Clinical patterns, surgical outcomes and prognostic factors among patients undergoing cleft palate surgery at Bugando Medical Centre, Tanzania

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Abstract
Background: Cleft palate poses major therapeutic challenges among otorhinolaryngology, plastic/reconstructive, oral and maxillofacial surgeons practicing in resource-limited countries. There is a paucity of prospective studies regarding this subject in Tanzania and Bugando Medical Centre (BMC) in particular. This study aims to determine the clinical patterns, surgical outcomes and prognostic factors among patients undergoing cleft palate repair at BMC
Methods: This was a cross-sectional study among patients undergoing cleft palate repair at BMC between January 2019 and June 2019.
Results: A total of 44 patients (M; F ratio = 1.4: 1) were studied. The majority, 35(79.5%) were within 1 year of age at presentation. One (2.3%) patient had two associated congenital anomalies. Only 10 (22.7%) patients had isolated cleft palate and the remaining 34(77.3%) patients had associated cleft lip. Half of the patients, 22 (50.0%) had a bilateral cleft palate. The majority of patients, 35(79.5%) had complete cleft palates. All patients underwent cleft palate repair, the majority at the age of 9 months. A total of 21 (47.7%) developed postoperative complications, mainly bleeding (10; 47.6%) and palatal fistula (9; 42.8%). No death was recorded in this study. Out of 44 patients, 34 were treated successfully giving an overall success rate of 77.3%. The success rate was significantly influenced by nutrition status (p= 0.020) and the width of the cleft (p=0.033).
Conclusion: This study showed that the majority of patients with cleft palate presented to BMC within 1 year of life. More than three-quarters of patients were treated successfully. Malnutrition and cleft width > 10 mm were the major prognostic factors affecting the treatment success. Appropriate measures focusing on these factors are vital in order to deliver optimal care for these patients in this region.

Keywords: cleft palate surgery, clinical patterns, surgical outcomes, prognostic factors, Tanzania

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Background

Cleft palate constitutes a major public health concern throughout the world resulting in several complications including malnutrition, facial disfigurement, growth distortion and recurrent ear infections (Wanjeri & Wachira., 2009; Ibrahim *et al.*, 2013) The presence of cleft palate has both aesthetic and functional implications for patients in their social interactions, particularly on their ability to communicate effectively and on their facial appearance with or without the involvement of the lip (Agrawal., 2009).

Globally, isolated cleft palate is the least common form of orofacial clefting (approximately 33% of all orofacial clefts) (Mai *et al.*, 2014). The incidence of isolated cleft palate varies widely geographically from 1.3 to 25.3 per 10,000 live births, with the highest rates in British Columbia, Canada, India and the lowest rates in Nigeria, Africa (Mossey & Little., 2009; Parker *et al.*, 2010; Taiwo *et al.*, 2016) Stratified by ethnicity/race, the highest rates of isolated cleft palate are observed in non-Hispanic Whites and the lowest in Africans (Mossey & Little., 2009). Cleft palate is more commonly reported in females than males, this is because developmentally, fusion delays in females (Mossey & Little., 2009; Taiwo *et al.*, 2016) In Tanzania, cleft palate commonly occurs in combination with cleft lip and rarely as an isolated type or in combination with atypical orofacial clefts (Manyama *et al.*, 2011). At Bugando Medical Centre, orofacial clefts including cleft palate are a single commonest cause of otorhinolaryngology and plastic/reconstructive surgical admissions and cleft palate repair is commonly performed procedure in otorhinolaryngology and plastic/reconstructive surgical wards (Manyama *et al.*, 2011).

The classification of cleft palate is crucial in determining the most appropriate surgical approach for each case (Watkins *et al.*, 2014). A cleft palate can be classified as syndromic or isolated (non-syndromic) depending on the presence or absence of other developmental anomalies (Mossey & Little., 2009; Mai *et al.*, 2014; Watkins *et al.*, 2014). Clefts affecting the palate can also be classified as complete or incomplete, unilateral or bilateral, primary or secondary depending on the degree of failure of fusion of palatal shelves (Donkor *et al.*, 2007; Calzolari *et al.*, 2004). Another least severe form of cleft palate is the sub-mucous cleft palate in which the underlying palatal musculature is deficient and inappropriately attached (Calzolari *et al.*, 2004; Watkins *et al.*, 2014 9,11).

The management of cleft palate remains a challenge for otorhinolaryngology, plastic/reconstructive, oral and maxillofacial surgeons, demanding both skill and a high level of expertise (Wanjeri & Wachira., 2009; Ibrahim *et al.*, 2013). A multidisciplinary approach involving plastic surgeons, oral surgeon, otolaryngologist, pediatrician, speech therapist, audiologist, orthodontists, psychologist, social worker, and a specialist nurse is needed to provide comprehensive treatment for cleft palate (Agrawal., 2009; Ibrahim *et al.*, 2013). However, in most developing countries like Tanzania the shortage of the qualified surgeons and other specialists as well as financial disparities and the unavailable equipped facilities result in inappropriate case management and sometimes many children with cleft palate even remain untreated (Manyama *et al.*, 2011).

 Despite the fact that cleft palate surgery is commonly performed in tertiary care hospitals in Tanzania including ours, there is a paucity of published data regarding this subject in our setting. The few available data on this subject focused on the prevalence and associated risk factors for all types of orofacial clefts. No study looked at the surgical outcomes of isolated cleft palate. This knowledge gap prompted the author to conduct this study in this sub-region. The objectives of this study were to determine the clinical patterns, surgical outcomes and prognostic factors among patients undergoing cleft palate surgery at Bugando Medical Centre, a tertiary care hospital in Tanzania.

Methods

Study design and setting

This was a cross sectional hospital based analytical study that was conducted in the otorhinolaryngological wards and theatres of Bugando Medical Centre (BMC) from February 2019 to June 2019. BMC is a referral, consultant and teaching hospital for the Catholic University of Health and Allied Sciences-Bugando (CUHAS-Bugando) and other paramedics and it is located in Mwanza city in the northwestern part of the United Republic of Tanzania. It is situated along the shore of Lake Victoria and has 890 beds. BMC is one of the four largest referral hospitals in the country and serves as a referral centre for tertiary specialist care for a catchment population of approximately 13 million people from neighboring regions in northwestern Tanzania. At BMC patients with cleft palate are usually admitted and treated in the otorhinolaryngological wards/clinics of Bugando Medical Centre. Most patients with orofacial clefts in the surrounding regions are usually referred to this hospital as it is the only centre that offers surgical expertise to repair orofacial clefts on the North-Western part of Tanzania.

Study population, sample size estimation, sampling procedure and recruitment of patients

The study included all patients with cleft palate who were admitted and subsequently operated at BMC during the period of study. Patients with alveolar clefts only and those who had attempted repair (secondary repair) were excluded from the study.The minimum sample size of this study was calculated using Yamane Taro formula n=N/1+Ne^2,where; n=sample size; N=45 (patients in 2017) (from Bugando Medical Centre database unpublished data) and e =marginal error, 0.05. Convenient sampling procedure for the patients who met inclusion criteria were performed until the sample size was reached.

Recruitment of patients who were enrolled prospectively was done in the otorhinolaryngology and reconstructive/plastic wards/clinics of Bugando Medical Centre. Patients who met the inclusion criteria were consecutively enrolled in the study after an informed written consent sought from the patients, parents or guardians. Preoperatively, the details of patients in terms of history, clinical features and hematological investigations were recorded on an investigator-designed proforma. It is the policy of the unit to admit patients 3 days preoperatively for counseling, instruction on feeding technique and taking of throat and nasal swabs for microbiology. Hematological investigations included full blood picture, Hemoglobin levels, grouping and cross-matching, coagulation profile, serum electrolytes, serum creatinine and urea. Nutrition status was measured using mid-upper-arm-circumference (MUAC).

Combined cleft lip and palate deformities were treated by either one- or two stage repairs involving rotation advancement repair of the lip and palate closure by von Langenbeck, Veau/Wardill/Kilner and Braithwaite repairs. Cleft palates were repaired by the von Langenbeck and Veau/Wardill/Kilner techniques.

Operational Definitions

- **Treatment success:** Absence of complications after 6 days of repair i.e. no fistula or wound dehiscence.
- **Poor outcome:** Complication resulting in wound dehiscence, oronasal fistula or death.
- **Good outcome:** No complication affecting outcome at discharge

Data collection
Data were collected using a pre tested coded checklist. Information to be collected included; demographic characteristics (age, sex, and area of residence), clinical characteristics (type of cleft palate, laterality, laterality, extent, site, associated congenital anomalies and other associated orofacial clefts), treatment characteristics (timing of surgery, type of surgery and duration of surgery) and outcome variables (postoperative complications, treatment success, length of hospital stay and mortality).

Statistical data analysis
The statistical data analysis was performed using STATA version 13. The median with Interquartile Range (IQR) and mean with standard deviation was calculated for continuous variables whereas proportions (percent) and frequency tables were used to summarize categorical variables. Chi-square ($\chi2$) test was used to test for the preliminary association between the prognostic factors and surgical outcomes. The level of significance will be considered at p value < 0.05.

Ethical consideration
The ethical approval to conduct the study was sought from the Joint CUHAS/BMC Research, Ethics and Review Committee (CREC/347/219). The permission to conduct the study at BMC was sought from hospital authority. Parents / guardian were informed about the study and the participation of their children. If they accept, they were asked to sign a written informed consent before being enrolled into the study. Parents / guardian's refusal to consent or withdrawal from the study did not alter or jeopardize their access to medical care. Patients were assured of confidentiality regarding the information to be collected. The study did not interfere with the decision of the doctor attending the patient.

Results

Socio-demographic characteristics
During the period of study, a total of 46 patients with cleft palate were managed at Bugando Medical Centre. Of these, two patients were excluded from the study due to failure to meet the inclusion criteria. Thus, 44 patients were available for the final analysis. Twenty-six (59.1%) were males and 18(40.9%) were females giving a male to female ratio of 1.4: 1. The age of patients at diagnosis ranged between 6 and 60 months with a median of 9 months (interquantile range, 6.5 – 12 months). The majority of patients, 35(79.5%) were aged between 6 and 12 months old at the time of presentation (Figure 1). Thirty (68.2%) of the parents of these patients came from rural areas located a considerable distance from the hospital.
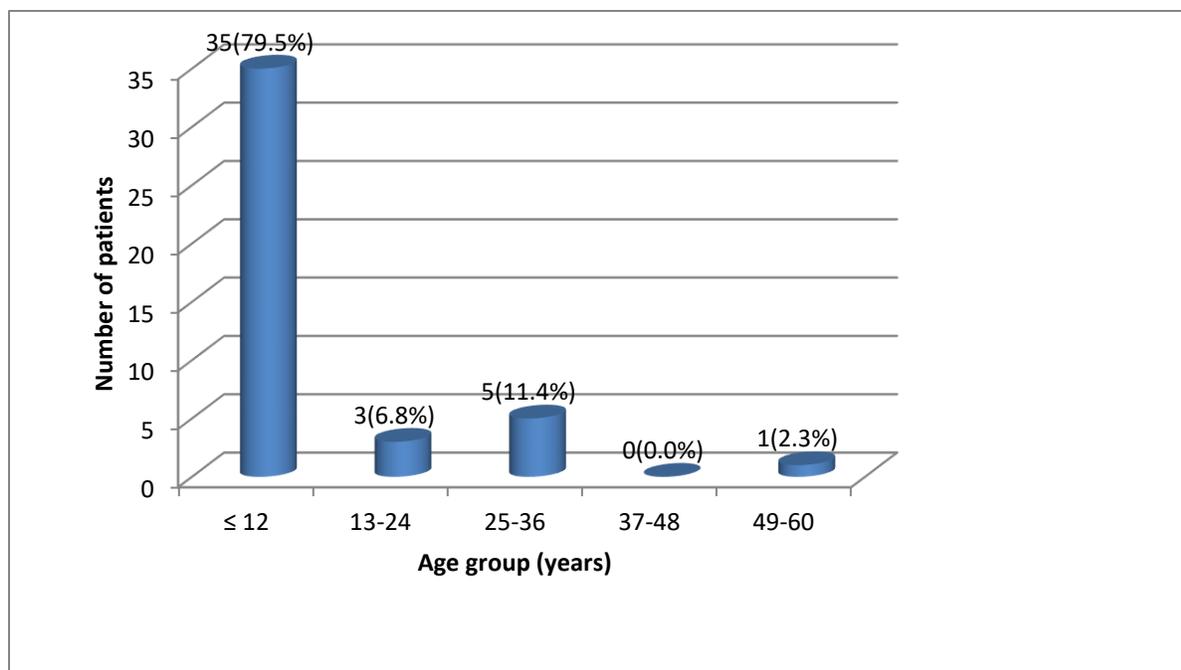
Figure 1: Age group distribution of patients

Clinical characteristics of patients

The majority of patients, 35 (79.5%) were aged between 6-12 months old at the time of presentation to hospital. One (2.3%) patient reported to have two congenital anomalies namely hypospadias and congenital heart disease (VSD). Table 1 below shows socio-demographic and clinical characteristics of patients undergoing cleft palate repair at Bugando Medical Centre

Table1: Socio-demographic and clinical characteristics of patients undergoing cleft palate repair at Bugando Medical Centre

Patient Characteristics	No. of Patient	Percentage %
Age-group(month)		
6-12	35	79.5
13-60	9	20.5
Sex		
Female	18	40.9
Male	26	59.1
Area of residence		
Rural	30	68.2
Urban	14	31.8
Associated congenital anomalies		
Yes	1	2.3
No	43	97.7
Nutrition Status		
Normal	27	61.4
Malnutrition	17	38.6

Width of Cleft(mm)		
≤ 10	26	59.1
>10	18	40.9
Laterality of Cleft palate		
Right	12	27.3
Left	10	22.7
Bilateral	22	50.0
Extent of Cleft palate		
Incomplete	9	20.5
Complete	35	79.5
Other orofacial cleft		
None	10	22.7
Cleft lip	34	77.3
Atypical	0	0.0

Surgical treatment of cleft palate

All patients in this study were managed surgically (cleft palate repair), all operated electively under general anaesthesia. The median age at surgery was 9 months (IQR, 6 to 13 months) and most of the patients, 35 (79.5%) were aged 12 months and below at surgery. The operative technique performed included *von-Langenbeck* in 22 (50.0%) patients and *combined von- Langenbeck and extended palatoplasty* in the remaining 22(50.0%) patients. The overall duration of operation ranged from 52 to 130 minutes with a median duration of 86 minutes (IQR, 58 to 102 minutes). The median duration of surgery in patients with unilateral cleft palate was 56 minutes (IQR, 44 to 68 minutes) while the median duration of surgery in those with bilateral cleft palate was 72 minutes (IQR, 70 to 132minutes). This difference was statistically significant (p = 0.002).

Outcome of surgical treatment

In this study, a total of 21 (47.7%) postoperative complications were recorded in 18 patients. Of these, postoperative bleeding was the most common postoperative complications accounting for 47.6% of cases (Table 2).   Postoperative bleeding and respiratory obstruction were managed conservatively whereas patients with palatal fistula and wound dehiscence were discharged home and scheduled for re-operation to be done three months after surgery. There was no death recorded in this study.

Table 2: Postoperative complications (N =21)

Postoperative complications	No. of patient	Percentage (Prevalence)%
Bleeding	10	47.6
Respiratory obstruction	1	2.3
Surgical site infections	0	0.0
Wound dehiscence	1	2.3
Palatal fistula	9	42.8

Out of 44 patients, 34 were treated successfully giving an overall success rate of 77.3%. The success rate was significantly influenced by nutrition status (p= 0.020) and the width of the cleft (p=0.033) as shown in Table 3 below.

Table 3: Analysis of prognostic factors of patients undergoing cleft palate repair at BMC

Prognostic Factor	Treatment Success		Chi-square	p-value
	Successful	Unsuccessful		

Age-group(month)				
6-12	26(74.29)	9(25.71)		
13-60	8(88.89)	1(11.11)	0.8693	0.351
Sex				
Male	20(76.92)	6(23.08)		
Female	14(77.78)	4(22.22)	0.0044	0.947
Residence				
Urban	11(78.57)	3(21.43)		
Rural	23(76.67)	7(23.33)	0.0195	0.888
Nutrition Status				
Normal	24(88.89)	3(11.11)		
Malnutrition	10(58.82)	7(41.18)	5.3693	**0.020**
Width of Cleft(mm)				
≤ 10	23(88.46)	3(11.54)		
>10	11(61.11)	7(38.89)	4.5305	**0.033**
Laterality of Cleft palate				
Right	10(83.33)	2(16.67)		
Left	9(90.00)	1(10.00)		
Bilateral	15(68.18)	7(31.82)	2.2086	0.331
Extent of Cleft palate				
Incomplete	8(88.89)	1(11.11)		
Complete	26(74.29)	9(25.71)	0.8693	0.351
Type of Surgery				
Von langenbeck	19(86.36)	3(13.64)		
Combined(Von+Extended)	15(68.18)	7(31.86)	2.0706	0.150
Duration of Surgery(min)				
<60	12(92.31)	1(7.69)		
60 -120	19(76.00)	6(24.00)		
>120	3(50.00)	3(50.00)	4.2375	0.120

Discussion

Cleft palate constitute a major public health concern worldwide and poses major therapeutic challenges among otorhinolaryngology, plastic/reconstructive, oral and maxillofacial surgeons practicing in resource limited countries (Agrawal., 2009; Wanjeri & Wachira., 2009; Ibrahim *et al.*, 2013). In this study, males were more affected than females which agrees in part with findings from Kenya(Onyango & Noah., 2005), but differs from most Caucasian series in which clefts of the palate occur more frequently in females (Croen *et al.*, 1998; Shapira *et al.*, 1999). The reason for this gender differences is unclear and warrants further investigation.

The age at presentation in our study does not support the hypothesis that patients with orofacial clefts including cleft palate in low and middle income countries tend to present at later age due to unavailability of specialized medical facilities (Adekeye *et al.*, 1985). As has been documented in Kenya (Onyango & Noah., 2005), the majority of patients with cleft palate in our study presented under the age of one year. The potential explanation for the observed age distribution could be improvements in the Tanzanian healthcare and health education systems in recent years, as well as the occasional availability of programs that support treatment of orofacial clefts supported by AMREF, SMILE TRAIN and mining companies in this region.

In keeping with other studies in low resource countries (Adekeye *et al.*, 1985; Onyango & Noah., 2005), more than two third of the patients in this study came from the rural areas located a considerable distance from the hospital. This observation has an implication on accessibility to health care facilities and awareness of the disease.

Orofacial clefts including cleft palate have long been known to be associated with other congenital defects, though the frequency and type of associated malformations observed varies considerably across studies (Onyango & Noah., 2005; Agrawal., 2009; Taiwo *et al.*, 2016). Various studies have reported that the incidence of associated anomalies with cleft palate can range from as low as 4.3% (Shprintzen *et al.*, 1985) to as high as 68.4% (Jensen *et al.*, 1988).

