect of the COVID-19 vaccine on other routine services.

Uptake of COVID-19 vaccine
Results indicate that study participants know COVID-19, its transmission and prevention. However, the uptake of vaccines for the prevention of COVID-19 is still low. In the Tanzanian context, the views of different leaders might have influenced community attitude and perception of the COVID-19 vaccine, consequently leading to low uptake. This is in line with the results of other studies which reported that uptake of COVID-19 vaccine is influenced by knowledge, attitude and perception towards the vaccination (Kabakama et al., 2022; Vasudevan et al., 2020)

Knowledge of COVID-19 Transmission
Participants in this study indicated that they know how the disease is transmitted. The frequently mentioned methods of disease transmission included droplets, contact with infected persons, such as shaking hands, being in congestions, such as churches, and touching contaminated objects. Local and international travel presented a high risk of COVID-19 transmission. For example, the first cases involved individuals who had returned from abroad.

Most people in Tanzania use public transport, so adherence to social distancing was difficult. Although international travel was reduced during the study, local and international travel by road continued. Interactions among fellow drivers and with other travellers, as well as customs and immigration officers, placed international truck drivers at an increased risk of contracting and transmitting the disease (Godbole et al., 2023; Kabakama et al., 2022; Metta et al., 2023; Mgongo et al., 2023).

COVID-19 vaccination hesitancy
Study participants attributed vaccine hesitance to controversial messages from leaders and influential people. The fear of being judged as not obeying the leaders placed individuals who wanted to be vaccinated in a very difficult position. Hence, many people decided to keep their vaccination status secret. The findings align with the WHO's three "C's" contributing to vaccination hesitancy: complacency, convenience, and confidence. (Galagali et al., 2022). Rates of vaccine hesitancy, as well as contributing factors, vary widely based on a person's location, background, and community. (Rodrigues et al., 2022; Vanderpool et al., 2023). Vaccine hesitance has been reported in other countries and is an important obstacle to the fight against COVID-19. (Dhama et al., 2021; Puri et al., 2020; Sialubanje et al., 2022).

Vaccine availability alone does not increase vaccine coverage if hesitancy and refusal rates are high due to mistrust, safety issues, and a lack of reliable information about COVID-19 vaccines. (Ali et al., 2024; Kricorian et al., 2022; Mashoto et al., 2024) . Whereas the frequently mentioned reason for low uptake of the COVID-19 vaccine among the study participants was leaders' controversial messages, other studies reported poor accessibility due to poor road connectivity,

which led to long hours of travel, and lack of transportation facilities were the barriers to vaccine uptake. (Babatope et al., 2023)(Ali et al., 2024). This implies that vaccine hesitation has different factors.

Prevention of COVID 19

Study participants mentioned wearing masks, covering their mouths with their elbows, hand washing with running water, using sanitizers, and vaccination as preventive measures to control the spread of COVID-19. This means study participants have good knowledge of the disease's prevention, which aligns with the findings of other studies. (Hager et al., 2020). However, knowing that vaccines help control the spread of disease may not necessarily translate into use.

Other factors play a significant role in one's decision to be vaccinated. COVID-19 vaccination exacerbated the existing human resource shortage, affecting the delivery of other routine health services. This study's findings are similar to those of the WHO regions and elsewhere. (Al-raeei, 2020; Paul et al., 2021).

Study strength

Purposive sampling of participants comprising health workers and community members with different demographic and socioeconomic characteristics (sex: male and female; age; place and province of residence: urban and rural settings) allows for comparing of participant views, which in turn provides an in-depth understanding of the subject under investigation. Using different data collection techniques (focus group discussions and in-depth interviews) and data sources allowed for triangulation of findings, which increased the study's internal validity.

Study limitations

Conducting the study at the beginning of the COVID-19 national mass vaccination, when the programme was still new in the country, may have affected the participants' views.

Conclusion

Awareness and knowledge on COVID-19 prevention and transmission are high among study participants, but vaccine uptake is low and influenced by highly ranked top leaders' controversial messages regarding vaccination. The Ministry of Health, under the communication section, should continue to reinforce the increasing awareness of COVID-19 and its means of transmission. The Ministry of Health should increase COVID-19 and provide means of transmission to top leaders. Furthermore, using community leaders and champions to deliver appropriate information on COVID-19 vaccination may help increase the uptake of the COVID-19 vaccine and prevent misconceptions among community members. To avoid disruption of delivery of other services, there is a need to strengthen the country's capacity for preparedness and response to emergencies and pandemics.

Conflict of interest

The author declares no conflict of interest.

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Clinical Presentation and Outcomes of COVID-19 Patients Supplemented with Approved Herbal Preparations in Tanzania: A Cohort Study

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Abstract

Introduction: During the COVID-19 pandemic, there was no known specific treatment for coronavirus Disease. Because of this, different countries and institutions have used different regimens to manage disease symptoms. In Tanzania, well-known and long-used herbal preparations believed to have antiviral activities were used as supplements to standard care for COVID-19 management. This study assessed the clinical presentation and outcomes of hospitalized COVID-19 patients receiving standard care plus herbal preparations in Tanzania.

Methods: An observational cohort study was conducted between February and May 2021 at 12 health facilities. Sociodemographic information, clinical presentation, past medical history, baseline, and follow-up laboratory records were documented. Each study participant was followed up for 14 days from enrolment.

Results: 285 participants were enrolled; their mean age was 59.2 ± 16.5 years, and males constituted 56% of the study participants. Nearly 33% were aged 50 years and above. The majority (72%) reported having at least one form of co-morbidities (raised blood pressure, diabetes mellitus, asthma, Chronic Obstructive Pulmonary Diseases (COPD) and other forms of heart problems apart from hypertension). More than 60% of the study participants reported to have used at least one form of locally available herbal preparations. Symptoms and signs reported at enrolment subsided relatively faster among those supplemented with herbal preparations than among their counterparts. PCR results of nearly 66% of the study participants had converted to PCR negative at different rates by day 7 (61 vs 78%) and by day 14 (64.3% vs 36.4%) among herbal and non-herbal users, respectively. Overall, proportionally mortality was higher among those who used standard care alone (23.3% vs 16.9%) compared to those supplemented with herbal preparations.

Conclusion: The use of herbal preparations in addition to standard care treatment showed a positive effect in subsiding signs and symptoms and decreasing mortality among COVID-19 patients. The findings from this study call for further research, especially clinical trials, to ascertain these findings.

Keywords: Herbal preparations, COVID-19 outcome, Clinical presentation

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Introduction

The emergence of the COVID-19 pandemic stretched the health systems globally. Despite different efforts employed by scientists, there were no established medications for the management of COVID-19, except for some of the approved COVID-19 vaccines (WHO, 2020a)

In many communities, herbal preparations are the main contributor to primary health care, building on longstanding cultural acceptability in its use (Agyei-Baffour et al., 2017), with anecdotal estimates of 80–90% of rural populations relying on plant-based herbal preparations for the management of the different health conditions (Attah et al., 2021). Several researchers around the globe have evaluated different herbal extracts and identified phytoconstituents with different mechanisms of action against the viral infection. Hence, herbal preparations were believed to alleviate the effects of infectious diseases such as severe acute respiratory syndrome-related coronavirus (SARS-CoV-2) and improve the clinical conditions of COVID-19 patients (Musoke et al., 2021a). Therefore, the World Health Organization (WHO), the Africa Center for Disease Control (CDC), and the African Union Commission for Social Affairs issued statements welcoming the use of herbal preparations for COVID-19 management (WHO, 2020b).

Evidence from different findings suggested that herbal preparations can reduce the severity of the disease and prevent COVID-19 infection (Chan et al., 2020; Musoke et al., 2021b; Vellingiri et al., 2020). Traditional herbal Chinese preparations have shown appreciable results in improving clinical symptoms and reducing mortality and recurrence rates of the virus (Liang et al., 2021; Luo et al., 2020). Furthermore, China and India have used herbal preparations in combination with other conventional medicines to improve the immunity of patients (Ni et al., 2020; Shankar et al., 2020; Wang et al., 2020).

Nevertheless, different findings suggested that herbal preparations have an effective therapeutic component when combined with conventional medicine in COVID-19 management (Ang et al., 2020; Panyod et al., 2020). Using herbal preparations for therapeutic purposes should not be underestimated since many botanical drugs show antiviral efficacy. Furthermore, the review of several African scientific research (Okaiyeto & Oguntibeju, 2021) has shown that African plants have demonstrated antiviral activity. In West Africa, several herbal preparations were documented to be used during the Ebola Virus outbreak; however, none were studied in conventional clinical trials (Suk et al., 2016).

Moreover, Tanzania harbours 24% of the globally known biodiversity hotspots. It is endowed with about 31% of the African flora, of which about 9% have natural products of pharmacological and economic importance (United Republic of Tanzania, 2014). This puts the country in a better position to contribute to managing the COVID-19 conditions in the country and other countries worldwide. Further, herbal preparations are well prepared and utilized from the family to the commercial levels. The use of herbal preparations in Tanzania continues to be important in primary health care in the country. These herbal preparations include NIMRCAF, Covidol, Covotanxa, Bingwa, Planet++, Uzima and Bupiji essential oil. Most herbal preparations' common ingredients include ginger, garlic, lemongrass, eucalyptus, and clove. Initially, these herbal preparations were tested for the presence of any toxicity indications at the Government Chemist Laboratory Authority of Tanzania. They were revealed to be non-toxic for human use and hence merit an observational study in humans to ascertain their safety (GCLA, 2020). Thereafter, they were approved by the Traditional and Alternative Health Council of Tanzania for use among COVID-19 patients and other related conditions.

This study was, therefore, conducted to assess clinical outcomes (subsiding of the signs and symptoms related to COVID-19 as well as conversion of the RT-PCR results) and patient health outcomes (alive or dead) among COVID-19 patients receiving treatment at 12 health facilities in Tanzania Mainland.

Materials and methods
Study design and setting
This observational cohort study aimed to assess herbal preparations' safety and health outcomes among COVID-19 patients in Tanzania. This study was conducted between February and May 2021 at 12 (10 public and 2 private) health facilities, which were purposefully selected because they were among the health facilities with high COVID-19 patients. The public health facilities included Muhimbili National Hospital, Jakaya Kikwete Cardiac Institute, Bugando Medical Centre, Kilimanjaro Christian Medical Centre and Benjamini Mkapa Hospitals. Other public health facilities included Amana, Temeke, Mwananyamala and Dodoma Regional Referral Hospitals. The private facilities were Shree Hindu Mandal and Kairuki Hospitals.

Study population and cohorts/groups
We approached patients hospitalized with COVID-19 in the study sites. Eligible participants were those confirmed to have COVID-19 by RT-PCR, aged 18 years and above, who consented to be part of the study. Patients with a known history of liver disease or chronic kidney disease were excluded. The study participants were categorized into two groups: One group included those who received standard care alone, and the other comprised those who received standard care and were supplemented with herbal preparations.

Sample size calculation
Our assumptions regarding the expected change in proportions of COVID-19 patients using herbal preparations were that 25% of them would have improved symptoms or clinical signs compared to the cohort using standard treatment alone. Considering alpha of 5%, Power $(1-\beta)$ of 80%, and using two proportions two-sided, non-inferiority comparison, we ended up with an estimated sample size of 62 patients per study group. The plan was to have eight groups of participants, of which seven would have been constituted by those using any of the approved herbal preparations plus standard care, and the remainder group included the participants who were on standard care alone. Overall, our target sample size was 500 study participants. However, due to the downslope of the COVID-19 second wave in the country, only 285 participants were enrolled.

Recruitment of the study participants
Medical personnel at the study sites attending to the COVID-19 patients were used to implement the study, including conducting interviews with the study participants. Since this was an observational study, healthcare providers only prescribed standard care treatment and were not involved in prescribing the herbal preparations. The participants determined their willingness to use or not use the herbal preparations. The research team focused on conducting interviews, observing, and recording health outcomes among the cohorts.

Participants were consecutively recruited, and we managed to enrol only 57% (n=285) of the required sample size because of the absence of more admitted COVID-19 patients as the pandemic was ending. Each Participant was followed up for 14 days. The participant was terminated from the study if they had completed 14 days of follow-up, withdrew from the study, were lost to follow-up after being discharged from the hospital or died within the follow-up period. If the participant still had COVID-19-related signs and symptoms or RT-PCR for Coronavirus was still positive, the participant was left to continue with the standard care management at the respective health facility.

Data collection
Face-to-face interviews were conducted with the eligible and consented study participants using a structured questionnaire. Interviews gathered information such as the history of using any of the

herbal preparations, name of the preparation used and duration of use, the experience of any adverse event (DAIDS Safety, 2010) on the due course of using the preparation (development of any new or worsening of the event). Participant's medical records were accessed to document sociodemographic information, clinical presentation on admission, past medical history, and baseline and follow-up laboratory records. Furthermore, mobile phone numbers were also collected for follow-up in case the participants were discharged before completing the follow-up duration. Data collection was done at baseline, day 7 and day 14. RT-PCR for Coronavirus was done at baseline for diagnosis and on days 7 and 14 for conversion assessment. Lactate dehydrogenase (LDH), D-dimer and ferritin levels were done for severity assessment at baseline and day 14.

Ethical consideration
The protocol for this study was approved by the National Health Research Ethics Subcommittee (NatHREC) in Tanzania, with ethical clearance number NIMR/HQ/R.8a/Vol. IX/3620. All study participants were 18 or older, and each provided written informed consent.

Data Analysis
The survey tool was programmed into and administered using Android tablets that contained an Open Data Kit (ODK). The programming process involved setting range and consistency checks to ensure the quality of the data collected was good. Field supervisors cleaned and synchronised the data on the NIMR main server in real-time. Data was exported from ODK to Excel in CSV format and later to Stata version 15 (STATA et al., USA) for further cleaning and analysis.

Results were presented as a comparison of the proportions of patients recovering from symptoms or clinical signs, proportions with RT-PCR conversion at day 7 or day 14 and the proportions of the health outcome (alive and dead) among COVID-19 patients in their respective cohorts. The probability and associated relative risks of all these endpoint events were compared on days 7 and 14 among COVID-19 patients in the cohorts. Pearson Chi-square statistics test was used to compare group differences for categorical variables. Bar graphs and tables were used to present the results pictorially. Outcome indicator rates and proportions were generated and compared mainly between herbal and non-herbal users. The prevalence of mortality in all COVID-19 patients, herbal users and non-herbal users was above 10%; thus, prevalence risk ratios (PRR) were estimated using the Modified Poison Logistic Regression Model, and we reported their 95% confidence interval (CI). This model was used since Classical Logistic Regression end up with wide confidence intervals once used to fit the model when the outcome of interest is greater than 10%; hence it is recommended when the outcome is less or equal to 10% (Fonseca Martinez et al., 2017; Thompson et al., 1998; Zou, 2004). We started with unadjusted models for each independent variable. All independent variables whose unadjusted prevalence risk ratio (RR) was significant at $p<0.20$ were candidates for multivariable analysis (Bursac et al., 2008; Gelman, 2013). Results were considered statistically significant if the p-value was <0.05.

Results
Socio-Demographic Characteristics of the Participants.
285 participants were enrolled between February and May 2021 at 12 health facilities. Table 1 reports on the sociodemographic characteristics of the study participants. The mean age was 59.2 ± 16.5 years. Males constituted 56% of the study participants. Nearly one-third (n=91) were aged 50 years and above. Seventy-two per cent (n=204) of the study participants reported having at least one form of co-morbidities, including diabetes, hypertension, asthma, Chronic Obstructive Pulmonary Diseases (COPD) and other forms of heart problems apart from hypertension. More than two-thirds (68.4%) reported using at least one form of herbal preparation.

Table 1: Socio-demographic characteristics of study participants at enrolment by herbal preparations use status (N=285).

Variable	Using Herbal preparation				Total	
	Yes		No			
	N	%	N	%	N	%
Age (years)						
Mean (SD)	58.0(15.9)		61.8(17.4)		59.2(16.5)	
Age group (in Years)						
<50	56	28.7	17	18.9	73	25.6
50 – 69	84	43.1	37	41.1	121	42.5
≥ 70	55	28.2	36	40.0	91	31.9
Sex						
Male	106	54.4	53	58.9	159	55.8
Female	89	45.6	37	41.1	126	44.2
Participants with at least one form of co-morbidities						
No	55	28.2	26	28.9	81	28.4
Yes	140	71.8	64	71.1	204	71.6
Region						
Dodoma	26	13.3	17	18.9	43	15.1
Mwanza	16	8.2	35	38.9	51	17.9
Kilimanjaro	43	22.1	11	12.2	54	19
Dar es salaam	110	56.4	27	30.0	137	48.1
Total	**195**	**100.0**	**90**	**100.0**	**285**	**100**

Type of herbal preparations reported to be used by the study participants

Here, we provide only information for those who have used the herbal preparations (n=195). During the interview, more than two-thirds (68.4%, n=195) of the 285 study participants reported using at least one form of herbal preparations. Figure 1 summarizes information on these different types of herbal preparations. Fifty-one per cent of these 195 participants (who were supplementing standard care with herbal preparations) reported using at least one of the seven herbal preparations used in this study. On the other hand, 49% of participants reported using homemade remedies containing mixtures of ginger, lemon, garlic, lemon grass, eucalyptus, and clove.
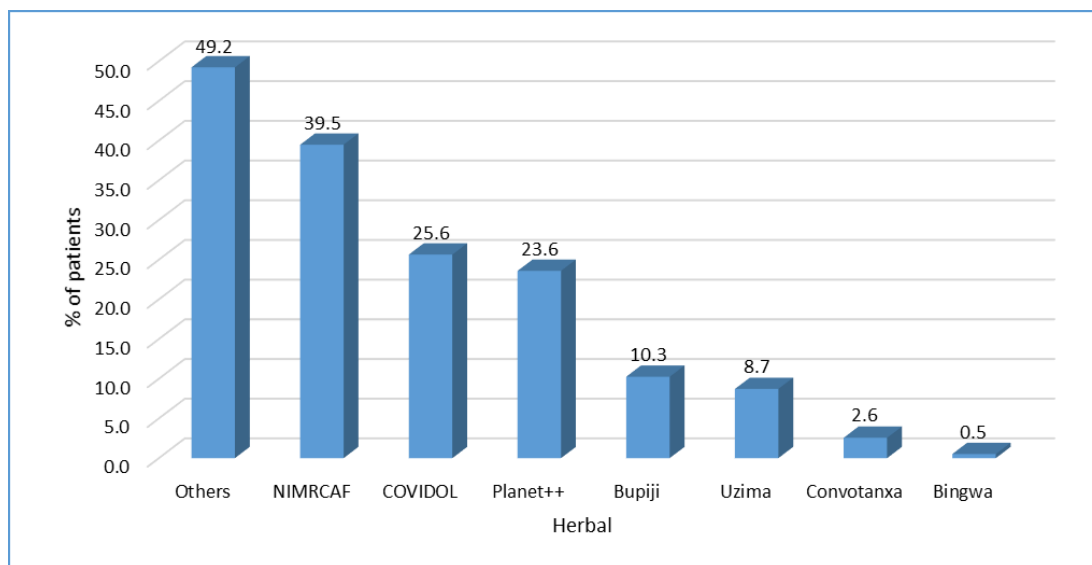
Figure 1: Type of herbal preparations reported to be used by the study participants (n=195)

Clinical symptoms and signs that study participants presented with at enrolment (N=285)

Figure 2 reports on the symptoms that study participants presented with at enrolment. The majority (88.8%) of participants presented with difficulty in breathing, followed by dry cough (78.6%) and fatigue (74.7%). The least reported symptoms were diarrhoea (9.8%) and runny nose (8.1%).
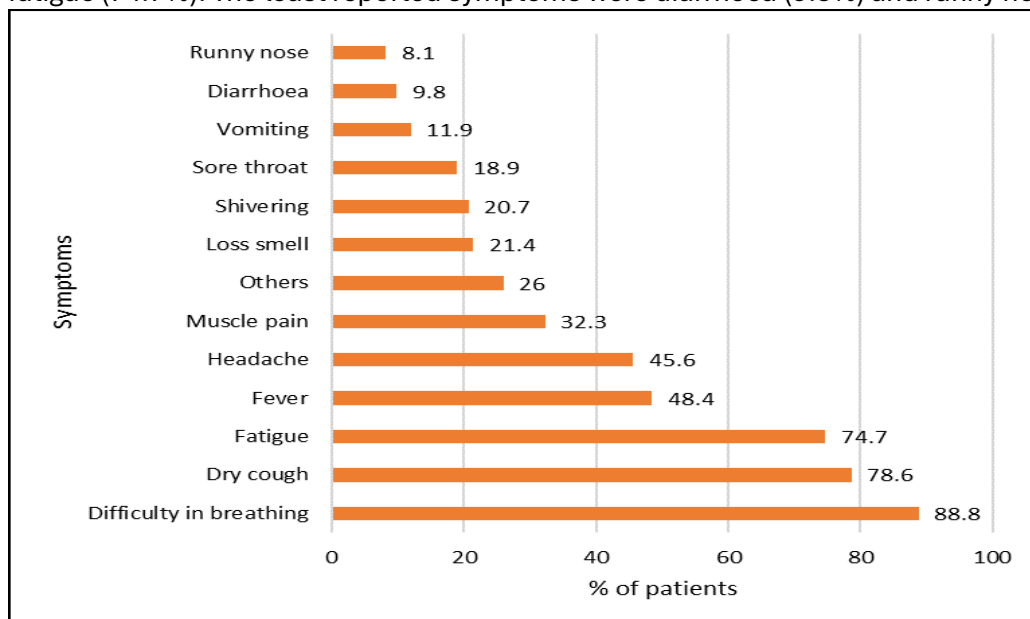
Figure 2: Type of symptoms that the study participants presented with at enrolment (N=285)

Duration of resolution of symptoms among herbal and non-herbal users (N=285)

During enrollment, difficulty in breathing (88.2% vs 90%), dry cough (79% vs 77.8%), fatigue (77.4% vs 68.9%), fever (46.7% vs 52.2%) and headache (46.2% vs 44.4%) were mostly reported by herbal and non-herbal users respectively (Table 2). By day 7, the proportion of study participants who reported still having trouble breathing was 48.7% and 40.7 %; dry cough (46.6% vs 48.6%); fatigue (48% vs 53.7%); fever (8.8% vs 11.1%) and headache (9.5% vs 20.4%) among users and non-herbal users respectively. On day 14, nearly all participants had resolved symptoms, and few were still

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presenting with difficulty in breathing (23.3%), dry cough (22.3% vs 36.7%), fatigue (38.9% vs 50%); fever (4.9% vs 1.1%) and headache (6.8% vs 10.0%) among users and non- herbal users respectively.

Table 2: Symptoms among the herbal and non-herbal users at day 0, 7 and 14

Symptoms	Using herbal preparations: Day 0 n=285		Using herbal preparations: Day 7 n=202		Using herbal preparations: Day 14 n=133	
	Yes, n=195(%)	No, n=90(%)	Yes n=148(%)	No n=54(%)	Yes n=103(%)	No n=30
Fever	91(46.7)	47(52.2)	13(8.8)	6(11.1)	5(4.9)	1(1.1)
Shivering	34(17.4)	25(27.8)	4(2.7)	1(1.9)	1(1.0)	0(0.0)
Dry cough	154(79.0)	70(77.8)	69(46.6)	26(48.6)	23(22.3)	11(36.7)
Vomiting	19(9.7)	15(16.7)	1(0.7)	1(1.9)	1(1.0)	1(3.33)
Diarrhea	20(10.2)	8(8.9)	6(4.1)	0(0.0)	1(1.0)	0(0.0)
Headache	90(46.2)	40(44.4)	14(9.5) *	11(20.4)	7(6.8)	3(10.0)
Difficulty in breathing	172(88.2)	81(90.0)	72(48.7)	22(40.7)	24(23.3)	7(23.3)
Runny nose	13(6.7)	10(11.1)	0(0.0)	0(0)	1(0.97)	0(0.0)
Sore throat	35(18.0)	19(21.1)	17(11.5)	4(7.4)	4(3.9)	0(0.0)
Fatigue	151(77.4)	62(68.9)	71(48)	29(53.7)	40(38.9)	15(50)
Muscle pain	60(30.8)	32(35.6)	19(12.8)	8(14.8)	8(7.8)	2(6.67)
Loss smell	41(21.0)	20(22.2)	6(4.1)	4(7.4)	1(1.0)	0(0.0)

Findings from the Physical and Clinical assessments among study participants at baseline, day 7 and day 14

Vital signs and physical examinations were done at baseline, days 7 and 14, for all study participants. During enrolment, more than 50% of the study participants presented with low oxygen saturation (<92% SPO$_2$) (Table 3). There was no significant difference between the two groups. The majority (about 80%) had normal physical findings except the respiratory system, where more than three-quarters (78.1%) of the herbal users had abnormal findings compared to 56.7% of non-herbal users. On the 7th day of follow-up, 38.5% of herbal users still had abnormal oxygen saturation compared to 44.4% of non-herbal users. The respiratory system was abnormal in 48.7% and 35.2% of herbal users and non-users, respectively. Furthermore, on day 14, less than 1/3 (<33%) of the participants, both herbal and non-herbal users, had abnormal oxygen saturation and respiratory physical findings.

Table 3: Physical and Clinical assessment among herbal users and non-users at baseline (N=285)

Variable	Herbal users n=195 (%)		Non-Herbal users n=90 (%)	
	Normal	Abnormal	Normal	Abnormal
Vital Signs				
Temperature	162(82.6)	34(17.4)	72(80.0)	18(20.0)
Oxygen Saturation	72(36.7)	124(63.3)	34(37.8)	56(62.2)
Respiratory rate	87(44.4)	109(55.6)	38(42.2)	52(57.8)
Heart rate	125(63.8)	71(36.2)	53(58.9)	37(41.1)
Systolic blood pressure	131(66.8)	65(33.2)	60(66.7)	30(33.3)
Diastolic blood pressure	145(74.0)	51(26.0)	67(74.4)	23(25.6)

RBG	142(79.8)	36(20.2)	62(78.5)	17(21.5)
Physical Examination				
General Appearance				
Respiratory	43(21.9)	153(78.1)***	39(43.3)	51(56.7)
Cardiovascular	164(83.7)	32(16.3)	75(83.3)	15(16.7)
Abdominal/ Gastrointestinal	172(87.8)	24(12.2)	83(92.2)	7(7.8)
Urogenital	178(96.7)	6(3.3)	86(93.0)	6(7.0)
Musculoskeletal	171(87.2)	25(12.8)	72(80.0)	18(20.0)
Neurological	187(95.4)	9(4.6)	81(90.0)	9910.0)
Psychological	166(85.6)	28(14.4)	70(77.8)	20(22.2)
Haematological/ Lymphatic	184(93.9)	12(6.1)	83(92.2)	7(7.8)
Skin/ Dermatological	191(97.4)	5(2.6)	89(98.9)	1(1.1)

Duration of RT-PCR status of the study participants to convert to RT-PCR Negative

All study participants were RT-PCR positive during enrolment. On day 7, RT-PCR information was available for 184 (146 herbal users and 38 non-users) participants. Nearly two-thirds (n=120) had converted to RT-PCR negative. Conversion was higher among non-herbal users than herbal users (78% vs. 61%).

On the other hand, on day 14, RT-PCR information was available for 67 (56 herbal users and 11 non-herbal users) study participants. Overall, 60% of these participants had negative PCR results. Among the participants with negative PCR results, 64.3% were herbal users compared to 36.4% non-herbal users (Figure 3).
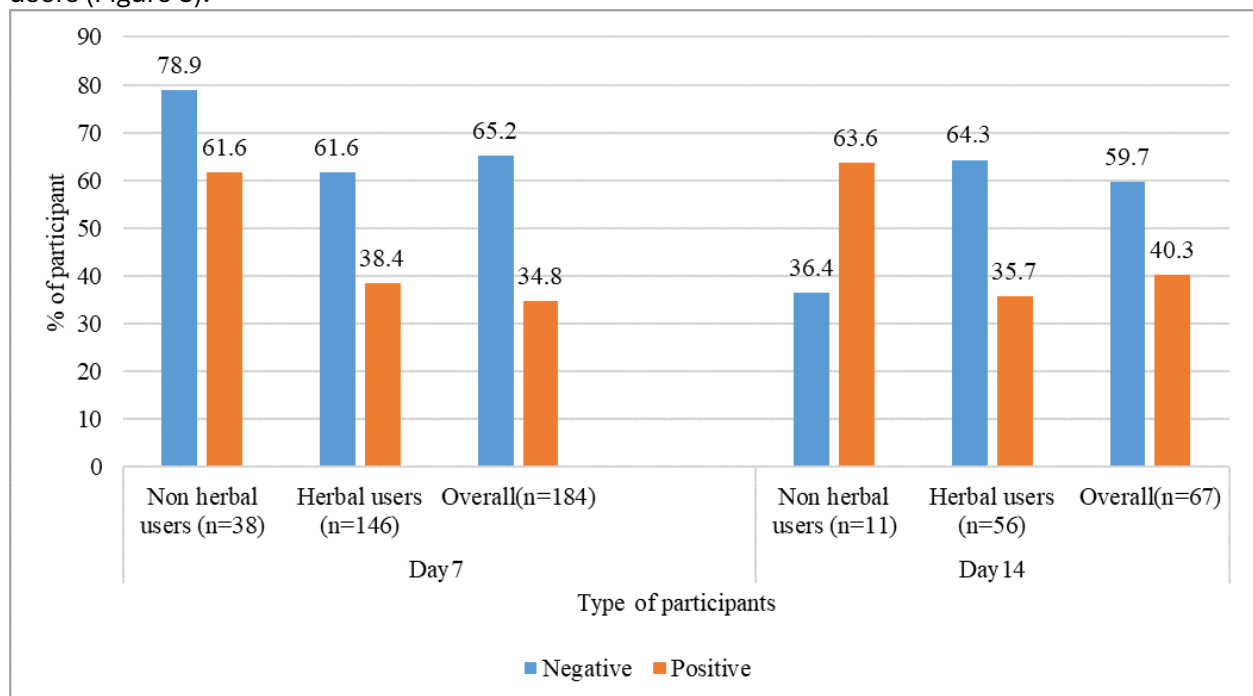
Figure 3: RT-PCR conversion at day 7 and 14 (n=67)

Health outcomes among study participants (N=285)

Of 285 enrolled participants, 54 (18.8%) died during the study period. Overall, proportionally mortality was higher among those who used standard care alone (non-herbal users) (n=21, 23.3%) compared to among those who supplemented standard care with herbal preparations (herbal users) (n=33, 16.9%), as shown in Figure 4. Further, an assessment of factors associated with mortality among COVID-19 patients using herbals and non-herbal users was done using Modified Poison Regression analysis involving adjustment for age and sex. Of these, only COVID-19 severity status was significantly associated with mortality, more among non-herbal users (APR=3.4, at 95%CI 1.5-8.1 with) compared to among herbal users (APR=2.3, at 95%CI 1.2-4.5). Other factors such as age, comorbidities, body mass index and inflammatory markers (d-Dimer, Ferritin and LDH) were not associated with mortality among COVID-19 patients in both groups.
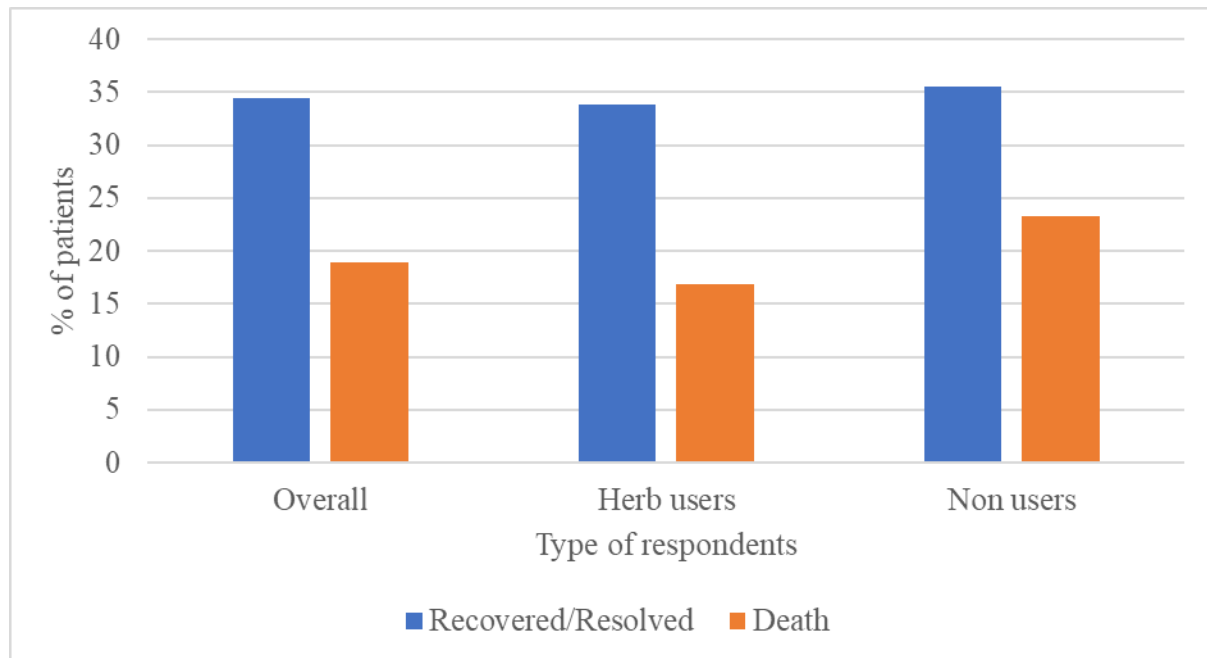
Figure 4: Patients' outcomes by herbal use status

Discussion

This study aimed to assess clinical presentations and outcomes among COVID-19 patients receiving standard care alone compared to those receiving standard care supplemented with herbal preparations. The findings reported that nearly three-quarters of the participants were 50 years and above, which is one of the risk factors for poor health outcomes among COVID-19 patients (Kaso et al., 2022; Li et al., 2021). Literature shows that comorbidities are the risk factor for severe COVID-19 and mortality (Booth et al., 2021a; Geng et al., 2021a). This study has also shown that 71% and 72% of the herbal users and non-herbal users had at least one form of co-morbidities, respectively, that posed a risk of poor health outcomes.

The findings showed that more than two-thirds (68.4%) of the participants reported using at least one form of herbal preparations. Herbal medicinal product use has increased tremendously over the past decades, and people worldwide rely on them in different healthcare settings (WHO, 2004, 2013). Moreover, in the COVID-19 era, there was increased use of herbal preparations with medicinal effects that had the capacity to modulate the immune response; hence, they were believed to have beneficial effects on preventing or treating COVID-19 (Kocaadam & Şanlier, 2017; Sharma et al., 2009).

Most symptoms (dry cough, fever, headache, and difficulty breathing) reported by participants during enrolment had resolved by day 7 more among study participants who were on herbal preparations than their counter group. By day 14, nearly all symptoms had resolved in both the participants using and not using herbal preparations. Similarly, in other studies, the median interval for symptom resolution ranged from 4 to 11 days from the enrollment date (Lubart et al., 2021; Tenforde et al., 2020). Furthermore, studies conducted in China showed significant improvement in symptoms among participants using herbal preparations for COVID-19 treatment compared to the group under standard care treatment (Ang et al., 2020; SUN et al., 2020).

Additionally, the findings from this study revealed that more than two-thirds of the participants had PCR conversion by day 7, and conversion was higher among non-herbal users than their counterparts. On the other hand, on day 14, the PCR conversion to negative was higher among the herbal users than their counterparts. The duration of PCR conversion observed in this study appeared to be longer than reported elsewhere (Deng et al., 2020; Zheng et al., 2020).

Furthermore, this study observed the use of herbal preparations and their effect on mortality among COVID-19 patients. In this study, we observed an overall mortality of 18.8%, and mortality was proportionally higher among non-herbal users compared to herbal users (55% to 60%). Other studies have reported similar findings (Oliveira et al., 2021).

Our study reported that proportionally, more non-herbal users progressed to a severe form of COVID-19 compared to their counterparts, and it was associated with a higher rate of mortality among non-herbal users. Other factors such as age, comorbidities, inflammatory markers, and body mass index were not associated with mortality. On the other hand, advanced age is reported elsewhere as one of the risk factors for severe forms of COVID-19 as well as COVID-19-related mortality (Alwafi et al., 2021; Booth et al., 2021b; Ciceri et al., 2020; Geng et al., 2021b).

Study Limitation

The design of the current study is subject to limitations. Due to the study's prospective nature, attaining the desired sample size was impossible because of the downsloping of the COVID-19 wave, which affected the recruitment of participants in most of the study sites. Moreover, healthcare providers were not involved in prescribing the herbal preparations as the use of herbal preparations was upon the participant's decision. Hence, this led to limited participants in some cohorts due to the facilities' uneven distribution of herbal preparations. However, this study is among the first to investigate clinical outcomes and patient health outcomes among COVID-19 patients supplemented with approved herbal preparations in this population. Therefore, it could become a basis for other studies with a larger population nationwide.

Conclusion

This study revealed that the use of herbal preparations in addition to standard care treatment has positive effects on the subsidence of the duration of presenting symptoms and signs and a reduction in the proportion of mortality among COVID-19 patients. However, further research, especially clinical trials, may be needed to ascertain these findings.

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Role of Community Health Workers in Early Detection, reporting and Response to Infectious Disease Outbreaks: Experience from Marburg Outbreak Management in Kagera region, Northwestern Tanzania

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Abstract

Background: Community health workers (CHWs) are involved in different segments of health promotion and surveillance systems to control the outbreak that occurred in March 2023. CHW initially detected and reported deaths of unknown causes through an established community electronic event-based surveillance. Later, it was confirmed to be MVD; until the end of the outbreak, a total of nine people were confirmed with Marburg viruses, and six of them died, making a case fatality rate of 66.7%.

Involvement of Community Health Workers in Response to Marburg Virus Disease: CHWs from the high-risk areas were oriented to the disease and appropriate control measures. They were guided on the necessary precautions to ensure their safety while working and equipped with infection protection equipment. CHWs were in a frontline position to support the mobilization of community members, awareness creation, provision of public health education, and psychosocial support. Reached the community members by visiting households, public places, schools, and worship places. They received monetary remuneration to commit outstanding time to the outbreak control efforts.

Conclusion: The lesson learnt is that trained CHWs adequately equipped with working tools, protective equipment and remuneration can contribute substantially to outbreak detection and response initiatives. We advocate for their involvement in future outbreak preparedness and response because of their centric position in communities where traditional outbreaks start. Recommend adopting policy and practice strategies that promote their integration and recognition by health systems as a paid cadre to sustain and enhance their efficiency.

Keywords: Community health workers, Outbreak detection, Marburg Virus, Tanzania

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Introduction

Participatory community-based approaches stem back to the 1978 Alma Ata declaration that identified community as central to the efficiency of primary health care services. Recently, there has been growing appreciation for the role of the community in implementing community-centred mitigations to achieve universal health coverage as part of Sustainable Development Goals. (Marston *et al.*, 2016). With the increased risk of occurrence of both infectious and non-infectious diseases in the settings characterised by optimal human-animal-environment interaction and health systems with limited capacity in pathogen detection, identification, and risk management, intersectoral, multisectoral and multidisciplinary approaches embracing community participation and engagement are key for efficiency and effectiveness of disease control and prevention programs.(George *et al.*, 2015).

Both the International Health Regulations 2005 (IHR) and Joint External Evaluation Tool (JEE) advocate for countries to have a skilled and competent workforce for maintaining sustainable public health surveillance and response mechanisms with emphasis on building sub-national level capacities.(Boyce and Katz, 2019). However, it has remained a challenge for most countries with limited resources and capacity to achieve this milestone because of inefficient surveillance systems and public health services at the community levels where outbreaks typically start.

The Tanzania government has undertaken several measures to strengthen its public health system, including strategies to improve various areas of the health sector. Notable steps included investments in infrastructure, new healthcare facilities, and renovating existing facilities. The government also strengthened healthcare financing, ensuring more citizens access to affordable and quality healthcare services. Moreover, public health campaigns have been established to educate the population on disease prevention, sanitation, and hygiene practices. Workforce development has remained a priority, focusing on the training and recruiting of healthcare workers to address the shortage of skilled personnel, especially at the sub-national levels. (Ministry of Health, Community Development, Gender, 2021a).

To link the formal health system with the community for early detection, reporting, and timely response to outbreaks through measures that are community-relevant and to address the shortage of community-based healthcare workforce to ensure efficiency in the provision of essential healthcare services, the Ministry of Health in Tanzania has established community health workers (CHWs) at the hamlet/street level (the lowest administrative level) throughout the country. Each hamlet is served by two volunteering CHWs (one female and one male) recruited from the same hamlet. Once recruited, the CHWs are expected to be trained on the basic concept of health promotion before they start working at the community level. (Ministry of Health, Community Development, Gender, 2021b).

The Government of Tanzania is already committed to considering CHW as an employed cadre, although this has yet to be realized. At the village level, there is a CHW supervisor and the primary health facility in charge, who are responsible to the health promotion coordinator at the district level council level and subsequently to the health promotion coordinator at the regional level and the community-based health service program at the national level. (Ministry of Health, Community Development, Gender, 2021b).

Available evidence suggests that CHWs who are equipped, trained, motivated, remunerated, and supported with supervision and Personal Protective Equipment (PPE) have been critical to public health surveillance systems and maintaining essential health services during periods of disease outbreaks, especially in workforce-constrained settings. (Madeleine et al., 2017; Scott *et al.*, 2018). Recent evidence has demonstrated the feasibility and significance

of deploying skilled and trained CHWs at the community level in Tanzania to enhance the functionality of the early warning and response system and efficiency in providing essential healthcare services. (Baynes *et al.*, 2017; Sindato *et al.*, 2021).

Results and discussion
Involvement of Community Health Workers in Response to Marburg Virus Disease
During the Marburg Virus Disease (MVD) outbreak in Kagera region of Tanzania in March 2023, CHWs were among the frontline workforces. This article highlights several roles they played in the disease outbreak management cycle. We highlight our approaches to orient them to MVD and their roles in mitigating the outbreak. While performing their routine activities within the community, the CHWs detected and reported the deaths of unknown causes directly into the electronic Event-Based Surveillance platform. The cause of death was subsequently confirmed in the laboratory to be MVD. Following this confirmation, a rapid risk assessment identified Bukoba District Council and Bukoba Municipality as the two (out of eight) districts of Kagera to be at high risk.

To enhance their efficiency and strengthen the functionality of the health system at the community level, the Ministry of Health, collaboratively with development partners, recruited 1,324 CHWs from the identified high-risk areas, oriented them to the MVD outbreak and its management before they were deployed back to the areas they lived and were working. Previous experience has shown that CHWs are traditionally trusted and accepted by their community, thereby representing a valuable role in designing and operationalising community-centred health-related mitigations, contact tracing, and promoting best practices. The involvement of CHWs in community-based surveillance is a practice that has been reported to be impactful in other settings of the African region. During the Ebola Virus Disease in West Africa, CHWs supported the detection, reporting, contact tracing, and response to the outbreak.(Miller *et al.*, 2018).

In Mali, a CHW spotted a yellow tint in a woman's eyes and reported it to the primary health facility, an event that was subsequently confirmed in the laboratory. (Dr. Ochiawunma Akwiwu Ibe and Dr. Doudou Diop, no date). During the COVID-19 outbreak in Somalia, CHWs supported the detection of cases and contact tracing. (Nyagah *et al.*, 2023). Similarly, in the Plague outbreak in Madagascar and the Ebola outbreak in the Democratic Republic of Congo (DRC), CHWs were involved in strengthening community-based surveillance, particularly in conducting contact tracing and alert reporting.(OKeeffe *et al.*, 2023).

We developed a one-day training material based on our approach to capacity-strengthening CHWs and experience gathered from participatory community-centric approaches during the COVID-19 pandemic in 2019-2021. We oriented the CHWs to the essential elements of MVD: detection, reporting, and response. The training package included awareness creation of MVD transmission, clinical manifestations, control and prevention practices, and community event-based surveillance. In addition, they were refreshed on matters related to working safely in the community, ethics consideration, and psychosocial support in response to the outbreak; previous approaches elsewhere reported enhancing the efficiency of CHWs in disease outbreak detection, reporting, and response through appropriate and relevant training. (Boyce and Katz, 2019).

The CHWs received infection prevention and control (IPC) and Information Education and Communication (IEC) materials, including posters, brochures, and banners. They were guided in the appropriate community engagement by collaborating with local leaders, religious leaders, ward health officers, and healthcare workers at the primary healthcare facilities. Similar

approaches have shown that when CHWs are effectively trained, motivated, supervised, and equipped with IPC and IEC materials, they effectively provide preventative, promotional, and limited curative services.(Boyce and Katz, 2019).

After the orientation, the CHWs were re-integrated into their respective communities with the support of local leaders. They were motivated to visit the community members at household levels daily and other gathering places, including markets and worshipping areas, for community engagement, sensitisation, and detection of clinical manifestations suggestive of MVD. To support efficient monitoring and reporting of signals of an MVD outbreak, two CHWs were assigned a hamlet or street to ensure that messages were delivered to every household, public place, institution, and place of worship.

The CHWs visited all 279 primary and secondary schools (reaching out to 328 661 students) and all 78,090 households in the two districts for awareness creation and sensitisation of preventive measures against MVD. They distributed 22,600 posters, 9,500 brochures, and 44 banners. We have learned that the CHWs supported communicating the MVD outbreak spread risk by playing an active role as community educators and mobilizers and promoting adherence to disease preventive measures. Residing from their community, this motivated packaging, delivery, and uptake of locally and culturally appropriate measures. They reduced the burdens felt by the under-staffed healthcare systems. Our approach is similar to that adopted to raise community awareness during the Ebola outbreak in Sierra Leone, whereby deployed CHWs visited households and public places.(Perry *et al.*, 2016; Miller *et al.*, 2018).

Local and religious leaders augmented the efforts of CHWs in Kagera Region as it happened in other countries like Côte d'Ivoire during the Ebola outbreak to enhance behavioral changes. (Gautier *et al.*, 2017)They helped with community engagement and health awareness sessions, sensitized people on hygiene measures to reduce the risk of exposure and infection, and addressed matters related to rumors and misconceptions in the community. They also used motorcycles equipped with megaphones to cover mitigations in the hard-to-reach areas.

Daily monitoring of CHWs' activities conducted by their local supervisors and officers in primary health care facilities helped ensure that the CHWs adhered to disease prevention and control measures and worked safely in the community. At a regional level, meetings were organised every morning to discuss the compiled report, which helped track and advise accordingly on the areas and gaps that needed improvement. A rapid assessment survey indicated that public health promotion efforts and reliable sources of information about the disease outbreak at the community level were primarily (82.4%) attached to CHWs, followed by a mobile van with a public announcement system, radio broadcasts, and key influential people.

Our participatory approaches, which recognized the value and position of CHWs in developing IEC materials and dissemination mechanisms, ensured that the interventions were culturally relevant for community members' uptake. A growing appreciation and consensus indicate that participatory community-centred approaches like ours in health education and promotion initiatives have significantly enhanced adoption and compliance with new interventions. (Golden and Earp, 2012).

Based on their active participation and roles, we plausibly suggest that the CHWs contributed substantially to the detection, reporting, and response to MVD and other efforts implemented to control the MVD outbreak in the country. Available evidence suggests that the involvement of trained CHWs in community-based surveillance prevents the spread of infectious disease outbreaks. (Perry *et al.*, 2016). Continuous training, compensation for their efforts, and supervision are essential for their efficiency in health promotion services and disease surveillance. (Madeleine Ballard, Amy Madore, Ari Johnson, Youssouf Keita, Elsa Haag, Daniel Palazuelos, Julie Rosenberg, 2017).

Conclusion

We have added further evidence to the existing experiences on the role of CHWs in providing health care services and enhancing the efficiency of surveillance systems, especially in the health systems facing human resource shortages for effective outbreak management. We have learned how the CHWs played an essential role as frontline sensors of MVD outbreak in Tanzania by detecting and reporting the initial cases.

Orienting them to the context of interventions against specific health problems and providing them with infection protective equipment, continuous supervision, and remuneration seem to enhance their efficiency and allow them to work safely in extending health services to the community level. Specific studies could provide broader evidence-based guidance on the best policy and practice options to sustain the efficiency, remuneration, and motivations of CHWs as they are currently working voluntarily.

Ethical considerations

Approval to publish this article was sought from the Medical Research Coordinating Committee of the National Institute for Medical Research, Tanzania.

Author contributions

EAM contributed to the idea's conception, acquired, analysed, and interpreted the data, and drafted and revised the manuscript. CS assisted in writing the manuscript and revised and edited the final draft. TH assisted in reviewing the manuscript. EGM, GM, JM, EK, FJ, LS, FK, MY, EM, MK, EK, MTM, MM, and PH contributed to writing and reviewing the manuscript. TN contributed to reviewing the manuscript. All authors read and approved the final manuscript.

Competing interests: None

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Missed Advanced Abdominal Pregnancy: A Case Report

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Abstract
Early diagnosis of an abdominal pregnancy is difficult since it is associated with a wide range of signs and symptoms. However, ultrasound is the most effective method for diagnosing an abdominal ectopic pregnancy. We present a case of advanced abdominal ectopic pregnancy, which progressed to the second trimester and ended up with fetal death. Despite having repeated ultrasound scanning, the diagnosis was missed. This case report emphasizes the need for a high index of suspicion and correlation of the patient's signs and symptoms with ultrasound findings to make an early diagnosis of abdominal ectopic pregnancy.

Keywords: Abdominal pregnancy, ectopic pregnancy, fetal death, Ultrasound, Tanga, Tanzania

Introduction
Abdominal pregnancy refers to a pregnancy that has implanted in the peritoneal cavity, external to the uterine cavity and fallopian tubes(Tegene *et al.*, 2022). Abdominal pregnancy is the rarest and the most severe type of extrauterine pregnancy, and it accounts for 1 to 1.4 per cent of all ectopic pregnancies. Early diagnosis of an abdominal pregnancy is difficult since it is associated with a wide range of signs and symptoms. (Tegene, Mohammed and Amana, 2022). Risk factors for abdominal pregnancy include tubal damage, pelvic inflammatory disease, endometriosis, assisted reproductive techniques, and multiparity.(Maas and Slabber, 1976; Ludwig *et al.*, 1999).

Advanced abdominal pregnancy (AAP) is an abdominal pregnancy after 20 weeks of gestation caused by the implantation of an abnormal placenta; it can cause severe maternal postpartum haemorrhage and coagulopathy, which could lead to death in severe cases.(Sharma *et al.*, 2012). Accordingly, the maternal mortality rate is approximately seven times higher in abdominal pregnancies compared with that in other ectopic pregnancies.(Kassam, 2007). The patient with AAP may present with a history of recurrent abdominal discomfort, painful fetal movement beneath the abdominal wall, the presence of fetal movements high in the upper abdomen, cessation of fetal movement, a closed and uneffaced cervix, or the failure of oxytocin to stimulate the gestational mass.

Ultrasound is the most effective method for diagnosing an abdominal ectopic pregnancy. (Tegene et al., 2022). However, studies have shown that the accurate diagnosis of abdominal pregnancy before surgery is very low, about 29%, and the accuracy increases with an increase in gestation age.(Chen *et al.*, 2023). Transvaginal ultrasound remains the first-line tool for diagnosing abdominal pregnancy. (Cohen *et al.*, 1985). The classic ultrasound finding is the absence of myometrial tissue between the maternal bladder and the pregnancy(Varma et al., 2003). In these cases, an empty uterus is usually visualized.

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Other findings include a poor definition of the placenta, oligohydramnios and unusual fetal lie, which can be misinterpreted as intrauterine if the ultrasonographer does not evaluate the myometrium.(Yagil *et al.*, 2007).

We present a case of advanced abdominal ectopic pregnancy, which progressed to the second trimester and ended up with fetal death. The diagnosis of abdominal pregnancy was missed despite having repeated ultrasound scanning. We obtained permission to publish this case study from Bombo Hospital authority, and the patient consented.

Case Report

A 35-year-old Tanzanian woman with two healthy children, gravida 3, para 2. The first child was born in 2014 through Cesarean Section (CS). However, four years later, she experienced a Spontaneous Vaginal Delivery (SVD) for her second child, who was born in 2018.

The history of her Last Menstrual Period (LMP) indicated that she had 32^{+5} weeks of pregnancy. She weighed 59kgs, and her fundal height was 20 weeks when she made the first antenatal clinic (ANC) visit at 23 weeks in a nearby health centre. During the second ANC visit at 32 weeks, they slightly increased weight (60kgs), and the fundal height was 22 weeks. During both visits, she felt fetal movements, and her blood pressure was 120/80mmHg. No ultrasound was done during the two antenatal visits.

On the day of admission at the District Referral Hospital (DRH) (30th December 2022), the patient was complaining of abdominal pain; her blood pressure was 100/80 mmHg, and her temperature was 36.5°C. On examination, the patient was pale with a previous CS scar, and fundal height was 26 weeks. According to the ultrasound findings, the gestation age was 25 weeks, but there was no fetal movement. The diagnosis at the DRH was Intra-abdominal pregnancy. On 31st December 2022, the patient was referred to a Regional Referral Hospital (RRH) for specialized care and management.

On arrival at the RRH, she was conscious, not pale, and the Blood pressure was 107/67mmHg with a pulse rate of 96b/min. During the abdominal examination, the patient had generalized abdominal tenderness; palpation did not detect any fetal parts, fundal height was 26 cm, and a fetoscope did not hear Fetal heart rate. Per vaginal examination, the patient had a closed cervix with spot bleeding. A full blood picture (FBP) investigation revealed a haemoglobin level of 11.3g/dl and a Hematocrit of 34.6%. Obstetric ultrasound reported a single fetus, adequate liquor, no fetal movement, no cardiac activities, and a gestation age of 26 weeks plus two days, and the diagnosis of missed abortion was made.

The medical evaluation was done, and induction was decided following the presence of a previous SC scar and the diagnosis of IUFD. Labour was induced 72 hours post admission, using an intracervical catheter, and later, four doses of misoprostol 25 were added. The induction review revealed no progress; thus, during the fourth day post-admission, a decision was made to prepare the patient for exploratory abdominal surgery. During the procedure, the surgeon noted that the placenta was attached to the uterine scar (Fig 1), confirming intra-abdominal pregnancy. Additionally, uterine wound dehiscence was found.

Opening the gestational sac revealed a dead fetus with fully developed body parts. The weight of the dead fetus was 400 grams. After the removal of the placenta from the uterine scar, the uterus was repaired, and the abdomen was washed with normal saline and closed in layers. Apart from monitoring vital signs, the patient was given intravenous Ampliclox, Gentamycin and Metronidazole for 72 hours, followed by oral Ampliclox and Metronidazole for five days. The patient was on Pethidine for 24 hours, followed by Diclofenac for 72 hours. The patient was discharged 72 hours after the surgery. Seven days after surgery, the patient was allowed to continue with follow-up visits to her hometown.
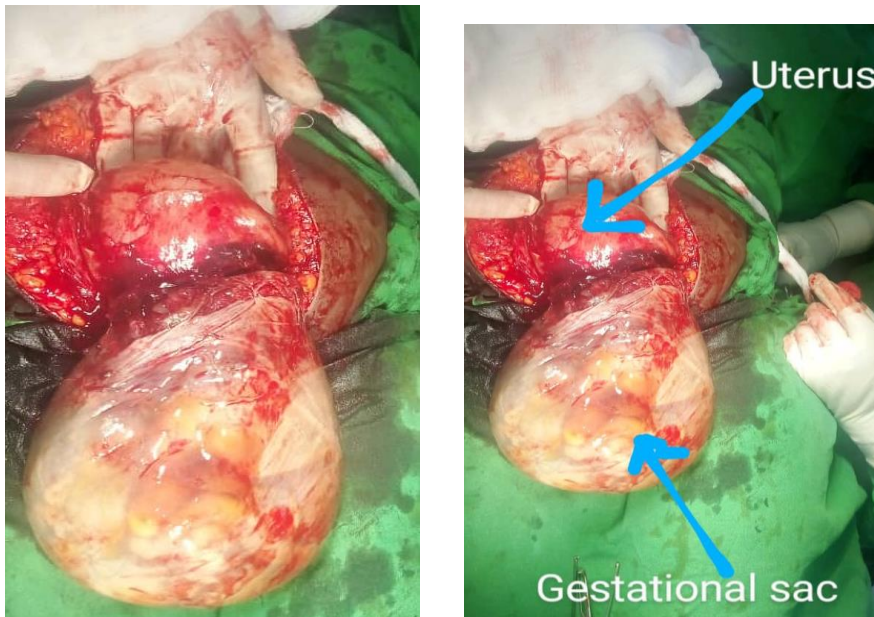
Fig. 1. Gestation sac and placenta attached to the uterine scar.