In the present study, the associated congenital anomalies were recorded in 2.3% of patients, a figure which is significantly lower than that reported from other parts of the world (Onyango & Noah., 2005). This low incidence of associated congenital anomalies in our study may be due to the fact that our patients with cleft palate were not routinely screened for associated anomalies soon after their admission. This may be contributed by lack of screening facilities in our centre as a result most of associated congenital anomalies in our study were diagnosed clinically. The co-existence of orofacial clefts with other congenital anomalies highlights the importance for clinicians to screen for associated congenital anomalies in these patients as the potential functional outcomes may be affected during treatment and rehabilitation

In this study, isolated cleft palate was reported in only 22.7% of patients. Similar findings have been observed in other African studies (Wanjeri & Wachira., 2009; Ibrahim *et al.*, 2013, but differs from most studies in Caucasian and Asian populations which have reported higher incidence of isolated cleft palate (Jensen *et al.*, 1988; Calzolari *et al.*, 2004; Rittler *et al.*, 2011). The low number of patients with isolated cleft palate in this study and other African studies is not clear but may reflect a higher mortality rate in this group associated with functional difficulties during feeding in young infants.

Regarding laterality, half of patients with cleft palate in the present study had bilateral clefts, an observation which is not in agreement with other studies which report high incidence of unilateral cleft palate (Onyango & Noah., 2005; Manyama *et al.*, 2011). More than three quarter of our patients had complete cleft palate. We could not establish the reason for this variation in laterality and extent of cleft palate in this region.

In the current study, all patients with cleft palate underwent cleft palate repair under general anesthesia. The goals of palatal surgery are closure of the communication between the oral and nasal cavities and construction of a functional velum that allows good speech production (Diah *et al.*, 2007). It is widely accepted that the cleft palate repair should be done before speech development (before 18 months of age) (Atack *et al.*, 1997). Early timely closure of cleft palate has demonstrated improved speech outcome, while late palate closure, although conferring better maxillary growth, has shown poor speech outcome (Katzel *et al.*, 2009; Sitzman & Marcus., 2014). In our study, the median age at palatal surgery was nine months which is within normal range. However, because of the short period of the study and non-availability of trained speech therapist in our centre, speech could not be assessed in the present study.

Various studies have reported that the occurrence of palatal fistula following cleft palate repair ranges from 0 to 63% and has been attributed to the surgical technique, expertise of the surgeon, large width of cleft palate, poor wound healing, tension or absence of multilayered closure, or infection of the operated site (Diah *et al.*, 2007; Sitzman & Marcus., 2014) . In this study, the incidence of palatal fistula was reported to be 42.8% which is high than 29.8% that was reported in Nigeria(Adekeye *et al.*, 1985). The reasons for the high incidence of palatal fistula in our series could not be objectively identified. However, it can be speculated that the large width of some cleft palate may result in tension closure, which could have caused the palatal fistula.

The overall good treatment success of 77.9% demonstrated in this study is comparable to the figures from several previous studies (Adebeye et al., 1985; Atack *et al.*, 1997; Diah *et al.*, 2007; Sitzman & Marcus., 2014; Taiwo *et al.*, 2016). This might be attributed to the experience of the surgeons in this centre, the strict selection criteria, good preoperative screening of subjects, good theatre/anesthetic and ward facilities, and competent surgical/medical staff of the hospital. Lack of speech therapist (speech therapy is needed in managing these patients with cleft palate) and short duration of study were the potential limitations in this study.

In conclusion, this study has demonstrated that the majority of patients with cleft palate presented to BMC within 1 year of life. The median age at palatal surgery was nine months. More than three quarters of patients were treated successfully. The palatal fistula following cleft palate repair was reported in 42.8% of cases. Malnutrition and cleft width > 10 mm were the major prognostic factors affecting the treatment success. It is therefore recommended that;-

- Appropriate measures focusing at improving nutrition and aggressive tissue mobilization during surgery are required to achieve closure of the wide palatal cleft are vital in order to deliver optimal care for these patients in this region
- Further study involving long term period and large sample size is necessary in this region to be able to assess speech outcome

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Motives for the first sexual experience and sexual behaviours practiced among out of school Youths in Mpimbwe District, Katavi Region Tanzania

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Abstract:

Background: Early sexual debut is a common practice among youth in Africa. However, little is known about the motives for the first sexual experience and subsequent sexual behaviours practised among out-of-school youths.

Objective: To determine motives for the first sexual experience and sexual behaviours practised among out-of-school youths in Mpimbwe District, Katavi region Tanzania

Methods: A cross-sectional study was conducted among 320 out-of-school youths in Mpimbwe district. Data was collected through structured questions, analyzed using SPSS version 22, (IBM Corp., Armonk, NY, USA) and results were summarised and presented in textual and tabular formats.

Results: The age of the respondents ranged from 15 to 24 years. Age at first sexual experience varied from 14 to 19 years with a median age of 16 years. By the age of 14, about a quarter of the girls (26.8%) and relatively few boys (1.9%) had their first sexual experience. None of the respondents reported using prevention against the consequences of unprotected sex during the first sexual experience. Pleasure was the main motive (79.1%) for the first sexual experience followed by gifts (18.6%) and these varied significantly by age and sex. The majority (98.4%) were aware of vaginal sex and had personal experience with it. Other common sexual behaviours reported were masturbation (81.9%) and anal sex (75.6%). None had practiced anal sex and a third of males (33.1%) and a few females (7.5%) had practiced masturbation. Other sexual behaviours reported were frotteurism and wet and dry sex.

Conclusion: Early sexual debut was common among out-of-school youths with less protection against the consequences of unprotected sex. Pleasure and gifts were the main motives for the first sexual experience. Different sexual behaviours are known and practised by the study respondents. There is a need for effective educational interventions on safe sex for informed decisions on sexual behaviour among this population sub-group.

Keywords: Sexual behaviour, Sexual Motives, Sexual experience, out-of-school, youth

Introduction

The United Nations defines youth as an individual aged between 15 – 24 years (Bersaglio, Enns, and Kepe 2015). This group represents about 1.2 billion of the world's population and close to 90 percent of those are living in less developed countries. Africa is home to the largest youthful population with more than sixty per cent of its population aged under 25 years. By 2030, Africa's youth population is projected to constitute about 42 per cent of the global youth. In Tanzania, this population sub-group constitutes about 20.4 of the total population (Tanzania demographic profile https://www.indexmundi.com/tanzania/demographics_profile.html).

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While the bulging youth population could be seen as an opportunity to reap in driving the continent economies and enhance sustainable development(Bosco Ekka, Prince Verma, and Harishchander Anandaram 2022), to realise this youths need to be informed, engaged, mentored and be healthy including being sexually healthy.

Youthhood marks a critical stage of human development that is accompanied by rapid biological transition, reproductive capability and psychological transition(Denno, Hoopes, and Chandra-Mouli 2015). It is a time of self-discovery as well as physical and cognitive development (Harrower 2019). At this stage youths pass through and experiences new situations and experiments different life events which may have negative consequences to their health and wellbeing if are not approached carefully (Girmay, Mariye, and Gerensea 2019). While curiosity and experimentation are normal, it is within this context that youth sexual development and sexual behaviours occur. Early age at sexual debut among youths is associated with risk sexual behaviours through adulthood (Durowade et al. 2017; Bengesai, Khan, and Dube 2018). It is also associated with elevated rates of sexually transmitted infections (Kaestle et al. 2005; Ankomah et al. 2011), having sex with high-risk and multiple sexual partners (Kassahun et al. 2019), unintended pregnancies, unsafe abortions and inconsistency condom use (Kassahun et al. 2019; Pringle et al. 2017) hence risking the sexual health and the general wellbeing of this young sub-population group.

In most of the Sub-Saharan African countries including Tanzania, pre-marital sex is culturally and religiously not encouraged even though there is evidence that many youths engage in pre-marital sex (Bengesai, Khan, and Dube 2018; O. Asante et al. 2018; Hailegebreal et al. 2022; Kalolo and Kibusi 2015). In Tanzania, about 15% of women aged 20 – 24 years reported experiencing sexual debut before they were 15 years old (Nkata, Teixeira, and Barros 2019). The same rate was also reported in Uganda (Sommer et al. 2016) and a slightly lower rate of 10% was reported in Kenya (Macro 2008).

Tanzania is one of the ten countries with the highest rate of teenage pregnancy (Nkata, Teixeira, and Barros 2019; Wado, Sully, and Mumah 2019) In 2016, 27% of the adolescents aged 15 - 19 years had either a birth or were pregnant, an increase from 26% in 2004-5 and 23% in 2010 (National Guidelines for Water). There is a wider inequality in marriage between adolescents residing in rural areas and urban living in settings. In rural settings, about 23% of the girls aged 15 years have been either married, divorced or widowed before the age of 18 years, compared to 12% in urban settings(OECD 2022).

Similarly, the share of adolescents and young women aged between 20 and 24 years married before the age of 18 is significantly higher in rural settings (24%) than in urban areas (4%). It is also estimated that 4% of boys in Tanzania are married before the age of 18 and in some rural areas some girls reportedly marry as young as 11 years. In such contexts it is significant to examine the aspects prompting the decisions of the youths from rural settings to initiate sexual activities. This study therefore aims to gain insights on the motives for the first sexual experiences and the different sexual behaviours practices among out-of-school youths in Tanzania. Such information could be useful not only for predicting sexual behaviours but also for shaping development of strategies to informed decisions on sex and sexual health among the out-of-school youths

Methodology

This study involved out-of-school youths aged 15 – 24 years in Mpimbwe District Council (DC) in Katavi Region. Mpimbwe DC is located in Southwest Region of Tanzania with an area of 7,704.84 square Kilometer. The district was established in 2016/2017 after the division of the former Mlele District. Mpimbwe DC has a total population of 117,539 people including 32,098 youths (14,411 males and 17687 females). The most recent data shows that the prevalence of HIV in the district is

5.7% among the general population and that of the youth population is 0.6% and 1.2% for males and females respectively(Tanzania 2018). This higher HIV prevalence in the district made it an appealing choice for the study to understand the motives for the first sexual experiences and sexual behaviors known and practiced in the setting to contribute to informed targeted interventions for improving sexual health and wellbeing of the youth population.

A multistage sampling method was used for recruiting the study respondents. A list of all the wards in the district was made and three wards were randomly picked. Thereafter, a list of the villages in each of the wards was made and from each ward two villages were randomly selected for the study. From each selected village, a sampling frame consisting of all households were constructed and 53 households were randomly selected. In households with two or more youths, one was randomly picked for the study.

Data was collected using structured interview guide. Apart from the information on respondents' demographic characteristics, motives for the first sexual experiences, partners of the first sexual experiences, venues for the first sexual experiences and awareness and practice of different sexual behaviors was obtained. The data collected was then processed and analysed using the Statistical Package and Service Solutions (SPSS) version 22 (IBM Corp., Armonk, NY, USA). Finally, the results were summarised and presented in textual and tabular formats.

Ethical consideration

Ethical approval for the study was obtained from the Muhimbili University of Health and Allied Sciences (MUHAS) Ethical Review Board (DA/287/298/01A). The ethical clearance facilitated approval to conduct the study from the administrative authorities of Katavi Region and Mpimbwe District, respectively. Each of the study respondents received detailed information on the nature of the study, assured of the confidentiality and anonymity of the information before providing written informed consent to take part in the study

Results

Characteristics of the study respondents

The study involved 320 youths out of which 51.6 were males. Their age ranged from 15 to 24 years with a median of 19 years. The majority of the respondents (43.2%) were primary school leavers, 12.5% did not have any formal education and very few (2.8%) had post-secondary education. Most respondents had a father (90.9%) and mother (94.7%) who were alive at the time of the study. As summarized in Table 1, almost two thirds (63.6%) were living with both parents and 7.2 % had their own living arrangements.

Table 1: Demographic characteristics of the study respondents (N320)

Variables	Male %	Female%	Total%
Respondents age			
< 14 years	24.8	36.8	30.6
>15 years	75.2	63.2	69.4
Education level			
No formal education	14.5	10.3	12.5
Incomplete Primary school	13.9	14.2	14.1
Complete Primary school	38.2	46.5	43.2
Incomplete Secondary school	11.5	14.2	12.8
Complete Secondary school	18.2	12.9	15.6
Post-secondary school	3.6	1.9	2.8
Living arrangements			
Both parents	62.8	64.5	63.6
Mother alone	18.9	18.7	18.8
Father alone	4.3	1.3	2.8
Relatives	6.7	8.4	7.5

Other arrangements	7.3	7.1	7.2

Age at first sexual experience

The age at first sexual experience varied from 14 to 19 years with median of 16years. By the age of 14, 14.1% of the respondents already had their first sexual experience. At this age about a quarter (26.8%) of the girls were sexually active compared to 1.9% of the boys.

There was a great variation in the type of partner during the first sexual experience. Close to three quarters (72.1% said they first had sex with their friends. This type of response was higher among females (74.5%) compared to males (69.8%). About 1 in 4 had their first sexual experiences with their fellow students and this was higher among males 28.3% compared to females (21.6%). Sex with relatives was reported by 3.9% of females and (2.9%) of the males. None of the study respondents used any protection against consequences of unprotected sex during the first sexual experience.

Motives for the first sexual experience

As summarized in Table 2, pleasure was the main motive (79.1%) for the first sexual experience especially among males. Gift as a motive was a response mainly given by females (37.5%).

Table 2 Variation on the motives for the first sexual experience by sex

Motives	Male (N=159)	Female (N=152)	Total (N=311)
Pleasure	98.1	59.2	79.1
Gifts	0.6	37.5	18.6
Money	1.3	3.3	2.3
Total	100.0	99.0	100.0

Chi-square = 72.941 and P.000

Sex for pleasure varied significantly by age. A large majority (83.6%) of those at the age of 15 and above tried sex for pleasure compared to 51.2% of those at the age of 14 or below. The younger ones were more likely to try sex in exchange of gifts (17.8%) compared to 14.2% of those aged 15years and above. The need for money was almost the same for the younger (2.3%) and older (2.2%) respondents (chi-squire = 25.696);P =0 .001)

Venue for the first sexual experiences

Venues where the first sexual experience took place revealed an interesting pattern. More than a half (51.6%) of the first sexual experiences took place either at the home of the partner or the respondent while 42.3% took place either in the bush or in abandoned buildings. Female youth were more likely to have their first sexual experience at the partner's home (55.6%) a venue which was reported by very few male youth (2.2%). The home of the respondent was more likely to be the venue for the first sexual experience for the males (33.3%) compared to the females (6.5%) as summarized in Table 3 below.

Table 3 Venues for the first sexual experience

Venues	Male (N=159)	Female (N=153)	Total
Partners home	2.2	55.6	31.4
Respondents home	33.3	6.5	20.2
Guest house	0.6	0	0.3
Bushes	25.2	16.3	20.8
Abandoned buildings	24.5	18.3	21.5
Hostel/school compound	8.2	3.3	5.8

When the venue for first sexual experience was examined in relation to age it was noted that the younger respondents aged 14years or less were more likely to have it at the partners' home (45.5%) compared to those who were older (29.1%) while the older ones were more likely to have it at their home (22.0%) compared to the younger ones (9.1%).

Sexual behaviours known and practiced
Virginal sex was known by a large majority (98.4%) of the respondents and had practised it before the time of the study. Awareness and practice of other types of sexual behaviours are as summarized in Table 4 below.

Table 4: Awareness and practice of other sexual behaviours among study respondents

Sexual Practices	% Known			% Practiced		
	Male	Female	Total	Male	Female	Total
Anal sex	75.2	75.6	75.6	0	0	0
Oral sex	58.8	61.9	60.3	37.8	31.2	34.5
Masturbation	93.3	69.7	81.9	33.1	7.5	22.6
Dry sex	13.9	41.9	27.5	0	26.2	18.9
Wet sex	30.9	33.1	32	35.3	47.2	41.3
Frotteurism	31.5	7.1	19.7	12.5	16.7	13.3

The other common other sexual behaviour known was masturbation (81.9) followed by anal sex (75.6%). While an equal proportion of males (75.2) and females (75.6%) were aware of anal sex none of them reported to have practiced it. On the other hand, masturbation was known to a large majority of the males (93.3%) and a third of them (33.1%) had practiced it while this type of sexual behaviour was known to 69.7% of the females and very few 7.5% said to have tried it.

Frotteurism, a practice common in overcrowded transport facilities in urban settings was known to 19.7% of the study respondents especially males (31.5%). However, only 13.3% of the respondents said they had practiced it including 16.7% of the females. Wet and dry sex which is fairly common in parts of East and Central Africa (Duby and Colvin 2014) was known to almost a third (32%) of the respondents. However, dry sex was practiced only by 26.2% of the female respondents while none of the males reported to have practised it. Wet sex was practiced by 47.2 of females and 35.3% of males.

Discussion
Many youths are sexually active but little is known about the motives for the first sexual experience and the sexual behaviours known and practiced particularly in rural districts in Tanzania. In this study an attempt was made to determine what motivated the youth to have sex for the first time and where such behaviour was initially attempted. Many of them started practicing sex at a fairly young age. By the age of 14 years more than a quarter of the girls (26.8%) and 1.9% of the boys were already sexually active. The likelihood of girls experiencing sexual activity earlier than boys has also been reported in Uganda (Renzaho et al. 2017; Sommer et al. 2016), Kenya (Obonyo 2010) and South Africa (Bengesai, Khan, and Dube 2018). This may be due to socio-cultural norms and practices that encourage young girls to marry relatively older men (Fagbamigbe and Idemudia 2017).

Early sexual debut is of particular concern in Tanzania since it is among the African countries where adolescent girls and young women account to 80% of the new HIV infections (Zanzibar 2017) which are mainly sexually transmitted. The association between early sexual debut and risk sexual behaviour (Kaestle et al. 2005; Doyle et al. 2012; Amo-Adjei and Tuoyire 2018), higher risk of exposure to pregnancy and sexually transmitted infections (Speizer et al. 2013; Shrestha, Karki, and Copenhaver 2016; Houlihan et al. 2016; Seff, Steiner, and Stark 2021) as well as the

general threat to health and wellbeing of the adolescents is well reported (Pringle et al. 2017; Taylor-Seehafer and Rew 2000; Mensch, Grant, and Blanc 2006). Improving access to age-appropriate sexual and reproductive health and rights education will not only be beneficial to adolescent health and well-being but also for the long-term HIV epidemic control.

This study reveals that pleasure and the need for gifts were among the main motives for the first sexual experience by the study respondents. Similar results were reported from a study involving adolescents in Anambra State in Nigeria (Duru et al. 2010). In their study peer group pressure, personal satisfaction and individuals' own curiosity were the other underlying motives for the initial sexual experiences   (Duru et al. 2010). Although sex is a basic human drive, there is a need to improve sex socialization during pubescence to support these young people to make informed decisions during sexual engagements and improve their sexual wellbeing as they mature towards adults.