Discussion

Although ultrasound is the most effective method for the diagnosis of abdominal pregnancy, this case of advanced abdominal pregnancy (26 weeks by ultrasound and 36 weeks by dates) was missed by ultrasound examination. Diagnosis and management of advanced abdominal pregnancy is still a challenge in today's medical world. However, the high index of suspicion aided with imaging studies can help in the timely diagnosis of this rare obstetrical occurrence, thereby preventing the associated life-threatening complications. Our patient's chief complaint was lower abdominal pain, and she had a scar following CS performed in 2014. Severe lower abdominal pain is one of the most consistent findings of abdominal pregnancy(Nama *et al.*, 2007) Moreover, one of the risks of abdominal pregnancy is a history of surgery.(Nunyalulendho and Einterz, 2008).

Ultrasound remains the first-line tool for diagnosing abdominal pregnancy.(Ankum *et al.*, 1996). The Ultrasound will show an empty uterus, absence of amniotic fluid between placenta and fetus, absence of myometrium between bladder and gestation and abnormalities with fetal parts close to the abdominal wall.(Ludwig *et al.*, 1999)ˌ(Nama *et al.*, 2007)ˌ(Nunyalulendho and Einterz, 2008). Sonographic diagnosis is missed in half of the cases.(Ludwig *et al.*, 1999). In most cases, the diagnosis is made at the time of surgery. Inadequate experience, inadequate vigilance, failure to correlate symptoms and clinical findings, and a low index of suspicion may have led to misdiagnosis. However, the repeated ultrasound did not help in the diagnosis of abdominal pregnancy, which in the current case led to the induction of labour. Care providers' response to a failed induced labour was in line with the recommendation for open laparotomy once abdominal pregnancy is diagnosed or suspected.(Cohen *et al.*, 1985). The patient was swiftly prepared for surgery, which confirmed the diagnosis and the life of the mother.

Studies have reported that an abdominal pregnancy has a higher incidence of fetal malformations and perinatal mortality.(Sharma *et al.*, 2012). A study which reviewed 39 cases of abdominal pregnancy reported that only two fetuses survived the reviewed cases.(Garzon *et al.*, 2018). Non-survival of the fetus in abdominal pregnancies may be related to the unstable blood supply to the placenta in the abdominal cavity and fetal stress deformity. (Rohilla *et al.*, 2018). In our case, there was no fetal malformation; however, stillbirth was observed.

Conclusion

This advanced abdominal pregnancy was missed apart from repeated ultrasound examinations of the patient at the District and Regional referral hospitals. Proper articulation of a high index of suspicion and a better understanding and interpretation of clinical and imaging findings and experience are required to prevent the negative consequences of abdominal pregnancy. Both obstetricians and radiologists should improve their skills to diagnose these cases in time so they do not reach such an advanced stage where management may become difficult. Therefore, in-house training is recommended for medical practitioners to further improve their skills in sonography.

Author contributions

MM contributed to the conception and design of the case study and drafted and revised the Case report. EM and AM critically revised the manuscript. KM contributed to the design of the case study and the writing and critical revision of the care report. MGC contributed to the conception and design of the case study and critically revised the case report. All authors read and approved the final report.

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Determinants of Hospital Performance under Variable Ownership Pattern: A Two-Stage Analysis

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Abstract

Background: Providing high-quality healthcare services at low or no cost, especially in a densely populated country like India, is an enduring challenge. Thus, the efficacy of government-run hospitals and healthcare instructions has become critical for developing and developing countries.

Aim: The current study aimed to investigate the relative performances under variable ownership patterns and scrutinise whether the differences in performances are significant or not to explore determinants of the performance of the hospitals.

Methods: The study has been conducted in East and West Bardhaman, West Bengal, India. Data envelopment analysis measures hospitals' performance under variable ownership patterns. The Mann-Whitney U Test is employed to examine whether the performance differences among these hospitals are significant. Finally, Censored Tobit Analysis is used to gain insight into the determinants of their performance. Hospitals are categorized according to their ownership pattern: government hospitals owned by the state government, public hospitals owned by public sector undertakings, and private authorities.

Results: Considering the input-output variables, relative performances have been measured. The hospitals under government ownership show the best performance, followed by public hospitals owned by public sector undertakings and private authorities. This performance level has significant determinants like the size of the hospital, bed occupancy rate, and the management and authority of the hospitals.

Conclusion: In a developing or underdeveloped nation, all healthcare service providers need to be efficient enough to attain the health of the masses. This study has revealed that the vision of 'health for all' can be reached through the mission of 'healthcare inclusion' strategy by including all hospitals on the supply side regardless of their motive, ownership pattern, or other phenomenon.

Keywords: Hospital Performance, DEA, Technical Efficiency, Tobit Analysis, Mann-Whitney U Test

Introduction

The healthcare along with its access and usage is a constant cognitive matter of the social thinkers. The Alma-Ata declaration in 1978 followed the objective of 'health for all'. The declaration expanded its scope in 1998 and included: "to attain health security for all, to achieve global health equity, to increase healthy life expectancy and to ensure access of essential healthcare of good quality for all" (WHO, 1998). It is believed that good health of the citizens of a country also contributes in wealth building for that country. Equitable access to fundamental healthcare services for every citizen is a basic demand for all countries (Clements et al, 2011). In the eight Millennium Development Goals (MDGs), the United Nation and its members expressed major focus on basic health issues; immense responsibility has been taken to provide a better healthcare and superior standard of living. The need of both quantitative and qualitative healthcare infrastructure required to be strengthened. The performance of the healthcare

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providers has also become crucial and critical. Performance of the healthcare institutions in the form of their efficiency can directly help state to achieve the goal of providing basic healthcare service to their citizens. Though it is important to find quality of the healthcare service (Chatterjee et al, 2019) but fulfilling the basic health demand also need to be quantified to obtain the maximum level of output. In many third world countries, resource constraint in healthcare sector is a very common agenda. The higher management and the administrators are thus in search of optimal allocation of resources to produce maximum output for their patients. A good cluster of patients are also ready to spend by their own, but the amount not always properly valued; reason is the inefficiency in hospital operation. This affects badly to the patients and also to the society in large. The health indicators show a poor picture for the developing and underdeveloped countries not only because of resource constraint, also the inefficient deployment, usage and operation contribute in such failure. The Indian Constitution also has the provision for providing basic healthcare to its citizens (Bajpai et al, 2005). In Five Year Plans, importance has been given to this healthcare issue, but the unequal distribution causes disparity in access of the healthcare service (Kumar et al, 2011); unequal distribution also varies in the supply side of the healthcare service through geographical jurisdictions (Chatterjee et al, 2016). A large part of population also shifts to the private healthcare service provider due to shortage of public healthcare service in India (Raman et al, 2012). At this point, the healthcare institutions with varied motives under alternative ownership patterns need to work together to realize the holistic vision of 'health for all' that may be achieved by putting them all together through a 'inclusive healthcare' strategy.

The first hospital efficiency related empirical literature has been discussed in 1980s (Procházková et al, 2011). Performances under different management categories of hospitals were estimated. The economic aspects of hospitals are examined with this performance and efficiency analysis. Different researchers have conducted their study in this aspect (Sun et al, 2017; O'Neil et al, 2008; Garcia-Lacalle et al, 2010; Rosko et al, 2011; Grosskopf et al, 2004; Lee et al, 2008; Blank et al, 2010; Nedelea et al, 2013 etc.). Researchers also have observed the determinants of the hospital performances (Rezaee et al, 2015; Shettian et al, 2017; Li et al, 2019; Leleu et al, 2018; Saquetto2019 etc). Though the researchers have enriched the hospital specific performance study, but the districts of the state of West Bengal have not witnessed such type of study with alternative distinct categories of hospitals. In the district level, very few studies have been conducted in the state of West Bengal, India (Sheet et al, 2013; Roy, 2014); but the nature of the study is different. Thus in the district of Purba and Paschim Bardhaman in the state of West Bengal, India, a scope has been observed to conduct performance and efficiency related study that may represent the hospital performance status under different ownership styles in a developing nation. Thus, a gap can be identified, which provides the scope to conduct research work in this area.

The outline of the study is as follows. The background of the study has been postulated in the next section. The objectives of the study have been framed in the third section. The methodological discussion has been carried out in the fourth section. The fifth section deals with the result and discussion part. The concluding remarks are given at the end.

Research Gap
Though the researchers have enriched the hospital specific performance study, but the districts of the state of West Bengal have not witnessed such type of study with alternative distinct categories of hospitals. In the district level, very few studies have been conducted in the state of West Bengal, India (Sheet et al, 2013; Roy, 2014); but the nature of the study is different. Thus in the district of Purba and Paschim Bardhaman in the state of West Bengal, India, a scope has been observed to conduct performance and efficiency related study that may represent the hospital performance status under different ownership styles in a developing nation. Thus, a gap can be identified, which provides the scope to conduct research work in this area.

The study's objectives were to explore the relative performance of three distinct categories of hospitals, scrutinize whether the differences in performances among the three hospital categories are significant, and retrieve the determinants of the hospitals' performance.

Methods
Data Source
There is cross-country evidence of hospital-specific comparative performance or efficiency studies (Fazria*et al.,* 2021; Alatawi*et al.,*2020; Botega*et al.,* 2020; Jing *et al.,* 2020; Küçük*et al.,* 2020; Ahmed *et al.,* 2019; Miguel *et al.,* 2019; Jat*et al.,*2013). This study has been conducted in the districts of Purba and PaschimBardhaman in West Bengal, India. Hospital-specific data has been collected from hospitals in the districts of Purba and PaschimBardhaman in West Bengal, India. These two districts can be termed undivided Bardhaman districts, which have been considered for the study because they may represent a broader geographical periphery. The undivided Bardhaman districts have been recently divided into Purba and PaschimBardhaman, which has a population of 7,723,663 per the 2011 census and ranked seventh out of 640 districts of the country.

Except for the capital city of the state of West Bengal, these districts jointly have a maximum number of hospitals, which is in all three categories of hospitals, which also ranked third considering the population covered per hospital among the districts of the state. The study has been carried out with twenty-five sample hospitals, which belong to three distinct categories of ownership pattern, namely, government hospitals run by state government (H_GOV), public hospitals run by public sector undertaking organizations (H_PSU) and hospitals run under private ownership (H_PVT). A structured questionnaire has been designed for this study. The hospital authorities have been asked to respond to that questionnaire. A participatory approach was followed during the entire data collection process as data reliability was highly significant in this sensitive study.

Sample Size
The population size is 72, which includes 27 government hospitals run by the state government, 26 public hospitals run by public sector undertaking organizations, and 13 hospitals run under private ownership. Stratified random sampling was used in this study, where the hospitals were divided into three strata, and almost forty per cent of each stratum was uniformly selected by random (without replacement) method. Finally, a sample size of twenty-five hospitals was pursued, comprising ten H_GOV, ten H_PSU, and five H_PVT.

Performance Measurement
The performance of the hospitals has been measured in this study in the light of relative efficiency values of the concerned hospitals. The two words, performance and efficiency have been used identically in the study. The performance or efficiency of hospitals has been measured with the econometric model, namely data envelopment analysis(DEA1). In last few decades a good number of studies have been conducted on hospital performance or efficiency with the help of data envelopment analysis methodology (Fazria et al, 2021; Ahmed et al, 2019; Jat et al, 2013; Kirigia et al, 2002; Kundurjiev et al, 2011; Kirjavainen et al, 1998 etc.). It is observed that more the efficiency value, better the performance and vice versa. The term 'efficiency' can be defined as the maximization of outputs with a given set of input or minimization of inputs for a given set of output. In this efficiency and performance study, the DEA has been applied by incorporating multiple inputs and multiple outputs. The technical efficiency and scale efficiency and the scale efficiency have been calculated through DEA method. If the firms (or, decision making units i.e., DMUs) under observation operate in the optimal scale then the 'constant return to scale' (CRS) has been applied. Coelli et al (1998) suggest that 'variable return to scale' can be applied in imperfect competition. In the Technical Efficiency (TE) study, the CRS and VRS assumptions permit to find the scale efficiency. Scale efficiency (SE) is the ration of technical efficiency at constant return to scale and variable return to scale. SE= TE_{CRS} / TE_{VRS}. Coelli (2002) suggests that

a decision making unit has scale inefficiency if the value of technical efficiency under the two assumptions are different, which that inefficiency can be estimated from the difference among them.

"Let Y be an (M × N) matrix of outputs of hospitals in the sample, where the element yij represents the ith output of the jth hospital. Let X be a (P × N) matrix of inputs, in which the element xkj represents the kth input of the jth hospital and z an N-vector of weights to be defined. Elements of these vectors are z1,…, zN. The vector yj (M × 1) is the vector of outputs and xj is the (P × 1) vector of inputs of the jth hospital. The CRS input-oriented measurement of technical efficiency for the jth hospital is calculated as the solution to the following mathematical programming problem.

$\lambda^j_c = \min_{\lambda,z} \lambda$,

subject to:

$$y_{1i} \leq y_{11}z_1 + y_{12}z_2 + \ldots + y_{1N}z_N$$
$$y_{2i} \leq y_{21}z_1 + y_{22}z_2 + \ldots + y_{2N}z_N$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
$$y_{Mi} \leq y_{11}z_1 + y_{12}z_2 + \ldots + y_{MN}z_N$$

$$x_{11}z_1 + x_{12}z_2 + \ldots + x_{1N}z_N \leq \lambda x_{1i}$$
$$x_{21}z_1 + x_{22}z_2 + \ldots + x_{2N}z_N \leq \lambda x_{2i}$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
$$x_{P1}z_1 + x_{P2}z_2 + \ldots + x_{PN}z_N \leq \lambda x_{Pi}$$

$z_j \geq 0$ for all j.

The scale value λ represents a proportional reduction in all inputs such that 0≤ λ ≤ 1, and λjc is the minimum value of λ, so that λjc xj represents the vector of technically efficient inputs for the jth hospital. Maximum technical efficiency is achieved when λjc equals unity. In other words, if the DEA gives the outcome λjc =1 , the hospital is operating at the best-practice and it is not able to improve its performance any further, given the existing set of observations. If λjc <1, we can conclude that the hospital is operating below the best-practice frontier.

The VRS technical efficiency for the jth hospital is computed as:

$\lambda^j_v = \min_{\lambda,z} \lambda$,

subject to:

$$y_{1i} \leq y_{11}z_1 + y_{12}z_2 + \ldots + y_{1N}z_N$$
$$y_{2i} \leq y_{21}z_1 + y_{22}z_2 + \ldots + y_{2N}z_N$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
$$y_{Mi} \leq y_{11}z_1 + y_{12}z_2 + \ldots + y_{MN}z_N$$

$$x_{11}z_1 + x_{12}z_2 + \ldots + x_{1N}z_N \leq \lambda x_{1i}$$
$$x_{21}z_1 + x_{22}z_2 + \ldots + x_{2N}z_N \leq \lambda x_{2i}$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
$$x_{P1}z_1 + x_{P2}z_2 + \ldots + x_{PN}z_N \leq \lambda x_{Pi}$$
$$l_1z_1 + l_2z_2 + \ldots + l_Nz_N = 1$$

$z \geq 0$.

Given these two technical efficiency estimates, the input-oriented scale efficiency measure for the jth hospital is calculated as the ratio of CRS technical efficiency to VRS technical efficiency, i.e. Sj = λjc / λ jv. Suppose the value of this ratio is equal to unity (i.e., Sj = 1). In that case, the hospital is scale-efficient, meaning that the hospital is operating at its optimum size, and hence that the productivity of inputs cannot be improved by increasing or decreasing the size of the hospital. If the value of this ratio is less than unity (i.e., $S^j < 1$), the hospital is considered to be not operating at its optimum size. In the first of two possible cases, (i), if $S^j <1$ and, $\lambda^j_c = \lambda^j_n$ the scale inefficiency results from increasing returns to scale. In other words, increasing the hospital's size helps improve its productivity and thereby reduces unit costs. In the second

possible case, (ii), if $S^j < 1$ and $\lambda^j_c < \lambda^j_n$, the scale inefficiency is due to decreasing returns to scale, indicating that the hospital can raise its productivity and lessen unit costs by choosing a smaller size." (Nguyen et al 2004).

In this study, the input-oriented DEA method has been applied, as resources are always considered to be limited, and from the given level of limited resources, the highest level of production is generated. The details of the input variables and output variables under study are listed in Table-1, which can be observed in earlier studies (Fazria et al., 2021; Ahmed et al., 2019; Fuentes et al., 2019; Ichoku et al., 2011, etc.).

Table 1: Details of the I/P variables and O/P variables

Variable	Type	Coding	Description
O/P	Accessing	IPB	In-Patient per bed per day
O/P	Accessing	DIS	Discharge per bed per day
O/P	Accessing	DEL	Delivery per bed per day
O/P	Accessing	ECG	ECG Cases
O/P	Accessing	XRA	X-Ray Cases
I/P	HR	DR	Doctors per bed
I/P	HR	NUR	Nurse per bed
I/P	HR	PMS	Paramedical Staffs(Number)
I/P	Instrument	ECM	ECG Machines (Number)
I/P	Instrument	XRM	X-Ray Machines (Number)
NOTE: O/P: Output Variables; I/P: Input Variables; HR: Human Resource			

Considering the above mentioned input and output variables, different models, as presented in Table-2, can be drawn to find the efficiency of different categories of hospitals (i.e., government hospitals run by state government, public hospitals run by public sector undertaking organizations and hospitals run under private ownership) under input oriented DEA set-up.

Table 2: Model Designs

Coding	Variables	Type	Treatment Dimension			Diagnosis Dimension		
			A	B	C	D	E	F
IPB	In-Patient per bed per day	O/P	√		√			
DEL	Delivery per bed per day	O/P		√	√			
ECG	ECG Cases	O/P				√		√
XRA	X-Ray Cases	O/P					√	√
DR	Doctors per bed	I/P	√	√	√			
NUR	Nurse per bed	I/P	√	√	√			
PMS	Paramedical Staffs(Number)	I/P				√	√	√
ECM	ECG Machines (Number)	I/P				√		√
XRM	X-Ray Machines (Number)	I/P					√	√
√: considered								

After obtaining the efficiency values of both the dimensions (treatment and diagnosis) of different categories of hospitals, it is important to insight whether the differences among the values are significant or not; the non-parametric Mann-Whitney U Test has been applied in this connection. Instead of the two-sample t-test, the nonparametric alternative i.e., the Mann-Whitney U test is employed in this study. To run the test, the individual technical efficiency values of the two hospital types are first ranked together in ascending or descending order as belonging to a random sample. Again, the same process is performed for other hospital pairs. The equality hypothesis related to the three categories of hospitals, i.e., government hospitals owned by state

government (H_GOV), public hospitals owned by public sector undertakings (H_PSU), hospitals owned by private authorities (H_PVT) can be described as follows in three pairs:

$$H_{01}: \mu_{H\_GOV} = \mu_{H\_PSU}$$
$$H_{02}: \mu_{H\_GOV} = \mu_{H\_PVT}$$
$$H_{03}: \mu_{H\_PSU} = \mu_{H\_PVT}$$

where, μ indicates the average efficiency of the hospitals. The test procedure then calculates the sum of the ranks assigned to the scores of the government hospitals owned by state government (R1) and the public hospitals owned by public sector undertakings (R2). Similarly, other ranks are calculated for the remaining two sets of observations. U-Test statistics are calculated as

$$U = n_1 n_2 + \frac{n_1(n_1 + 1)}{2} - R_1 .$$

The statistic has a sampling distribution with a Mean = $\mu_U = \dfrac{n_1 n_2}{2}$, and Standard error =

$\sigma_U = \sqrt{\dfrac{n_1 n_2 (n_1 + n_2 + 1)}{12}}$. n_1 and n_2 are two sets of sample. Under null hypothesis it can be observed

that, U is asymptotically normally distributed as $N(\mu, \sigma^2)$ i.e. $Z = \dfrac{U - \mu_U}{\sigma_U} = \dfrac{U - {n_1 n_2}/{2}}{\sqrt{{n_1 n_2 (n_1 + n_2 + 1)}/{12}}}$

Finally, the conclusion is reached by comparing the calculated value of Z with the critical value of Z.

Determinants of Performance

The determinants of the performance level in the form of efficiency value have been analyzed with the following measurement by adopting the censored maximum likelihood assessment. This methodology has also found in the study of earlier researchers (Jing et al, 2020; Samsudin et al, 2016; Zere et al, 2020; Ahmed et al, 2019; Fried et al, 1999 etc.).

$$TE = \gamma_0 + \gamma_1 DUMY_1 + \gamma_2 DUMY_2 + \gamma_3 LOC + \gamma_4 BS + \gamma_5 OPP + \gamma_6 BOR + \varepsilon$$

where $\gamma_{i(i=1,2,.....,6)}$ are coefficients

TE is the previously obtained technical efficiency

$DUMY_1$ =1 if it is a government hospitals run by state government

$DUMY_2$ =1 if it is a public hospitals run by public sector undertaking organizations

LOC =1 if it is an urban hospital and 0 if it is a rural hospital

BS is the number of available hospital beds

OPP is the number of out-patients received treatment from the hospital

BOR is the bed occupancy rate

The details of these independent variables are presented in the Table-3, which can be observed in earlier studies (Jing et al, 2020; Küçük et al, 2020; Samsudin et al, 2016; Zere et al, 2020; Saquetto et al, 2019; Rezaee et al, 2015; Ichoku et al, 2011 etc.)

Table 3: Details of Independent Variables for Finding the Determinants of Performance

Independent Variables/ Determinants	Coding	Details
Hospital size	BS	Available hospital beds (No.)
Accessibility	BOR	Bed occupancy rate
Out-patients' pressure	OPP	Out-patient's received treatment from the hospital (No.)
Hospital location	LOC	If, urban:1; rural:0

Hospital ownership	DUMY$_1$	If, it is a government hospitals run by state government:1; otherwise:0
Hospital ownership	DUMY$_2$	If, it is a public hospitals run by public sector undertaking organizations: 1; otherwise: 0

Zere (2000) has found that the size of the hospital has a direct influence on hospital efficiency; it has also been found the BOR (bed occupancy rate) also influences the efficiency level of the hospital. This is hypothesized that the number of outpatient receiving treatment influencing the performance of the hospital. The ownership pattern and the geographical presence have been considered with importance by applying necessary dummy variables in the proposed model.

Results and discussions
Measurement of Performance: Data Envelopment Analysis

In this study, the hospital performance has been performed through the efficiency measurement model as Data Envelopment Analysis. Multiple input-output models have been formulated and estimated accordingly. Though the individual models have shown their specific expression in the assessment process, the final performance has been arrived through the overall inclusion of the considered variables which are depicted in two final models of two dimensions (Model C and F). In present study 'input orientation' assumption has been deployed; in this assumption, the inputs are considered as constant with the focus on output maximization. The 'Decision Making Units' (DMUs) which has been considered in this study are purely service organization where the forecasting of demand on peak or slack period or even in general state is considerably critical (Zeithaml, 2009). The output oriented assumption where to measure efficiency through minimization of resources for a given level of output is less effective with the present nature of study with healthcare service providing institutions.

Table 4: Measurement of Efficiency in Treatment Dimension

DMUs	No of DMUs	Average Efficiency Score TE$_{VRS}$
Model A		
H_GOV	10	0.797
H_PSU	10	0.365
H_PVT	05	0.276
ALL	25	0.520
Model B		
H_GOV	10	0.769
H_PSU	08	0.333
H_PVT	04	0.153
ALL	22[2]	0.498
Model C		
H_GOV	10	0.832
H_PSU	8	0.375
H_PVT	4	0.197
ALL	22	0.550

Note: DEAP statistical package has been deployed for analysis part.
H_GOV: Government hospitals run by state government; H_PSU: Public hospitals run by public sector undertaking organizations; H_PVT: Hospitals run under private ownership; TE$_{VRS}$: Technical Efficiency under the assumption of Variable Return to Scale

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[2] Some of the resource variables and output variables are not available in few of the DMUs; so, the analysis has been conducted with 22 DMUs only. In some other models similar limitation also observed.

The above analysis, presented in Table-4, has been conducted with the models under treatment dimension. The analysis with diagnosis dimension models have also been conducted similarly and same has been presented in the table-5.

Table 5: Measurement of Efficiency in Diagnosis Dimension

DMUs	No of DMUs	Average Efficiency Score
		TE$_{VRS}$
Model D		
H_GOV	06	0.924
H_PSU	10	0.557
H_PVT	05	0.701
ALL	21	0.696
Model E		
H_GOV	06	0.712
H_PSU	10	0.802
H_PVT	04	0.708
ALL	20	0.756
Model F		
H_GOV	05	0.690
H_PSU	10	0.890
H_PVT	04	0.757
ALL	19	0.810

Note: DEAP statistical package has been deployed for analysis part.
H_GOV: Government hospitals run by state government; H_PSU: Public hospitals run by public sector undertaking organizations; H_PVT: Hospitals run under private ownership; TE$_{VRS}$: Technical Efficiency under the assumption of Variable Return to Scale

Considering the performance of different categories of hospitals, both for 'treatment dimension' and 'diagnosis dimension', the final two models i.e., model C and F have been have been finalized foe carrying this study forward. From the above analysis, the technical efficiency scores have of aforesaid models has been acquired for further analysis. It has been found that the government hospitals run by the state government show high level of performance followed by public hospitals run by public sector undertaking organizations and hospitals run under private ownership as per model C of the treatment dimension; in model F of diagnosis dimension, the result is different where the public hospitals run by public sector undertaking organizations are showing the best performance, followed by hospitals run under private ownership and government hospitals run by the state government.

Significance across Differences in Performances among Hospitals: Mann Whitney U Test
The obtained values from the previous analysis for both treatment and diagnosis dimension among three categories of hospitals are now required to be confirmed whether their differences are significant or not; Mann Whitney U Test has been deployed for purpose. The result of Mann Whitney U Test is presented in Table-6.

Table 6: The Mann Whitney U Test Result

	Combination	H_GOV and H_PSU			H_GOV and H_PVT			H_PSU and H_PVT		
	Hospital	H_GOV	H_PSU	Total	H_GOV	H_PVT	Total	H_PSU	H_PVT	Total
Treatment	N	10	8	18	10	4	14	8	4	12
	Mean Rank	13.3	4.8	9.5	9.5	2.5	7.5	8.3	3.0	6.5
	Sum of Ranks	133	38	171	95	10	105	66	12	78

	Test Statistic[b]	Mann-Whitney U	2.00			.00			2.00
		Wilcoxon W	38.00			10.00			12.00
		z	-3.39			-2.84			-2.38
		Asymp. Sig. (2-tailed)	.001			.004			.017
		Exact Sig. [2*(1-tailed sig.)]	.000 [a]			.002 [a]			.016 [a]
	Remarks		The technical efficiency (TE) of H_GOV and H_PSU are Significantly Different			The technical efficiency (TE) of H_GOV and H_PVT are Significantly Different			The technical efficiency (TE) of H_PSU and H_PVT are Significantly Different
Diagnosis Dimension	Combination		H_GOV and H_PSU			H_GOV and H_PVT			H_PSU and H_PVT	
	Hospital		H_GOV	H_PSU	Total	H_GOV	H_PVT	Total	H_PSU	H_PVT	Total
	N		5	10	15	5	4	9	10	4	14
	Mean Rank		6.0	9.0	8.0	4.8	5.3	5.0	8.0	6.3	7.5
	Sum of Ranks		3.	90	120	24	21	45	80	25	105
	Test Statistic[b]	Mann-Whitney U	15.00			9.00			15.00
		Wilcoxon W	30.00			24.00			25.00
		z	-1.46			-.26			-.89
		Asymp. Sig. (2-tailed)	.145			.798			.376
		Exact Sig. [2*(1-tailed sig.)]	.254[a]			.905[a]			.539[a]
	Remarks		The technical efficiency (TE) of H_GOV and H_PSU are not Significantly Different			The technical efficiency (TE) of H_GOV and H_PVT are not Significantly Different			The technical efficiency (TE) of H_PSU and H_PVT are not Significantly Different
			[a] Not corrected for ties. [b] Grouping Variable: Hospital								
			Note: The Mann Whitney U Test or Rank Sum Test has been conducted by using SPSS statistical package								

The results show that the differences in performance among three categories of hospitals are significant in treatment dimension, but the same is not significant in diagnosis dimension. Thus, the performance result among these categories of hospitals in diagnosis dimension is dropped at this point. Further discussion in this study is carried forward with the results of treatment dimension among these three categories of hospitals. Figure-1, 2 and 3 show the diagrammatic representation of the average efficiency scores of the DMUS in treatment dimensions.
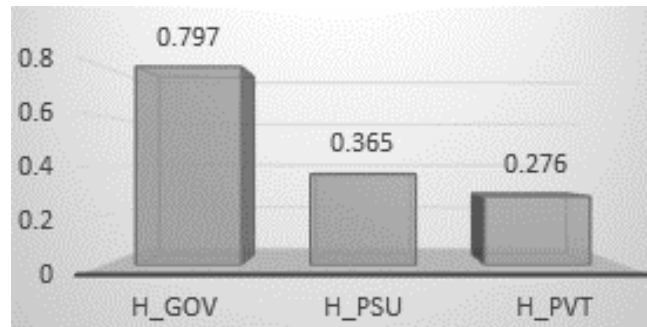
Figure 1: Measurement of Efficiency in Treatment Dimension According to Model-A
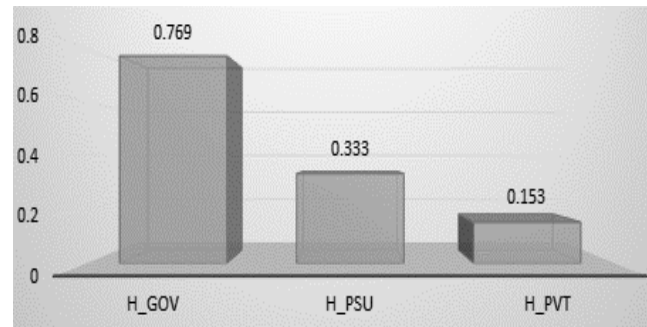
Figure 2: Measurement of Efficiency in Treatment Dimension According to Model-B
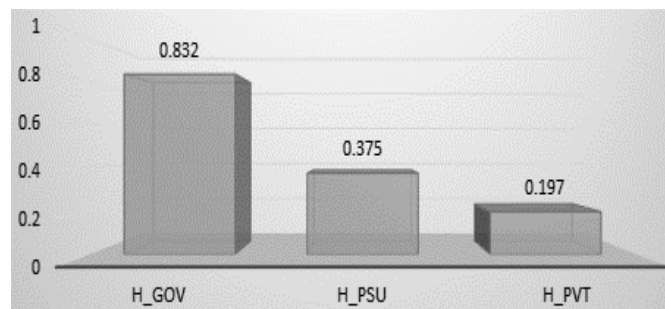
Figure 3: Measurement of Efficiency in Treatment Dimension According to Model-C

Determinants of Performance: Censored Tobit Analysis

In the second stage of this study, the discussion has been carried out with the technical efficiency values of treatment dimension which are obtained in the first stage through data envelopment analysis. The values obtained in treatment dimension are now considered as dependent variable for finding the determinants of the performance. The independent variables used in this study include bed size, bed occupancy rate, location of the hospital, pressure of patients in out-patient department and two variables (based on the ownership of the hospitals, whether as the hospital is a government hospitals run by state government or a public hospitals run by public sector undertaking organizations). The censored tobit analysis has been performed to find out the determinants of the performance of the hospitals.

Table 7: Determinants of Performance

Dependent Variable: Technical Efficiency (TE)			
Method: Maximum Likelihood - Censored Tobit			
Variable	Coefficient	Std. Error	z-Statistic	Prob.
---	---	---	---	---
BS	-0.00096	0.00048	-1.99570	0.046
BOR	0.33886	0.14470	2.34185	0.019
OPP	0.10421	0.07557	1.37895	0.168
LOC	9.56E-07	6.37E-07	1.50076	0.133
$DUMY_1$	0.64505	0.07526	8.57004	0.000
$DUMY_2$	0.20721	0.06485	3.19511	0.001

> Note: The Maximum Likelihood - Censored Tobit has been conducted by using SPSS statistical package

The results obtained from the analysis and presented in Table-7, show that the bed size of the hospital, the bed occupancy rate and the ownership pattern of hospitals are the significant determinants of performance of different categories of hospitals. It can be opined that the smaller size hospitals in terms of bed size, the performance is on the better side. In literature, Masiye (2007) also insight on more supervision as well as control on relatively smaller sized healthcare institutions for better performance. Other studies also found that the efficiency has a inverse relationship with the size of the hospital (Alatawi et al,2020; Botega et al, 2020 etc.). When the number of in-patients is more, occupying more number of bed, the performance of the hospital also becomes better. In literature, Zere (2000) has pointed that high demand of service in terms of bed occupancy rate maximizes the use of resources of supply side and thus maximizes the performance also. The performance of hospitals also becomes better when the hospital is run by state government and also by the public sector undertaking organizations. In the existing literature, Lee et al (2009) have found that the not-for-profit hospitals are better performer than the for-profit hospitals in the United States.

Conclusion

The present study has been conducted to determine hospital performance determinants in a selected geographical jurisdiction. In the first stage of the study, the hospitals' performances in the form of efficiency estimation were conducted; in the second stage, the determinants of the obtained performance level in the form of efficiency values from the first stage were explored. So, in the first stage of the study, considering the input-output variables, different models were designed, and the relative performance was measured under two unanimous specifications, namely, treatment dimension and diagnosis dimension.

Among the three categories of hospitals, the differences in performances related to the treatment dimension are significant, unlike the performance of the diagnosis dimension. It has been found that the treatment-oriented performance level is on a larger scale in hospitals under government ownership, followed by public hospitals run by public sector undertaking organizations and hospitals run under private ownership. The performance level, which was obtained through the estimated efficiency value in the first stage, was studied, and it was revealed that the performance of these hospitals is significantly related to the size of the hospital and the bed occupancy rate. The management and authority of the hospitals also take a significant role in the performance level.

It is a long allegation to the developing and developed countries regarding the inefficient and insufficient allocation of healthcare resources in achieving the 'health for all' goal. The performance of any form of healthcare organization becomes crucial in this backdrop. The myth of inefficiency in government or public-owned hospitals has been revealed and discarded in this study. However, it can be said that further scope is there to improve efficiency, which may be achieved by better management in small state government hospitals and decentralized management in large state government hospitals. In a developing or underdeveloped nation, all alternative healthcare providers need to be efficient enough for the rationale of mass health profit. Thus, the other two categories of hospitals under different ownership patterns must also be better performers by achieving better efficiency values.

The hospitals owned by public sector undertakings have limited output because they cater mostly to their employees; these hospitals need better management and allow more access for patients other than their existing employees for operational justification; well-designed awareness generation among outsiders may also be very useful in this regard which not only improve their performance but also add values to the entire organization by better branding and social responsibility. The hospitals under private ownership pattern also need to attract more patients and thus optimally use the available resources for better performance; the government

floated social health insurance facilities like 'Ayushman Bharat PM-JAY' and 'SwasthyaSathi' may be given much priority to attract more everyday people and justify the utilization of the available resources in this regard. This round initiative can help a developing nation to develop its healthcare availability, which in turn may satisfy the vision of 'health for all' through the mission of a 'healthcare inclusion' strategy by including all hospitals in the supply side regardless of their motive, ownership pattern or any other phenomenon.

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Oral Prosthesis Cleaning Practice and Oral Health Status of Removable Oral Prosthesis Wearers who attended Kilimanjaro Christian Medical Centre, Moshi, Tanzania

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Abstract

Background: Maintaining good oral health and extending the lifespan of prostheses require effective and routine cleaning procedures for complete and partially removable appliances. Removable oral prostheses should be cleaned daily to remove bacterial plaque and prevent infections, such as Candida albicans and denture stomatitis. Patients with affected prostheses must practice good oral hygiene for the rest of their lives. This study aims to assess the Oral prosthesis cleaning practice and oral health status of Removable Oral Prosthesis Wearers who attended Kilimanjaro Christian Medical Centre, Moshi, Tanzania.

Materials and methods: The sample size was calculated using the formula for cross-sectional studies developed by Kish and Leslie (1965), and convenience sampling was employed. This hospital-based descriptive cross-sectional study involved 200 patients who attended the Kilimanjaro Christian Medical Centre dental clinic in Moshi, Tanzania. A closed-ended tool and a self-administered questionnaire were used to assess the oral prosthesis cleaning practices and oral health status of removable oral prosthesis wearers. Descriptive and logistic regression analyses were then conducted using STATA software version 15.0. A p-value of less than 5% was considered statistically significant.

Results: The average age of the participants was 57 years, with 56% female. This study revealed that the majority, 44%, had good denture hygiene. It also found that 49.5% of patients over 60 had poor hygiene habits. Additionally, 64.0% of the participants did not sleep with their dentures, and 27.0% cleaned them more than twice daily. Only 9.5% of the participants received annual examinations for their dentures, and 25.95% had inflammation on the denture's fit surface. The independent predictors of good oral hygiene were age, frequency of denture check-ups, frequency of denture cleaning, and palatal erythema.

Conclusions: The study found that the hygiene practices for removable dentures were unfavourable. Most patients sleep with dentures in place; the preferred cleaning method is water and toothpaste. Therefore, dentists should instruct patients on proper denture care to prevent oral cavity infections.

Keywords: Prosthesis hygiene, denture cleaning frequency, oral mucosa lesion

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Introduction

Removable oral prostheses, such as full and partial dentures, are vital for individuals who have lost a few or all their natural teeth. These prostheses help restore essential functions such as mastication, speech, and aesthetics, significantly improving the quality of life for wearers. However, maintaining oral hygiene while using these devices is important, as improper care can lead to various oral health issues, including mucosal infections, plaque accumulation, and even systemic diseases (Coulthwaite & Verran, 2007).

Proper cleaning practices for removable oral prostheses are essential to prevent the growth of harmful microorganisms that can cause conditions like denture stomatitis, halitosis, and periodontal diseases (Szalewski, 2017). Appropriate cleaning methods and solutions can help remove food debris, plaque, and stains, reducing oral infection risk. Despite the importance of these practices, many wearers of removable oral prostheses often lack sufficient knowledge about proper hygiene techniques, leading to suboptimal oral health outcomes.

Studies have shown considerable variation in the oral hygiene practices and health status of removable prosthesis wearers worldwide. Factors such as age, socioeconomic status, educational background, and access to dental care play significant roles in influencing these practices (Mushtaq et al., 2019; Shankar et al., 2017). Specifically, in developing countries, limited access to dental healthcare services and education on proper prosthesis care often exacerbate oral health issues among wearers.

In Tanzania, where oral health awareness and access to dental care can be limited, there is a pressing need to understand the current practices and oral health status of individuals wearing removable oral prostheses. Kilimanjaro Christian Medical Centre (KCMC) in Moshi is a healthcare institution that provides dental services to a diverse population. While there is a growing awareness of the importance of oral health, there is still a knowledge gap concerning the specific practices adopted by prosthesis wearers and their impact on oral health, such as access to dental care and follow-up, limited awareness of appropriate cleaning products, variability in cleaning practices, and inadequate patient education.

This study aims to discover the cleaning practices and health status of removable oral prosthesis wearers attending KCMC. By assessing the current practices and identifying any associated oral health issues, this research seeks to contribute valuable insights that could guide patient education and improve oral health outcomes for this population. Understanding these dynamics is crucial for developing targeted interventions and recommendations that can enhance the quality of life for oral prosthesis wearers in the community.

Methodology

This was a hospital-based cross-sectional study involving removable oral prosthesis wearers aged 18 years and above who attended the Dental clinic at KCMC Hospital between February and June 2022 (88 Males and 112 Females). The subjects had worn a single or full denture for at least seven days prior to the commencement of the study. The subjects were examined for oral tissue conditions after completing a questionnaire. A convenient sampling technique used a minimum of 200 subjects, calculated using the Kish and Leslie formula to select oral prosthesis wearers who attended the Dental clinic at KCMC Hospital and met inclusion criteria.

A closed-ended tool and a self-administered questionnaire were used to assess the Oral prosthesis cleaning practice and oral health status of Removable Oral Prosthesis Wearers. The questionnaire variables were adopted from different authors (Shankar *et al*., 2017; Auon & Gerges, 2017; Ogunride & Opeodu, 2015; Shigli *et al.,* 2015; Turgut Cancaya *et al.,* 2020 and

Nair *et al*., 2016). The questionnaire collected information such as the patient's age, sex, sleeping with the dentures, denture checkups, information on dentist instruction, denture use duration and rinsing a denture after every meal. The degree of palatal erythema was scored using Budtz-Jorgensen criteria (Budtz & Bertram, 1970), which describes the inflammation seen on the palatal mucosa. Palatal erythema was scored using the following clinical index.
0=No inflammation.
1=Inflammation present
The oral prosthesis hygiene was examined using the denture cleanliness index (Mylonas et al., 2016). This index grades the severity of denture cleanliness according to the amount of staining on the surface of the oral prosthesis fitting. The dental personnel applied a liquid plaque-disclosing dye, E102 Tartrazine, in combination with E 133 Brilliant blue FCF, to the fitting surface of the oral prosthesis to disclose the plaque.
0= Clean denture; no plaque is visibly seen, no staining, no plaque detectable.
1=Denture is visibly clean. Little staining (<25% staining of fit surface).
2= Denture has visible plaque and/or debris. Moderate staining of fit surface (25-50% staining of the fit surface).
3=Denture has visible plaque and/or debris. Severe staining of fit surface (>50% staining of the fit surface).
4=Denture has visible calculus deposit(s) on any surface
However, in this study, the oral prosthesis hygiene level was classified as clean/good denture (0 and 1), Moderate (2), and Poor denture (3 to 4). This was adopted from Mylonas et al. (2016; Syatirah et al., 2021; Turgut Cankaya Z, 2020). Furthermore, data were collected, organized, managed, and stored in a computer, secured, backed up, and preserved. Data were checked and cleaned. Variables were labelled and coded for easy interpretation.
Categorical variables with levels were identified and coded efficiently as per their levels. In some variables, categorization was based on previous literature studies. Quality of data was observed throughout in order not to lose its meaning and have wrong results. Data entry was done using Excel. Descriptive and logistic regression analyses were then conducted using STATA software version 15.0. A p-value <5% was used to determine statistical significance.

Ethical consideration
Ethical approval was sought from Kilimanjaro Christian Medical University College (KCMUCo) and the Research Ethics Review Committee, with clearance number PG 02/2022. Permission to carry out the study was obtained from the relevant authorities at the KCMC. Confidentiality and anonymity were maintained and observed at every step, from data management to analysis and presentation, and participant codes were used instead of names.

Results
Socio-demographic characteristics of the participants
There were 200 participants, of whom 112 (56%) were women. Among them, 76 participants (38%) had completed their primary education. Additionally, 116 participants (58%) were married or partnered, and 145 (72.5%) were self-employed. The average age of the participants was 57 years, with a standard deviation of ±17.4 years. Most participants were aged 60 or older. The socio-demographic characteristics of the participants are summarized in Table 1.

Table 1: Socio-demographic characteristics of the study participants (N=200)

Characteristics	n (%)
Sex	
Male	88(44)
Female	112(56)
Age(years)	
18-40	40(20)
41-60	61(30.5)
60+	99(49.5)
Education level	
Never	8(4)
Primary	76(38)
Secondary	53(26.5)
University	63(31.5)
Employment status	
Employed	44(22)
Self-employment	147(73)
Student	9(4.5)
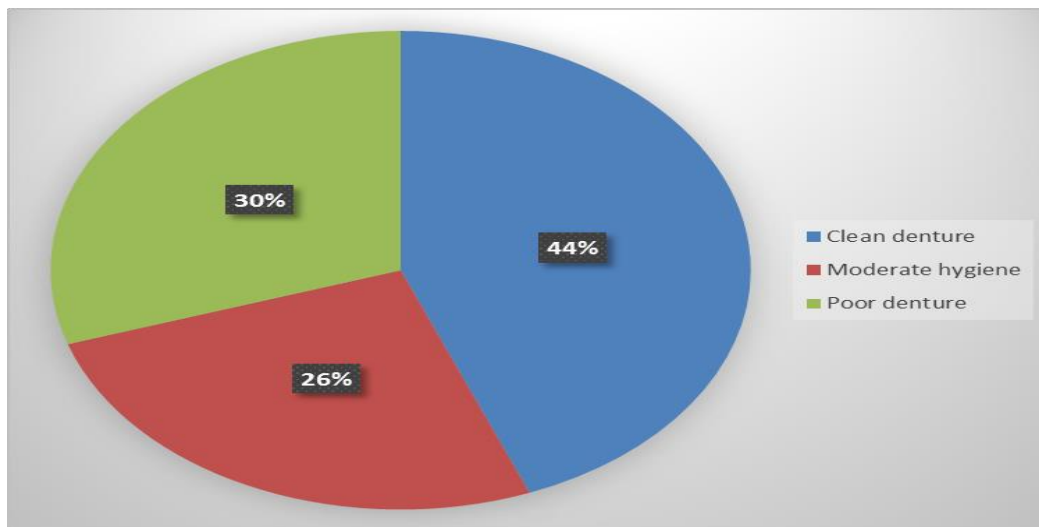
Figure 1: Summarized hygiene levels among study participants at KCMC dental clinic

Non-cleaning habits of the participant's denture

Table 2 displays non-cleaning practices. Of the 200 participants, 81 (40.5%) had new dentures, and 128 (64%) did not sleep with their dentures. After receiving their dentures from a dentist, 143 participants (71.5%) received instructions, and more than half of the participants 118 (59%) had used them for less than a year.

Table 2: Non-cleaning habits of the participant's denture (N=200)

Characteristics	n (%)
Denture checkups	
Every 3 to 6 months	15(7.5)
Once a year	19(9.5)
Not applicable/new	81(40.5)
Never	85(42.5)
Sleep with denture	
No	128(64)
Yes	72(36)
Dentist instruction on how to clean dentures	
Yes	143(71.5)
No	57(28.5)
Denture duration	
Less than one year	118(59)
More than one year	82(41)

Cleaning habits of the participant's denture (N=200)

More than two-thirds of the participants, 148 (74%), soaked their dentures in a solution when not using them. Specifically, 138 participants (69%) soaked their dentures in cold water overnight, and 142 (71%) rinsed them after every meal. Additionally, 89 participants (44.5%) reported cleaning their dentures at least twice daily. Most participants cleaned their dentures with a toothbrush (193, or 96%), and 146 participants (73%) used toothpaste and water. However, 126 participants (63%) were using dentures for the first time.

Table 3: Cleaning habits of the participant's dentures (N=200)

Characteristics	n(%)
Soak a denture in any substance when not wearing a denture.	
Yes	148(74)
No	52(26)
Substance to soak a denture	
Cold water	138(69)
Others specify	62(31)
Rinse a denture every after-meal	
Yes	142(71)
No	58(29)
How often to clean denture	
Once a day	57(28.5)
Twice a day	89(44.5)
More than twice a day	54(27)
Using a denture brush/toothbrush to clean dentures	
Toothbrush	193(96.5)
Others	7(3.5)
What do you use to clean a denture?	
Toothpaste and water	146(73)
Others specify	54(27)

Hygiene level by socio-demographic and cleaning habits characteristics

In the adjusted analysis shown in Table 4, older patients aged 60 years and above had three times higher odds of having moderate or poor denture condition compared to those aged 18-40 years with clean dentures (COR 3.46; 95% CI: 1.17-10.16; P-value = 0.024). Those who slept with their dentures had three times higher odds of having moderate or poor denture conditions compared to those who did not sleep with their dentures (COR 3.34; 95% CI: 1.32-8.4; P-value = 0.006).

Individuals who went for regular denture checkups once a year and those who were new denture wearers had 0.12- and 0.23-times lower odds, respectively, of having moderate or poor denture conditions compared to those who had checkups every 3-6 months (COR 0.12; 95% CI: 0.02-0.82; P-value = 0.031) and (COR 0.23; 95% CI: 0.06-0.90; P-value = 0.042).

In terms of denture hygiene, those who cleaned their dentures more than twice a day had 0.32 times lower odds of having moderate or poor denture conditions compared to those who cleaned their dentures once a day (COR 0.32; 95% CI: 0.11-0.97; P-value = 0.045). Slight inflammation of the palate was associated with twice the odds of having moderate or poor denture conditions compared to a non-inflamed palate (COR 2.43; 95% CI: 1.05-5.9; P-value = 0.038)

Table 4: Adjusted Logistic regression by socio-demographic and cleaning habits characteristics

Characteristics	COR(95%CI)	P-value	AOR(95%CI)	P-value
Sex				
Male	1			
Female	0.871(0.52-1.46)	0.603		
Age				
18-40	1			
41-60	1.583(0.74-3.40)	0.240	1.232(0.39-3.88)	0.721
60+	3.165(1.54-6.49)	0.002	3.457(1.17-10.16)	**0.024**
Sleeping with denture				
No	1			
Yes	5.67(2.87-11.22)	<0.001	3.34(1.32-8.4)	**0.006**
Smoking				
Yes	1			
No	0.858(0.30-2.39)	0.769		
Denture checkup				
Every3-6month	1			
Once a year	1.549(0.43-5.57)	0.502	0.117(0.07-0.82)	**0.031**
New	0.239(0.83-0.69)	0.008	0.232(0.06-0.95)	**0.042**
Never	3.316(1.21-9.08)	0.020	0.859(0.19-3.93)	0.845
Frequency of cleaning denture				
Once a day	1			
Twice a day	0.656(0.35-1.22)	0.180	0.628(0.22-1.83)	0.393
bre than twice a day	0.357(1.17-0.73)	0.005	0.323(0.11-0.97)	**0.045**
Palatal erythema				
No inflammation	1			
Inflammation present	2.300(1.16-4.58)	0.018	2.425(1.05-5.9)	**0.038**

*Footnote: *COR-Crude odds ratio:* * AOR-Adjusted odds ratio, *Bolded p-value indicates statistical significance (P-value<0.05), *Adjusted for Age, sleep with denture, denture check-up, denture cleaning, denture duration and palatal erythema.

Oral health status information of the study participants

The study's findings reveal that 178 participants (89%) had never noticed an unpleasant odour while wearing their dentures, and 141 participants (70.5%) had never experienced a burning sensation. Additionally, 156 participants (78%) had never observed a reddish lesion when removing their dentures. Among the subjects who used only upper dentures, palatal erythema was clinically evaluated. None of the 117 participants (74.05%) who underwent examinations reported irritation. (Shown in Table 5).

Table 5: Summarized self-reported and clinical examination of oral health status conditions of the study participants (N=200)

Characteristics	n (%)
Bad smell with denture	
Yes	22(11)
No	178(89)
Burning sensation while wearing denture	
Yes	59(29.5)
No	141(70.5)
White or reddish lesion after denture insertion	
Yes	44(22)
No	156(78)
Degree of palatal erythema (maxillary upper denture) (N=158)	
No inflammation	117(74.05)
Inflammation present	41(25.95)

Discussion

This study assessed oral prosthesis cleaning practices and health status among removable oral prosthesis wearers who attended K.C.M.C Dental Clinic from February 2022 to June 2022. The findings showed that 44% of participants had clean dentures, 26% had moderate or fair denture hygiene, and 30% had poor denture hygiene. This differs from a study in Nigeria where most participants (78.7%) had good denture hygiene, with fair and poor hygiene levels at around 15% each (Ogunride & Opeodu, 2015). Similarly, a Malaysian study reported that 68% had clean dentures, 26% had moderate hygiene, and 6% had poor hygiene. The discrepancy between these studies and ours may be attributed to differences in the age groups studied; the other studies mainly included middle-aged participants who are more likely to have the dexterity needed for proper denture cleaning, while our study primarily involved elderly participants who seldom had denture checkups and often wore complete dentures.

Among participants over 60 years in our study, 35.5% had clean dentures, 23.2% had moderate hygiene, and 41.4% had poor hygiene. Additionally, 32.32% of those over 60 cleaned their dentures once daily, differing from an Indian study where 28.2% of participants above 60 cleaned their dentures daily (Apatrim *et al*., 2013). Research indicates that more frequent denture cleaning helps control plaque accumulation. For instance, two studies (Ogunride & Opeodu, 2015; Syatirah *et al*., 2021) found that cleaning dentures twice daily resulted in 80% and 43% oral hygiene levels, respectively. The lower levels of adequate denture hygiene among older adults may be due to physical limitations or forgetfulness, highlighting the need for dental practices to provide personalized care plans and support, such as reminders and assistance with denture cleaning.

The study also found that 36% of participants slept with their dentures in their mouths. This percentage is lower than those reported in Brazil (88%) and Iran (55.1%) (Apratim *et al*., 2013;

Syatirah et al., 2021), but higher than those reported in India (13.2%) (Mushtaq *et al.*, 2019) and Nigeria (20.2%) (Aoun & Gerges, 2017). Reasons for this could include the presence of partners, poor knowledge, and beliefs that removing dentures may cause facial muscles to shrink. However, wearing dentures day and night can increase the risk of infections and oral health problems, such as denture stomatitis and gum sores. Dentures should be removed at night to maintain good dental and overall health. Public education on the risks of prolonged denture use and the benefits of nighttime removal can help prevent complications and promote better oral hygiene.

Regarding denture cleaning frequency, 27.5% of participants in our study cleaned their dentures more than twice a day. This result aligns with a Lebanese study (26.5%) (Aoun & Gerges, 2017), but is lower than the 73.58% reported in Brazil (Peracin *et al.*, 2010). The difficulty in cleaning certain areas, such as the flange's intramural labial and buccal sides, inside surfaces, and spaces between the teeth, may necessitate more frequent cleaning. However, participants in our study were motivated by a desire to improve personal oral hygiene and prevent stains and bad odors. We recommend cleaning dentures at least once daily, with twice a day ideal—once in the morning and once before bed.

The study highlights that only 9.5% of participants visited the dentist annually for routine examinations. This percentage is like that in Nigeria (10.1%), where patients often visit the dentist for treatment or denture adjustments. However, it is higher than the 13% reported in Malaysia (Syatirah *et al.*, 2021). The long-term use of dentures and the failure to attend follow-up visits may explain this, as participants tended to seek dental care only when experiencing issues with their dentures, such as breakage or poor fit. Regular dental checkups are crucial for monitoring oral health, adjusting dentures, and detecting potential issues early. Encouraging the community to schedule regular dental visits can improve oral health management and ensure timely interventions.

After the clinical examination in this study, 25.95% of participants showed signs of oral mucosal inflammation, such as denture stomatitis. This differs from a report in India by 50% (Bhat *et al.,* 2003). Possible causes include poorly fitting dentures that cause trauma to the oral mucosa, excessive plaque formation, overextended denture flanges, and nocturnal wearing. Dental professionals should prioritize ensuring proper denture fit and regular adjustments to enhance comfort and prevent oral trauma, ultimately improving the quality of life for denture wearers.

Conclusion

This study highlights several key aspects of denture hygiene and oral health status among removable oral prosthesis wearers at KCMC Dental Clinic from February to June 2022. The findings reveal that a significant portion of participants had inadequate denture hygiene, with only 44% maintaining clean dentures. This is notably lower than the hygiene levels reported in studies from Nigeria and Malaysia, possibly due to differences in age demographics and associated dexterity.

The data shows that elderly participants, particularly those over 60, struggled with maintaining proper denture hygiene. The study emphasizes the need for regular denture cleaning, as more regular cleaning has been associated with better oral hygiene. However, challenges such as physical limitations and forgetfulness among older adults highlight the importance of providing personalized care plans and support from dental professionals.

Furthermore, the study observed a concerning trend of participants sleeping with their dentures in place, which can increase the risk of oral infections and conditions like denture stomatitis. Public education on the benefits of removing dentures at night is essential to diminish these risks.

Furthermore, the low rate of annual dental visits among participants underscores the need for regular checkups to monitor and maintain oral health. Such visits are crucial for detecting potential issues early and ensuring the proper fit of dentures, which can prevent trauma to the oral mucosa.

This study suggests increased attention to education, personalized care, and regular dental checkups can significantly improve denture wearers' oral health and quality of life. Addressing these factors is vital in promoting better denture hygiene practices and reducing the incidence of associated oral health problems.

Recommendations

The results from this study recommend that an oral health education program to improve denture hygiene practices among removable denture wearers be designed to reduce the risk of acquiring denture-induced oral diseases. It is also crucial that dental professionals advise people who wear dentures to adhere to the best practices advised during insertion. These include frequent examinations of their appliances, rinsing them after every meal, and storing them in a dry place covered in water while not in use. Lastly, ensuring durable denture hygiene and good oral health maintenance is important.

Conflict of interest

None.

Author contributions

All authors made equal contributions.

Data sharing statement

To be provided upon request.