Use of preventive gears such as condom during sexual intercourse is one of the recommended measures to prevent sexual partners from unintended sexual outcomes such as unwanted pregnancies and sexually transmitted diseases(Duru et al. 2010). However, in this study none of the adolescents reported to use any prevention against the consequences of unprotected sex during the first sexual experience. Not using protective gears during the first sexual experience was also reported among adolescents from other parts of Tanzania (Nkata, Teixeira, and Barros 2019) and elsewhere (Magnusson, Masho, and Lapane 2012). This behaviour could be informed by the reported limited sexual education and negotiation skills (Mmbaga et al. 2017) and knowledge of STIs and HIV or prevention activities in sexual and reproductive health among the adolescent population(Nkata, Teixeira, and Barros 2019) .

The existing literature shows that sexual education is most effective when delivered to pre-sexually active young people(Boonstra 2015; Hendriksen et al. 2007). Facilitating acquisition of this knowledge should be accompanied by improved access to adolescents sexual and reproductive health services in order to enable knowledge translation into practice.

This study further inquired from the respondents the sexual behaviours known and practiced. Vaginal sex was the commonly known and practiced sexual behaviour reported. Other sexual behaviours commonly known and reported in the study included masturbation, oral and anal sex although none of the respondents reported personal experience anal sex.

The current study findings differ from what was earlier reported in a systematic review that anal sex between men and women is a wide spread practice in sub-Saharan Africa (Morhason-Bello et al. 2019) including the East African countries (Duby and Colvin 2014; Shayo et al. 2017) . This difference could be explained by the fact that these studies had different population groups. However, it is also possible that because anal sex is illegal and culturally unacceptable in the Tanzanian settings, study respondents did not want to be associated with it.

Evidence shows that both men and women in Africa practice anal sex for a variety of reasons including to maintain virginity, contraception, fulfilment of male pleasure, relationship security, menstruation, financial gain and prestige (Duby and Colvin 2014).It may not be surprising to see similar reasons influencing the same sexual practices among the out-of-school youth. This is also because in other settings in Tanzania, a study observed self-reported anal sex among adolescents and youths to be around 8%(Morhason-Bello et al. 2019).

This study had to contend with one major limitation. Since a discussion on sexual behaviours with the youth is not culturally and morally favoured in Tanzania there might be chances of under-reporting on the sexual behaviours known and practiced in the study. Reporting on sexual practices among the respondents as a topic is culturally sensitive and one that could attract stigma among the youths' social circles. Therefore, the findings from this study provide critical insights on the motives for the first sexual experience and sexual behaviours known and practised that are useful for informing sexual education programs targeting out-of-school youths and the general youth sub-population group in rural settings in Tanzania and elsewhere.

Conclusion

The study has found that early sexual debut is a common practice among out-of-school youths. This practice was mainly motivated by the want for pleasure or gifts and protective measures against the consequences of unprotected sex were rarely observed. Virginal sex was the main sexual practice even though the youth were aware of other types of sexual behaviours Consequently, the study establishes an urgent need for interventions to providing effective, sufficient and appropriate education among out-of-school youths on sexuality and safer sex for informed decision on sexual practices and improving their sexual health and well-being in general.

Data availability

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request

Conflict of interest

Authors declare that they have no conflict of interest

Authors' contributions

EM, AM and ML conceived and designed the study. AM collected the data. EM performed the analysis and the interpretation of the data, and wrote the manuscript. All authors participated in the interpretation of the data and editing of the manuscript and approved the final manuscript for publication

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Abdominal re-operations: indications, early surgical outcomes and prognostic factors at Bugando Medical Centre, Mwanza Tanzania

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Abstract
Background: Abdominal re-operation is any repeated operation for an intra-abdominal procedure or wound complication on index admission or on a subsequent admission to the hospital within a post-operative period of sixty days. It is usually performed in case of post-operative complications either as a re-laparotomy, stoma or wound complications depending on the initial type of surgery. Incidence of abdominal re-operation differs according to the hospital's settings, patient's baseline clinical condition and type of primary abdominal surgery. Despite the increased number of surgical re-admissions, and post-operative complications, there is still a paucity of data describing burden, indications, outcomes and prognostic factors of abdominal re-operations at Bugando Medical Centre (BMC). This study was conducted to determine indications, early surgical outcomes and prognostic factors for abdominal re-operations at BMC.
Methods: This was an analytical cross-sectional study that was conducted at BMC from May 2017 to May 2018. Data were entered into a Microsoft Excel sheet and statistical analysis was done using STATA version 15.
Results: A total of 104 patients were enrolled, of whom 41(39.4%) were males and 63(60.6%) were females, giving a male-to-female ratio of 1: 1.5. Their ages at diagnosis ranged from 1 day to 76 years with a median age of 29 [IQR 17 – 46] years. The most common indications for abdominal re-operation were peritonitis 45 (43.3%), burst abdomen 29 (28.0%) and anastomotic leak 18 (17.3%). Stoma complications 7 (6.7%), haemorrhage 4 (3.9%) and post-operative paralytic ileus 1 (1.0%) were also recorded indications but at a lesser frequency. The mortality rate following abdominal re-operation was 28.9% (n=30). Older age and increasing number of abdominal re-operations were the main independent predictors of mortality following abdominal re-operations (p < 0.001).
Conclusion: Abdominal re-operation is associated with high mortality. The most common indications for abdominal re-operation were peritonitis, burst abdomen and anastomotic leak. Predictors of mortality were older age and an increasing number of abdominal re-operations. Hence it is recommended that patients with peritonitis, burst abdomen or anastomotic leak be managed in a timely and well-planned manner to minimize the number of unnecessary re-operations which may increase the risk for mortality.

Keywords: Abdominal re-operations, indications, outcomes, prognostic factors, Tanzania

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Introduction

Abdominal re-operation is any repeated operation for an intra-abdominal procedure or wound complication on the index admission or on a subsequent hospital admission within a post-operative period of 60 days (Girgor'ev *et al.*, 2003). Although surgeons generally take pride when there is no need for re-operation, there are circumstances where failure of one or multiple surgical requirement(s) necessitates abdominal re-operations. In addition, there are a number of other complications that occur after primary surgeries which may culminate in urgent abdominal re-explorations which may prove to be lifesaving (Girgor'ev *et al.*, 2003; Yovtchev *et al.*, 2010).

Abdominal re-operations may be influenced by many factors including but not limited to the rank of the first attending surgeon, the indication for the primary surgery, the technique and skills of the attending surgeon, the patient's co-morbid conditions and sterility of the surgical environment and equipment (Holzheimer & Gathof., 2003; Yovtchev *et al.*, 2010). Reoperation rates are classified according to the type of operation. These are divided into re-laparotomy (considered as a re-opening of the abdomen, abdominal washout, small bowel resection, further colorectal resection, open drainage of intra-abdominal abscess, division of adhesions, formation of stoma, stoma complications (considered as an operation on a stoma, excluding closure of stoma and stoma formation) and wound complications requiring re-operation (Zacharias *et al.*, 1999; Burns *et al.*, 2011).

Abdominal re-operation can be categorized as early or late; radical or palliative; urgent or elective; planned or unplanned depending on the performed period, its purpose, urgency and whether or not it is scheduled (Ching *et al.*, 2003; Yovtchev *et al.*, 2010). Urgent abdominal re-explorations following complicated abdominal surgeries are generally known as *'final choice'* operations, with high morbidity and mortality rates (Ching *et al.*, 2003).

It is not necessary that all the abdominal re-operations are done due to failure of some requirements but there are a number of complications that occur after primary surgeries that may require urgent abdominal re-explorations, they are lifesaving and obligatory operations to be performed (Koirala *et al.*, 2015). Redo laparotomies are called on demand if it has to be done because of the patients' condition and are called planned if the second laparotomy is decided upon during the course of the first surgery, for example: in case of severe intra-abdominal sepsis or post-damage control surgery(Wain & Sykes., 1987; Koirala *et al.*, 2012).

Staged abdominal re-operation (STAR) for abdominal trauma is a damage control surgery where there are modified sequence using rapid life saving techniques delaying the definitive resection and reconstructive surgery until when the patient can be adequately resuscitated and stabilized in the surgical intensive care unit (Johnson *et al.*, 2001; Taviloglu., 2003; Koirala *et al.*, 2012). The technique of abdominal packing with planned abdominal re-operation was first described in the beginning of 20th century as peri-hepatic packing, at that time liver lacerations were frequently packed with absorbable or non-absorbable material sutured in place (Taviloglu., 2003).

Staged abdominal re-operation is a technique of serial operations, planned either before or during the index operation and performed within 24 to 48 hours, with temporary closure of the abdomen often culminating into a final aponeurosis to aponeurosis abdominal closure (Lonasoff *et al.*, 2002; Taviloglu., 2003; Koirala *et al.*, 2012). Success of a surgeon would be proportionate to his correct responses to such questions as "to whom, when, under what conditions, why and how the surgery should be conducted" when urgent abdominal reoperations is required (Unalp *et al.*, 2006).

A large number of patients undergo various operative procedures every day and laparotomy forms a large proportion. At times, laparotomies have to be re-done due to complications like biliary peritonitis, faecal fistula, burst abdomen or anastomotic leak (Billing *et al.*, 1991; Koirala *et al.*, 2012). Incidence of abdominal re-operation is also found to be higher in hospital setup with training facility and it has contributed to morbidity and mortality (Patel *et al.*, 2016). This study aimed to explore on

abdominal re-operations, their indications, outcomes and prognostic factors at Bugando Medical Centre so that we may be able to explore potential interventions that will halt the associated morbidity and mortality.

Methods and patients
Study design
It was an analytical cross sectional study where all patients with indications to undergo abdominal re-operation in general surgical, urological and gynecological wards at Bugando Medical Centre between May 2017 and May 2018 were evaluated and considered for enrollment.

Study setting
This hospital-based study was conducted at the Emergency department (EMD), intensive care unit (ICU), general surgical, urological and gynecological wards of BMC for all patients who underwent abdominal re-operation were included in the study if they consented. BMC is one of the four zonal and tertiary referral hospitals in Tanzania; it is situated along the shores of Lake Victoria in Mwanza City in the Northwestern part of Tanzania. The hospital has 960 beds and serves as a referral center for tertiary specialized care for a catchment population of approximately 18 million people from neighboring regions (Mara, Kagera, Shinyanga, Simiyu and Geita). It is a consultant and teaching hospital to Catholic University of Health and allied sciences – Bugando (CUHAS- Bugando) and other health training institutes.

The hospital has well designed and equipped EMD where by all surgical emergencies are reviewed in consultation with surgical departments where by all patients with emergency surgical conditions are stabilized before sending to the operating room. Also the hospital has modern and equipped: Adult, Pediatric and Neonatal Intensive care unit (ICU) with a bed capacity of 12 for the adults and 10 for pediatrics. It is through the ICU where by those patients with emergency surgical conditions that underwent damage control abdominal surgeries and necessitated re-exploration as staged abdominal re-explorations were admitted.

Majority of patients who underwent damage control surgeries in operating theatre are transferred to ICU for stabilization before the definitive surgery, Patients with long duration of surgery and those who underwent abdominal re-explorations, ICU remains the safe place post-operatively. The hospital has specialized and super specialized departments, general surgery, obstetrics and gynecology, urology are among the specialized departments where by a number of abdominal surgical operations are conducted, most of the patient with planned and un planned abdominal re-explorations are found admitted here. In a year, from January 2016 to December 2016 a total of 120 number of surgical re admission were intervened.

Study Population
The study included patients of all age group and gender with planned and unplanned abdominal re-operations done at BMC, in ICU, general surgery, obstetrics and gynecology and urology departments, all referred cases that need abdominal re-exploration presenting at EMD. This study included patients of all age groups and sex who underwent abdominal re-operation under general anesthesia at BMC. Patients referred to BMC with indications for abdominal re-operation and those who gave consent to participate in the study were also included in the study.

Patients who underwent first abdominal surgery more than 60 days, patients with initial primary laparoscopic procedure, superficial abdominal operation that did not require general anesthesia and patients with insufficient details on the primary surgery were excluded from the study.

The minimum sample size required for this study was calculated using Yamane Taro (1967). Patients who met the inclusion criteria were enrolled serially until required sample size was reached.

Recruitment of patients to participate in the study was done at the A & E, ICU, gynecological, urological and general surgical departments. All patients who underwent abdominal re-operations and meet the inclusion criteria were offered information and explanations about the study and requested for his/her informed written consent before being enrolled in the study. The diagnosis and need to re-operate was established based on clinical findings (symptoms and signs), laboratory and radiological findings at admission. Patients with emergency abdominal trauma who were not clinically stable, a staged abdominal re-operation were done after the first damage control surgery was performed. These patients were then sent to ICU for hemodynamic stabilization and re-operation performed within 48 hours.

Since these patients were in critical clinical condition their next of kin gave consent. However, when their clinical condition improved, they were informed about the study and asked for their willingness to continue participating in the study. Before being subjected to abdominal re-operation, all patients were resuscitated with intravenous fluids to correct electrolytes deficits, nasogastric tube and urethral catheterization were inserted. Broad spectrum antibiotics were administered and relevant pre-operative investigations were performed. Every patient was followed up from time of admission until time of discharge/death.

Data Management
Data collection
Both Swahili and English version questionnaire was used to collect information on the socio-demographic data (i.e. age and sex), referral details, indications for abdominal re-operation, co-morbid conditions, details of primary surgery (indications for the first surgery and Rank of the surgeon who performed the procedure and intra-operative duration of the first surgery). Information on interval to abdominal re-operation, number of subsequent abdominal re-operations was recorded. Post-operative data including: length of hospital stay, development of complications and mortality were collected. Mobile phone communication was used to obtain referral details.

Statistical data analysis
Statistical data analysis was done using STATA version 15. Categorical variables were summarized into proportions and frequency distributions. Continuous variables were summarized into mean (standard deviation) and median (interquantile range). Data were further displayed using histograms and pie chart. Categories for different predictor variables were made based on literature findings and clinical experience. Univariate analysis using logistic regression was done between each predictor variable and outcome variable to obtain crude odds ratios (cOR) with their respective 95% CI and p-values. All predictor variables with a p-value ≤ 0.10 were considered for the final multivariate analysis model where adjusted odds ratios (aOR) with their respective 95% CI and p-values were obtained. All variables with p-value ≤ 0.05 in the final logistic multivariate analysis model were considered to be independent predictors of the outcome variable (mortality from abdominal re-operation).

Ethical considerations
The approval to carry out the study was sought from the Joint CUHAS/BMC Research, Ethics and Committee (CREC/224/2017) before the commencement of the study. Also, permission was sought from BMC authority. A written informed consent was requested from each participant and/or close relative after explaining the aim and importance of the study as well as the study procedures. For patients < 18 years of age and those who were critically ill, parents/guardians or next of kin were

requested to give consent on their behalf. Patient's refusal to give consent or withdraw from the study did not alter or jeopardize their access to medical care at BMC. Confidentiality was strictly maintained during data collection and thereafter.

Results

From May 2017 to May 2018 a total of 115 patients who underwent abdominal re-operations at BMC. Participants were screened for eligibility of being recruited into the study. Of those 104 (90.4%) patients fulfilled the inclusion criteria and were enrolled into the study, whereas 11 (9.6%) patients were excluded from the study due to failure to meet the inclusion criteria as shown in Figure 1 below.
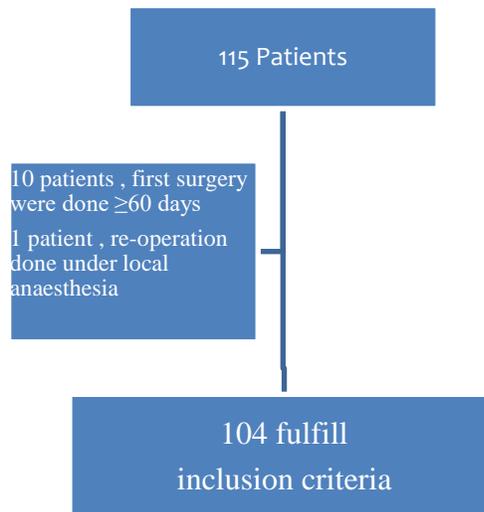

Figure 1: Flow chart showing recruitment of patients who underwent abdominal re-operation at BMC

Demographic and clinical characteristics of the patients enrolled into study

Of the 104 patients enrolled, 41 (39.4 %) were male and 63 (60.6%) were females, giving a male to female ratio of 1: 1.5. Their age at diagnosis ranged from 1 day to 76 years with the median age of 29 [IQR 17 – 46] years. The majority of patients, 69 (66.4%) were in the age <40 years. 95 (91.4%) of patients had no premorbid illness and 9 (8.6%) had premorbid illness. Most of the abdominal re-operation was done as emergency surgeries 90 (86.5%) and few as elective surgeries 14 (13.5%). Majority of patients had one abdominal re-operation 81 (77.9%) and the interval from the first abdominal surgery to the re-operation was 4 to 6 days in majority of them 55 (52.9%). Table 1 below summarizes the distribution of demographic and clinical characteristics of enrolled patients.