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Awareness and availability of micronutrients powders among mothers and caregivers of children aged 6 - 59 months in Zanzibar City

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Abstract
Background: Micronutrient powders (MNP) are designed to supplement micronutrients in foods consumed by children or pregnant women in settings where micronutrient deficiencies are prevalent. Organisations, including humanitarian agencies, the Ministry of Health, and non-governmental organisations distribute them. This study aimed to assess the awareness and availability of micronutrient powders (MNPs) among mothers and caregivers in Zanzibar City. The study specifically aimed to assess the understanding of MNPs among mothers and caregivers and to assess the use of MNPs among children in Zanzibar.
Methods: The study employed a longitudinal design, whereby data were collected at a single point in time over two months. A combination of qualitative and quantitative approaches was employed. Purposive sampling was used to identify sellers of MNPs sachets. A total of 365 respondents were surveyed, comprising two MNPs sellers in Zanzibar and 263 caregivers and mothers in Zanzibar. The former was interviewed face-to-face, while the latter completed a pre-tested questionnaire and checklists. However, the study involved three focus group discussions with customers of MNPs, namely mothers and caregivers, to collect data.
Results: The results indicated that most mothers and caregivers were unaware of the MNPs. The product was not readily available or used during the study period. Furthermore, there was a lack of clarity regarding the product among mothers and caregivers. The mothers and caregivers believed that the MNPs were a strategy for vaccinating their children and/or making them infertile.
Conclusions: Community health workers needed training to counsel mothers and caregivers appropriately. Further research is required to ascertain the beliefs and social norms regarding MNPs among parents of children under five in Zanzibar.

Keywords: Micronutrients powders, micronutrients, under-five-children, mothers and caregivers

Introduction
Micronutrient powders (MNP) are designed to supplement micronutrients in foods consumed by children or pregnant women in settings where micronutrient deficiencies are prevalent (WHO, 2016). They are a form of home-based fortification whereby the micronutrients are sprinkled onto home-prepared foods before consumption. This makes them an easy-to-use form of fortification (Hodgins & Klemm, 2021). Various organisations, including humanitarian agencies, the Ministry of Health, and various non-governmental organisations, distribute them.

In Tanzania, the Feed the Future programme introduced the MNPs in 2013. The sachets were labelled "virutubishi" and distributed to local shops and health facilities through health workers. A

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single sachet cost 200 TShs. The World Health Organization (WHO, 2016) recommended consuming one sachet every other day.

According to the WHO (2008), an iron deficiency prevalence rate of 40% is considered a public health problem. Children under the age of five years are the most vulnerable social group to micronutrient deficiencies. Such children require micronutrients to facilitate their accelerated growth and development. Several studies have demonstrated the efficacy of home food fortification using micronutrient powders (MNPs) in enhancing iron status among children under the age of five (Adu-Afarwuah *et al.,* 2008; Christofides, 2006; Zlotkin *et al.,* 2003).

Notwithstanding the availability of MNPs in developing countries, their use in certain settings is limited (Ndemwa et al., 2011). One reason for this is the lack of training of community health workers to guide mothers and caregivers on using MNPs and proper information regarding the product and its benefits (Kodish *et al.,* 2022).

A study conducted by Reerink *et al*. (2017) to examine MNP use and delivery strategies, with Tanzania identified as a key informant as an implementer, concluded that different mechanisms should be adopted to educate communities on the importance of MNPs. Such mechanisms should include community involvement and social behaviour change communication (SBCC) designs. A project entitled "Tuboreshe Chakula," implemented in Tanzania, has delivered training seminars to government health service providers and village health workers on the use of MNPs. Furthermore, mothers and caregivers were instructed on using MNP to enhance the quality of complementary foods and the location of MNP sachets (Secure Nutrition, 2015). This study assessed the awareness of MNPs among Mothers and Caregivers and the use of MNPs among under-five Children in Zanzibar

Materials and Methods
Study Area Description
The study was conducted in Zanzibar City, where iron deficiency anaemia was high (65.4%, TDHS, 2016). Zanzibar City is divided into three administrative regions: North, South and Urban West. The regions are subdivided into two districts each. The West B district has seven constituencies, 14 wards and 34 Shehias. The region's total population is 344,517, according to the 2022 Population and Housing Census (Census, 2022). The Zanzibar North Region borders the West B district to the north, the Central/South Region to the east, the Indian Ocean to the south, and the Zanzibar Urban District to the west. The district is characterised by a tropical climate, with 20° and 40° Celsius temperatures. Additionally, the district experiences a bimodal rainfall pattern, with a long rainy season spanning from March to May and a shorter rainy season from September to December each year. The district receives between 900 mm and 1,200 mm of rain during the long rainy season and 400 mm to 500 mm during the short rainy season (District Profile, 2017).

Study design
The study employed a longitudinal design, collecting data at baseline, midline and endline within two months. The study's objective was to assess the awareness and availability of maternal and newborn health (MNH) products among mothers and caregivers of children aged between six and 59 months. The West B district was selected randomly from six districts where the study was conducted. The district is divided into seven constituencies, further subdivided into 14 wards and 34 Shehias. A list of reproductive and child health clinics was obtained and randomly selected. A combination of qualitative and quantitative approaches was employed.

Description of the study population
The study included mothers and caregivers of children aged between 06 and 59 months attending RCH clinics. Additionally, sellers of MNPs in Zanzibar City were included in the study.

Sampling size and sampling procedure
Mothers and caregivers of children aged between six and 59 months were identified from selected RCH clinics in the West B District. The sellers of MNPs were identified through purposive sampling. The total number of mothers and caregivers was calculated using a formula proposed by Fisher *et al*. (1991).

The sample size was calculated using the following formula:

$N = Z^2 * Pq / d^2$

N = the desired sample size

d = the degree of accuracy desired (precision level) (acceptable error 0.05 or 5%)

P = the prevalence of iron deficiency among under-five children in Zanzibar City (65%, TDHS, 2016)

Q = 1-P

Z = the standard normal deviate (which was 1.96, corresponding to 95% confidence)

The prevalence of anaemia in Zanzibar was 65%, the Z-statistic corresponding to a 95% confidence interval for a two-tailed test (1.96), and the degree of accuracy was 5% (0.05). A total of 350 mother-child pairs were included in the study. A further 35 under-five children were included in the sample, representing 10% of the total, to compensate for any loss to follow-up. Consequently, the sample size was 385 mother-child pairs. Twenty-two mothers or caregivers were lost to follow-up and thus unable to be assessed after the intervention. Consequently, 363 mothers of children aged between six and 59 months attending the RCH clinics in Zanzibar City participated in the study. Therefore, this study was responded to by 365 respondents, 363 mothers and caregivers of children and 02 sellers of MNPs in Zanzibar.

Data collection
Survey method
In this study, the survey method was applied as the primary method for data collection, along with semi-structured questionnaires. The questionnaire was structured in such a way to answer research objectives; questions were made clear to all respondents. The researcher and trained enumerators submitted this to caregivers and mothers of children aged 6 to 59 months, introduced them to how to fill out and respond to questions, and then later collected them back for analysis. The socio-demographic characteristics of the mothers and/or caregivers were obtained using a pre-tested questionnaire by trained enumerators.

Prior to the commencement of data collection, the questionnaire was subjected to a preliminary evaluation. A sample of 12 mothers or caregivers of children aged 6-59 months was selected for pre-testing in Ilala Ward, Dar es Salaam. The questionnaire was administered to the mothers/caregivers at the RCH clinics during the clinic days through face-to-face interviews. Qualitative data was gathered through in-depth interviews and focus group discussions. The data collected was not numerical. Mothers and caregivers of children aged 6 to 59 months were asked to respond to general questions. Interviewers probed and explored the respondents to identify and define their perceptions, opinions, and feelings towards using MNPs and their benefits for their children.

In-depth interviews

In-depth interviews were conducted with two MNP sellers in Zanzibar City. The interviewers invited the retail sellers to discuss their sales rates and the information they had about MNPs. The interviewer ensured the environment was conducive to a positive and productive conversation. The objective of the in-depth interviews was to elicit the following information: perceptions of MNPs, opinions on the benefits of MNPs, and the impact of under-five children's health and attitudes.

Focus group discussions

This data collection method involves assembling key personnel who affect the study or are affected by the study to make joint discussions upon the study. In this study, three groups were purposely selected: the first comprised 7 respondents, the second comprised 5 respondents and the last with 8 respondents. These groups aimed to find different views on mothers' and caregivers' perceptions of factors that influence the usage of MNPs by their children during their RCH visits. Here, the researcher designed specific topics that formed the subject of discussion. The information sought included mothers and/or caregivers' values, culture, opinions and attitudes about MNPs. Likewise, each group discussed the topic under study transparently and came up with the findings that were analyzed and associated with other data collected through other methods to develop realistic findings.

Ethical consideration

Permission and ethical clearance were obtained from the Zanzibar Health Research Ethical Committee (ZAHREC) and the District Health Officials where the study was conducted. Parents of eligible children were informed of the study's purpose, objectives, and benefits. Participation in the study was voluntary, and participants were free to withdraw from it at any time if they desired. Parents who agreed to participate signed a consent statement. Confidentiality was maintained, and personal information was not shared without consent.

Data Analysis

Descriptive statistical analyses were applied to analyse quantitative data with a statistical package for social science (SPSS) software version 26. The findings from the descriptive part of this study were organized and presented in the form of words, numbers, frequencies and percentages using tables. The researcher used a data processing technique informed by Cohen, Manion, and Morrison (2007), emphasizing the relationship between data analysis and creation in qualitative research conducted through interviews. To identify significant themes, qualitative data was subjected to content analysis, which included organization, transcribing, coding, categorization, and interpretation.

Results

Socio-demographic characteristics

The study examined the socio-demographic characteristics of caregivers and mothers in Zanzibar City regarding their awareness and access to micronutrient powders (MNPs). The findings revealed a diverse range of educational levels, marital statuses, and numbers of children under the age of five in the participants' households, which reflected the varied demographic profile of the community (Table 1).

Table 1: Socio-demographic characteristics of the caregivers/mothers

Socio-economic attribute (N=363)	Number of respondents (Percent)
Education level	
No education	5 (1.4%)
Adult education	8 (2.2%)
Primary education	82 (22.6)
Secondary education	194 (53.4)
Diploma/certificate	41 (11.3)
University	33 (9.1)
Marital status	
Married (monogamous)	246 (67.8)
Married (polygamous)	93 (25.6)
Widowed	7 (1.9)
Divorced	8 (2.2)
Single	8 (2.2)
Other	1 (0.3)
Number of under five children in household	
One	262 (72.2)
Two	98 (27.0)
Three	2 (0.6)
Four	1 (0.3)

Table 1 indicates the education and marital status of the household heads. Approximately half of the participants had completed secondary school (53.4%, n=194), 22.6% (n=82) had completed primary education, 11.3% (n=41) had completed a diploma or certificate, 9.1% (n=33) had completed a university degree, 2.2% (n=8) had completed an adult education programme, and 1.4% (n=6) had no formal education. About 67.8% (n=246) of the respondents were married in a monogamous relationship, 25.6% (n=93) were married in a polygamous relationship, 1.9% (n=7) were widowed, 2.2% (n=8) were divorced, and 2.2% (n=8) were single. Most mothers/caregivers (72.2%, n=262) had one child under the age of five years in the household, while 27% (n=98) had two children under the age of five years, 0.6% (n=2) had three children under the age of five years, and 0.3% (n=1) had four children under the age of five years.

Awareness of MNPs among mothers and caregivers

The study assessed mothers' and caregivers' awareness of Zanzibar City micronutrient powders (MNPs). The study aimed to ascertain whether respondents were aware of MNPs, where they had obtained this information, their usage of MNPs for children under five years of age, and the frequency with which they used MNPs for this age group (Table 2).

Table 2: Awareness of MNPs among mothers and caregiver at baseline of the study

Have you heard about MNPs (N=363)	No of respondents (Percent)
Yes	63 (17.4)
No	300 (82.6)
If yes, where did you hear about MNPs?	
Health professional	9 (2.1)

Relatives, family members, neighbours	48 (12.8)
Others	6 (1.7)
Not heard	300 (82.6)
Have you ever used the MNPs for under five children	
Yes	11 (3.0)
No	352 (97.0)
If yes, how often did you use the MNPs for under five children	
Once per week	8 (2.2)
Twice per week	3 (0.8)
Not used	352 (97.0)

Table 2 indicates that most mothers and caregivers at the study's baseline (82.6%, n=300) had not previously heard of MNPs. A mere 17.6% (n=64) had previously been aware of MNPs. The average number of respondents indicated that they had learned about MNPs from relatives, family members, and neighbours (n=48), while others reported that they had learned about MNPs from health professionals (n=9). Only 3% (n=11) of those who heard about MNPs used them. Among the respondents, 2.2% (n=8) reported using MNPs once weekly, while 0.8% (n=3) reported using them twice weekly. During the study's baseline period, none of the respondents used MNPs.

Use of MNP sachets during the study period
The assessment conducted in Zanzibar City focused on utilising micronutrient powder sachets among mothers and caregivers. The objective was to assess the awareness and accessibility of MNPs in the community, focusing on Midline and Endline. This section presents the findings on the usage frequency and the number of respondents who incorporated MNP sachets into their routine during the study period.

Table 3: Number of respondents who used MNPs sachets during the study period

No. of MNP sachets per week (N=363)	Midline	Endline
	N (%)	N (%)
0	198 (54.5)	165 (45.5)
1	18 (5.0)	23 (6.3)
2	74 (20.4)	92 (25.3)
3	60 (16.5)	67 (18.5)
4	11 (3.0)	14 (3.9)
5	2 (0.6)	2 (0.6)

At the study's outset, none of the respondents had used the MNPs for the previous seven days. A more significant proportion of respondents (54.5%, n=198) did not utilise the MNPs during the study period. Of the respondents, 42.4% (n=84) indicated they were not interested in using MNPs, while 53.5% (n=106) reported that the shops selling them MNPs were conveniently located near their residences. Additionally, 4.0% (n=8) of respondents stated that they did not have access to a place to buy the MNPs. Only 16.5% and 3.0% of all respondents reported using three and four sachets per week, respectively, during the midline period. This figure increased slightly to 18.5% and 3.9% during

the ending period. Table 2 presents the number of sachets used by respondents throughout the eight-week study period.

The reaction of the children to the use of food mixed with MNPs

This study examines an essential aspect of the efficacy of micronutrient powders (MNPs) in Zanzibar City: children's reactions to meals containing MNPs. It is, therefore, of great importance to understand their reaction, as this will inform the planning of effective micronutrient supplementation initiatives.

Table 4 presents the reactions and changes in appetites for the under-five children who were given foods mixed with MNPs. 165 children who consumed MNPs during the midline period were surveyed. Of these, 14.0% (n=51) expressed a positive sentiment towards the MNPs-fortified foods, 7.4% (n=27) exhibited an adverse reaction, and 23.9% (n=87) reported no discernible difference in the taste of the foods. Regarding appetite, 27.3% (n=99) of respondents indicated that children's appetite increased after four weeks of using MNPs, while 13.3% (n=48) reported no change in appetite.

Table 4: **Reaction and change of appetites of the children given food mixed with MNPs after 4 weeks**

Reaction to food mixed with MNP (N=363)	MIDLINE	ENDLINE
	Respondents (N)/ Percent (%)	Respondents (N)/ Percent (%)
Liked	51 (14.0)	60 (16.5)
Disliked	27 (7.4)	37 (10.2)
No Difference	87 (23.9)	101 (27.8)
Not Used	198 (54.5)	165 (45.5)
Change of appetite		
Increased	99 (27.3)	137 (37.7)
Decreased	18 (5.0)	16 (4.4)
No Difference	48 (13.3)	45 (12.4)
Not Used	198 (54.5)	165 (45.5)

Availability of MNPs in Zanzibar City

The distribution of MNPs in Tanzania was conducted by the Social Liberation and Empowerment Organization (SOLEO). SOLEO is the primary distributor of Virutubishi in Zanzibar. Two leading sellers of the product are in Zanzibar: one in Bwejuu and another in Fuoni Kwandundu. Bwejuu is situated in a location that is remote from the city centre. In contrast, Kwandundu is situated near the city centre, in an area that is easily accessible by road and has a concentration of shops. "Virutubishi" is available nationwide in pharmacies, supermarkets, and grocery stores. In Zanzibar, however, they were only available in two local shops, which made them less accessible to families in need.

SOLEO commenced the sale of MNPs in Zanzibar in March 2020. Both outlets are retail establishments selling other SOLEO food products, including composite maize flour, peanut butter,

and chocolate. One sachet was sold in Zanzibar at 200 Tanzanian Shillings (TShs). One package comprising 30 sachets was sold at 6,000 TShs.

Frequency of MNP sales

During the interview, the interviewer asked the respondents about the frequency and trends of MNP sales at their respective shops.

The first interviewee responded that,

> *Sure, at Fuoni Kwandundu, I've observed fluctuations in sales over the past year. From March to May 2021, I sold approximately 450 sachets of "Virutubishi" monthly. However, I did notice an increase in sales from June to August, reaching around 540 sachets per month. It's been quite variable, but I am hopeful for consistent growth.*

The second interviewee responded that,

> *At Bwejuu, I've experienced a moderate level of sales for "Virutubishi." On average, I sell between 300 and 450 sachets monthly. It's been relatively steady, but I am always looking for ways to increase awareness and accessibility among parents in our community.*

However, regarding what influences parents/caretakers to buy MNPs from sellers' shops, respondents were asked to explain what reasons they think contribute to parents/caretakers preferring to buy smaller quantities of MNPs from their shop within the interview session.

The first interviewee responded that,

> *Based on our interactions, it seems that many parents prefer buying a few sachets of MNP daily rather than purchasing the whole package of 30 pieces at once. I believe this could be due to financial constraints among families. So, I try to accommodate their needs by offering smaller quantities for purchase.*

The second interviewee responded that,

> *From my observations, financial limitations play a significant role in parents' purchasing decisions. Many prefer to buy a few sachets at a time rather than investing in the entire package. I understand their circumstances and aim to provide flexible options to accommodate their needs effectively.*

The study conducted in Zanzibar City has revealed a concerning trend of low sales of micronutrient powders among caregivers. Both sellers asserted that sales were low. Fuoni Kwandundu sold approximately 450 sachets of "Virutubishi" from March to May 2021, with sales increasing to approximately 540 monthly sachets from June to August. In contrast, Bwejuu sold a maximum of 300 to 450 sachets of "Virutubishi" monthly. The sellers indicated that most parents and caregivers preferred to purchase a limited quantity of MNP daily rather than purchasing the entire package of 30 units. This may be attributed to a lack of sufficient funds.

Despite fluctuations in sales, both sellers noted relatively low figures. The preference for purchasing smaller quantities of MNPs daily rather than the entire package suggests that financial constraints are a significant factor among families.

Discussion

Socio-economic and Demographic Characteristics of the Respondents

The study's findings provide a detailed picture of the socio-demographics of mothers and caregivers in Zanzibar City, shedding light on their awareness and access to essential healthcare interventions such as micronutrient powders (MNPs). The diversity of educational backgrounds among participants, ranging from no formal education to university graduates, highlights the necessity of

tailoring informational campaigns about MNPs to accommodate varying levels of literacy and understanding. Similarly, the distribution of marital statuses, with a significant proportion being married (both monogamous and polygamous), widowed, divorced, or single, indicates the necessity of employing multifaceted approaches to reach different family structures effectively. Furthermore, the prevalence of households with one child under the age of five underscores the potential for targeted interventions to optimise the impact of MNPs on child nutrition and health outcomes.

These findings have implications for formulating policy and implementing healthcare practices to improve maternal and child health in Zanzibar. Policymakers and healthcare practitioners must recognise and address diversity within the community. Educational initiatives on MNPs must be tailored to suit the varying educational levels and marital statuses prevalent among mothers and caregivers. Moreover, interventions should consider the specific needs of households with multiple children under five, ensuring equitable access to MNPs and other essential healthcare services. By understanding and responding to the socio-demographic characteristics revealed in this study, policymakers can design more inclusive and practical strategies to enhance awareness, availability, and utilisation of MNPs, ultimately contributing to improved maternal and child health outcomes in Zanzibar City.

These findings are consistent with those of Khattak *et al*. (2017), which indicate that children of parents with higher education levels have better nutritional statuses than children of parents with lower education levels. This may be attributed to parents with higher education levels demonstrating greater awareness and higher income levels. Several studies have demonstrated a correlation between the nutritional status of children and their parents' literacy levels (Kunwar & Pilai, 2011; Burchi, 2012). Polygamous marriages result in more children, which places greater financial demands on the head of the household. Children who lived with both parents had better nutritional status than those with single parents (Odencrants *et al.,* 2013).

A study by Samuel *et al*. (2021) found that mothers aged 25 years and above were more likely to adhere to the use of MNPs than their younger counterparts. Several studies have demonstrated that families with children under five have better healthcare and consume healthier foods and supplements (Abuya *et al.,* 2012; Bhusal, 2022).

Concepts of mothers/caregivers regarding the importance of home fortification with MNP

The study has revealed a significant discrepancy in the awareness and utilisation of MNPs among mothers and caregivers in Zanzibar City. With the overwhelming majority remaining unaware of MNPs, there is a clear need for intensified educational campaigns to disseminate information about the benefits and availability of MNPs, mainly targeting underserved communities. Furthermore, the low utilisation rate among those aware of MNPs highlights the necessity for raising awareness and ensuring the accessibility and affordability of MNPs. The reliance on informal sources for information suggests the potential for leveraging community networks in disseminating knowledge about MNPs.

These findings emphasise the need to integrate MNPs into existing healthcare services and promote their usage through culturally appropriate channels, thus bridging the gap between policy intent and community practices in addressing childhood malnutrition. None of the respondents had ever used the MNPs per the WHO (2016) recommendations. Most mothers and caregivers who had used the MNPs during the study period reported no difference in the reaction to food consumed after mixing with the MNPs. That appetite had been improved in some children. These findings are consistent with those reported by Kodish *et al*. (2022).

Additionally, there were similar misconceptions regarding MNPs among parents of under-five children, as reported by Kasankala *et al*. (2018). These were associated with low education among the mothers and caregivers (Samuel *et al.,* 2021; Liu *et al.,* 2022). Some of the misconceptions included the belief among mothers and caregivers that MNPs were a government strategy to control birth rates and that consumption of MNPs would render their children infertile (Secure Nutrition, 2015). One mother at the RCH clinic stated that the MNPs were a strategy devised by Western countries to vaccinate children against the coronavirus forcibly. Other misconceptions were related to the side effects of MNP consumption, such as diarrhoea, vomiting, and abdominal discomfort. This led the mothers/caregivers to believe that MNPs have adverse outcomes on their children's health (Kyei-Arthur *et al.,* 2020). Additionally, some mothers and caregivers believed that children would lose their appetite for food if they disliked food mixed with MNPs, even when food was not mixed with MNPs (Goyena *et al.,* 2019).

Coverage and availability of micronutrients powder
The study provides a detailed understanding of the availability and utilisation of micronutrient powders (MNPs) among mothers and caregivers in Zanzibar City. Notwithstanding the notable awareness of MNPs, their availability remains constrained, with distribution predominantly managed by a single organisation. The fluctuating sales trends observed by shopkeepers indicate that some factors, including family financial constraints, influence demand for MNPs. This has led to a preference for purchasing smaller quantities. These findings emphasise the necessity of addressing accessibility constraints and tailoring distribution strategies to better align with the economic realities of caregivers. Policy interventions could focus on expanding distribution channels and exploring subsidy programmes to ensure equitable access to MNPs, aiming to enhance nutritional outcomes for under-five children in Zanzibar.

As per WHO (2011) recommendations, children under five should consume at least two sachets of MNPs per week. The results indicated a low level of coverage and utilisation of the product in Zanzibar, with only two regional outlets selling MNPs. A study in Kenya revealed that MNPs were utilized at a low rate among under-five children, in contrast to fortified foods, which were more readily available and consumed more frequently (Leyvraz *et al.,* 2018). Consequently, it was necessary to implement various distribution strategies for MNPs to encourage their usage. It is recommended that channels such as health facilities and community-based counselling be used to deliver education and the product (Jefferds *et al*., 2015; Tumilowicz *et al*., 2019). However, Schott *et al*. (2021) reported that a community-based MNP delivery system was more efficient.

One of the reasons for the cessation of MNP usage by mothers and caregivers was a shortage of the product (Tumilowicz *et al*., 2019). In this study, the MNPs were not readily available in nearby pharmacies, retail outlets, or health centres. The sole retailers offering the product had purchased it from the SOLEO agent in Dar es Salaam. The cost of the product has been identified as a significant barrier to utilisation by Jefferds *et al*. (2010). During the interview, some mothers and caregivers indicated they could not purchase the product thrice weekly.

Additionally, some mothers and caregivers reported lacking sufficient support from their partners and in-laws. The social, cultural and behavioural factors of mothers/caregivers were identified as the primary cause of the failure of numerous nutrition interventions (Schnefke *et al*., 2019). Health professionals in the RCH clinics did not promote the MNPs to mothers/caregivers during RCH clinics. This could be attributed to a lack of training on the part of the health workers.

Their primary responsibility is disseminating information and providing consumers with accurate guidance regarding MNPs (Creed-Kanashiro *et al.,* 2016; Locks *et al.,* 2018).

Usage of MNPs in Zanzibar

The findings indicate a significant lack of awareness and accessibility of micronutrient powders (MNPs) among mothers and caregivers in Zanzibar City. The baseline data indicates a striking absence of MNP usage, with over half of the respondents not utilising MNPs during the study period. The primary reasons for non-usage are disinterest and limited availability due to geographical constraints or a lack of nearby vendors. Although there was a modest increase in MNP usage towards the end-line period, it remained considerably low. These findings underscore the pressing necessity for targeted initiatives to enhance awareness and improve the accessibility of MNPs, particularly in remote areas. It is recommended that policy initiatives focus on strengthening distribution networks and implementing educational campaigns to promote the benefits of MNPs and mitigate nutritional deficiencies among children in Zanzibar. At the study's baseline, most mothers and caretakers were not utilising MNPs. This was due to a lack of awareness and accessibility to the product. This finding was consistent with that reported by Dusingizimana *et al*. (2021) in Rwanda.

The availability of MNPs was constrained even though the qualitative data indicated a low purchase rate by parents, which resulted in a correspondingly low demand. One of the vendors expressed frustration regarding the low sales of the MNPs, mainly the "Virutubishi" product. This was due to a lack of product promotion in Zanzibar. A study conducted in Kenya concluded that there was a necessity for the promotion of MNPs to ensure their continued availability (Suchdev *et al*., 2013). Furthermore, it is recommended that different strategies be employed to enhance the distribution channels and boost the uptake and adherence to the use of the product (Hodgins & Klemm, 2021).

Even though most parents were willing to utilise the MNPs following nutrition education and claimed to do so during the midline and end-line of the study, there was no significant increase in the sales rates reported by the sellers. The parents indicated the outlet location from which they purchased their MNPs, but after interviewing the sellers, they found no significant increase in MNP sales. Teshome et al. (2018) reported that parents and caregivers who self-reported home fortification practices overestimated their use and adherence to MNPs.

Sellers of MNPs in Zanzibar City reported that most parents purchased daily sachets rather than monthly packages due to their limited incomes. The purchase of individual sachets daily made it challenging to adhere to the recommended number of sachets per week due to the distance between households and shops. These findings were consistent with those of a study conducted in Rwanda by Dusingizimana *et al*. (2021).

Conclusion

There was a notable increase in the awareness of mothers and caregivers regarding MNPs, their usage, and the benefits associated with them during the study. Most mothers/caregivers had never seen the product at the study's outset. This indicated a lack of coverage of public nutrition programmes regarding home-based food fortification and product availability. Furthermore, the level of education impacted the overall acceptance and understanding of the benefits of MNP usage. Mothers and/or caregivers with higher levels of education exhibited more positive attitudes towards the product. The head of the household and other family members, such as in-laws, influence the usage of MNPs and their acceptability.

Recommendations

It is recommended that further promotion of the MNPs be undertaken in Zanzibar, particularly in health centres and RCH clinics, where mothers and caregivers of under-five children could benefit. Additionally, it was recommended that community health workers be trained to provide mothers and caregivers with accurate information about the MNP products.

Strengths and limitations

The study increased awareness among mothers and caregivers regarding the usage and benefits of MNPs for their children. Most participants lacked awareness of the product, and all were consuming MNPs at the study's baseline. The study was conducted during the global pandemic 2020, which undoubtedly influenced mothers' and caregivers' perceptions of nutritional programmes. Some of the responses provided by mothers and/or caregivers may have been inaccurate.

Competing Interests

None

Acknowledgements

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Magnitude of Repeat Use of Emergency Contraceptives Among Women of Reproductive Age in Tanzania

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Abstract

Background: Emergency contraceptives are intended to mitigate the risk of conceiving unwanted pregnancies following unprotected sexual intercourse. However, there is concern about the increasing repeated use of emergency contraceptive pills among women of reproductive age.

Objectives: This study aimed to determine the use and magnitude of repeated use of emergency contraceptive pills and associated factors among women of reproductive age.

Methods: A cross-sectional study was conducted in six out of twenty-six administrative regions of mainland Tanzania. A total of 1,284 women of reproductive age were interviewed using a structured questionnaire.

Results: The rate of ever use of emergency contraceptives was 17.4%. One out of 10 women of reproductive age have used emergency contraceptive pills in the previous 12 months. Nearly half of clients of emergency contraceptive pills were prevented by their spouses or partners from using regular family planning methods. Of the 224 users of emergency contraceptives, 198 (88.4%) affirmed that they had used the pills more than once. Of those, 159 (80.3%) reported to have used emergency contraceptive pills several times (more than three times). Knowledge of the use of emergency contraceptive pills varied with education, marital status, geographical location, age, and wealth index. Most women of reproductive age (82.9%) do not know the appropriate use of emergency contraceptive pills, particularly in Mbeya and Mwanza, where all interviewed women of reproductive age were not aware that emergency contraceptive pills are used to avoid unwanted pregnancy in emergencies only. A significantly low proportion of women of reproductive age in Mbeya (6.7%), adolescent girls (34.6%), slightly over one-third of married and unmarried women, and those in middle and lower wealth index knew the right time to take emergency contraceptive pills. A significantly low proportion of women of reproductive age in Mbeya (36.7%) agreed that emergency contraceptive pills are safe for use and that they can be recommended to a friend. Nearly one-third of women of reproductive age in Mwanza (27.3%), one-fifth of women of reproductive age with tertiary education (21.6%), and almost a quarter of employed women of reproductive age (24%) had a negative perception of the use of emergency contraceptive pills. Repeated use of emergency contraceptive pills was associated with the region of residence, the status of the use of regular FP methods, education, knowledge of indication and appropriate time to take emergency contraceptive pills, and perceived safety of emergency contraceptive pills.

Conclusion: Although the use of emergency contraceptives is still modest, the proportion of women of reproductive age who reported several repeated uses of emergency contraceptive pills is high, particularly so among women of reproductive age in Mwanza and Mtwara, those with tertiary education and those who do not know that prescription is not required to get emergency contraceptive pills. Interventions to educate women of reproductive age on indication and appropriate use of emergency contraceptives are required.

Keywords: Emergency Contraceptives, Pills, Repeated use, Tanzania

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Background

Women of reproductive age (WRA) may, at times, find themselves at risk of conceiving unintended pregnancy following unprotected sexual intercourse in a range of situations, including rape, drunkenness, and bribery. To mitigate this risk, WHO recommends making available over-the-counter emergency contraceptive pills (ECPs) without a doctor's prescription to women who wish to use them **(WHO, 2024)**. Several such pills are available, including those with ulipristal acetate (UPA) as the active ingredient and those with levonorgestrel (LNG) **(WHO, 2022)**. Usually, such pills are available in single-dose formulations or sometimes in split doses (**Atkins et al., 2021**).

Technically, emergency contraception refers to methods of contraception that can be used to prevent pregnancy after sexual intercourse. These are recommended for use within 5 days but are more effective the sooner they are used after the act of intercourse. The pills prevent pregnancy by preventing or delaying ovulation, and they do not induce an abortion. The copper-bearing IUD prevents fertilization by causing a chemical change in sperm and egg before they meet. Emergency contraception cannot interrupt an established pregnancy or harm a developing embryo (**WHO, 2018**).

The over-the-counter ECPs are very safe, with confirmed harmlessness to even women who cannot use routine hormonal contraceptive methods **(WHO, 2021; WHO, 2016)**. The ECPs have virtually no contraindications, partly due to the short-term nature of their use. The pills are also significantly efficacious, with the overall ability to prevent pregnancy by 95% **(WHO, 2021)**. However, several factors affect the effectiveness of ECPs, including the type of active ingredient and co-medications. Other user-related factors include the day within the menstrual cycle, the time lapse between intercourse and pill uptake, and body mass index (BMI) **(ECEC, 2023)**.

Since there are no absolute medical contraindications and no age limits for the use of emergency contraception, any woman or girl of reproductive age may need emergency contraception to avoid an unwanted pregnancy. In 2017, an estimated 308 million unwanted births were avoided because of the usage of modern contraception, including emergency contraceptives (**WHO,2019**). Between now and 2030, sub-Saharan Africa is projected to experience the largest increase in modern contraceptive use among its major regions (**UN, 2020**).

In Tanzania, the Family Planning guidelines recognize that all men and women, including young people (10–24 years of age), irrespective of their parity and marital status, are eligible to access accurate and complete family planning information, including ECPs, education, and services (**Mariki et al., 2022**). All individuals have a right to information about the benefits of family planning for themselves and their families. Individuals have the right to know where and how to obtain family planning information, both inside and outside a facility setting, to make informed choices about their method of preference **(TMDA, 2020)**. Clients also have a right to choose where to go for family planning services (i.e., physical location or service-delivery modes such as community-based family planning, pharmacy or over-the-counter service, hospital, health centre or family planning clinic) and the type of service provider with whom they feel most comfortable.

Accessibility of ECPs as over-the-counter drugs to end users has been argued to have multitudes of advantages, including imparting women with greater control over their health, reducing costs, and giving them convenience and confidentiality. On the other hand, there are concerns about the over-the-counter availability of ECPs, such that users miss personal contact with a healthcare provider for support and information. Without guidance from healthcare providers, there might be increased risky behaviour and misuse, including repeated use of the ECPs. This contrasts with the intended use of ECPs as they are not meant for regular use but rather as emergency intervention following unprotected sexual intercourse.

The WHO has identified several niche areas where there is an information gap regarding the over-the-counter availability of ECPs, and one of them is whether women who access ECPs have adequate information to take the pills correctly. In Tanzania, among several emergency oral contraceptives, Postinor-2 (P2) is more popular (TMDA, 2015). A study conducted in the northern part of Tanzania reported that 24.4% of females have ever used emergency contraceptives, of which 90.2% used the ECPs several times (**Mariki et al., 2022**). Overuse of ECPs has also been reported in Nigeria and Kenya (**Ajayi et al., 2017; Chin-Quee, 2014**). Recent anecdotal evidence indicates increasing repeat use of ECPs in Tanzania, but accurate data on ECPs repeat use and factors contributing to such practice is largely lacking. Therefore, this study was undertaken to determine the magnitude of repeated use of ECPs and identify factors contributing to repeated use among WRA.

Methods
Study design and sites
A cross-sectional study was conducted in six randomly selected regions of Tanzania's Mainland: Arusha, Dar es Salaam, Dodoma, Mwanza, Mbeya, and Mtwara.

Study population and sample size
With the accepted margin error of 2.5%, provided the confidence level is 95% and that 24% of WRA (married and unmarried) in Tanzania Mainland use ECs, the calculated sample size for women of reproductive age (WRA) was 1,129. After considering a non-response rate of 15%, the sample size was increased to 1,298. Dar Es Salaam region contributed 44% of the sample size. Thus, the proportion to population size technique was employed to sample the required number of study participants from three randomly selected councils.

Sampling procedures
A multistage sampling approach was employed to select WRA. In the first stage, 6 out of 26 (25%) regions. Except for Dar Es Salaam, in each of the remaining 5 regions, one council was randomly selected from a list of councils in the respective region. The selected councils included Meru, Kondoa, Rungwe, Masasi, and Magu in Arusha, Dodoma, Mtwara, Mbeya, and Mwanza regions, respectively (2nd stage). Due to its socioeconomic diversity and the fact that many WRA, Temeke, Ubungo, and Ilala councils in Dar es Salaam were randomly selected to participate in this study,

With the help of village or street leaders, a list of households with a woman of reproductive age (WRA) was prepared and used as a sampling frame in the respective villages and streets. A systematic sampling approach was used to select households. A WRA (15 – 49 years) was interviewed in each sampled household. However, where there was more than one eligible woman, the person to be interviewed was selected using a simple random sampling technique.

Data collection
A structured questionnaire was used to collect the required information, which included the sociodemographic profile of WRA, the use of ECPs, frequency of use, and the circumstances which led to the use of ECPs. Other collected information included knowledge on indication and appropriate time to take ECPs, awareness of ECPs availability in the market, and the fact that no prescription is required to get ECPs. Perceived ECP safety was assessed using a positive and negative statement with 5 response options: 1 strongly agree to 5 strongly disagree. In the analysis, the response to the negative statement was reversed, and the total score was generated by summing

up the scores for positive and negative statements and then dichotomizing the score into agreed and disagreed.

Data analysis

Responses from open-ended questions were coded to generate quantifiable responses. Frequency distribution was used to study data patterns and search for inconsistencies. The bivariate association was deduced from the Chi-square test. Multivariate analysis was performed to explore how age and location interact with other social factors to influence access and use of ECPs. Comparison across stratified groups was done using Chi-square or other appropriate statistical tests. The wealth index was assessed using household dwellings and poor population indicators. The number of household members, building materials used for walls and floor, source of fuel for cooking, and household possessions, including land for cultivation and livestock, were summed up and created variables grouped into four quintiles (high, middle, low, and lower wealth index). Data was analysed using SPSS version 21.

Ethical considerations

Ethical clearance was sought from the Medical Research Coordinating Committee of the National Institute for Medical Research – Ref Number NIMR/HQ/R.8a/Vol.IX/4499. Permission to implement the study was sought from relevant authorities. Before any interview with individual respondents, the informed consent and assent forms (for study participants below 18 years) were read in a language the respondent understood. Privacy and confidentiality were maintained throughout the study. Participants were free to withdraw from the study at any point during the interview without worrying they would be penalized.

Results

Profile of study participants

The response rate was 98.9%, most respondents (61%) belonged to the middle wealth quintile, and over 40% were unmarried and attained primary and secondary education (Table 1). A significantly high proportion of WRA in the middle wealth quintile live in urban areas (not shown in the table: 75% urban versus 51.9% rural; P<0.0001). Mbeya (75%) and Dodoma (71.1%) had a significantly high proportion of WRA who peasants were. The mean age at marriage was 21 years (SD=3.9), and more than 10% of WRA in Mwanza (14.1%), Mtwara (13%), and Dodoma (11.8%) got married before the age of 18 years. Over half of WRA have heard about ECPs. However, a significantly low proportion of WRA in Mbeya (16.7%), Dodoma (24.5%), and Mtwara (34.5%), those with no formal education (36.2%) and those aged 40 – 44 years (41%), cohabiting (42%), peasants (37%), those in lower wealth index (42%) and rural dwellers (50%) have heard about ECPs (Table 1).

Table 1. Profile of the Interviewed Women of Reproductive Age and Those Who Have Heard About Emergency Contraceptive Pills (N = 1,284)

	Profile		Heard about ECPs	
	Number	**Per cent**	**Number**	**Per cent**
Age group				
15 – 19 years	185	14.4	95	51.4
20 – 24 years	301	23.4	188	62.5
25 – 29 years	270	21.0	168	62.2
30 – 34 years	217	16.9	124	57.1

35 – 39 years	148	11.5	66	44.6
40 – 44 years	105	8.2	43	41.0*
45 – 49 years	48	4.5	31	53.4
Education level				
Primary	557	43.4	237	42.5
Secondary	555	43.2	345	62.2
Tertiary	125	9.7	116	92.8
No education	47	3.7	17	36.2*
Current marital status				
Married	541	42.1	267	49.1
Cohabiting	133	10.4	56	42.1*
Married but not living together	36	2.8	24	66.7
Not married	574	44.7	368	64.1
Occupation				
Peasant	288	22.4	97	33.7*
Petty business	504	39.3	298	59.1
Livestock	12	0.9	7	58.3
Employed	75	5.8	60	80.0
Self-employed	148	11.5	93	62.8
Student	153	11.9	98	64.1
Other	104	8.1	62	59.6
Wealth Index				
High	169	13.2	91	53.8
Middle	783	61.0	470	60.0
Low	287	22.4	135	47.0
Lower	45	3.5	19	42.2*
Residence				
Urban	504	39.3	320	63.5
Rural	780	60.7	295	50.6*
All	**1,284**	**100.0**	**715**	**55.7**

Use of Emergency Oral Contraceptives
Of the interviewed WRA, 17.4% reported to have ever used ECPs. The use of ECPs varied slightly in terms of education, socioeconomic status, age, location of residence, and marital status. A significantly high proportion of those who have ever used ECP were from Magu-Mwanza (36.4%), followed by Masasi-Mtwara (26.2%) and Meru-Arusha (20%). Among WRAs who used ECPs, 20.3% were aged 25 – 29 years, and 19.2% were unmarried.

Table 2. Prevalence of ECPs Use in Different Periods (N=1,284)

Council	1 – 7 days	2 – 4 weeks	1 – 3 months	4 – 6 months	7 – 12 months	>12 months	Ever used	Previous 12 months	Used at least once
Meru	2.6	2.6	2.6	4.0	2.0	13.2	20.5	13.1	27.2
Ilala	3.1	0.1	1.3	0.0	0.4	13.8	4.9	5.3	19.1
Ubungo	4.5	5.1	4.5	4.5	0.0	9.6	17.8	18.5	28.0
Temeke	0.4	0.0	2.6	4.4	2.6	19.3	13.2	10.1	29.4
Kondoa	2.5	0.0	3.8	0.6	1.9	9.4	8.2	8.8	18.2
Rungwe	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	15.0
Masasi	0.0	0.0	1.2	2.4	7.1	47.6	26.2	10.7	58.3
Magu	0.5	0.5	2.3	2.7	4.1	8.2	36.4	10.0	36.4
All	**1.9**	**1.1**	**2.5**	**2.5**	**2.5**	**14.3**	**17.4**	**10.1**	**24.4**

To check on questions determining the prevalence of lifetime use of ECPs, each respondent was asked when the last time she used ECPs was. The percentage of WRA who reported to have used ECPs at least once was increased from 17.4% to 24.4%. None of the WRA in Rungwe reported to have used ECPs in the past 12 months. In Masasi-Mtwara, a significantly high proportion of WRA (58.3%; P value=.001) reported to have used ECPs at least once in their lifetime (Table 2). The use of ECPs at least once was commonly reported by young women aged 20 – 24 years and women aged 40 - 44 years (Table 3). High use of ECPs was observed in Councils, where most interviewed WRAs acknowledged that they were not using any of the regular FP methods (Figure 1).
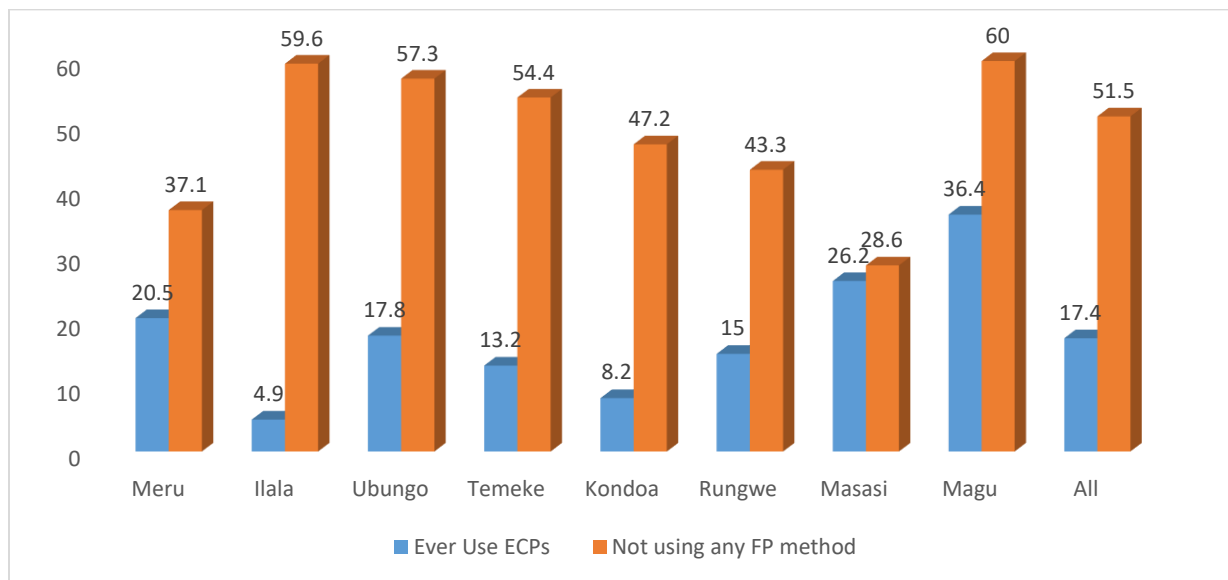
Figure 1. Relationship Between ECPs and Current Use of FP methods

Repeat Use of Emergency Oral Contraceptives
Among WRA who used ECPs in the past 12 months, 54.5% reported repeat use, and a substantial proportion of users (25.6%) consumed ECPs up to three times in a week (Table 4). The councils with a high proportion of WRA who had used ECPs more than three times in the past 12 months included Magu (100%), Kondoa (75%), Masasi (70%), and Ubungo (61%) (Table 5). In addition, nearly half of

those who used ECPs more than 3 times in the past 12 months were aged 15 – 19 years (42.9%) and 30 – 34 years (Table 3).

Table 3. Prevalence of ECPs Use by Age Group (N=1,284)

Age group	1 – 7 days	2 – 4 weeks	1 – 3 months	4 – 6 months	7 – 12 months	>12 months	Ever used	Previous 12 months	Used at least once
15 – 19	1.6	0.5	1.6	2.2	1.6	**19.5**	13.5	7.6	27.0
20 – 24	1.3	1.7	4.7	2.0	2.3	11.0	16.9	12.0	22.9
25 – 29	2.6	1.9	3.3	1.9	3.3	15.6	19.6	13.0	**28.5**
30 – 34	0.9	0.9	0.9	4.6	2.3	14.3	**20.3**	9.7	24.0
35 – 39	1.4	0.0	0.0	2.7	2.0	16.9	18.2	6.1	23.0
40 – 44	1.0	0.0	1.9	1.9	0.0	7.6	17.1	4.8	12.4
45 – 49	8.6	1.7	3.4	1.7	1.7	13.8	10.3	**17.2**	**31.0**
All	**1.9**	**1.1**	**2.5**	**2.5**	**2.2**	**14.3**	**17.4**	**10.1**	**24.4**
P value	**.01**	**.01**	**.01**	**.01**	**.01**	**.01**	**.39**	**.01**	**.04**

Table 4. Proportion of WRA Reporting Repeat ECPs Use by Period of Consumption (N = 313)

Period	2 – 3 times	>3 times	All
1 – 7 days	25.6	8.8	8.1
2 – 4 weeks	12.8	5.0	6.6
1 – 3 months	15.4	12.6	13.1
4 – 6 months	10.3	16.4	15.2
7 – 12 months	2.6	13.8	11.6
>12 months	28.2	44.0	40.9
Ever used	28.2	31.4	30.8
Past 12 months	66.7	51.6	54.5

Table 5. Proportion of WRA who Used ECPs More Than Three Times by Council and Period of Consumption (N=198)

	1 – 7 days	2 – 4 weeks	1 – 3 months	4 – 6 months	7 – 12 months	>12 months	Ever used	Past 12 months
Meru	7.4	3.7	11.1	22.2	11.1	40.7	40.7	55.6
Ilala	8.3	-	16.7	-	-	58.3	25.0	25.9
Ubungo	6.5	19.4	19.4	16.1	-	38.7	22.6	61.3
Temeke	2.6	-	7.9	23.7	13.2	50.0	15.8	47.4
Kondoa	0.0	-	50.0	0.0	25.0	25.0	75.0	75.0
Rungwe	-	-	-	-	-	-	-	-
Masasi	-	-	-	20.0	50.0	30.0	30.0	70.0
Magu	2.7	10.8	10.8	21.6	45.9	8.1	45.9	100.0
All	**3.8**	**5.0**	**12.6**	**16.4**	**13.8**	**44.0**	**31.4**	**51.6**

Circumstances of Oral Emergency Contraceptive Use

A significantly high proportion of WRA who used ECPs at any point in their lives (47.9%) said their spouses/partners prevented them from using regular FP methods (Figure 2).
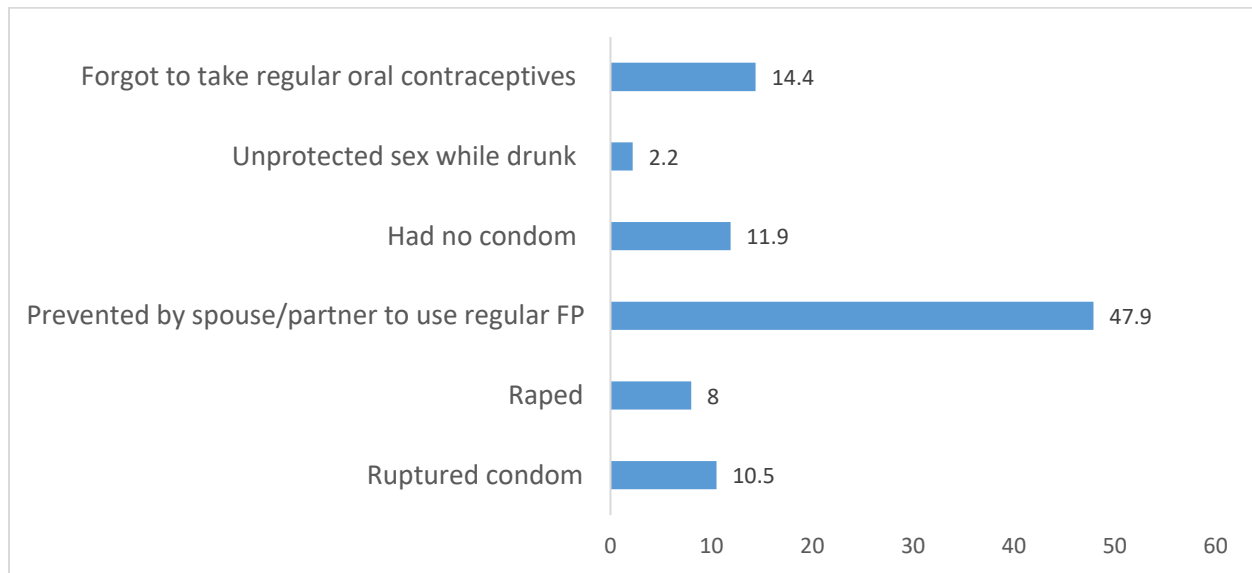
Figure 2. Circumstances which led to the use of Emergency Contraceptive Pills

Knowledge of Appropriate Use and Right Time to Take ECPs

Over half of the interviewed did not know the correct use of ECPs or when the right time to take them was. Knowledge varied with geographical location, age, occupation, education, and marital status. A high proportion of WRA in Kondoa and Rungwe, unmarried adolescent girls and older women, those with less or no education, and rural dwellers had limited knowledge of the appropriate use of ECPs and the right time to take them (Table 6).

Table 6. Knowledge of Appropriate Use and Most Right Time to Take Emergency Contraceptive Pills (N = 1,284)

	Don't know the appropriate use of ECPs n (%)	Don't know the right time to take ECPs n (%)
All	**735 (57.2)**	**750 (58.4)**
Council		
Meru	76 (50.3)	80 (53.0)
Ilala	130 (57.8)	**155 (68.9)****
Ubungo	83 (52.9)	88 (56.1)
Temeke	110 (48.2)	127 (55.7)
Kondoa	**127 (79.9)****	**128 (80.5)****
Rungwe	**51 (85.0)****	**54 (90.0)****
Masasi	58 (69.0)	16 (19.0)
Magu	100 (45.5)	102 (46.4)
Age group		
15 – 19 years	**119 (64.3)****	110 (59.5)

20 – 24 years	153 (50.8)	167 (55.5)
25 – 29 years	141 (52.2)	146 (54.1)
30 – 34 years	118 (54.4)	125 (57.6)
35 – 39 years	89 (60.1)	90 (60.8)
40 – 44 years	**72 (68.6)****	**77 (73.3)****
45 – 49 years	**43 (74.1)****	35 (60.8)
Education level		
Primary	**366 (65.7)****	**381 (68.4)****
Secondary	298 (53.7)	296 (53.3)
Tertiary	38 (30.4)	43 (34.4)
No education	**33 (70.2)****	**30 (63.8)****
Marital status		
Married	**455 (64.1)****	**463 (65.2)****
Unmarried	280 (48.8)	287 (50.0)
Occupation		
Peasant	**204 (70.8)****	198 (68.8)
Petty business	269 (53.4)	288 (57.1)
Livestock	**11 (91.7)****	**9 (75.0)****
Employed	32 (42.7)	30 (40.0)
Self-employed	77 (52.0)	74 (50.0)
Student	85 (55.6)	82 (53.6)
Other	57 (54.8)	69 (66.3)
Wealth Index		
High	91 (53.8)	91 (53.8)
Middle	434 (55.4)	447 (57.1)
Low	179 (62.4)	179 (62.4)
Lower	31 (68.9)	33 (73.3)
Residence		
Urban	270 (53.3)	309 (61.3)
Rural	**465 (59.6)***	441 (56.5)

**P<0.001; *P<0.05

Perception of WRA on the use and safety of ECPs

Generally, WRAs had a positive perception of using ECPs. However, a significantly low proportion of WRAs in Mbeya (36.7%) agreed that ECPs are safe for use and can be recommended to a friend. Nearly one-third of WRAs in Mwanza (27.3%), one-fifth of WRAs with tertiary education (21.6%), and almost a quarter of employed WRAs (24%) had a negative perception of the use of ECPs (Table 7).

Table 7. Perception on Use of ECPs Among of Women of Reproductive Age

	Agreed that ECPs are safe for use and can be recommended to a friend (Positive perception) – n (%)	Agreed that ECPs are not safe, kill the foetus, promote promiscuous and spread of STIs/HIV (Negative perception) – n (%)
All	978 (76.2)	142 (11.1)
Council		

Meru	142 (94.0)	17 (11.3)
Ilala	135 (60.0)	16 (7.1)
Ubungo	103 (65.6)	18 (11.5)
Temeke	182 (79.8)	17 (7.5)
Kondoa	131 (82.4)	9 (5.7)
Rungwe	**22 (36.7)***	1 (1.7)
Masasi	71 (84.5)	4 (4.8)
Magu	192 (84.5)	**60 (27.3)***
Age group		
15 – 19 years	133 (71.9)	27 (14.6)
20 – 24 years	242 (80.4)	31 (10.3)
25 – 29 years	213 (78.9)	29 (10.7)
30 – 34 years	172 (79.3)	26 (12.0)
35 – 39 years	112 (75.7)	12 (8.1)
40 – 44 years	**69 (65.7)***	9 (8.6)
45 – 49 years	**37 (63.8)***	8 (13.8)
Education level attained		
Primary	432 (77.6)	41 (7.4)
Secondary	403 (72.6)	70 (12.6)
Tertiary	111 (88.8)	**27 (21.6)***
No education	**32 (68.1)***	4 (8.5)
Current marital status		
Married	407 (75.2)	43 (7.9)
Cohabiting	106 (79.7)	9 (6.8)
Not living together, married	23 (63.9)	4 (11.1)
Not married	442 (77.0)	86 (15.0)
Occupation		
Peasant	219 (76.0)	9 (3.1)
Petty business	384 (76.2)	54 (10.7)
Livestock	7 (58.3)	1 (8.3)
Employed	59 (78.7)	**18 (24.0)***
Self-employed	115 (77.7)	22 (14.9)
Student	116 (75.8)	27 (17.6)
Other	78 (75.0)	11 (10.6)
Wealth Index		
High	125 (74.0)	25 (14.8)
Middle	606 (77.4)	94 (12.0)
Low	212 (73.9)	21 (7.3)
Lower	35 (77.8)	**2 (4.4)***
Location		
Urban	368 (73.0)	**78 (15.5)***
Rural	**610 (78.2)***	64 (8.2)

*P<0.01

Factors associated with repeated ECP use

In multinomial logistic regression, councils where WRA live, age and occupation maintained their significant association with repeat use of ECPs. WRA in Temeke (OR = 0.07; 95% CI 0.01 – 0.34) and Masasi (OR = 0.03; 95% CI 0.002 – 0.37) were less likely to report repeat use of ECPs in three months when compared to WRA in Magu. Compared with other occupations, peasants, petty business, livestock keepers, employed, self-employed, and students were less likely to report repeat use of ECPs within three months (Table 8). However, when interaction term access point and access rating were included in the model, WRA in urban with easy access to health facilities were more likely to report repeat use of ECPs in three months (OR=2.9, 95% CI 11.0 – 8.4; p=0.044). Similarly, WRA in Ubungo (OR = 7.9; 95% CI 1.2 – 44.5; p = 0.029) and Ilala (OR = 5.7, 95% CI 1.2 – 26.9) WRA who acknowledged that there is no difficulty in accessing ECPs were more likely to report repeat use within the three months.