Table 1: Distribution of demographic and clinical characteristics of enrolled patients (N=104)

Patient's variables	Number (n)	Percent (%)
Age group		
<40 years	69	66.4
≥40 years	35	33.6
Sex		
Male	41	39.4
Female	63	60.6
Premorbid illness		
No	95	91.4
Yes	9	8.6
Interval for abdominal re-operation(from the first surgery)		
48 hours	13	12.5

3 days	15	14.4
4–6 days	55	52.9
>6 days	21	20.2
Number of abdominal re-operation(s)		
Single abdominal re-operation	81	78.0
Multiple abdominal re-operations	23	22.0
Admission pattern		
Obstetrics and gynecology	21	20.2
ICU	30	28.8
Surgical wards	53	51.0
Hospital stay		
≤ 14 days	53	51.0
>14 days	51	49.0
Urgency of surgery		
Elective surgery	14	13.5
Emergency surgery	90	86.5

Indications and details of the primary surgery
The most common indications for the primary surgery were intestinal obstruction 30 (28.8%) as shown in Figure 2 below.
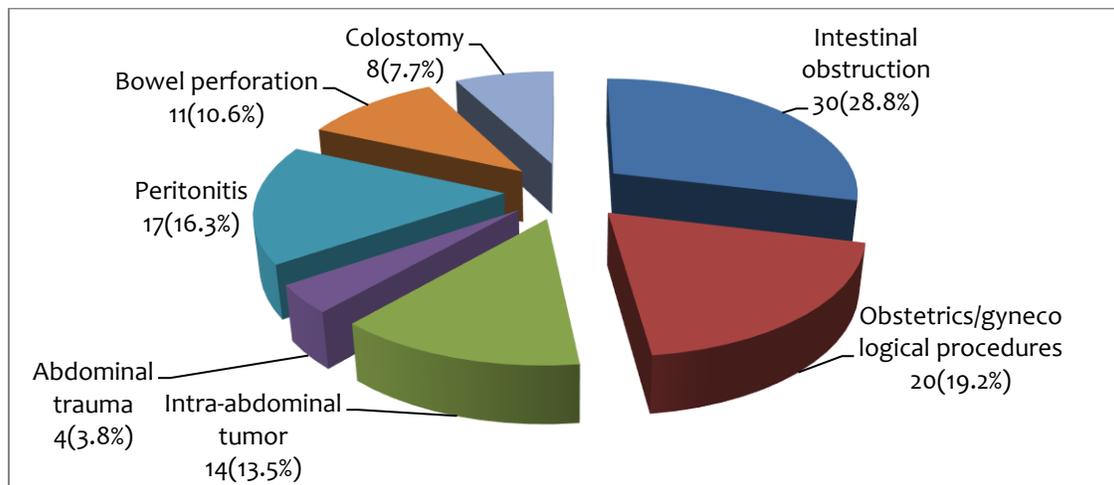

Figure 2: Indications for primary abdominal surgery among patients who had abdominal re-operations at BMC

Table 2: Indications and details of the first/primary surgery (N=104)

Patient variables	Number (n)	Percent (%)
First surgeon's rank		
Junior (registrar/residents)	95	91.3
Senior(specialist)	9	8.7
Duration of the first/primary surgery		
1 –2 hours	24	23.1
≥ 3 hours	80	76.9
Health facility for the first/primary surgery		
District hospital	24	23.1
Regional hospital	39	37.5
Tertiary hospital	41	39.4
Contamination status of first/primary surgery		
Clean-contaminated surgery	100	96.0

| Dirty surgery | 4 | 4.0 |

Indications for abdominal re-operation

Of the 104 patients who underwent abdominal re-operation, the most common indications were peritonitis 45 (43.3%) followed by burst abdomen 29 (28.0%), anastomotic leak 18 (17.3%) as shown in Figure 3 below.
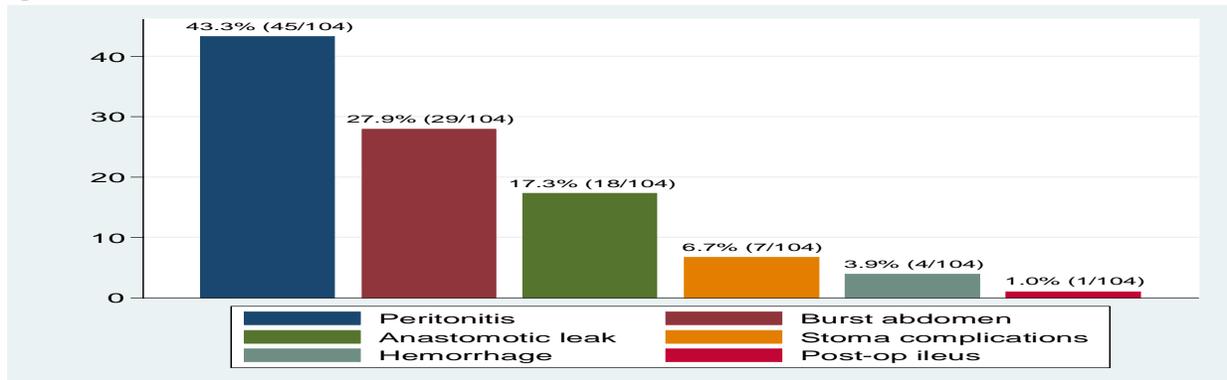

Figure 3: Indications for abdominal re-operations

Complications of abdominal re-operations

Of the 104 patients who underwent abdominal re-operation, 35(33.7%) developed complications. Of these, surgical site infection was the most common post-operative complications following abdominal re-operations as shown in Figure 4 below.
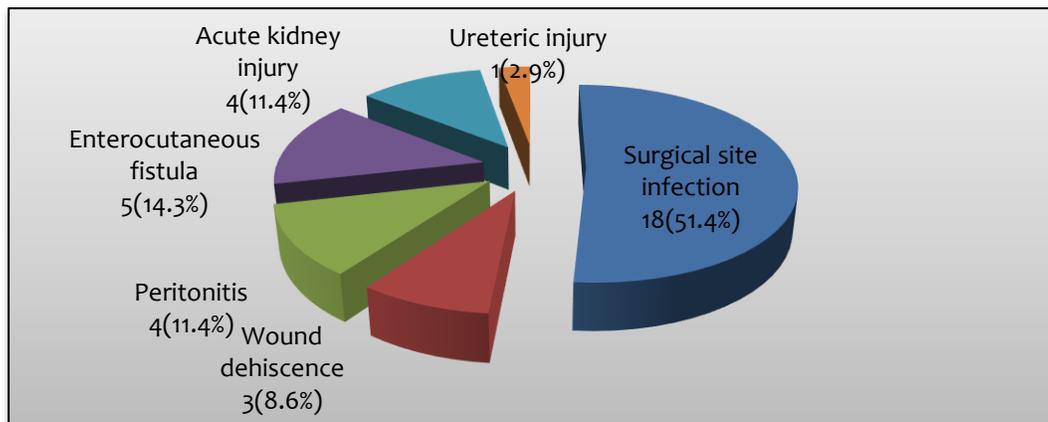

Figure 4: Post-operative complications following abdominal re-operations

Mortality among abdominal re-operated patients
Out of 104 patients, 30 patients died giving a mortality rate of 28.9%. Figure 4 summarizes the proportion of patients who died following abdominal re-operation
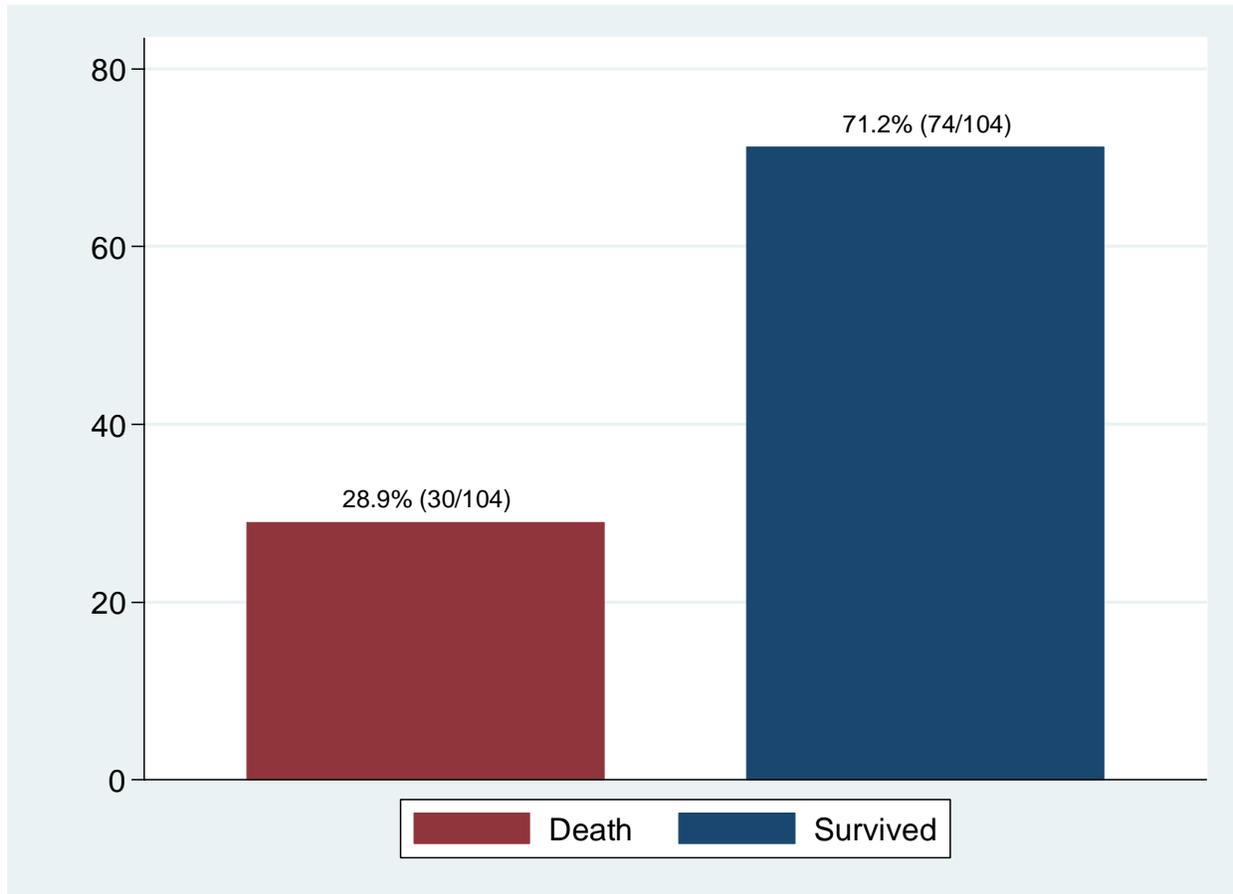

Figure 5: Proportion of patients who died following abdominal re-operation at BMC
Predictors of mortality among patients undergoing abdominal re-operation at BMC

Table 3 below summarizes predictors of mortality among patients who underwent abdominal re-operations according to univariate and multivariate logistic regression analysis.

Table 3: Predictors of mortality among patients who underwent abdominal re-operations according to univariate and multivariate logistic regression analysis

Patient	Survival		Univariate		Multivariate analysis	
	Died	Alive	OR[95% CI]	p-value	OR[95% CI]	p- value
Characteristics	n (%)	n (%)				
Age group						
<40	10 (33.3)	59 (79.7)	1.0			
≥40	20 (66.7)	15 (20.3)	7.9 [3.1 –20.3]	<0.001	9.3 [2.5 –34.1]	0.001
Sex						
Male	15 (20.3)	7 (23.3)	1.0			
Female	59 (79.7)	23 (76.7)	0.8 [0.3 –2.3]	0.729		
Primary Surgery						
Intestinal obstruction	11 (36.7)	19 (25.7)	1.0			
Obstetrics/gynecology	0 (0.0)	20 (27.0)	·			

Intra-abdominal tumor	5 (16.7)	9 (12.2)	0.9 [0.3 –3.6]	0.951		
Abdominal trauma	2 (6.7)	2 (2.7)	1.7 [0.2 –14.0]	0.609		
Peritonitis	10 (33.3)	7 (9.4)	2.5 [0.7 –8.3]	0.146		
Bowel perforation	2 (6.7)	9 (12.2)	0.4 [0.1 –2.1]	0.270		
Colostomy	0 (0.0)	8 (10.8)	.	.		
Indications for re-operation						
Stomal complications	0 (0.0)	7 (9.5)	1.0			
Peritonitis	17 (57.7)	28 (37.8)	1.6 [0.5 –5.2]	0.454		
Burst abdomen	7 (23.3)	22 (29.7)	0.8 [0.2 –3.1]	0.781		
Post operative ileus	0 (0.0)	1 (1.35)	.	1.0		
Hemorrhage	1 (3.3)	3 (4.1)	0.9 [0.1 –10.4]	0.910		
Interval for re-operation						
48 hours	4 (13.3)	9 (12.2)	1.0			
3 days	5 (16.7)	10 (13.5)	1.1 [0.2 –5.5]	0.885		
4-6 days	16 (53.3)	39 (52.7)	0.9 [0.2 –3.4]	0.905		
>6 days	5 (16.7)	16 (21.6)	0.7 [0.1 –3.3]	0.656		
Diagnostic modality						
Lab findings	1 (3.3)	0 (0.0)	1.0			
Imaging	1 (3.3)	4 (5.4)	0.7 [0.1 –6.8]	0.732		
Clinical and lab	3 (10.0)	23 (31.1)	0.3 [0.1 –1.4]	0.147		
Clinical, lab and Imaging	16 (53.3)	23 (31.1)	1.9 [0.7 –5.0]	0.224		
Rank of a surgeon						
Junior (registrar/residents)	29 (96.7)	66 (89.2)	1.0			
Senior (Specialists)	1 (3.3)	8 (10.8)	0.3 [0.0 –2.3]	0.246		
Duration of the first surgery						
1-2 hours	3 (10.0)	21 (28.4)	1.0			
≥3 hours	27 (90.0)	53 (71.6)	3.6 [1 –13]	0.054		
Facility for the primary surgery						
District hospital	7 (23.3)	17 (22.9)	1.0			
Regional hospital	13 (43.3)	26 (35.1)	1.2 [0.4 –3.7]	0.730		
Tertiary hospital	10 (33.3)	31 (41.9)	0.8 [0.3 –2.4]	0.673		
Admission						
Obstetrics and Gynecology	0 (0.0)	21 (28.4)	1.0			
ICU	17 (56.7)	13 (17.5)	10.8 [2.1 – 54.1]	0.004		
Surgical wards	13 (43.3)	40 (54.1)	2.6 [0.5 –13.0]	0.240		
Number of abdominal re-operation						
One surgery	14 (46.7)	67 (90.5)	1.0			
More than one surgery	16 (53.3)	7 (9.5)	10.9 [3.7 –31.5]	<0.001	5.3[1.2 –23.0]	0.024
Complications						
No	18 (60.0)	51 (68.9)	1.0			
Yes	12 (40.0)	23 (31.1)	1.5 [0.6 –3.6]	0.384		
Hospital stay						
≤ 14 days	14 (46.7)	39 (52.7)	1.0			
>14 days	16 (53.3)	35 (47.3)	1.3 [0.5 –3.0]	0.577		

Discussion

Abdominal re-operation remains frustrating for surgeons worldwide and it is performed due to the complications observed following the initial operation and is associated with high morbidity and mortality (Harbrecht *et al.*, 1984; Richards *et al., 2012*). In this study, the majorities of patients who underwent abdominal re-operations were in the second and third decade of life which is in keeping with other studies in African countries (Scriba *et al.,* 2015; Ugumba *et al.,* 2018). However, this is contrary to studies in developed countries which showed that the age at presentation is about a decade or two later compared to what is reported in African reports (Ching *et al.*, 2003; Martínez-Casas *et al.,* 2010). The high life expectancy and disease pattern, more malignant condition in the western world which tends to occur in older age, may contribute to this discrepancy.

The female predominance demonstrated in this study is in keeping with previous observations reported in studies performed elsewhere (Burns *et al.*, 2011; Uysal *et al.*, 2017). Many studies done elsewhere among patients who underwent abdominal re-operations demonstrated male predominance (Ching *et al.*, 2003; Unalp *et al.*, 2006; Martínez-Casas *et al.*, 2010; Koirala *et al.*, 2015; Patel *et al.*, 2016). However, equal gender distribution was reported in a previous study from Ethiopia (Kirubel *et al.*, 2020). The female predominance in this study may be contributed by the high number of obstetrics and gynecological patients which are exclusively females.

In the current study, the most common indications for abdominal re-operation were peritonitis, burst abdomen and anastomotic leak. This finding is in keeping with other studies which demonstrated similar indication patterns (Hinsdale *et al.*, 1984; Krivitskiĭ *et al.*, 1984; Zavernyi *et al.*, 1992; Lojpur *et al.*, 2005; Unalp *et al.*, 2006; Uysal *et al.*, 2017; Zala *et al* ., 2022). This observation could be explained by the fact that septic abdomen following peritonitis or intra-abdominal collection like abscess, anastomotic leaks are associated with diffuse contamination and inflammation. Therefore, this necessitates abdominal re-operation for repeating peritoneal lavage in-order to achieve control of infection. On the other hand burst abdomen could be explained by the experience of the operating surgeon. In addition to this, the type of primary surgery could influence the occurrence of burst abdomen specifically for those dirty primary surgeries. In contrast to our study, studies done by Koirala *et al* (2015) and Ching *et al* (2003) revealed hemorrhage being the commonest indication which is very low in our patients. This discrepancy can be explained by the complexity and type of the first surgery. In these two studies, there is high burden of liver and pancreatic surgery which were usually complicated by bleeding.

In line with other studies (Mamchich *et al.*, 1992; Koperna & Schulz., 2000; Ching *et al.*, 2003; Mushaya *et al.*, 2005; Unalp *et al.*, 2006; Koirala *et al.*, 2015; Patel *et al.*, 2016), most primary abdominal operations requiring re-operations in our study were done for emergency surgeries than elective and most of them were performed by junior doctors. The high rate of emergency abdominal surgeries requiring re-operations in this study can be explained by the fact that there are inadequate patient preparations during emergency surgical procedures and this can predispose them to complications that may require re-operations. In addition, the majority of emergency primary surgeries in the present study were performed by junior doctors (registras and residents) who may have little experiences in forming these surgeries. This calls for direct supervision of junior doctors in order to reduce the incidence of complications that follow emergency abdominal operations. On the other hand, in elective surgery, there is time to plan and optimize the patient before the operation and therefore these surgeries are less likely to develop complications requiring reoperations.

In this study and many other studies (Leshchenko *et al.*, 1991; Unalp *et al.*, 2006; Koirala *et al.*, 2015; Scriba *et al.*, 2015; Ugumba *et al.,* 2018), surgeries for bowel obstructions, gynaecology/obstetrics conditions, bowel perforation and peritonitis were the top most primary abdominal operations that complicated and required reoperations. On the contrary, studies from developed nations

demonstrated GI malignancies as the most common index surgery (Billing *et al.*, 1991; Girgor'ev *et al.*, 2003). This may reflect the difference in disease incidence.

The interval from the first surgery to the repeated one was analyzed and found that the interval of 4-6 days was mostly practiced at Bugando Medical Centre. In the study of Unalp *et al* (2006), the mean re-dolaparatomy interval was 4 days, whereas it was 12.7 days in the study of Koirala *et al* (2015). Longer interval time could be explained by the fact that usually surgeons were optimizing patient's condition and selecting a more conservative approach before sending patients for abdominal re-operations.

Complications are not totally avoidable in surgery, in some cases surgeon may have to perform repeated operations which may consequently be associated with increased morbidity and mortality of the patient. In the current study it was found that 33.7% patients experienced complications following abdominal re-operations. Our proportion of postoperative complications was relatively lower compared to 66.4% that was reported by Koirala *et al* (2015). In this study, surgical site infection was the most common complication following abdominal re-operation accounting for 51.4% of cases. This figure is higher than 39.1% that was reported by Pérez-Guerra *et al* (2017). High rate of surgical site infection in the present may be attributed to contamination of the laparotomy wound during the surgical procedure. Surgical site infections contribute significantly in increasing health care cost, both for patients and hospitals. Ensuring proper sterilization and aseptic precautions is a major remedial factor in preventing post-operative surgical site infections.