Table 8. Factors Associated with Repeated Use of Emergency Contraceptive Pills

	Odd Ratio	95% CI
Council		
Meru	1.5	0.28 – 7.81
Ilala	0.8	0.78 – 3.87
Ubungo	2.8	0.74 – 10.9
Temeke	**0.1**	**0.01 – 0.34**
Kondoa	3.6	0.65 – 24.5
Rungwe	-	-
Masasi	**0.03**	**0.002 – 0.37**
Magu	1	
Age group		
15 – 19 years	0.23	0.03 – 1.68
20 – 24 years	0.47	0.19 – 2.48
25 – 29 years	0.20	0.04 – 1.07
30 – 34 years	**0.07**	**0.01 – 0.48**
35 – 39 years	**0.03**	**0.004 – 0.31**
40 – 44 years	0.29	0.03 – 2.94
45 – 49 years	1	
Education level attained		
Primary	0.46	0.07 – 3.09
Secondary	0.29	0.04 – 1.96
Tertiary	0.60	0.08 – 4.47
No education	1	
Current marital status		
Married	1.05	0.46 – 2.43
Unmarried	1	
Occupation		
Peasant	**0.15**	**0.03 – 0.95**
Petty business	**0.11**	**0.03 – 0.41**
Livestock	**0.02**	**0.001 – 0.912**
Employed	**0.15**	**0.03 – 0.79**

Self-employed	**0.06**	**0.01 – 0.35**
Student	**0.05**	**0.01 – 0.33**
Other	1	
Wealth Index		
High	0.9	0.09 – 21.5
Middle	1.2	0.13 – 22.1
Low	1.2	0.11 – 22.1
Lower	1	
Location		
Urban	1.8	0.62 – 6.10
Rural	1	
ECPs are safe for use	1.2	0.62 – 6.10
ECPs promote promiscuous	3.2	1.01 – 10.5
Do not know correct ECPs use	0.9	0.38 – 1.97
Do not know right time to take ECPs	0.9	0.24 – 3.23
Not using any FP method	2.1	0.95 – 4.83

Discussion

Coercive intercourse towards women of reproductive age (WRA) is among a range of causal situations that often put this group of people into conceiving unintended pregnancies **(Fauˊndes et al., 2003)**. The worldwide introduction of emergency contraceptives, as recommended by the WHO, aims to safeguard WRA against this socioeconomic burden of medical importance **(WHO, 1998)**. The simplistic nature of the use of pill-forms of these contraceptives, coupled with their excellent safety profile, have made authorities all over the world categorize them as over-the-counter drugs and, therefore, bypass the need for a doctor's prescription **(Jackson et al., 2003; Leelakanok et al., 2020)**. This enhances access and makes them ideal for risk mitigation against unintended pregnancies to WRA in emergencies **(Mariki et al., 2022)**.

This study has revealed a well-distributed clientele of ECPs across age groups, geographical locations, economic status, and marital status in Tanzania. The overall use rate of 17.4% is distributed across regions, ranging from the lowest in Dodoma (8.2%) to the highest in Mwanza (36.4%). The use rate of ECPs is more meaningfully interpreted when compared to the rate of unintended pregnancies in the study society. According to one organization that deals with reproductive health issues, Guttmacher, the annual average occurrences of unintended pregnancies in the years 2015 through 2019 in Tanzania was 105 pregnancies per 1,000 women aged 15 to 49 years (Guttmacher Institute**, 2022**). The East African average was 99 pregnancies per 1,000 WRA. By implication, therefore, the revealed rate of use of 17.4% still leaves around 10% of WRAs to unintended pregnancies.

Multitudes of reasons have been put forward by the interviewees in this study as to why they use ECPs. The reasons include rape, raptured condom, alcohol influence, lack of condom, partner's objection to using regular FP methods, and forgetfulness to take regular oral contraceptives. For all these reasons, mentioning the partner's objection to regular FP methods is the most common. As such, this reason alone is almost mentioned more often than all other reasons combined. This implies a continued presence of male dominance and the ill effects of Tanzanian society on decision-making.

A notable disparity between Mbeya and the other regions in the reported use rate within the past 12 months calls for attention. Mbeya has shown a zero-use rate among the interviewees in the past 12

months. Without an immediate probable reason for this disparity, it may be assumed that the results have occurred by chance due to sampling. Nonetheless, particular attention may be needed in this region. This calls for further research to unveil any hidden reason behind this.

Despite the unmatched proportion of users of ECPs versus the actual need for the service, as shown above, there are concerns that there is a probable irrationality, particularly overuse of emergency contraceptive pills in Tanzanian society. This concern comes from a range of hints starting from speculative experts' ideas, anecdotal literature as well as sporadic studies done in patchy geographical areas that do not ideally represent the whole country **(Kagashe *et al.*, 2013; Mariki *et al.*, 2022; Samson *et al.*, 2023; Hinju *et al.*, 2005; Karwani *et al.*, 2024)**. This was the reason why this study was carried out. This study has revealed a significant level of irrational overuse of emergency contraceptive pills among users in Tanzania. This high proportion of WRAs who overuse ECPs accounts for almost 80% of all such users.

Although ECPs have been commended for their impressive tolerability by the users and appreciable protection against unintended pregnancies, these pills are not ideal for regular use. Replacing regular FP methods with ECPs or any level of overuse of the ECPs has to be avoided for many reasons. These include the fact that ECPs are less effective than regular contraceptive methods. Regular contraceptives like birth control pills, intrauterine devices (IUDs), and implants provide more reliable and consistent protection against pregnancy when used correctly. Emergency contraceptive pills are designed for occasional emergencies and must be taken within a specific time frame after unprotected intercourse (usually within 72-120 hours) **(Mariki *et al.*, 2022)**. This timing can be difficult to manage consistently and is less practical than regular contraceptives.

From a biological point of view, ECPs contain higher doses of hormones compared to regular contraceptive pills. Frequent use of high doses can lead to more pronounced side effects such as nausea, irregular bleeding, and hormonal imbalances (**Leelakanok *et al.*, 2020)**. Other rational reasons that have excluded ECPs from regular use include menstrual cycle disruption, where regular use of ECPs can lead to irregular menstrual cycles, making it difficult to predict ovulation and menstrual periods, which can cause additional stress and uncertainty. Emergency contraceptive pills also do not protect against sexually transmitted infections (STIs); instead, consistent use of condoms, in conjunction with regular contraceptives, is recommended for STI prevention. Consideration of costs and accessibility is also important; it should be noted that regular use of ECPs can be more expensive and less accessible compared to obtaining a prescription for regular contraceptives, which are often covered by insurance and available in longer-term supplies. Therefore, it is recommended to use more effective, lower-dose, and more manageable methods of contraception for ongoing family planning needs rather than relying on ECPs.

Conclusion

By and large, this study reveals two main issues of concern about ECPs in Tanzanian society: the presence of a significant number of WRA who still do not use ECPs despite their exposure to unconsented yet unprotected intercourse, thus leading to unintended pregnancy and the presence of a significant number of WRA who irrationally use ECPs by making them their regular FP methods. It is recommended that educational programs, particularly for women of reproductive age, be introduced to society to bridge this knowledge gap on the proper use of ECPs.

Study limitations

This study divulges the existing situation of ECP overuse in Tanzania by limiting its scope to quantitative methods. However, with limited discussion of the reasons behind it, it hardly offers solutions to mitigate the overuse. Therefore, further research of a qualitative nature is called for.

Conflict of interest: None.

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Prevalence and risk factors for depression among patients with spinal cord injury attended at Kilimanjaro Christian Medical Centre from August 2021 to May 2022

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Abstract

Background: Depression after SCI inhibits physical rehabilitation and exacerbates physical health complications, which results in more extended lengths of stay for inpatient care, less independence following discharge, poor compliance with self-care, higher medical expenses, and increased risk of suicide.

Objective: To determine the prevalence and risk of depression among patients with SCI who attended Kilimanjaro Christian Medical Center from August 2021 to June 2022.

Methodology: This is a hospital-based analytical cross-sectional study conducted at KCMC orthopedic and physiotherapy departments whereby 129 patients with SCI were captured, and those who were below 18 years, with less than 2 weeks of history of spinal cord injury, polytrauma patients, patients with a history of psychiatric illness and SCI patients with cognitive speech problems were excluded from the study .74 patients were interviewed using questionnaire and Swahili version of PHQ-9 depression assessment questionnaire. The associations were measured using the Fischer exact test and Odds ratio with 95% CI with a significance level set at $p<0.05$.

Results: 74 participants were included in this study, the median age of the study participants being 36 years, ranging (from 21 to 74) years, and predominantly males being 55 (74.3%). The prevalence of Depression after SCI was found to be 35.1%. Factors such as SCI duration of ≥ 6 months (OR=3.50, 95% CI: 2.44 – 28.0, p=0.001), having pressure sore (OR=8.40, 95% CI: 1.02 – 6.92, p<0.001), having bowel dysfunction (OR= 3.20, 95% CI: 2.02 – 6.75, p=0.001), having sexual dysfunction (OR=3.80, 95% CI: 3.50 – 4.80, p=0.001) and non-surgical management of SCI (OR=11.40, 95% CI: 1.41 – 91.86, p=0.023), have more odds of developing depression after SCI and were statistically significance.

Conclusion: More than a third of patients with SCI had depression. The risk factors of depression after SCI included patients with Complete SCI (ASIA A), Cervical spine injury, patients managed conservatively, those with prolonged hospital stay, patients without health insurance and patients with complications after SCI such as pressure ulcers, neurogenic bowel, neurogenic bladder, and sexual dysfunction.

Keywords: Spinal cord injury, Depression, KCMC

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Introduction

The spinal cord serves as the conduit for information between the brain and peripheral, so cord Injury is a devastating condition that results from an insult to the spinal cord and causes damage that will affect the conduction of sensory and motor signals across the site(s) of the lesion(s). The annual global incidence of spinal cord injury ranges between 8.3-10.4 per million people, with variation seen in developed and developing countries (Knowledge, 2010)

90% of spinal cord injuries are caused by trauma, mainly Motor traffic crashes. Falling from height is the second cause of SCI, but it has been reported to increase the number of falls in recent years in developing countries. (Moshi *et al.*, 2020).

Young males of economic and reproductive age are more affected than others. As a result, mortality after SCI is five times higher compared to people without an SCI, with worse survival rates in low and middle-income countries. Men to women (2:1). (WHO, 2015). Trauma to the vertebrae may occur at a different level of the spine: Cervical C1-C7, Thoracic T1-T12, Lumbar L1-L2, and sacral spine S1-S2. The patient may develop body weakness after trauma that could be quadriplegia when the injury occurs at the cervical or higher thoracic and paraplegia when it occurs at the lumbar vertebra (Jr, 2017).

After trauma, the Severity of spinal cord injury is checked by assessing neurological deficit by clinical examination of a critical group of muscles and sensory functions below the level of spine injury. The commonly used score system is the ASIA scale to score neurological deficit after injury, and the patient may have Complete spine injury (Asia A), incomplete spine injury (BCD) or normal sensory and motor function below injury level (Asia E) after assessment. (Jr, 2017).

Management of spinal cord injury starts with advanced trauma life support (ATLS), resuscitation, then initial management by stabilizing the spine using neck colour, halo-vest, and skull traction for cervical injury and thoracolumbar corset for thoracic and lumbar spine injury to prevent secondary damage and disease progress from less severe to Severe form of spine cord injury and prevents complication. Radiological examination, usually by X-rays and CT scan, is used for osseous assessment of the spine vertebra and its stability, and an MRI is performed for soft tissue (disc, cord, nerve, and nerve roots) pathology. (Fehlings, 2017).

Definitive management after spinal cord injury could be surgical or non-surgical, depending on the severity and stability of the spine after injury. Surgical management is associated with fewer hospital stays, and patients will start early ambulation, which helps to minimize complications after SCI. Management of SCI patients involves a multi-disciplinary approach with Psychotherapy, daily social support, physiotherapy, and rehabilitation. (Fehlings, 2017).

SCI results significantly in reduced functional independence and difficulties with socialization. Many individuals with SCI will experience severe medical complications, including pressure ulcers, pneumonia, deep venous thrombosis, neurogenic bladder and bowel dysfunction, spasticity, and pain.(Sezer, Akkuş and Uğurlu, 2015)

Also, SCI patients experience severe psychological, psychosocial, and neurobehavioral issues. For example, they are at increased risk of developing anxiety disorders, substance abuse, feelings of helplessness, poor coping skills, low self-esteem, and Depression.

Depression is a mental disorder that presents sadness, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep or appetite, feelings of tiredness, and poor concentration(World Health Organization, 2017). Depression tends to affect the quality of life of affected individuals, and it depends on disease severity. Sometimes, it may lead to suicide(Kanter *et al.*, 2008). Depression is among the high-ranked causes of disability globally. Depression is a common mental disorder, and more than 300 million people worldwide suffer from an episode of Depression(WHO, 2015). WHO ranked Depression the fourth leading cause of disability worldwide.

Duration of depressive symptoms is an essential criterion in making a diagnosis in patients suspected to have Depression with loss of interest or pleasure in nearly all activities as key core features of the illness. Depressive symptoms should be present most of the time for at least two consecutive weeks to make a diagnosis, distinguishing Depression from ordinary mood changes (Saito *et al.*, 2010). Risk factors for depression after SCI include age, pattern and severity of SCI injury, duration of injury, physical complications after SCI, extended hospital stay, expenses in management and level of social family support. (Lohoff, 2010).

Methodology
Study design
This hospital-based analytical cross-sectional study involved all patients with spinal cord injuries who attended the KCMC orthopaedics and physiotherapy department from August 2021 to June 2022.
Study area
This study was conducted at KCMC Hospital in northern Tanzania. The hospital serves about eleven million people from neighbouring regions and sometimes outside the country. It is a referral hospital in Tanzania in the Moshi Rural district of the Kilimanjaro Region. According to the 2012 national census, the region and district had a population of 1,640,087 and 201,150 respectively.
Study population
From August 2021 to June 2022, all patients with SCI were admitted to orthopaedic wards and attended the orthopaedic and physiotherapy clinics at KCMC Hospital.
Study variables
Independent variable
Age, Sex, level of education, occupation, marital status, Mechanism of injury, duration of injury, the severity of the injury, duration of hospital stays, and Complications of injury.
Dependent variables: Depression after SCI
Eligibility Criteria
Inclusion and Exclusion criteria: All patients above 18 with SCI attended KCMC hospital
during the study period.
Exclusion criteria
Patients with a previous history of psychiatric illness and Patients with severe cognitive speech impairment. Patients with incomplete or missing information on files or hospital electronic systems.
Sample Size and Sampling Technique.
Sampling methods
All patients admitted during the study period who met the inclusion criteria were considered, and a convenient sampling technique was used to select candidates.
Sample size
The minimum sample size was calculated according to the following formula:
Prevalence was estimated to be 5%.(Bombardier *et al.*, 2012)
This was a cross-sectional study done from data from 2008 to 2010
$$n = \frac{Z^2 P (1 - P)}{(SE)^2}$$
Where- by;
Z =standard deviation = 1.96
P= proportion.
SE= is the standard tolerable error (0.05).
n =is a minimum required sample size
From the calculation, the minimum sample size was approximately 73 patients.

Data Collection Tools, Methods, and Procedures
Data collection tools
Data were collected using a structured questionnaire and PHQ-9 checklist for depression symptoms assessment. The questionnaire comprised socio-demographic information, the mechanism of injury, the duration of injury, the severity of the injury, the duration of hospital stay, complications after SCI injury, and initial and definitive treatment modalities after spinal cord injury. Depression after Spinal cord injury was assessed using PHQ-9.

Data collection methods and procedure
All SCI patients admitted to the orthopaedic ward and those who attended physiotherapy and orthopaedic follow-up clinics were identified, and patients who met the inclusion criteria were approached. The scope of the study was explained, and consent was sought. A structured questionnaire was used to collect data. The details of the socio-demographic data, mechanism of injury, duration of injury, level of injury, severity of the injury, mode of treatment, complications of injury, and duration of stay at the hospital were initial and final treatments of SCI obtained from patients and the files system.

Depression was measured using the Patient Health Questionnaire Score (PHQ-9). The PHQ-9 contains nine questions about depressive symptoms over the past two weeks. Patients were then asked to respond to nine depressive symptoms that appeared on the PHQ-9 checklist. Each question has four possible responses, scoring 0 to 3. Then the reaction of Items was summed, ranging from 0-27. A score above 10 was used as a cut-off to indicate possible Depression. The extracted data were exported into Excel and transferred into a secured hard drive for the study utility.
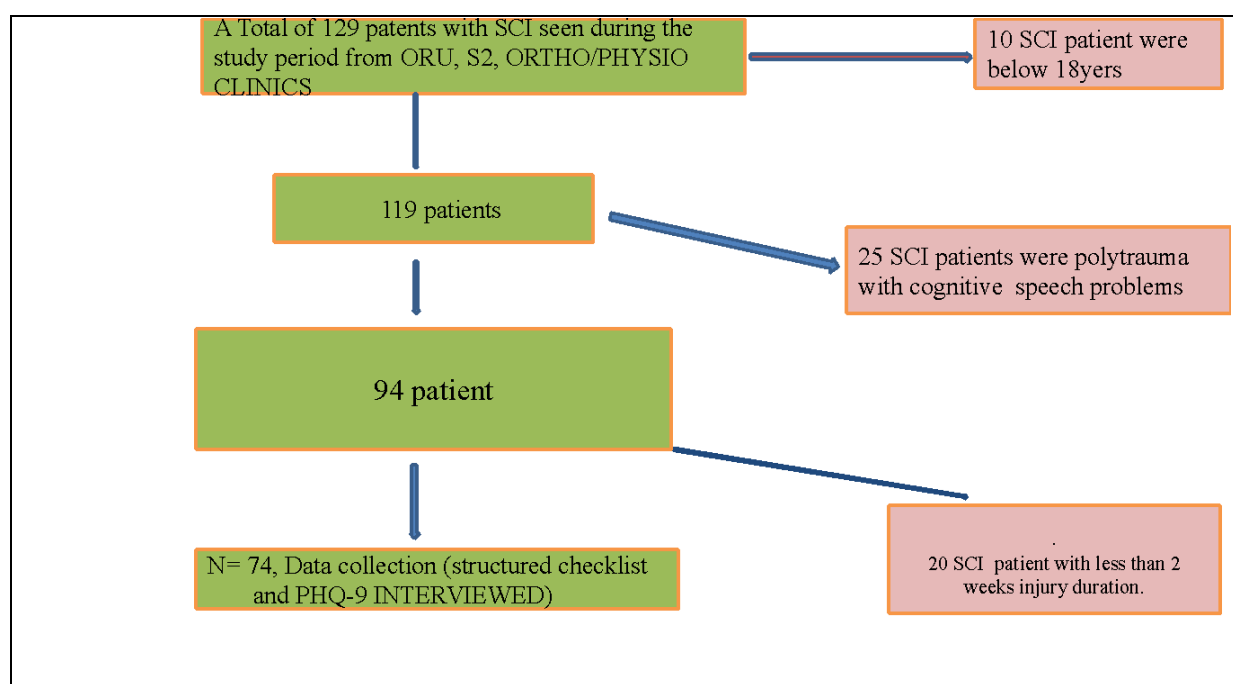
Figure 1: Data recruitment a logarithm.

Data Management and Analysis
The data from the registry was reviewed and checked for completeness before being transferred to the statistical package for analysis purposes. Data was coded and entered into the computer using SPSS program version 25. Mean and standard deviation (SD) were used to summarize the numerical data, such as the age of the patients in years. In contrast, frequency and proportions

were employed to summarize categorical variables using tables and figures. The relationship between variables was tested using Chi-square or Fisher's exact test where appropriate. Cross-tabulation was done to estimate the proportion of spinal cord injury. Classical Logistic regression models were used to assess the association between independent variables and Depression; the Odds ratio (OR) and their respective 95% confidence interval were used to report the strength of the association. A p-value of less than 0.05 was considered statistically significant.

Ethical consideration

Permission to perform this research was obtained from the Director of KCMC and the Research Ethical Committee of Kilimanjaro Medical University College. Permission was also sought from the Department of Orthopedics and Physiotherapy at KCMC Hospital. Then, informed consent was obtained from clients before filling out the questionnaire; patient records were kept confidential, and only patient initials were recorded during data collection. There is no conflict of interest in conducting this study. Access to this information was only for research purposes. Privacy and confidentiality were ensured using an encrypted password.

Results

Demographic characteristics of the study participants

This study included a total of 74 study participants. The study participants' median (range) age was 36 (21 – 74) years. However, almost half of the study participants, 33 (44.6%), were aged 18 – 34. Also, the majority, 68 (91.9%) were males, 55 (74.3%) were residing in rural areas, 43 (58.1%) had primary education, 38 (51.4%) were married, 66 (89.2%) were not employed, 60 (81.1%) cover hospital bills by using family cash, median (range) number of children was 1 (0-7) children, and 24 (32.4%) had more than 2 children. This is shown in Table 1.

Table 1 : Demographic characteristics of the study participants (N=74)

Characteristics	n (%)
Age (years) (median (range)	36 (21 - 74)
Age (years)	
18 – 34	33 (44.6)
35 – 55	29 (39.2)
56 – 74	12 (16.2)
Sex	
Male	68 (91.9)
Female	6 (8.1)
Residence	
Urban	19 (25.7)
Rural	55 (74.3)
Education level	
None / Primary	46 (62.2)
Secondary	28 (37.8)
Marital status	
Single	23 (31.1)
Married	38 (51.4)
Cohabiting	10 (13.5)
Divorced/separated	3 (4.1)
Occupation	
Employed	8 (10.8)
Unemployed	66 (89.2)
Health expenses coverage	
Health insurance	14 (18.9)
Family cash	60 (81.1)
Number of children (median (range)	1 (0 - 7)
Number of children	
No children	29 (39.2)

1 to 2	21 (28.4)
> 2	24 (32.4)

Clinical characteristics of the study participants

Regarding clinical characteristics of the study participants, 40 (54.1%) had fallen from a height, and the median (range) duration of SCI was 8 (1 – 96) months, whereby 45 (60.8%) had ≥ 6 months of SCI. The median (range) hospital stay was 2 (1 – 12) months, whereby 51 (68.9%) had ≥ 2 months of hospital stay, and 12 (16.2%) had associated injuries. This is shown in Table 2.

Table 2: Clinical characteristics of the study participants (n=74)

Characteristics	n (%)
Mechanism of injury	
Falling	40 (54.1)
Road traffic accident	32 (43.2)
Violence	2 (2.7)
SCI duration (months) (median (range)	8 (1 - 96)
SCI duration (months)	
< 6	29 (39.2)
≥ 6	45 (60.8)
Hospital stay (months) (median (range)	2 (1 - 12)
Hospital stay (months)	
< 2	23 (31.1)
≥ 2	51 (68.9)
Associated injuries	
No	62 (83.8)
Yes	12 (16.2)

The pattern and severity of SCI among spine-injured patients who attended KCMC

A large proportion of the study participants, 32 (43.2%), had cervical spinal cord injury, followed by thoracic 26 (35.2%), and the least was the lumbar 16 (21.6%). On the other hand, most of the study participants, 37 (50.0%), had ASIA A followed by ASIA E 13 (17.6%). This is shown in Figures 1 and 2.

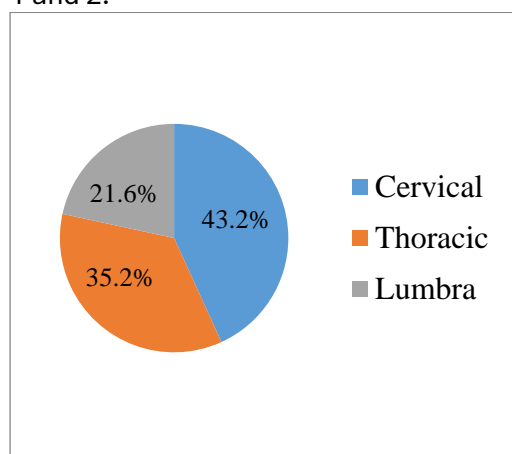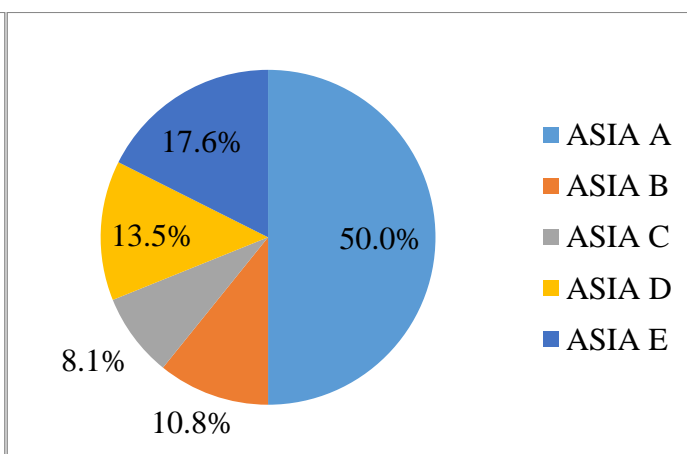**Figure 2: The pattern of SCI**

Figure 3: The severity of SCI

Management characteristics of the study participants

Regarding management, 36 (48.6%) were immobilized as initial management, and 16 (21.6%) had surgery as their final management. The mean (SD) rehab after SCI was 27.2 (16.7) days, whereby 61 (82.4%) started rehabilitation in ≥ 7 days. On the other hand, 33 (91.7%) had bedside

dressing of the pressure sores, 60 (81.1%) were catheterized as management of the bladder dysfunction, 51 (68.9%) were assisted with bowel dysfunction, 51 (68.9%) were assisted by the caregiver to change position, and 33 (44.6%) had an explanation about SCI complications. This is shown in Table 3.

Table 3 : Management characteristics of the study participants (N=74)

Characteristics	n (%)
Initial management of SCI	
Immobilized	36 (48.6)
Not immobilized	38 (51.4)
Final management	
Surgical	16 (21.6)
Non-surgical	58 (78.4)
Rehab after SCI (days) (mean (SD)	27.2 (16.7)
Rehab after SCI (days)	
< 7	13 (17.6)
≥ 7	61 (82.4)
Pressure sore management (n=36)	
Bedside dressing	33 (91.7)
Surgical	3 (8.3)
Bladder dysfunction management	
Urethral catheterization	60 (81.1)
Normal emptying	14 (18.9)
Bowel dysfunction management	
Alone	23 (31.1)
Assisted	51 (68.9)
Manage change position	
Manage alone	23 (31.1)
Assisted by the care-giver	51 (68.9)
Explanation of SCI complication	
No	41 (55.4)
Yes	33 (44.6)

The complications of SCI among spine-injured patients attended at KCMC

Most of the study participants 50 (67.6%) had bladder dysfunctions followed by bowel dysfunction 46 (62.2%). This is shown in Figure 3.
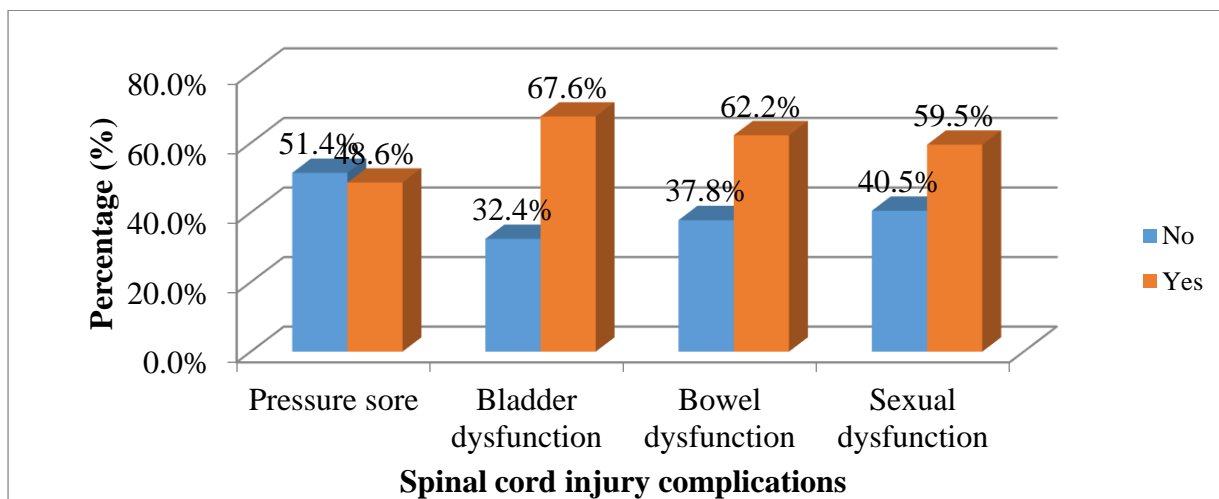
Figure 4: The complications of SCI among spine-injured patients attended at KCMC

Depression status of study participants
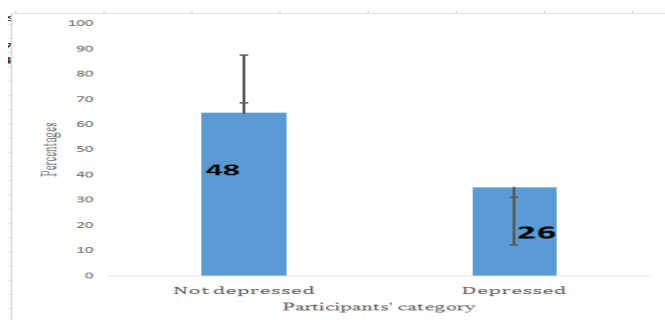
Figure 5: Depression score;10>depressed,<Non-depressed

Risk factors of Depression after SCI among spine-injured patients who attended at KCMC

Factors such as SCI duration of ≥ 6 months (OR=3.50, 95% CI: 2.44 – 28.0), ASIA B (OR=0.20, 95% CI: 0.01 – 0.99), ASIA CDE (OR=0.02, 95% CI: 0.00 – 0.18). Having pressure sore (OR=8.40, 95% CI: 1.02 – 6.92), having bowel dysfunction (OR= 3.20, 95% CI: 2.02 – 6.75), having sexual dysfunction (OR=3.80, 95% CI: 3.50 – 4.80), non-surgical management (OR=11.40, 95% CI: 1.41 – 91.86). Having ≥ 7 days rehab after SCI (OR= 8.33, 95% CI: 1.01 – 18.25), bowel dysfunction management (OR=2.11, 95% CI: 2.01 – 16.80), being assisted by a caregiver to change position (OR=2.12, 95% CI: 1.60 – 16.9), and explanation about SCI (OR=0.70, 95% CI: 0.30 – 0.90). This is shown in Tables 4, 5 and 6.