The overall mortality rate following abdominal re-operations has been reported in literature to range from 20-40% (Ching *et al.*, 2003; Unalp *et al.*, 2006; Gedik *et al.*, 2009; Martínez-Casas *et al.*, 2010; Patel *et al.*, 2016; Prabhu *et al.*, 2017). In this study the mortality following abdominal re-operation was 28.9% which is within the range in literature. This finding agrees with the overall mortality of 29.7% that was reported by another study following abdominal re-operation (Hutchins *et al.,* 2004). Higher mortality rates of 37.0% and 61.5% were reported by Unalp *et al* (2006) and Koirala *et al* (2015) respectively.

Several factors have been reported in the literature to be associated with mortality following abdominal reoperations (Martínez-Casas *et al.*, 2010; Patel *et al.*, 2016). Most studies have reported that age is associated with mortality following abdominal reoperations (Ching *et al.*, 2003; Unalp *et al.*, 2006; Martínez-Casas *et al.*, 2010; Patel *et al.*, 2016). In this study, age 40 years and above was significantly associated with mortality which is consistent with reports of other studies (Ching *et al.*, 2003; Unalp *et al.*, 2006; Martínez-Casas *et al.*, 2010; Patel *et al.*, 2016). Ching *et al* (2003) reported that mortality rate increases with advancing age, rising from 23% in younger patients below 50 to 75% in those over 80 years. Other studies done in India and Europe have also revealed association between older age and mortality (Martínez-Casas *et al.*, 2010; Patel *et al.*, 2016). High mortality rate in older age group could be due to instability to the surgical stress for the older populations, also multiple organ failure which affects many of the older population, though in this study multiple organ failure was not dealt with, creating a room for further studies that will explore the contribution of multiple organ failure to mortality among older patients who underwent abdominal re-operation.

The association between the number of abdominal re-operations and mortality among patients undergoing abdominal reoperations has been largely studied (Rygachev *et al.*, 1997; Srivastava *et al.,* 2016). It has been reported in the study of Rygachev *et al* (1997) that the mortality rates were significantly higher in multiple abdominal re-operations compared to single abdominal re-operations. In the study of Koirala *et al* (2015), the mortality rates were reported to be 23.6% in single abdominal reoperations and 61.2% in multiple abdominal re-operations. In this study, the number of abdominal re-operations was found to be significantly associated with mortality in multivariate logistic analysis whereby patients who underwent multiple abdominal re-operations had a significant higher mortality

than those who had single abdominal re-operation. Multiple abdominal re-operations are associated with prolonged exposure to risks of anesthesia as well as fluid and electrolytes derangement and multiple organ failure. The interaction of these factors may explain the elevated mortality in patients with multiple abdominal re-operations.

The major limitation in this study was insufficient information about primary surgery for patients referred to BMC. However, despite this limitation, the study has provided local data that can guide health care providers in the management of these patients.

In conclusion, the most common indications for abdominal re-operation at BMC were peritonitis, burst abdomen and anastomotic leak. The mortality and complication rates following abdominal re-operation at BMC were 28.9% and 33.7% respectively. Advanced age (40 years and above) and multiple abdominal re-operation were the main predictors of mortality in patients undergoing abdominal re-operation. It is therefore recommended that timely and planned abdominal re-operation for patients with peritonitis should be advocated in order to lower mortality rate. Watchful waiting or re-laparotomy on demand should be practiced particularly for relatively old patients. Surgeons should make urgent abdominal re-operation decision without delay. Since multiple abdominal re-operations are associated with mortality, the first re-operation is very crucial.

Acknowledgements

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Predictors of Human Papilloma Virus Knowledge and Vaccine acceptability among College Students of a private University

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Abstract

Objectives: In low to middle-income countries, 12% of all female cancers were attributed to Human papillomavirus (HPV) which is the leading infectious cause of malignancy globally. This study identified the predictors of HPV knowledge and vaccine acceptability among college students of a private university with a highlight of the influence of the Health Belief Model.

Methods: This was a cross-sectional study conducted among 388 students of a privately owned university using a stratified sampling technique. The questionnaire was designed to assess the predictors of HPV Knowledge and highlight how the Health Belief Model influenced vaccine acceptability.

Result: Respondents' perception of HPV screening benefits correlates positively (r=0.45, p<0.001) with vaccine acceptance. There is a negative weak correlation between the perception of HPV susceptibility and vaccine acceptability (r= -0.06, p=0.215). Predictors of overall knowledge of HPV infection include course of study, mother's employment status and good family health status. The predictors of HPV vaccine acceptability were moderate knowledge of HPV infection and course of study

Conclusion: Perceived benefits of HPV screening positively influence vaccine. The cues to action that influenced HPV knowledge include the choice of course of study, perception of good family health and mother's employment status. Perception of susceptibility to contracting HPV can be increased with better education and improved ways of counselling on the need for HPV screening, testing and vaccination.

Keywords; Predictors, Human papillomavirus, knowledge, vaccine acceptability, students.

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Introduction

Human Papillomavirus (HPV) is the leading infectious cause of malignancy that contributes mainly to the high incidence and prevalence of cervical cancer globally (World Health Organization 2005; McCusker et al. 2013). Of the 12 high-risk strains of HPV, only types 16 and 18 are responsible for the majority of HPV-related cancers (Crosbie et al. 2013). HPV infections are sexually transmitted and are commonly established in the first decade of sexual activity among young women (Crosbie et al. 2013). HPV-related cancers include cervical cancers (CC) and vaginal, vulvar, anal, penile, oropharyngeal, and oral cancers. The incidence of cervical cancer remains a burden worldwide, especially in developing countries.

Worldwide, over 200 million women are infected with HPV DNA, of which type 16 or 18 or both accounted for 50% (World Health Organization 2022). A large proportion of those infected has been reported in low to middle-income countries where 12% of all female cancers were attributed to HPV (World Health Organization 2022). Eighty per cent of those affected with cervical cancers were found in developing countries (Cutts et al. 2007). Nigeria, a developing country has an increasing burden of cervical cancer ranking behind breast cancer as the leading cause of cancer burden with an estimate 14,943 cases and 10,400 deaths occurring in 2018 (Bray et al. 2018).

A prevalence rate of 23.7% has been reported among Nigerian women with HPV-related cervical cancer (Muñoz et al. 2022). The importance of primary and secondary prevention of HPV-related diseases has become a global point of advocacy for women and men (Lowy et al. 2008). Vaccination against HPV infection among adolescents and youths prior to their first sexual exposure has been emphasized as a preventive strategy for the occurrence of cervical cancers (Okunade et al. 2017). The two approved HPV vaccines – Gardasil and Cervarix have provided an opportunity to ensure the burden of cervical cancer is curbed (Okunade et al. 2017; Erickson, Alvarez, and Huh 2013). There are some variations about the age range of receiving the HPV vaccine. The World Health Organization recommends offering HPV vaccine to girls prior to their first sexual exposure, at the age of 9 to 13 years. The efficacy of the vaccine is better before exposure to the infection (World Health Organization 2009). Meanwhile, the Nigerian Federal Ministry of Health recommends the vaccination should be given between 9 to 26 years and before the initiation of sexual exposure (Federal Government of Nigeria n.d.).

Considering the education system in Nigeria, tertiary institution students have become a common focus of education about HPV vaccines (Okunade et al. 2017). This is because, it is believed that the risk of unprotected sexual intercourse tends to be higher due to the perceived freedom from parental supervision among this population. Also, there are reports of reduced knowledge of HPV and the need to receive this vaccination (Okunade et al. 2017; Oluwole et al. 2019). Many of these students lack the information about how they can engage in the primary prevention of cervical cancer through HPV vaccination. Hence, many previous studies had paid more attention to assessing the knowledge of students about HPV. However, there are few studies in Nigeria about vaccine acceptability among the students from tertiary institutions. The few studies on this subject in Nigeria sought to assess the knowledge of the students as a factor influencing their vaccine acceptability (Okunade et al. 2017; Oluwole et al. 2019).

While the knowledge base is a strong correlate of vaccine acceptability, the family structure and their perception about the vaccine may be additional factors that needs to be investigated. It may be interesting to know how the socioeconomic background of the students influence their vaccine acceptability considering the financial implication of HPV vaccination. Also, the parental influence and family dynamics could be influencing students' decisions to accept the vaccine. Additionally, the perception of the students about HPV-related diseases is important in understanding vaccine acceptability. The degree to which a student think they may be susceptible to HPV infection if

unvaccinated may play a role in their decision making. Perception of susceptibility have been shown to influence decisions relating to screening and prevention of infectious diseases (Ayosanmi et al. 2020; Johnson et al. 2008). Therefore, this study purposed to determine the predictors of HPV knowledge and vaccine acceptability among Nigerian college students.

Materials and methods
Design
This was a cross-sectional study conducted through self-administered questionnaires among health sciences' students of a privately owned tertiary institution.
Sample size
Sample size estimation was done using the Fisher's exact formula (Pourhoseingholi, Vahedi, and Rahimzadeh 2013). Using the acceptability rate of 74% obtained from a previous study (Idowu et al. 2019), 296 respondents was required to obtain a statistically significant data at a 95% confidence interval with a population of 1,263 participants (Bartlett, Kotrlik, and Higgins 2001). Using a stratified sampling technique, a proportional allocation was used to recruit 400 participants from the departments of medicine and surgery (MBBS), nursing and basic medical sciences. The students from three academic years (200-400 levels) were considered for the study. So, 243 (out of 770), 113 (out of 354) and 44 (out of 139) students were selected from MBBS, nursing and basic medical sciences, respectively. A total of 388 students responded giving a response rate of 97%. Only the Faculty of health sciences students of the privately owned university, who were unmarried were included in the study.
Study tools
The study instrument was adapted from a previous validated instrument (Sandfort and Pleasant 2009). The questionnaire was designed to highlight how two constructs of Health Belief Model (HBM) could influence vaccine acceptability. The Health Belief Model is a psychological model that makes attempt to predicts health related behavior in terms of certain belief pattern (Mckellar and Sillence 2020). The two constructs of the HBM chosen were perceived susceptibility and cues to action.

The perceived susceptibility was assessed using an attitudinal question asking *Currently I believe I have a high probability of contracting HPV infection.* The answers were dichotomized – agreed/disagreed. The cues to action were measured using variables that could have motivated the action to accept HPV vaccination. These variables include overall knowledge of the student about HPV, course of study, parental socioeconomic status, parental level of education, and family health rating. All these variables were measured with binary responses. Pilot testing was done among twenty medical students from a public institution with their responses excluded from the main survey. The pilot participants provided some feedback regarding the wordings and clarity of the questionnaire. Responses from the pilot testing were used to improve the wordings of the final survey and not added to the main survey sample size.
Study variables
The independent variables include participants' socio-demographic characteristics, history of family health. The dependent variables are HPV vaccine acceptability and perception of HPV susceptibility, overall knowledge of HPV and screening benefit.
Data Analysis
The data collected for the study were analyzed in the Statistical Package for Social Sciences (SPSS) version 23.0 for Windows, (IBM Corp., Armonk, N.Y., USA). Descriptive statistics using frequencies and percentage distribution were calculated for categorical variables. The Pearson correlation were used for bivariate analyses while the multivariate logistic regression was used for the multivariable analysis. P-value < 0.05 was considered statistically significant at 95% confidence interval.

Ethical Approval
Participants consented to participate in the survey and none of the students required parental consent. All data collected were kept confidential and secured in a locker. The study was approved by the university research ethics review board with ethics number ABUADHREC 12/06/2022/87. The date of approval is 12/06/2022.

Results
Socio-demographic features of respondents
About 65% were more than 18 years, with a mean age of 18.2 ± 1.53. There are 377 females and 11 male participants. 93% of the students came from a monogamous family structure. The assessment of parental occupation shows that 91.2% of the fathers and 97.9% of the mothers were senior civil servants/professionals. University degree reported for 87.6% of the fathers and 87.1% of the mothers of the participants. Almost 97% of the students came from a family with high social class.

Table 1. Socio-demographic Characteristics of Respondents

Parameters	Frequency (*n*=388)	Percent
Age		
Less than 18	136	35.1
18 and above	252	64.9
Mean age	18.2±1.53	
Range	14, 27	
Family Background		
Monogamous	361	93.0
Polygamous	27	7.0
Course of Study		
Medicine and surgery (MBBS)	248	63.9
Basic medical sciences	49	12.6
Nursing	91	23.5
Religion		
Christianity	346	89.2
Islam	40	10.3
Traditional	2	0.5
Ethnic group		
Yoruba	160	41.2
Igbo	105	27.1
Hausa	15	3.9
Others	108	27.8
Father's Occupation		
Senior public servant, professional, large-scale traders	354	91.2
Intermediate grade public servant and Senior School Teachers	5	1.3
Junior school teacher, drivers, artisan	23	6.0
Petty traders, Laborers, messengers, and similar grades	2	0.5
Unemployed	4	1.0
Father's Education		
University graduate	340	87.6
HND/NCE	18	4.6
Secondary	25	6.5
Primary	2	0.5
No formal	3	0.8

Mother's Occupation		
Senior public servant, professional, large-scale traders	380	97.9
Intermediate grade public servant and senior school teachers	2	0.5
Junior school teacher, drivers, artisan similar grades	1	0.3
Petty traders, laborers, messengers and similar grades	3	0.8
Unemployed	2	0.5
Mother's Education		
University graduate	338	87.1
HND/NCE	23	5.9
Secondary	10	2.6
Primary	8	2.1
No formal	9	2.3
Social class		
High	375	96.7
Middle	11	2.8
Low	2	0.5

Family Health Status
Over ninety percent (96.4%) of the respondents rated their family health status as very good while 99% reported no family history of cervical cancer. Almost eighty-five percent (84.8%) of the participants reported that their family health challenge is not sexually related. In addition, over thirty percent (31%) admitted a family history of non-cervical cancer. Over fifty-nine percent (59.5%) of those studied did Pap's smear text prior to the study.

Knowledge of Human Papilloma Virus Infection among Respondents
The Knowledge of human papillomavirus (HPV) infection among respondents is shown in table 2. Analysis of general knowledge items (total score of 19) revealed a mean score of 14.9(SD ± 2.4). Only 8 (2.1%) of the respondents got 100% correct responses for HPV knowledge. The Knowledge of HPV testing (total score of 6) showed a mean score of 3.4 (SD ± 1.1). Only 5 (1.3%) of the respondents got 100% correct responses for HPV testing. Also, a mean score of 5.4 (SD ± 1.4) was obtained for knowledge of HPV vaccination (total score of 7). 97 (25%) of the respondents got 100% correct responses for HPV vaccination.

Respondents' Overall Knowledge of Human Papillomavirus
The categorization of overall knowledge of HPV among the respondents was done with a score of 1 point for each correct response in Table 2 with either a 'true' or a 'false' thus obtaining a total score of 32 points. The overall HPV knowledge was subsequently scored into three groups ≤10 = poor score, 11-21 = moderate score; ≥22 good score. The mean of the overall knowledge score for human papillomavirus infection was 23.8 (SD ± 3.3). None of the respondents got 100% correct responses. A total of 309 (79.6%) respondents had a good knowledge level, 79 respondents (20.4%) had a moderate knowledge level while none of the respondents had poor knowledge level of HPV.

Table 2. Knowledge of Human Papilloma Virus Infection among Respondents

	True n(%)	False n(%)
General Knowledge items		
HPV is very rare	117 (30.2)	271 (69.8)
HPV always has visible signs or symptoms	244 (62.9)	144 (37.1)
HPV can cause cervical cancer	333 (85.8)	55 (14.2)
HPV can be passed on by genital skin-to-skin contact	303 (78.1)	85 (21.9)
There are many types of HPV	327 (84.3)	61 (15.7)
HPV can cause HIV/AIDS	93 (24)	295 (76.0)
Human Papilomavirus (HPV) is a sexually transmitted infection that often cause cancers of various types	374 (96.4)	14 (3.6)
HPV is dangerous	375 (96.6)	13 (3.4)
HPV infection affects all these parts; male and the female genitalia, the anus, rectum, mouth and throat	333 (85.8)	55 (14.2)
HPV can be passed on during sexual intercourse	372 (95.9)	16 (4.1)
HPV can cause genital warts	353 (91)	35 (9.0)
Men cannot get HPV	70 (18)	318 (82.0)
Using condoms reduces the risk of getting HPV	312 (80.4)	76 (19.6)
HPV can be cured with antibiotics	121 (31.2)	267 (68.8)
Having many sexual partners increases the risk of getting HPV	369 (95.1)	19 (4.9)
HPV usually doesn't need any treatment	45 (11.6)	343 (88.4)
Most sexually active people will get HPV at some point in their lives	131 (33.8)	257 (66.2)
A person could have HPV for many years without knowing it	312 (80.4)	76 (19.6)
Having sex at an early age increases the risk of getting HPV	281 (72.4)	107 (27.6)
HPV Testing items		
An HPV test can tell how long you have had an HPV infection	292(75.3)	96(24.7)
If a woman tests positive for HPV she will definitely get cervical cancer	102(26.3)	286(73.7)
An HPV test can be done at the same time as a [Pap test/Smear test/Pap smear test	321(82.7)	67(17.3)
HPV testing is used to indicate if the HPV vaccine is needed	289(74.5)	99(25.5)
When you have an HPV test, you get the results the same day	152(39.2)	236(60.8)
If an HPV test shows that a woman does not have HPV, her risk of cervical cancer is low	289(74.5)	99(25.5)
HPV Vaccination items		
HPV vaccines require three doses	307(79.1)	81(20.9)
The HPV vaccines offer protection against all sexually transmitted infections	89(22.9)	299(77.1)
The HPV vaccines are most effective if given to people who have never had sex	270(69.6)	118(30.4)
Someone who has had HPV vaccine cannot develop cervical cancer	73(18.8)	315(81.2)
The HPV vaccines offer protection against most cervical cancers	288(74.2)	100(25.8)
One of the HPV vaccines offers protection against genital warts	324(83.5)	64(16.5)

Girls who have had the HPV vaccine do not need a [Pap test/Smear test/Pap smear test] when they are older	89(22.9)	299(77.1)

Respondents' Attitude and Perception toward HPV

Only 15.5% of the respondents were perceived to be susceptible to HPV while about 39% accepted to be screened for HPV infection. Despite the high rated score in the overall knowledge assessment about HPV, over three-quarter of the participants feels that they don't have enough knowledge about the virus. About 75% of the respondents accepted to be vaccinated against HPV but almost 80% of them did not feel it is necessary to ask their partners to get vaccinated. Almost 90% of the participants would like to receive more information about HPV.

Table 3. Respondents' Attitude and Perception toward HPV

Statements	Agree n(%)	Disagree n(%)
Currently I believe I have a high probability of contracting HPV infection	60(15.5)	328(84.5)
I will like to get screened for HPV	151(38.9)	237(61.1)
I believe getting screened for HPV will be beneficial to my health	287(74)	101(26)
I have enough knowledge of HPV, HPV vaccination and prevention against HPV	91(23.5)	297(76.5)
I am willing to get vaccinated against HPV	290(74.7)	98(25.3)
It is not necessary asking my partner to get vaccinated against HPV	76(19.6)	312(80.4)
I will like to receive more information about HPV vaccination	347(89.4)	41(10.6)

Relationship between HPV Knowledge, Perception and Vaccine Acceptance

The relationship between respondents' knowledge and perception of HPV and vaccine acceptance is shown in table 4. Knowledge of HPV vaccination (r=0.25, p<0.001), general knowledge of HPV infection (r=0.15, p=0.004) and overall knowledge (r=0.21, p<0.001) showed weak positive correlations with HPV vaccine acceptability. Respondents' perception about HPV screening benefit correlates positively (r=0.45, p<0.001) with vaccine acceptance. However, there is a negative week correlation between the perception of HPV susceptibility and vaccine acceptability.

Table 4. Relationship between HPV Knowledge, Perception and Vaccine Acceptance

	HPV vaccine Acceptance	
	r	p value
Knowledge scores		
Knowledge of HPV Testing	0.02	0.648
Knowledge of HPV vaccination	0.25	<0.001*
General Knowledge of HPV infection	0.15	0.004*
Overall knowledge	0.21	<0.001*
Respondents' perception		
HPV Susceptibility	-0.06	0.215

HPV screening benefit	0.45	<0.001*
Seriousness	0	0.997

r: correlation coefficient; *: Correlation is significant at p< 0.05

Table 5 below shows a bivariate logistic regression analysis of the predictors of vaccine acceptability and HPV infection knowledge. Identified predictors of the overall knowledge of HPV infection among participants were studying medicine and surgery (MBBS), mother's employment status, good rating for family health status, having family history of non-cervical cancer and not having a sexually transmitted infection affecting the family health. The predictors of HPV vaccine acceptability were moderate knowledge of HPV infection and course of study.

Table 5. Bivariate Predictors of HPV Knowledge and Vaccine acceptability

	HPV vaccine Acceptance			HPV Knowledge		
	Disagree	Agree	p value	Moderate	Good	p value
Socio-demographics						
Age						
less than 18	37(27.2)	99(72.8)	0.599[y]	27(19.9)	109(80.1)	0.96[y]
18 & above	61(24.2)	191(75.8)		52(20.6)	200(79.4)	
Gender						
Family background						
Monogamous	90(24.9)	271(75.1)	0.755[y]	72(19.9)	289(80.1)	0.619[y]
Polygamous	8(29.6)	19(70.4)		7(25.9)	20(74.1)	
Course of study						
MBBS	56(22.6)	192(77.4)	0.236	39(15.7)	209(84.3)	**0.004***
Nursing	26(28.6)	65(71.4)		23(25.3)	68(74.7)	
Basic medical	16(32.7)	33(67.3)		17(34.7)	32(65.3)	
Religion						
Christianity	88(25.4)	258(74.6)	0.968[y]	67(19.4)	279(80.6)	0.232
Others	10(23.8)	32(76.2)		12(28.6)	30(71.4)	
Ethnic group						
Yoruba	46(28.8)	114(71.3)	0.581	38(23.8)	122(76.2)	0.23
Igbo	23(21.9)	82(78.1)		22(21.0)	83(79.0)	
Hausa	3(20.0)	12(80.0)		4(26.7)	11(73.3)	
Others	26(24.1)	82(75.9)		15(13.9)	93(86.1)	
Father's Occupation						
Employed	98(25.5)	286(74.5)	0.576[f]	79(20.6)	305(79.4)	0.586[f]
Unemployed	0(0)	4(100.0)		0(0)	4(100.0)	
Father's Education						
Formal	98(25.5)	287(74.5)	0.575[f]	79(20.5)	306(79.5)	1.00[f]
No formal	0(0)	3(100)		0(0)	3(100)	
Mother's Occupation						
Employed	97(25.1)	289(74.9)	0.442[f]	77(19.9)	309(80.1)	**0.041*[f]**
Unemployed	1(50.0)	1(50.0)		2(100.0)	0(0.0)	
Mother's Education						
Formal	95(25.1)	284(74.9)	0.698[f]	77(20.3)	302(79.7)	1.00[f]
No formal	3(33.3)	6(66.7)		2(22.2)	7(77.8)	
Social class						
High	96(25.6)	279(74.4)	0.530[f]	76(20.3)	299(79.7)	0.733[f]
Others	2(15.4)	11(84.6)		3(23.1)	10(76.9)	

Family Health						
I rate the state of my family Health status as very good						
Yes	95(25.74	279(74.6)	1.00[f]	71(19.0)	303(81.0)	**0.002*[f]**
No	3(21.4)	11(78.6)		8(57.1)	6(42.9)	
Ever had sexually transmitted disease						
Yes	3(30.0)	7(70.0)	0.718[f]	4(40.0)	6(60.0)	0.125f
No	95(25.1)	283(74.9)		75(19.8)	303(80.2)	
Never done Pap test before						
Yes	42(26.8)	115(73.2)	0.660[y]	34(21.7)	123(78.3)	0.694[y]
No	56(24.2)	175(75.8)		45(19.5)	186(80.5)	
Family history of cervical cancer						
Yes	2(50.0)	2(50.0)	0.266[f]	2(50.0)	2(50.0)	0.186[f]
No	96(25.0)	288(75.0)		77(20.1)	307(79.9)	
Family history of non-cervical cancer						
Yes	31(25.6)	90(74.4)	1.00[y]	33(27.3)	88(72.7)	**0.032*[y]**
No	67(25.1)	200(74.9)		46(17.2)	221(82.8)	
The health challenge of my family is not sexually related						
Yes	82(24.9)	247(75.1)	0.846[y]	60(18.2)	269(81.8)	**0.023*[y]**
No	16(27.1)	43(72.9)		19(32.2)	40(67.8)	
Overall Knowledge level						
Moderate	34(43)	45(57)	**<0.001*[y]**			
Good	64(20.7)	245(79.3)				
Course of Study						
MBBS	27(7.0)	221(57.0)	**0.004**			
Nursing	22(5.7)	69(17.8)				
Basic medical	11(2.8)	38(9.8)				
Perceived HPV Screening benefit						
Agree	39(13.6%)	248(86.4%)	**0.000**			
Disagree	59(58.4%)	42(41.6%)				

[y]: Yate's correction; f: Fisher's exact test; *:p<0.05

Logistic Regression Models

In order to isolate cofounders, significant factors at the bivariate analyses (tables 4 and 5) were inserted into two different logistic regression models (models 1 and 2), presented in Table 6. Perceived HPV screening benefit influenced HPV vaccine acceptance (AOR: 7.63; 95% CI: 4.46 – 13.06) among the students. Medical students (MBBS) were twice more likely to have good overall knowledge of HPV infection testing and vaccination than basic medical students (AOR: 2.35; 95% CI: 1.15 – 4.80). Similar results held for students with no family history of non-cervical cancer (AOR: 1.98; 95% CI: 1.15 – 3.40) and non-sexually related family health challenge (AOR: 2.13; 95% CI: 1.11 – 4.09). Also, students who rated their family health status as good (AOR: 4.82; 95% CI: 1.56 - 14.96) were more likely to have better knowledge of HPV infection than those who did not.

Table 6. Predictors of HPV infection Knowledge and Vaccine Acceptance

Variables	B	p value	AOR	95% C.I.	
				Lower	Upper
Model 1- HPV Vaccine Acceptance					

Knowledge of HPV vaccination	0.20	0.074	1.22	0.98	1.52
General knowledge of HPV infection	0.04	0.612	1.04	0.90	1.20
Perceived benefit of HPV screening	2.03	<0.001*	7.63	4.46	13.06
Overall knowledge level (good)	0.45	0.339	1.56	0.63	3.90
Model 2- HPV infection overall knowledge					
MBBS	0.86	**0.019***	2.35	1.15	4.80
Nursing	0.40	0.321	1.49	0.68	3.29
Basic medical [ref]					
Mother's occupation (employed)	23.09	0.999	$1.1×10^{10}$	0	-
I rate my family health status as very good (yes)	1.57	**0.006***	4.82	1.56	14.96
Family history of non-cervical cancer (No)	0.68	**0.013***	1.98	1.15	3.40
The health challenge of my family is not sexually related (yes)	0.76	**0.023***	2.13	1.11	4.09

B: Coefficient of regression; [ref]: reference category; *: p value < 0.05; AOR: Adjusted odds ratio; 95% CI: 95% Confidence interval

Discussion
The knowledge of HPV infection, knowledge of HPV vaccination, perception of HPV screening benefit correlates with vaccine acceptability. However, there is a negative week correlation between the perception of HPV susceptibility and vaccine acceptability. Identified predictors of the overall knowledge of HPV infection among participants were course of study, mother's employment status, good rating for family health status, having family history of non-cervical cancer and not having a sexually transmitted infection affecting the family health. The predictors of HPV vaccine acceptability were moderate knowledge of HPV infection and course of study

The study assessed the predictors of human papilloma virus knowledge and vaccine acceptability among college students in a south-western Nigeria privately owned institution. The correction rates of HPV knowledge ranged from 33.8% to 96.6%. This is higher than what was found among university students in Korea (Kim and Ahn 2007). The difference may be attributable to the limitation of the study in Korea to only nursing students. In addition to this, the depth of teaching and subsequent knowledge about infectious diseases may be higher among medical students than their nursing counterpart. Sandfort and Pleasant reported insufficient understanding of the HPV knowledge in some important aspect among college student (Sandfort and Pleasant 2009). The lack of good understanding of HPV infection may be the reason why a large proportion of our respondents falsely responded that HPV always has visible signs and symptoms.

The finding of over 50% of students who had done Pap's smear was higher than what was found in South Africa where less than 10% did Pap's smear among the university students studied (Hoque and Hoque 2009). The ease of affording the investigation and possible high educational level of affluent parents of students in privately owned university may be responsible for this. It is not uncommon to expect children of parents in high socioeconomic class to rate their family health status as good. Their parents' had the capacity to pay for maintaining good health.

The finding of over 75% vaccine acceptability was similar to what was reported in some other studies (Cunningham, Davison, and Aronson 2014; Idowu et al. 2019; Z. Iliyasu et al. 2010; Ndikom and Oboh 2017). The high rate of vaccine acceptability may not be unconnected with the fear of developing cancer of the cervix in future. This is similar to what was reported among medical students in the Northern state of Nigeria (Idowu et al. 2019). In this study, a good overall knowledge score of HPV also

related significantly with vaccine acceptability. Perhaps an exposure to adequate knowledge of HPV had a positive influence on students' desire to seek for preventive measures

The low perception of susceptibility to contracting HPV infection.in this study is similar to what was reported among college students in the United State of America (Barnard et al. 2017). The high knowledge of HPV infection in this study did not influence the attitudes of the students in their perceptive susceptibility to contracting HPV infection. This might be an indication that the knowledge acquired might influence a desire to seek for preventive measures but may not affect their behaviour and practice. Thus the need for personal counseling on the dangers of HPV infection. Those with positive perception of their susceptibility to contracting HPV infection related significantly with course of study. This may be attributed to the depth of teaching received by the medical students as against that of the other students.

It was found that medical students were twice more likely to have good overall knowledge of HPV infection testing and vaccination than the nursing and basic medical students. On the contrary, a study done among medical students by Iliyasu et al in the Northern Nigeria reported that majority of their participants had poor knowledge of HPV (Zubairu Iliyasu et al. 2022). This difference may be attributed to the difference in the students recruited by iliyasu et al who were dental students and allied health workers whose level of exposure to teaching on HPV infection may be minimal.

The perceived benefit of HPV vaccination, a good knowledge of HPV infection and vaccination had significant relationship with vaccine acceptability. This has been reported in studies that vaccine hesitancy is greatly influenced by ignorance and perceived danger (Doornekamp et al. 2020; Rey et al. 2018). Good perception of HPV screening benefit and high level of willingness to get vaccinated in this study may be a reflection of how adequate knowledge often influenced cue to action in people. In addition to this, a large proportion of the students showed seriousness in getting more information about HPV vaccination. This may indicate the acceptance that adequate knowledge was still needed by the students studied. Inadequate information have been noted to be the major reasons behind low HPV vaccine acceptability (Adejuyigbe et al. 2015).

The employment status of mothers was significantly related with HPV knowledge among the students. This was corroborated by documented report of children of employed mothers who showed higher socio-emotional outcome and cognitive scores (Salimiha, Perales, and Baxter 2018). The status of the students' family health was also observed to be significantly associated with HPV knowledge. The family that is concerned about their health will likely spend more time to seek knowledge about conditions that may affect them adversely. Furthermore, it was also discovered that the students from families with history of non-cervical cancer and those with family health challenge that are not sexually related have significant relationships with good HPV knowledge. Health seeking behavior has been reported to be influenced by multifaceted factors which include physical, socio-economic, cultural and political contexts (Shaikh and Hatcher 2005).

In conclusion, this research revealed that having a good knowledge of HPV infection may not necessarily translate to students taking precautionary measures against contracting the disease. Vaccine acceptability can be increased if more efforts is devoted to adequate knowledge of HPV infection, screening benefit and students' engagement in medical studies. Medically related courses, mother's employment status, good rating of students' family health status all contribute to increased overall knowledge of HPV. The low perception of susceptibility to contracting HPV can be increased with improved education and counseling about HPV knowledge, screening and testing. This study was done among medically inclined students so the findings may not be used as criteria to judge the knowledge base of HPV infection and vaccine acceptability in the general population.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contribution

ATA – Conceptualization, Original draft, Review, Editing, Data Curation, Formal Analysis, Fund acquisition, Investigation, Project Administration, Methodology, validation, visualization and supervision

AOS - Conceptualization, Original draft, Review of manuscript, Editing and reconstruction of the manuscript.

OAA - Original draft, Review, Editing, Fund acquisition, Investigation, Project Administration, validation, visualization and supervision

AFO - Original draft, Review, Editing, Data Curation, Formal Analysis, Fund acquisition, Investigation, Project Administration, validation, visualization and supervision

IAO - Original draft, Review, Editing, Fund acquisition, Investigation, Project Administration, validation, visualization and supervision

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Orthodontic Treatment Compliance and Duration Among Adolescent and Young Patients at Smiles Dental Clinic

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Abstract

Introduction: Patient compliance is a core issue as it can strongly affect the objectives and results of orthodontic treatment and the length of time a patient must wear orthodontic appliances.

Objective: This study aimed to explore factors affecting compliance and duration of orthodontic treatment among patients at Smiles Dental Clinic, Dar Es Salaam, Tanzania

Methods: Dental records for 2016 to 2023 of 176 adolescent and young orthodontic patients aged 10 to 24 years were extracted from a private dental clinic in the city of Dar Es Salaam. The collected secondary data included the age and sex of the patient, duration of treatment, missed appointments, oral hygiene, bracket and molar tube failure, insurance status and whether a patient was a day or boarding school student.

Results: The majority of the patients demonstrated inadequate compliance with orthodontic treatment. A significantly higher proportion of non-insured patients (15.9%) demonstrated good compliance to orthodontic treatment than insured (5.9%). A significantly high proportion of boarding school patients missed appointments and frequently experienced breakage of orthodontic appliances. Treatment duration was significantly longer in patients who missed appointments, with poor compliance and bracket and/or molar tube breakage. Variance in treatment duration was explained most significantly by bracket breakage.

Conclusion: The studied patients had poor orthodontic compliance, which negatively impacted the treatment duration.

Keywords: Orthodontic, Compliance, Orthodontic Treatment, Bracket, Molar Tube, Breakages, Tanzania.

Introduction

According to clinical realms and research evidence, patient compliance is a core issue as it can strongly affect the objectives and results of orthodontic treatment and the length of time a patient must wear orthodontic appliances. The diagnostic and clinical skills of the orthodontist, favourable biological characteristics of the patient (bone turnover, craniofacial morphology, stage of growth, etc.), the patient's willingness to cooperate during treatment and to follow all treatment recommendations (i.e. patient compliance), and the use of an appropriate and effective orthodontic appliance are key to the success of orthodontic treatment (Chow &Cioffi, 2018).

The issue of patient compliance is complex, multifactorial and wide-ranging in nature. Compliance in orthodontics relates to keeping appointments, following oral hygiene instructions, wearing elastics and other patient-dependent appliances, and avoiding hard sticky food that might de-bond the brackets and other parts of the appliance (Aljabaa et al 2015). Previous studies attempted to predict the factors that might affect compliance during orthodontic treatment. Patient-related factors such as the desire for treatment and relationship with parents were considered important factors motivating patients to comply (Mehra et al, 1998; Tuncer et al 2015).

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Verbal praise and communication were rated as important methods for improving compliance (Lin et al, 2015). On the other hand, pain and inconvenience associated with fixed orthodontic appliances were inversely correlated with compliance (Egolf et al, 1990). Reduced patient compliance results in increased treatment time and additional costs to both the healthcare provider and the patient (Richter et al, 1998).

The outcome of orthodontic treatment can be influenced by the relationship between the clinician and the patient which impacts adherence to appliance care and maintenance of oral hygiene (Kafle et al., 2020). In most cases, patients are blamed for not complying with treatment recommendations without considering the practitioner's ability to understand individual patient's needs and to make appropriate treatment plans taking into account other socio-economic factors. Bracket failure during orthodontic treatment has been associated with orthodontic emergencies and delayed treatment time (Khan et al., 2022) and is a common problem in adolescent patients than adults (Bukhari et al., 2016). It has been observed that compliance of school children with orthodontic appliances in boarding schools is highly affected by the failure of pupils and students to attend scheduled follow-up appointments due to school regulations and academic reasons. This eventually affects the cost and duration of the treatment time.

Studies have shown that adherence to orthodontic treatment follow-up visits strongly correlates with health insurance status. Medical-insured patients are more likely to miss orthodontic treatment follow-up visits than non-insured patients (Vithanaarachchi et al., 2017). In Tanzania, major insurance companies include the National Health Insurance Fund (NHIF), Jubilee, Strategis and the National Social Security Fund (NSSF). Recently, awareness of orthodontic treatment in Tanzania is picking up as more and more patients request their health insurers to cover orthodontic treatment. Therefore, this retrospective clinical cohort study aimed to explore factors affecting orthodontic treatment compliance among patients seen at the Smiles Dental Clinic, in Dar Es Salaam, Tanzania.

Smiles Dental Clinic is a privately owned health facility located in the city centre of Dar Es Salaam region, a major commercial city in Tanzania. The clinic provides orthodontic and other types of dental treatments. On average, the clinic provides dental treatment to 500 patients per month. The clinic began to accept NHIF patients in 2016.