Table 4: Demographic factors associated with Depression after SCI among spine patients (N=74)

Characteristics	Depression		Total	OR (95 % CI)	p-value
	Not Depressed <10 n (%) 48 (64.9)	Depressed ≥ 10 n (%) 26 (35.1)	n (%)		
Age (years)					
18 – 34	19 (39.6)	14 (53.9)	33 (44.6)	1	
35 – 55	20 (41.7)	9 (34.6)	29 (39.2)	0.61 (0.21 - 1.73)	0.356

56 – 74	9 (18.7)	3 (11.5)	12 (16.2)	0.45 (0.10 - 1.98	0.293
Sex					
Male	42 (87.5)	26 (100.0)	68 (91.9)		
Female	6 (12.5)	0 (0.0)	6 (8.1)		0.085
Residence					
Urban	13 (27.1)	6 (23.1)	19 (25.7)	1	
Rural	35 (72.9)	20 (76.9)	55 (74.3)	1.24 (0.41 - 3.77)	0.707
Education level					
None / Primary	27 (56.2)	19 (73.1)	46 (62.2)	1	
Secondary	21 (43.8)	7 (26.9)	28 (37.8)	0.47 (0.17-1.34)	0.158
Marital status					
Single	14 (29.2)	9 (34.6)	23 (31.1)	1	
Married	28 (58.3)	10 (38.5)	38 (51.4)	0.55 (1.18 - 1.68)	0.297
Cohabiting	4 (8.3)	6 (23.1)	10 (13.5)	2.33 (0.51 -10.6	0.274
Divorced/separated	2 (4.2)	1 (3.8)	3 (4.1)	0.77 (0.06 - 9.88)	0.846
Occupation					
Employed	7 (14.6)	1 (3.9)	8 (10.8)	1	
Unemployed	41 (85.4)	25 (96.1)	66 (89.2)	4.27 (0.49 - 36.77)	0.187
Health expenses coverage					
Health expenses	10 (20.8)	4 (15.4)	14 (18.9)	1	
Family cash	38 (79.2)	22 (84.6)	60 (81.1)	1.45 (0.41 - 5.168)	0.569
Number of children					
No children	18 (37.5)	11 (42.3)	29 (39.2)	1	
1 to 2	13 (27.1)	8 (30.8)	21 (28.4)	1.01 (0.32 - 3.20)	0.991
> 2	17 (35.4)	7 (26.9)	24 (32.4)	0.67 (0.21 - 2.14)	0.503

Table 5: Clinical factors associated with Depression after SCI among spine patients (n=74)

	Depression				
	Not Depressed <10 n (%)	Depressed ≥ 10 n (%)	Total		
Characteristics	48 (64.9)	26 (35.1)	n (%)	OR (95 % CI)	p-value
Mechanism of injury					
Falling	26 (54.2)	14 (53.9)	40 (54.1)	1	
Road traffic accident	21 (43.8)	11 (42.3)	32 (43.2)	0.97 (0.37 - 2.59)	0.956
Violence	1 (2.1)	1 (3.9)	2 (2.7)	1.86 (0.11 - 32.00)	0.671

SCI duration (months)					
< 6	28 (58.3)	1 (3.9)	29 (39.2)	1	
≥ 6	20 (41.7)	25 (96.1)	45 (60.8)	3.50 (2.44 - 28.0)	0.001
Hospital stay (months)					
< 2	23 (47.9)	0 (0.0)	23 (31.1)	-	
≥ 2	25 (52.1)	26 (100.0)	51 (68.9)		<0.001
Associated injuries					
No	42 (87.5)	20 (76.9)	62 (83.8)	1	
Yes	6 (12.5)	6 (23.1)	12 (16.2)	2.1 (0.60 - 7.3)	0.245
Neurological status					
ASIA A	14 (29.2)	23 (88.5)	37 (50.0)	1	
ASIA B	6 (12.5)	2 (7.7)	8 (10.8)	0.20 (0.01 - 0.99)	0.049
ASIA C/D/E	28 (58.3)	1 (3.9)	29 (8.1)	0.02 (0.00 - 0.18)	<0.001)
Level of SCI					
Cervical	19 (39.6)	13 (50.0)	32 (43.2)	1	
Thoracolumbar	29 (60.4)	13 (50.0)	42 (56.8)	0.66 (0.25 - 1.72)	0.389
Pressure Sore					
No	37 (77.1)	1 (3.9)	38 (51.4)	1	
Yes	11 (22.9)	25 (96.1)	36 (48.6)	8.40 (1.02 - 6.92)	<0.001
Bladder dysfunction					
No	24 (50.0)	0 (0.0)	24 (32.4)	-	
Yes	24 (50.0)	26 (100.0)	50 (67.6)		<0.001
Bowel dysfunction					
No	27 (56.3)	1 (3.9)	28 (37.8)	1	
Yes	21 (43.7)	25 (96.1)	46 (62.2)	3.20 (2.02 - 6.75)	0.001
Sexual dysfunction					
No	29 (60.4)	1 (3.9)	30 (40.5)	1	
Yes	19 (39.6)	25 (96.1)	44 (59.5)	3.80 (3.5 - 4.8)	0.001

Table 6: Management factors associated with Depression after SCI among spine patients (n=74)

	Depression				
	Not Depressed <10 n (%)	Depressed ≥ 10 n (%)	Total		p-value
Characteristics	48 (64.9)	26 (35.1)	n (%)	OR (95 % CI)	
Initial management of SCI					
Immobilized	23 (47.9)	13 (50.0)	36 (48.6)	1	
Not immobilized	25 (52.1)	13 (50.0)	38 (51.4)	0.56 (0.28 - 1.16	0.864
Final management					
Surgical	15 (31.2	1 (3.9)	16 (21.6)	1	
Non-surgical	33 9(68.8)	25 (96.1)	58 (78.4)	11.40 (1.41 - 91.86)	0.023

Rehab after SCI (days)

< 7	12 (25.0)	1 (3.9)	13 (17.6)	1	
≥ 7	36 (75.0)	25 (96.1)	61 (82.4)	8.33 (1.01 - 18.25)	0.048
Pressure sore management (n=36)					
Bedside dressing	10 (90.9)	23 (92.0)	33 (91.7)	1	
Surgical	1 (9.1)	2 (8.0)	3 (8.3)	0.87 (0.07 - 10.70)	0.916
Bladder dysfunction management					
Urethral catheterization	34 (70.8)	26 (100.0)	60 (81.1)		
Normal emptying	14 (29.2)	0 (0.0)	14 (18.9)		<0.001
Bowel dysfunction management					
Alone	22 (45.8)	1 (3.9)	23 (31.1)	1	
Assisted	26 (54.2)	25 (96.1)	51 (68.9)	2.11 (2.01 - 16.80)	0.004
Manage change position					
Manage alone	22 (45.8)	1 (3.9)	23 (31.1)	1	
Assisted by the care-giver	26 (54.2)	25 (96.1)	51 (68.9)	2.12 (1.60 - 16.90)	<0.001)
Explanation of SCI complication					
No	25 (52.1)	16 (61.5)	41 (55.4)	1	
Yes	23 (47.9)	10 (38.5)	33 (44.6)	0.70 (0.30 - 0.90)	0.043

Discussion

This study was carried out to determine the patterns and management of SCI associated with risks of Depression among spine-injured patients attended at Kilimanjaro Christian Medical Center from August 2021 to June 2022. 74 participants were included, and the median was 36, similar to the study in Canada ('dryden2005.pdf', no date). Most of the study participants were males residing in rural areas who had primary education but were mainly not employed. Similar findings were observed in a study done in Nigeria by ((Ishaku *et al.*, 2021)) which found that the majority were males aged between (18-39) Areas of residence, education level, and marital status were found in research done in northern Tanzania by((Moshi *et al.*, 2020), and (Rashid *et al.*, 2017)) they both found that most of their study participants were from a rural area, had primary education, married and were not employed. Another study done in Moshi, Tanzania by ('obayemi2019.pdf', no date) showed similar results: most participants did not have insurance to cover their hospital bills.

Regarding patterns of spinal cord injury, this study found that most participants had fallen from height as the mechanism of injury and had cervical spine injury as a level of spinal cord injury. After neurological examination, most had 37 (50.0%), Asia, A score (complete SCI) as the severity of spinal cord injury, studies done in Canada, Nigeria and Northern Tanzania by ('dryden2005.pdf', no date), (Ishaku *et al.*, 2021), (Moshi *et al.*, 2017), and (Rashid *et al.*, 2017) showed similar findings most of their study participants had cervical spine injuries. But on mechanisms of injury, both studies were done in Canada and Nigeria by (Dryden *et al.*, 2005) and (Ishaku *et al.*, 2021). Results showed that this is the leading cause of SCI, and the difference in

findings is because most of the study participants were from an urban area with a huge number of traffic and motor vehicles, while in this study, most participants are from a rural area.

Studies in Nepal, Iran, Canada, and Nigeria (Adhikari *et al.*, 2020), ('GHJAZADEL.pdf', no date), (Dryden *et al.*, 2005), and (Ishaku *et al.*, 2021) found that incomplete SCI Asia score(BCD) were most encountered severity of SCI after neurological examination while this study found that many participants had complete SCI Asia A score and this difference in findings is because in their studies they group sum the results of Asia score B, C and D as incomplete SCI while this study each Asia score has separate results so in all these studies Asia A is most encountered without summation of results similar to this study.

The Median (range) duration of SCI was 8 (1 – 96) months whereby 45 (60.8%) had ≥ 6 months duration of SCI and this study found that the median (range) hospital stay was 2 (1 – 12) months whereby 51 (68.9%) had ≥ 2 months of hospital stay, the similar results about hospital stay were found by research done in Moshi Tanzania by (Moshi *et al.*, 2017) and (Rashid *et al.*, 2017) showed that most participants stayed hospital more than 2 months their the mean length of hospital stay was (64.2 ± 54.3 days) and 71.6 (±76.2) days with a median duration of stay 46 days respectively. Similar results about the duration of spinal cord injury were observed in a study done in Nepal by (Adhikari et al., 2020), which showed that the median duration of spinal cord injury was 8(2.25).

Regarding management after spinal cord injury, most participants, 58(78.4%) were treated non-surgically as their final management. Similar findings were seen in a study done in northern Tanzania by (Rashid *et al.*, 2017), which found that only 2 (1.6%) patients out of 125 underwent surgical spinal cord decompression.

This study found that for most of the participant's complications after spinal cord injury, 67.6% had neurogenic bladder dysfunctions, followed by neurogenic bowel dysfunctions 62.2%, and 59.2% had sexual dysfunctions. Lastly, 51.4% develop pressure ulcers; a similar study was done in Turkey and Iran by ('GHJAZADEL.pdf', no date), ('SEZER TURKEYpdf.pdf', no date).

In this study, the prevalence of Depression after SCI among spine-injured patients who attended KCMC was found to be higher (35.1%) than that in the general population and similar results of prevalence were found in studies done in the USA(22.2%), Canada(28.9%), by (Williams and Murray, 2015), (Dryden *et al.*, 2005).

In this study factors such as SCI duration of ≥ 6 months (OR=3.50, 95% CI: 2.44 – 28.0, p=0.001), prolonged hospital stay(months) ≥ 2 p-values <0.001,   incomplete SCI {(ASIA B (OR=0.20, 95% CI: 0.01 – 0.99, p=0.049), ASIA CDE (OR=0.02, 95% CI: 0.00 – 0.18, <0.001)} had more odds of developing Depression after spinal cord injury and all are statistically significant, the similar findings were reported by studies done in Nepal and Nigeria and northern Tanzania by (Adhikari *et al.*, 2020), (Ishaku *et al.*, 2021), ('obayemi2019.pdf', no date).
Also, having pressure soreness (OR=8.40, 95% CI: 1.02 – 6.92, p<0.001), bowel dysfunction (OR= 3.20, 95% CI: 2.02 – 6.75, p=0.001), and patients who complain of sexual dysfunction (OR=3.80, 95% CI: 3.50 – 4.80, p=0.001) have more odds of developing Depression observed in this study and results were statistically similar to the study done in Iran by ('GHJAZADEL.pdf', no date).
Regarding management outcomes participants who underwent non-surgical management (OR=11.40, 95% CI: 1.41 – 91.86, p=0.023), who delayed rehabilitation ≥ 7 days after SCI (OR= 8.33, 95% CI: 1.01 – 18.25, p=0.048), who assisted in bowel emptying for bowel dysfunction management (OR=2.11, 95% CI: 2.01 – 16.80, p=.004), being assisted by caregiver to change position (OR=2.12, 95% CI: 1.60 – 16.9, p< 0.001) have more odds of developing depression in this study.

Also, in this study, nearly half of the participants who received cancelling and explanation of spinal cord injury progress and prognosis by attending caregivers who are not professional cancellers had less Depression (OR=0.70, 95% CI: 0.30 – 0.90, p=0.043) compared to those who were not cancelled about SCI prognosis.

Conclusion

This study found that the prevalence of depression after spinal cord injury was 35.1%, which we found that the predominant mechanisms of SCI were fall from height, complete SCI (Asia A) as the most form of severity, and cervical spine's most common level of SCI.

Moreover, this study shows that the most predominant complications after SCI were pressure ulcers, neurogenic bladder, and bowel and sexual dysfunctions. The risk factors of Depression after SCI were complete SCI (Asia A), cervical spine injury, long duration to have SCI, non-surgical management, Delay to start physiotherapy, extended hospital stay, lack of health insurance to cover hospital bills, pressure ulcers, bowel, bladder and sexual dysfunction and cancelling about SCI prognosis received from the caregiver who is not professional cancellers.

Limitation

Tools not able to assess Depression less than 2 weeks in SCI patients.

ABBREVIATION

ASIA: American Spinal Cord Injury Assessment scale; ATLs: Advance trauma life supports; DSM: Diagnostic and statistical manual of mental disorder; EHMS: Electronic health management system; EMD: Emergency Medical Department; KCMC**:** Kilimanjaro Christian Medical Centre; KCMUco :Kilimanjaro Christian Medical University College; MRI: Magnetic Resonance Imaging; ORU:Orthopaedic and rehabilitation unity; PHQ-9 :Patient health questionnaire NO 9 for depression assessment; RTAs : Road traffic accident; S2: Surgical ward number 2 (for orthopedic patient admission); SCID: Structured clinical interviews for DSM1V; SPSS: Statistical Package for the Social Sciences;
TSCI: Traumatic Spinal Cord Injury; WHO: World Health Organisation.

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Effectiveness of a preoperative checklist in reducing **surgery cancellations in a tertiary hospital in a low-income country**

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Abstract.
Background: A high surgery cancellation rate has been a problem at Muhimbili National Hospital for a decade, ranging from 16% to 29%, with patient factors accounting for up to 40% of cancelled surgeries. One critical aspect of addressing the problem was the implementation of a preoperative checklist to double-check the preoperative workup and reduce cancellations due to patient factors. This paper aimed to determine the effectiveness of a preoperative checklist in reducing the cancellation rate of planned surgeries.
Methods: A 6-month quasi-experimental study was conducted at Muhimbili National Hospital. We enrolled 298 and 300 patients in the control and interventional phases, respectively. The data was gathered using a pre-tested checklist, coded, entered, and analysed using SPSS version 22.0.
Results: The checklist implementation reduced the cancellation rate from 19.1% to 16.3%, with patients' factors significantly decreasing from 46 (15.4%) in the control group to 14 (4.7%). p=0.000.
Conclusions: A preoperative checklist reduces cancellations due to patient factors and is a promising tool for reducing surgery cancellations. It is recommended that the preoperative checklist be used regularly at MNH to reduce surgical cancellations.

Keywords: preoperative checklist, surgery cancellation

Background.

The planned surgery combines the necessary teams to prepare materials, theatre space, and timing. Mental and psychological preparation is required for the patient and his or her family (Chalya et al., 2011). Patients and hospitals suffer significantly when an operation is cancelled on the surgery day (Mohammed et al. et al., 2015; Dix and Howell, 2001). The global burden of cancellation rates ranges from 4% to 17% of planned surgeries (Ebrahimipour et al., 2014). The most common reasons for cancellation are patient-related, such as incomplete preoperative workups, changes in the patient's clinical status, and the patient failing to appear on the day of surgery; hospital-related factors include time constraints, operating room unavailability due to previous operations being delayed, interference with emergency operations, insufficient postoperative ICU beds, and default anaesthetic machines (Schofield et al., 2005).

The rate of cancellation of elective surgeries at Muhimbili National Hospital (MNH) has been observed to be high, with patients' related factors contributing a high percentage (Mbembati et al., 2008); efforts to improve the situation have been laid out, such as establishing a preoperative anesthesia clinic and performing preoperative workups for inpatients and outpatients before listing

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patients for surgery, but the trend has remained the same. As a result, it emphasized the importance of instituting a preoperative checklist to address patient-related factors. The preoperative checklist under consideration is a locally designed checklist that includes components for patient identification, diagnoses, the type of surgery to be performed, and preoperative investigations (laboratory, imaging, and pathological).

This checklist has never been used before, but its implementation is intended to reduce errors in preoperative workups of patients scheduled for surgery, thereby lowering the cancellation rate of scheduled surgeries on the day of surgery. Surgeons should use this checklist before sending the patient to the operating room. Whether using a preoperative checklist will reduce the cancellation rate of planned surgery is still unknown in our settings. Our objective was to determine the effectiveness of a preoperative checklist in reducing the cancellation rate of planned surgeries. A preoperative checklist is essential because it ensures efficient management of the nation's insufficient theatre space for referred cases and avoids frustration for patients and hospital staff. The data obtained from this study will be used to plan elective surgeries effectively.

Methods

We conducted a hospital-based, quasi-experimental study in the surgical department of Muhimbili National Hospital in Dar es Salaam, Tanzania. This tertiary hospital has patients from all over the country.

Study duration: Our study lasted six months and was divided into control and experimental phases, each lasting three months. The control phase lasted three months, from 1 June to 31 August 2017, and the experimental phase lasted three months, from 1 November 2017 to 31 January 2018. During the two phases of the study, all patients listed for elective surgery in Firm I and II of the Surgical Department at MNH were included.

Data collection

During the control phase, baseline data on the rate of surgery cancellations on the day of surgery were collected. The preoperative checklist was not used during this phase, and data on cancelled cases and reasons for cancellations were collected. Once the operation list was available in the ward, the preoperative checklist was attached to the patient's files and completed under the supervision of the resident surgeon. While filling out the checklist, any missing or derangements in patients' preoperative workups were discovered and corrected.

If the derangements were not expected to be corrected before the scheduled surgery, a senior surgeon was contacted to discuss possibly cancelling the surgery and finding a replacement. The data on the cancelled cases and the reasons for cancellations was then gathered. Patients were enrolled in the study in both phases once the operating list was available in the ward and then followed up until the day of discharge from the hospital.

Data management and analysis

The principal investigator reviewed the collected data for completeness and errors. The data was cleaned, coded, and entered SPSS version 20 for analysis. The data was backed up on a CD and in the principal investigator's email. All data were collected using a pre-tested checklist, and the research team double-checked the information for completeness and consistency. All collected data were analyzed using the SPSS computer package version 22.0.

Ethical approval

The MUHAS research ethics committee approved the study, and the MNH Teaching, Research, and Consultancy Coordination Unit approved data collection.

Results

During this study, 598 people were scheduled for elective surgery, with 298 in the control group and 300 in the interventional group. The mean age of patients in both study groups was comparable. In the intervention and control groups, females outnumbered males by 1.5:1 and 1.2:1, respectively. In both study groups, participants with malignant disease were listed for surgery at a higher rate than those with benign disease, by a ratio of 1.5 to 2 in the interventional and control groups, respectively. However, as shown in Table 1, the differences between the study groups were not statistically significant.

Table 1: Characteristics of patients in the two study groups

Characteristics	Interventional (n=300) f (%)	Controls (n=298) f (%)	P value
Age:			
11 – 30	42 (14.0)	52 (17.4)	
31 – 50	145 (48.3)	114 (38.3)	
51 – 70	86 (28.7)	102 (34.2)	
>70	27 (9.0)	30 (10.1)	0.098
Mean age (years)	47.2±16.9	47.8±16.2	0.671
Sex:			
Male	119 (39.7)	134 (45.0)	
Female	181 (60.3)	164 (55.0)	0.190
Disease groups			
Benign diseases	122 (40.7)	99 (33.2)	
Malignant diseases	178 (59.3)	199 (66.8)	0.059

Table 2 shows that the two study groups cancelled 106 (17.7%) of the 598 planned surgeries. The number of cancelled surgeries decreased from 57 (19.1) in the control group to 49 (16.3%) in the interventional study group, with an odds ratio (OR) of 1.03, indicating that participants in the interventional group were 3% more likely than controls to be operated on.

Table 2: Number of surgeries cancelled and reasons for cancellation in the study groups

Surgery	Interventional group n=300 f (%)	Control group n=298 f (%)	Total N=598 f (%)
Done	251 (83.7)	241 (80.9)	492 (82.3)
Cancelled	49 (16.3)	57 (19.1)	106 (17.7)
Total	300 (100.0)	298 (100.0)	598 (100.0)

Table 3 shows that after implementing the checklist, patient-related factors decreased significantly from 46 (15.4%) in the control group to 14 (4.7%); this finding was statistically significant, p = 0.000. The interventional group experienced 35 (11.7%) more cancellations due to hospital-related factors than the control group, which was statistically significant (p = 0.000).

Table 3: Reasons for cancellation of surgeries in the two study groups

Reason	Interventional (n=300) f (%)	Control (n=298) f (%)	Total (N=598) f (%)	P value
Patient factors	14 (4.7)	46 (15.4)	60 (10.0)	0.000
Hospital factors	35 (11.7)	11 (3.7)	46 (7.7)	0.000
Total	49 (16.3)	57 (19.1)	106 (17.7)	

Table 4 shows a reduction in the number of surgeries cancelled due to incomplete lab workups, incomplete investigations (i.e., ECG, ECHO, colonoscopy, bronchoscopy), anemia, prolonged bleeding indices (coagulopathy), and hypokalemia, though the reduction was not statistically significant

Table 4: Patient-related factors in cancellation rates

Patient related factors	Interventions (n=300) f (%)	Controls (n=298) f (%)	P value
Incomplete lab works	1 (0.3)	8 (2.7)	0.018
Incomplete other investigations	1 (0.3)	7 (2.3)	0.03
Hypokalemia	5 (1.7)	13 (4.4)	0.54
Anemia	5 (1.7)	9 (3.0)	0.274
Prolonged bleeding indices	0 (0.0)	3 (1.0)	0.081
Absconded	0 (0.0)	4 (1.3)	0.044
Hypertension	2 (0.8)	3 (1.0)	0.648
Hypotension	0 (0.0)	2 (0.7)	0.155
No consent	0 (0.0)	2 (0.7)	0.155
Unstable patient	0 (0.0)	2 (0.7)	0.155
Bradycardia	0 (0.0)	1 (0.3)	0.315
Died before day of surgery	0 (0.0)	2 (0.7)	0.155
Patient refuse surgery	2 (0.7)	1 (0.3)	0.567
Family refuse surgery	0 (0.0)	1 (0.3)	0.315
Wrong diagnosis	1 (0.3)	0 (0.0)	0.319
Change of plan	2 (0.7)	0 (0.0)	0.158
Total	19 (6.3)	57 (19.1)	

* A patient may have had multiple reasons for cancellation.

Theatre renovation accounted for most cancelled surgeries in the case group (17 (5.7%), followed by time-barred 13 (4.3%); however, time-barred was the main factor in the control group, as shown in Table 5 below.

Table 2: Hospital-related factors in cancellation rate

Hospital related factors	Interventions (n=300)		Controls (n=298)		P value
	f	(%)	f	(%)	
Theatre renovation	17	(5.7)	1	(0.3)	0.000
Time barred	13	(4.3)	9	(3.0)	0.394
No ICU bed	1	(0.3)	1	(0.3)	0.996
No ETT Right lung	1	(0.3)	0	(0.0)	0.319
No laparoscopic tower	2	(0.7)	0	(0.0)	0.158
No mesh	1	(0.3)	0	(0.0)	0.319
Total	35	(11.7)	11	(3.7)	0.000

Discussion

Cancellation of surgery on the day of surgery has been a significant concern in surgical practices worldwide, including ours. As a result, the purpose of this study was to highlight the current status of the rate of surgery cancellation at MNH and the impact of the preoperative checklist in ensuring that listed patients meet the minimum set criteria to be fit for elective surgery. In our study, age did not affect the cancellation of the operation between the two study groups, and the difference in mean and different age groups between the control and interventional groups was not statistically significant, like other studies (Haynes et al., 2009, Baradaran Binazir et al., 2016). Furthermore, there were no significant differences in patients' sex or diagnoses between the interventional and control groups, implying that they did not affect the rate of cancellation or patient outcome in this study.

The cancellation rate of surgeries on the day of surgery at MNH has been a significant issue for the past decade. According to our findings, one out of every five planned surgeries in the control group is cancelled. On the other hand, implementing the preoperative checklist resulted in a 3% decrease in cancellations. The preoperative checklist was completed a day before surgery, allowing for earlier detection of missing laboratory workups and ordering them accordingly. Early detection of derangements in the patients' laboratory workup, such as anemia and electrolyte imbalances, was also detected earlier, and corrections were initiated immediately.

However, for those derangements that could not be corrected immediately, such as severe anemia with a hemoglobin level of less than 5 g/dl, operations were cancelled before the day of surgery, efforts to find replacements from the inpatients failed in most attempts, and unfortunately, the two surgical firms were not accustomed to preparing a waiting list for outpatients who are ready for surgery to be contacted whenever an opportunity to operate arises. However, higher cancellation rates were observed in other African hospitals (Chalya et al., 2011, Elrahman et al., 2014, Ebirim et al., 2012). Our study found that patient factors were responsible for one out of every six cancelled surgeries in the control group; however, using a preoperative checklist reduced the contribution of patient factors by 11% because patients' factors were detected and corrected before the day of surgery.

If the preoperative checklist could have been completed before patients were listed for elective surgery, it could have had a more significant impact (than what was found in the study) in reducing the number of cancelled surgeries due to patient-related factors; thus, the list of patients for elective surgery would be comprised of only those patients cleared by the preoperative checklist to be ready

for surgery. In the same setting, as well as in other centres, higher contributions of patient-related factors to surgery cancellation were observed at 40 %(Ebirim et al., 2012, Elrahman et al., 2014) Cancellation of surgeries due to hospital-related factors contributed significantly to 12% in the interventional group versus 4% in the control group; this is because, unlike the rate reported by previous studies, the use of a preoperative checklist aimed at minimizing patient-related factors rather than hospital-related factors.

Conclusion

This study found that using a preoperative checklist reduced the number of cancellations due to patient factors. If all patients are cleared by it, a preoperative checklist is a promising tool for reducing the cancellation rate of planned surgeries.

Contribution of the author

All authors contributed equally to completing this work and have read and approved the final manuscript version.

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