Materials and methods

We conducted a prospective cohort study of 176 patients aged 10 – 24 years who were treated with fixed orthodontic appliances stainless steel 0.022-inch MBT and 0.018-inch Roth bracket system from 2016 to 2023. Sixteen patients who did not initiate orthodontic treatment at Smile Dental Clinic were excluded from the analysis. As a standard practice, patients under treatment were reviewed every 6 to 8 weeks, and comprehensive clinical notes were recorded at every visit. At the beginning of the treatment, all brackets were conventionally ligated with elastomeric ties. During data collection, patients' clinical notes were retrieved to record information on orthodontic compliance and treatment duration which was measured in months and later converted in years. Other collected information included demographic profile, oral hygiene, number of missed appointments, number of visits with reported appliance breakage (incidence of breakage) and total numbers of breakage (broken brackets and/or bands), bracket and molar tubes failure, insurance status and whether a patient was a day or boarding school student. For each visit made, the Periodontal Index was used to assess the patient's oral hygiene and a score of 0 and 1 was assigned for poor and good oral hygiene respectively. Compliance with orthodontic treatment was assessed by two items which included several missed

scheduled appointments and oral hygiene status. Thus, a composite score of the two items was generated and dichotomized into good and poor compliance

Collected data was analyzed using SPSS version 23.0 (IBM Corp, Armonk, NY, 2015). Chi-square statistics was used to test the association between orthodontic treatment compliance and independent variables including age, sex, treatment duration and the number of times molar tube and bracket break. T-test was used to compare treatment duration between groups (compliance versus non-compliance; and bracket or molar tube failure versus non-failure). The level of significance was set at P < .05.

Ethical considerations

Permission to conduct this retrospective study was obtained from Smiles Dental Clinic administration with the approval letter No. SDC/RES/23/01 The study was conducted according to the ethical principles outlined in the Declaration of Helsinki.

Results

The mean age of studied adolescents and young patients was 16 years (SD = 3.6). Over half of the orthodontic patients did not have health insurance. The majority of the patients (89.2%) had poor compliance to orthodontic treatment but did not vary with adolescents' and young's sex and age. However, significantly high proportions of uninsured adolescents and young orthodontic patients (15.4%) and those in day school (16%) had good compliance to orthodontic treatment compared to insured clients (5.9%) and patients in boarding schools (6.9%) respectively. Patients with poor compliance experienced more incidences of broken brackets and molar tubes (Table 1). However, the frequency of broken bracket and/or molar tubes did not vary with sex and age (Table 2).

Table 1. Profile of Studied Orthodontic Patients

	Patients with poor treatment compliance	Patients with good treatment compliance
All	157 (89.2)	19 (10.8)
Mean number of visits (SD)	2.6 (1.4)	4.8 (1.2)***
Sex		
Males	58 (90.6)	6 (9.4)
Females	99 (88.4)	13 (11.6)
Age		
10 – 14 years	56 (88.9)	7 (11.1)
15 – 19 years	58 (90.6)	6 (9.4)
20 – 24 years	47 (87.8)	6 (12.2)
Health insurance		
Insured	80 (94.1)	5 (5.9)
Not insured	77 (84.6)	14 (15.4)*
School/College/University		
Boarding	94 (93.1)	7 (6.9)
Day	63 (84.0)	12 (16.0)*
Broken brackets		
None	26 (66.7)	13 (33.3)
Up to two times	94 (94.9)	5 (5.1)
More than twice	37 (97.4)***	1 (2.6)
Broken molar tube		
None	41 (77.4)	12 (22.6)
Up to two times	111 (94.1)	7 (5.9)
More than two times	5 (100)***	0 (0.0)

*P>0.005; **P>0.001; ***P>0.0001

Table 2. Mean and Proportion of Patients with Brackets and /or Molar Tube Breakage

Breakage frequency	Male (n=64)	Female (n=112)	All (n=176)
0	12.5	16.1	14.8
1	18.8	23.2	21.6
2	18.8	18.8	18.8
3	21.9	17.0	18.8
4	7.8	9.8	9.1
5	6.3	8.9	8.0
6	6.3	2.7	4.0
7	3.1	0.9	1.7
8	3.1	1.8	2.3
9	1.6	0.9	1.1
Mean (SD)	2.8 (2.2)	2.4 (1.9)	2.5 (2.0)
Age			
10 – 14 years	22 (88.0)	24 (85.7)	46 (86.8)
15 – 19 years	17 (81.0)	29 (87.9)	46 (85.2)
20 – 24 years	17 (94.0)	41 (80.4)	58 (84.1)
All	56 (87.5)	94 (83.9)	150 (85.2)

Treatment duration was significantly longer for patients with poor compliance, broken molar tubes and brackets, and those in boarding schools (Table 3). When compared to day scholar patients, a significantly high proportion of boarding school patients had missed dental appointments, poor compliance, broken brackets and broken molar tubes. On the other hand, a significantly high proportion of day scholar patients had visited dental clinics for orthodontic treatment more than twice (Table 4). In multiple logistic regression, only the broken bracket maintained its significant association with poor orthodontic treatment compliance (Table 4).

Table 3. Mean Treatment Duration

	Number of patients	Mean	Standard deviation	P value
Sex				0.433
Male	64	2.45	0.61	
Female	112	2.38	0.66	
Broken bracket				0.005
Yes	39	2.5	0.6	
No	137	2.1	0.5	
Broken molar tube				0.000
Yes	53	2.5	0.6	
No	123	2.1	0.5	
School/College/University				0.026
Boarding	101	2.5	0.6	
Day	75	2.3	0.7	
Treatment compliance				0.003
Good	19	2.0	0.5	
Poor	157	2.5	0.6	

Table 4. Comparison of Treatment Compliance and Duration, and Appliance Breakage Among Boarding and Day Scholar Orthodontic Patients

	Boarding (%)	Day (%)	All (%)	P value
Missed appointment	93 (92.1)	56 (74.7)	149 (84.7)	0.002
Poor compliance	94 (93.1)	63 (84.0)	157 (89.2)	0.048
Broken molar tube	77 (76.2)	46 (61.3)	123 (69.9)	0.033
Broken bracket	86 (85.1)	51 (68.0)	137 (77.8)	0.007
Made 2 or more visits	54 (53.5)	51 (68.0)	105 (59.7)	0.036

Table 5. Factors Associated with Inadequate Orthodontic Treatment Compliance

	*Adjusted OR	95% CI
Broken molar tube	1.6	0.5 – 5.2
Yes		
No	1	
Broken bracket		
Yes	**5.4**	**1.6 – 18.1**
No	1	
Health insurance		
Yes	0.3	0.1 – 1.2
No	1	
School/College		
Day	0.9	0.3 – 2.8
Boarding	1	
Dental visits		
2 or more visits	0.1	0.1 – 1.2
One visit	1	

*Controlled for age and sex

Discussion

Compliance means acting by a specific goal, desire, request, condition or direction. Orthodontic treatment typically lasts 1 to 3 years, and therefore patient compliance needs to be sustained throughout the treatment period (Cărămidă et al., 2021). Apart from duration, orthodontic treatment compliance is also influenced by the frequency of treatment schedules and the complexity of the required behaviours. The notation that reduced patient compliance results in increased treatment time was also affirmed by our study. Treatment duration was significantly longer for patients with poor compliance probably because of inadequate monitoring of the treatment progress due to missed appointments. This finding is in line with what has been reported by another study conducted outside Tanzania which demonstrated that prolonged treatment time is associated with missed appointments, band/bracket breakage and increased lower incisor inclination (Li et al., 2016; Farruqui et al., 2018). However, in our study, the variance in treatment time was explained most significantly by breakages. Similar findings have been reported by other studies which attributed most of the variance in treatment time to the number of missed appointments and breakages (Farruqui et al., 2018).

Although it is well known that sending appointment reminders to orthodontic patients is effective in improving dental attendance and reducing the treatment duration and bracket bond failure (Li et al 2016; Al-Abdallah), managing patients who are in boarding school present a challenge of reduced dental attendance. In this study, a high proportion of patients in boarding made few dental

visits and experienced more appliance breakage which may have contributed to the long treatment duration in this group.

The experience of appliance breakage was the same for male and female orthodontic patients. This is in contrast to the finding of another study in which females had significantly better compliance (Al-Abdallah et al., 2021). The incidences of broken brackets and/or molar tubes may have disrupted the healing process which led to longer treatment duration. This is in line with the findings of a study which demonstrated that on average, treatment time increases by 0.6 months for each additional failed bracket (Stasinopoulos et al., 2018).

Failure of boarding school orthodontic patients to attend regular follow-up appointments in most cases is due to academic reasons, especially for patients in their final year of studies. Therefore, during orthodontic treatment planning, careful consideration should be observed before initiating fixed orthodontic treatment.

In line with the findings of other similar studies (Bukhari et al, 2016; Li et al, 2016), this study indicated that a significantly high proportion of uninsured patients demonstrated good orthodontic treatment compliance compared to insured patients. majority of patients with insurance packages demonstrated inadequate compliance to orthodontic treatment compared to non-insured patients. However, a significant association between orthodontic compliance and health insurance status disappeared in multiple logistic regression. This may be due to the small sample size of the current study.

Similar to the observations of other studies (Kafle et al. 2016; Farruqui et al., 2018), our study did not find a significant association between orthodontic treatment compliance and age, and sex. However, other studies have reported sex and age to be significant factors in patient compliance (Nahajowski et al., 2022; Tsomos et al. 2014; Barbosa et al., 2018). Several reasons may explain the observed differences. Our study focused only on adolescents and young people who were treated with fixed orthodontic appliances while other studies included older people in the study population, assessed compliance and treatment duration of removable orthodontic appliances and used a different approach to data collection.

Conclusion

Poor orthodontic compliance and appliance breakage particularly among patients in boarding schools compromised treatment duration. Orthodontists should be careful when preparing treatment plans for patients who are in boarding schools.

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Awareness about first aid management of epistaxis among medical students of the State University of Zanzibar, Tanzania

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Abstract
Background: Epistaxis is the most common otorhinolaryngology emergency and can be unilateral or bilateral due to a variety of pathologies of the nose, paranasal sinuses, and nasopharynx. It tends to be self-limiting on most occasions. It may be severe enough to necessitate medical attention and lead to life-threatening complications when left without prompt intervention. There is a scarcity of published data regarding awareness of first aid management of epistaxis among medical students in Zanzibar, Tanzania, thus the study aimed to address such an existing gap.
Methods: This was an analytical cross-sectional study that recruited 395 medical students. Data was collected using semi-structured questionnaires and analysis was done by Statistical Package for Social Sciences (SPSS) version 23 and a p-value <0.05 was considered to be statistically significant.
Results: About two-thirds (89.4%) of the medical students had good knowledge of first aid management of epistaxis and 85.3% of the participants had a good attitude toward first aid management of epistaxis. Almost half of the respondents of this study (52.7%) had good practice regarding first aid management of epistaxis. A significant association was found between academic year and overall knowledge, attitude and practices on first aid management of epistaxis among medical students.
Conclusions: Medical students of the State University of Zanzibar were found to have adequate knowledge about first aid management of epistaxis thus empowering them to provide first aid management of epistaxis and also with good attitude and practices towards handling patients with epistaxis.
Keywords: Epistaxis, first aid, awareness, knowledge, medical students, Tanzania

Introduction
Epistaxis is one of the most common ear, nose and throat conditions encountered by primary care and emergency physicians and it is one of the otorhinolaryngological emergencies (Krulewitz & Fix., 2019; Abu-Zaid et al.,2020; Abraham et al., 2017). Epistaxis causes anxiety in both patients and healthcare providers (Alhejaily et al., 2019). Epistaxis exhibits a bimodal distribution pattern and affects up to 60% of the population in their lifetime, with 6% requiring medical attention (Gilyoma & Chalya., 2011; Almuhlim et al., 2017). Epistaxis ranges from mild to severe form and is considered a life-threatening condition when it occurs since its course remains unpredictable.

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Epistaxis has been causing a significant workload in accident and emergency departments and 66.7% of the population experience epistaxis during their lifetime (Alhejaily et al., 2019; Almuhlim et al., 2017). There are variable causes of epistaxis which can be local or systemic and the reported incidence varies from 10% to 60% of individuals (Faistauer et al., 2009). It is more common in males than females and shows an increasing incidence with age (Alhejaily et al., 2019; Almuhlim et al., 2017). The diagnosis of idiopathic epistaxis requires a careful history, physical examination, and laboratory workups to rule out any possible etiologies (Abraham et al., 2017; Varshney & Saxena., 2005). Though epistaxis is common among young adults and children and rare among neonates but reaches its peak in the sixth decade (Varshney & Saxena., 2005). Awareness of first aid management of epistaxis remains crucial not only in alleviating non-life-threatening episodes of epistaxis but also in lifesaving when epistaxis occurs in the absence of nearby healthcare facilities where efforts may be directed at preventing worsening of epistaxis thus reducing mortality and morbidity (Sowerby et al., 2021)

Despite its crucial importance, unfortunately, little is known about awareness of first aid management of epistaxis among medical students despite its high prevalence.[10]   Studies from different parts of the world involving students in their various years of training have shown variable levels of knowledge, attitude and practises regarding first aid management of epistaxis a study that was done in Saudi Arabia reported that 74.6% of medical students considered epistaxis to be a medical emergency and also 87.1% of the medical students reported bleeding disorders to be the commonest cause of epistaxis (Al-Musa et al., 2017). Regarding the source of knowledge about first aid management of epistaxis, a study from Saudi Arabia found 53.6% of the medical students to have reported self-teaching as the main source of information on first aid management of epistaxis (Alyahya et al., 2019).

When the attitude of medical students is to be considered pertaining to first aid management of epistaxis, a study from Saudi Arabia found 75.3% of the medical students to have reported that if epistaxis cannot be stopped after 10-20 minutes upon direct nasal compression then it requires seeking of emergency medical care (Alyahya et al., 2019). Regarding various practices on first aid management of epistaxis, a study from Nepal found nasal packing to be the first line measure used by emergency clinical staff (Adhikari et al., 2006) while in Saudi Arabia, 34.3% of the medical students chose nose compression while 33.8% chose nasal packing as the first line measure in the management of epistaxis (Al-Musa et al., 2017) and both were non-surgical measures.

Even though there are several published studies on epistaxis in Tanzania, there is no study to date that has determined the awareness of medical students on first aid management of epistaxis despite the fact that medical students will be front liners in the management of epistaxis upon graduating and this study aims to explore the awareness of medical students on first aid management of epistaxis at the State University of Zanzibar which is the largest public University in Zanzibar.

Methods
Study design, area and study duration
A university-based cross-sectional study underpinned by a quantitative approach was conducted at the State University of Zanzibar from November 2021 to January 2022.

Sampling technique, sample size and study population
The convenience sampling technique was utilized to recruit three hundred and ninety-five medical students upon consenting to participate.

Sample size estimation

The sample size for this study was calculated using the following formula;

N= Z²P(1-P)
E²

Where;

n = sample size

z= standard normal deviate 1.96 for 95% confidence level

p = prevalence, p ~ 64% of medical students reported epistaxis as an emergency case (Alyahya et al., 2019).

E= margin of error which is 5%

Therefore,

N= 1.96² × 0.64 (1-0.64) / 0.05² = 354.04 ~ 354

The minimum estimated sample size was 354

Adjusting for non-response rate (f% assumed to be 10%) (Smith and day-1984)

Then

N'=N x adjusted factor (100%/100%-f %)

N'=354 X (100%/100%-10%) =393

Therefore, the adjusted required sample size was 393 medical students though 395 medical students were recruited in this study.

Inclusion criteria

All medical students who consented to participate in the study and who were present during the data collection

Exclusion criteria

Any medical student who was found to have been transferred from another university in less than one year by the time of data collection

Data collection tools

A structured questionnaire adapted from previously published studies and thereafter modified accordingly to fit the current study was used to collect the relevant data (Al-Musa et al., 2017; Alyahya et al., 2019). The first and final version was prepared in English since the study participants were all conversant with English. The questionnaire comprised four parts: (i) Socio-demographic characteristics of the medical students, (ii) Knowledge of epistaxis among medical students (iii) Attitude on first aid management of epistaxis among medical students (iv) Practices on first aid management of epistaxis among medical students.

The questionnaire comprised both open and closed-ended questions. Self-administered questionnaires were employed to collect relevant data from the selected participants. The procedure included a self-introduction by one of the researchers who is the primary person who collected data from all three hundred and ninety-five medical students, and an introduction to the topic and purpose of the study. The researcher then requested their participation in the study.

Participants were assured of free participation and withdrawal from the study at any time if they wished to do so. Moreover, reviewing the literature as well as pilot testing the instrument prior to the study by involving 10% of the actual sample size from the State University of Zanzibar and who were then excluded from the actual study assessed the validity of the tool

Measurement of variables

Dependent variable: The dependent variable for the study was awareness of first aid management of epistaxis where several parameters were assessed such as knowledge of epistaxis among medical students, attitude on first aid management of epistaxis, and practices on first aid management of epistaxis among medical students. To determine the level of knowledge on epistaxis among medical students, the total score was computed for the seven set questions where the correct answer was scored one point, and other responses were scored zero. Similarly, to assess attitudes on first aid management of epistaxis among medical students, five questions were set and the correct response was scored 1 point and other responses were scored zero. On the other hand, to assess practices on first aid management of epistaxis among medical students, eight questions were set where the correct response was scored 1 point and other responses were scored zero.

Independent variables: The independent variables for the study were the socio-demographic characteristics of the participants including the year of study.

Data processing and analysis
The collected data were cleaned and analyzed using the SPSS version 23 software package. Descriptive statistics were performed to present frequency distribution for socio-demographic characteristics, knowledge of epistaxis among medical students, attitude on first aid management, and practices on first aid management of epistaxis among medical students. A chi-square test was performed to establish the relationship between the selected independent and dependent variables. All the independent variables with p-values <0.05 were regarded to be statistically significant.

Rating scale type
The seven items on the knowledge dimension on epistaxis among medical students were assessed using a five-point Likert scale ranging from 1 to 5 (1=very unconfident, 2=fairly unconfident, 3=neutral, 4=fairly confident and 5=very confident). Higher scores represented better knowledge of epistaxis among medical students. The five items on the attitude on first aid management of epistaxis among medical students were evaluated on a five-point Likert scale ranging from 1 to 5 (1=very unconfident, 2=fairly unconfident, 3=neutral, 4=fairly confident and 5=very confident). Higher scores similarly represented better attitudes on first aid management of epistaxis among medical students. The eight items on practices on first aid management of epistaxis were evaluated on a three-point Likert scale ranging from 1 to 3 (1=don't know, 2=no, 3=yes). Higher scores indicated good first-aid management practices of epistaxis among medical students.

Ethical consideration
The study was submitted to the Directorate of Research, Publication and Consultancy of the University of Dodoma for ethical approval. The ethical committee assessed and gave the ethical approval for this study dated 22nd November 2021 under the approval number MA.84/261/02/. Furthermore, permission for conducting the research was obtained from the administration of the State University of Zanzibar. The individual informed consent both verbal and written was obtained from the study participants after they had been fully informed about the study goals and the process involved. The participants were ensured of privacy and confidentially. Anonymity was maintained by using the code number on the questionnaire instead of the participant's name. The participant had absolute freedom and right to withdraw from the study at any time.

Results
Socio-demographic characteristics of medical students
In this study, a total of 395 medical students were recruited where the majority were from the second year 118(29.9%) and the third year 122(30.9%), while the minority of 28(21.3%) were from the fifth year. Males, 311(78.7%) predominated in this study and females were 84(27%). The majority of the students belonged to the age group, 22-27 years (73.2%) and the least number of students were aged 28-33 years, 8(2.0%). Regarding marital status, the majority of the students were single, 367(92.9%) while 28(7.1%) were married **(Table 1).**

Table 1: Socio-demographic characteristics of medical students, (n = 395)

Socio-demographic characteristics	Sub variable	Frequency, n(%)
Gender	Male	311 (78.7)
	Female	84 (21.3)
Age (years)	16-21	98 (24.8)
	22-27	289 (73.2)
	28-33	8 (2.0)
Marital status	Married,	28 (7.1)
	Single	367 (92.9)
Academic year	First-year	96 (24.3)
	Second year	118 (29.9)
	Third year	122 (30.9)
	Fourth-year	31 (7.8)
	Fifth year	28 (7.1)

Knowledge of epistaxis among medical students

The majority of the medical students, 388(98.2%) ever had seen someone with a bleeding nose while 7 (1.8%) of them had never seen or encountered someone with epistaxis. Regarding the cause of epistaxis, 199(50.4%) reported bleeding disorders to be the commonest known causes of epistaxis followed by fingernail trauma, 113(28.6%) while 18(4.6%) don't know the cause of epistaxis. Regarding the proper position that a patient with epistaxis should be positioned, 319(80.8%) of the students knew the correct position which is sitting with the head tilted forward rather than backward but 41(11.6%) reported lying down with an ice pack over the nasal bridge. Similarly, 329(83.3%) medical students mentioned the cartilaginous part of the nose as the proper site to pinch the nose during epistaxis while 2(0.5%) mentioned the bony part. Regarding environmental causes of epistaxis, 337(85.4%) thought hot weather to be the cause of epistaxis while 47(11.9%) considered cold weather as the cause of epistaxis. (Table 2)

Table 2: Knowledge of epistaxis among medical students, (n=395)

Variable	Categories	Frequency, n(%)

Ever experienced nose bleeding or seen someone with a bleeding nose	Yes	388 (98.2)
	No	7 (1.8)
The most common cause of epistaxis	Nasal bones fracture	29 (7.3)
	Fingernail trauma	113 (28.6)
	Bleeding disorders	199 (50.4)
	Hypertension	36 (9.1)
	I don't know	18 (4.6)
Proper position that a patient with epistaxis should be positioned	Sitting with head tilted forward	319 (80.8)
	Sitting with head tilted backward	16 (4.1)
	Lying down and elevate the legs	2 (0.5)
	Lying down with an ice pack over the nasal bridge	41 (10.4)
	I don't know	17 (4.3)
Duration for pinching the nose when having epistaxis	Less than 5 min	8 (2.0)
	5-10 min	18 (4.6)
	10-20 min	219 (55.4)
	More than 20 min	150 (38.0)
Ideal location to pinch the nose as a primary measure to stop epistaxis	Cartilaginous part(lower down)	329 (83.3)
	Bony part (higher up)	2 (0.5)
	Both	45 (11.4)
	I don't know	19 (4.8)
Other possible causes of epistaxis (may circle more than one correct response)	Hot weather	337 (85.4)
	Cold weather	47 (11.9)
	I don't know	11 (2.8)
Main source of knowledge regarding first aid management of epistaxis	Self-taught	334 (84.6)
	First aid course	2 (0.5)
	Mass media	1 (0.3)
	Observation of senior doctors	19 (4.8)
	Medical books/curriculum	30 (7.6)
	Guessing	3 (0.8)
	Workshops	5 (1.3)
	Others	1(0.3)

Overall knowledge of epistaxis management among medical students
A total score was computed for the seven sets of questions that were assessing knowledge, the correct answer was given one point, and other responses were given zero. Generally, in this study

majority of the respondents (89.4%) had good knowledge while 10.6% had poor knowledge regarding epistaxis management.

Source of knowledge regarding first aid management of epistaxis among medical students
The main source of knowledge on first aid management of epistaxis was self-taught, 334(84.6%) followed by medical books/curriculum, 30(7.6%), and the first aid courses being the least source of knowledge, 2(0.5% **(Figure 1).**

Attitude on first aid management of epistaxis among medical students
In this study, 378(95.7%) medical students considered epistaxis to be one of the medical emergencies while only 6(1.5%) reported it not to be a medical emergency. Results regarding the attitude of seeking medical emergency care, 325(82.3%) medical students showed that persistent nose bleeding for more than 10–20 minutes with direct nasal compression seems to be considered mostly by medical students as an indicator for a patient with epistaxis to seek medical care 325(82.3%) followed by recurrent nasal bleeding more than four times per week despite all preventive measures, 215(54.4%), however direct nasal trauma 19(4.8%) was the least reason reported to seek medical emergency care. Similarly, 269(68.1%) medical students mentioned the method of pinching the nose again for 10–20 minutes more and reassessing after as a proper attitude if the patient continues to bleed in the emergency room after primary measures have been done, while 49(12.4%) considered to keep the patient under observation in the emergency room and reassess later. (Table 3)

Table 3. Attitude on first aid management of epistaxis among medical students, (n=395)

Variable	Categories	Frequency, n(%)
Whether epistaxis is considered to be one of the medical emergencies	Yes	378 (95.7)
	No	6 (1.5)
	I don't know	11 (2.8)
When should a patient with epistaxis seek emergency care	Persistent nose bleeding for more than 10–20 min with direct nasal compression	325 (82.3)
	Recurrent nasal bleeding more than four times per week despite all preventive measures	215 (54.4)
	Massive nasal bleeding	180 (45.6)
	After direct nasal trauma	19 (4.8)
	I don't know	20 (5.1)
What one should do if the patient continues to bleed from the nose in the Emergency Room after the primary measures have been done	Pinch the nose again for 10–20 min more and reassess after	269 (68.1)
	Refer the patient to an otolaryngologist to take further care	263 (66.6)

	Keep the patient under observation in Emergency Room and reassess later	49 (12.4)
	Don't know	27 (6.8)
Preferred way for breathing during epistaxis	Breath by using the nose as usual	7 (1.8)
	Mouth breathing	315 (79.7)
	Uses of both the nose and mouth	62 (15.7)
	Don't know	16 (4.1)
What to do if a patient with epistaxis get into shock	Examine the nose	85 (21.5)
	Compress the nose	39 (9.9)
	Put the patient in supine position with the head lowered	258 (65.3)
	Put the patient in supine position with the head backward	52 (13.2)
	Start anti shock treatment	232 (58.7)
	Nasal packing	61 (15.4)
	Don't know	35 (8.9)

Toward controlling nasal bleeding.
A total score was computed for the five-set questions that were assessing attitude among medical students where the correct answer was given one point, and other responses were given zero. Generally, in this study majority of the respondents (85.3%) had a good overall attitude while (14.7%) had a poor overall attitude regarding first aid management of epistaxis.

Practices on first aid management of epistaxis among medical students
The study has found 337(85.4%) medical students reported that nonsurgical treatment was the preferred modality of treating epistaxis while 31(7.8%) reported both nonsurgical and surgical treatment modalities. However, topical vasoconstrictors 268(67.8%) and anterior nasal packing 280(70.9%) were the most reported treatment modalities while the least reported method was the use of a Foley catheter 212(53.7%). Similarly, 177(44.8%) medical students thought electro cauterization was the third choice while 137(34.7%) thought it to be the second choice. (Table 4.0).

Table 4 Practices on first aid management of epistaxis among medical students, (n=395)

Variable	Categories	Frequency, n(%)
Preferred treatment modality for epistaxis	Non- surgical treatment	337 (85.4)
	Surgical treatment	2 (0.5)
	All of the above	31 (7.8)

	I don't know	25 (6.3)
Preference of using topical vasoconstrictors only like adrenaline to stop nasal bleeding	Yes	268 (67.8)
	No	65 (16.5)
	I don't know	62 (15.7)
Preference of using nasal packing as an ideal method to control anterior nasal bleeding	Yes	280 (70.9)
	No	32 (8.1)
	I don't know	83 (21.0)
Whether silver nitrate cauterization is an ideal modality to arrest anterior epistaxis	Yes	233 (59.0)
	No	47 (11.9)
	I don't know	115 (29.1)
Whether use of Foley catheter for ballooning is still safe for treatment of posterior nasal bleeding	Yes	212 (53.7)
	No	67 (17.0)
	I don't know	116 (29.4)
Whether one would wish to use posterior nasal packing to arrest bleeding at the woodruff's plexus	Yes	224 (56.7)
	No	61 (15.4)
	I don't know	110 (27.8)
Preference choice for electro cauterization in treatment of uncontrolled epistaxis	First choice	24 (6.1)
	Second choice	137 (34.7)
	Third choice	177 (44.8)
	Don't know	57 (14.4)
Whether plastic surgery can be an option to control recurrent epistaxis	Yes	264 (66.8)
	No	23 (5.8)
	I don't know	108 (27.3)

Overall practices on first aid management of epistaxis among medical students
A total score was computed for eight set questions that assessed practices, the correct answer was given one point and other responses were given zero. Generally, in this study, almost half of the respondents (52.7%) had overall good practice while (47.3%) had overall poor practice regarding first aid management of epistaxis.

Association between academic year and overall knowledge on epistaxis first aid management
This study has found a significant association between the academic year of study and overall knowledge on first aid management of epistaxis of which the level of good knowledge was increased as the academic year of study increased, (p-value=0.039). (Table 5.0)

Table 5. The association between academic year and overall knowledge of first aid management of epistaxis, (n=395)

		Overall knowledge of epistaxis		Total, n(%)	p-value
		Poor knowledge, n, (%)	Good knowledge, n, (%)		
Academic year	First-year	18 (18.8)	78 (81.3)	96 (24.3)	0.039
	Second year	12 (10.2)	106 (89.8)	118 (29.9)	
	Third year	9 (7.4)	113 (92.6)	122 (30.9)	
	Fourth-year	2 (6.5)	29 (93.5)	31 (7.8)	
	Fifth year	1 (3.6)	27 (96.4)	28 (7.1)	
	Total	42 (10.6)	353 (89.4)	395(100)	

Association between academic year and overall attitude on first aid management of epistaxis among medical students

The study has found a statistically significant association between academic year and overall attitude on first aid management of epistaxis since the desired good attitude was observed from the third year of study to the fifth year, their corresponding p-values are 0.000 (Table 6.0)

Table 6. The association between academic year and overall attitude on first aid management of epistaxis among medical students, (n=395)

		Overall attitude on first aid management of epistaxis		Total, n(%)	p-value
		Poor attitude, n, (%)	Good attitude, n, (%)		
Academic year	First-year	32 (33.3)	64 (66.7)	96 (24.3)	0.000
	Second year	16 (13.6)	102 (86.4)	118 (29.9)	
	Third year	10 (8.2)	112 (91.8)	122 (30.9)	
	Fourth-year	0 (0.0)	28 (100)	31 (7.8)	
	Fifth year	0 (0.0)	28 (100)	28 (7.1)	
	Total	58 (14.7)	337 (85.3)	395 (100)	

Association between academic year and overall practices on first aid management of epistaxis among medical students

There was a statistically significant association between the academic year of study and overall practices regarding first aid management of epistaxis among medical students. Good practices were observed from the third year of study, since the p-value=0.000 (Table 7.0)

Table 7. The association between academic year and overall practices on first aid management of epistaxis among medical students, (n=395)

Academic year		Overall practices of epistaxis management		Total, n(%)	p-value
		Poor practices, n, (%)	Good practices, n, (%)		
	First-year	79 (82.3)	17 (17.7)	96 (24.3)	
	Second year	65 (55.1)	53 (44.9)	118 (29.9)	
	Third year	34 (27.9)	88 (72.1)	122 (30.9)	0.000
	Fourth-year	3 (9.7)	28 (90.3)	31 (7.8)	
	Fifth year	6 (21.4)	22 (78.6)	28 (7.1)	
	Total	187 (47.3)	208 (52.7)	395 (100)	

Discussion

Medical students are expected to be front liners in the management of patients with epistaxis upon graduating from medical school therefore assessing their awareness of the management of epistaxis remains of paramount importance in improving the quality of graduates who will be competent to serve the community at large upon completion of their doctor of medicine degree training. So far this is the first study in Tanzania to explore the awareness of medical students on first aid management of epistaxis.

Knowledge of first aid management of epistaxis among medical students

Regarding knowledge of epistaxis among medical students at the State University of Zanzibar, the Majority of the medical students (98.2%) considered epistaxis to be a medical emergency. Such findings appear to be similar to what was found in Saudi Arabia where 74.6% of medical students considered epistaxis to be a medical emergency (Al-Musa et al., 2017)

In our study, half (50.4%) of the medical students reported bleeding disorders to be the commonest cause of epistaxis followed by fingernail trauma (28.6%). Such findings appear to correlate with what was found in Saudi Arabia where 87.1% of the medical students reported bleeding disorders to be the commonest cause of epistaxis (Al-Musa et al., 2017).

Pertaining to the knowledge of the correct size for pinching the nose as a primary measure to arrest epistaxis, 83.3% of the medical students knew the correct site and that is the cartilaginous part of the nose, while 11.9% of them chose the incorrect site and 4.8% didn't know the exact site to pinch the nose. Such findings appear to be dissimilar to those found in several studies done elsewhere where few of the students knew the correct site for nose pinching which is the cartilaginous part (Sowerby et al., 2021; Al-Musa et al., 2017; Mugwe et al., 2014)

Regarding the source of knowledge about first aid management of epistaxis, 84.6% of the students reported self-teaching as the commonest source while the second commonest sources were curriculum/medical books (4.8%). Such finding appears to be similar to what was found by Alyahya et al. in Saudi Arabia where 53.6% of the medical students reported self-teaching as the main source of information on first aid management of epistaxis (Alyahya et al., 2019). Generally, the majority of the medical students (89.4%) in our study had good knowledge of first aid management of epistaxis.

Attitude on first aid management of epistaxis among medical students
The majority of the medical students (80%) identified the proper position that a patient with epistaxis should be positioned, which is tilting the head forward rather than backward. Such findings appear to be similar to those from Saudi Arabia where 80.6% of the medical students knew the same proper position in which a patient with epistaxis should be positioned (Al-Musa et al., 2017) and also depicted similarity from the study that was done in Kenya where 60% of the clinical staffs knew the correct position to position a patient with epistaxis (Mugwe et al., 2014).

Regarding the attitude of seeking emergency medical care during persistent epistaxis, 82.3% of the students showed that if bleeding continues after 10–20 minutes with direct nasal compression, then it implies the proper time to seek emergency care. Such finding appears to be similar to what was found in a study from Saudi Arabia whereby 75.3% of the medical students reported that if epistaxis cannot be stopped after 10-20 minutes upon direct nasal compression then it requires seeking emergency medical care (Alyahya et al., 2019).

Practices on first aid management of epistaxis among medical students
The study has found that 85.4% of medical students report non-surgical treatment as the preferred modality of treating epistaxis while 7.8% reported both non-surgical and surgical treatment modalities. Anterior nasal packing (70.9%) was the most preferred treatment modality followed by topical vasoconstrictors (67.8%), These results appear to be somehow in line with what was found in a study from Kenya where the first aid measure known by most of the clinical staff was nose pinching (94.0%) and nasal packing (80.6%) (Mugwe et al., 2014). Similar findings can be depicted in a study from Nepal where nasal packing was found to be the first line measure used by emergency clinical staff (Adhikari et al., 2006) while 34.3% of the medical students in Saudi Arabia chose nose compression while 33.8% chose nasal packing (Al-Musa et al., 2017) and both were non-surgical measures similar to what has been reported in our study.

Conclusion
Medical students of the State University of Zanzibar had adequate knowledge and positive attitude about first aid management of epistaxis thus empowering them to provide first aid management of epistaxis upon completion of their medical training.

Conflict of interest
The authors have no conflicts of interest to declare

Authors' contributions:
ZSA: Conceptualization, project administration, methodology, supervision, data analysis, writing the original draft. HM: Conceptualization, data curation and analysis, writing the original draft. AAK: Conceptualization, data curation, data analysis, writing the original draft. All authors have reviewed and approved the final draft and are responsible for the content and similarity index of the submitted manuscript

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Oral hygiene practice and the relationship between sugary food intake and dental caries among adults in Mbeya, Southwest Tanzania

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Abstract

Background: Dental caries is a common dental health issue, but its prevalence varies across countries due to differences in oral healthcare programmes, lifestyles, and socio-economic status. Diet and fluoride exposure are major factors influencing the caries process. Sugars in the diet provide a substrate for bacteria in dental plaque, leading to tooth demineralisation. Our study assessed oral hygiene practice and the relationship between dental caries and sugary food intake among adults in Mbeya, Tanzania.

Methods: A community-based cross-sectional study was conducted among healthy adults in Mbeya selected through random sampling. The questionnaire was used to collect information on oral health practices and dental caries risk factors through interpersonal conversations. Oral cavity physical examinations were also conducted to assess oral cleanliness based on visible plaque presence and dentition status classified by the number of decayed, filled, and missing teeth due to caries. Data was analysed using SPSS version 23. χ^2-test and logistic regression were used for studying associations.

Results: Our study included 168 participants. Nearly all 166 (98.8%) reported brushing their teeth. All participants reported sugary food intake, with 143 (85.1%) consuming sugary foods more than three times daily and 25 (14.9%) less than three times daily. Decayed teeth were present in 126 (75%) participants. Among those eating sugary foods over three times daily, 112 (66.7%) had dental caries versus 31 (18.5%) without caries (χ^2=5.655, p=0.017). Reduced toothbrushing frequency is associated with increased decay (COR 2.839, 95% CI 1.172-6.873, p<0.05). The mean decayed, missing, and filled teeth score was 1.45 (± 0.45).

Conclusion: Findings indicate a positive oral hygiene practice overall. High sugar intake and inadequate brushing contributed to a high dental caries prevalence, indicating the need for improved oral health education, preventive efforts, and better access to dental services to address the substantial tooth decay burden.

Keywords: dental caries, sugary diet intake, adults, Mbeya, Tanzania

Introduction

Dental caries, also known as tooth decay, is caused by specific oral bacteria that feed on carbohydrates on the tooth surface. This produces acid and waste that dissolves tooth minerals (Balakrishnan et al., 2000). Caries is a multifactorial disease affecting people of all ages, leading to the irreversible destruction of dental tissue through prolonged interaction with food, dental plaque, and microorganisms (Caufield et al., 2005). It involves the breakdown of dental hard tissues by acidic by-products from bacterial fermentation of dietary carbohydrates, especially sucrose (Fejerskov, 2004; Yadav & Prakash, 2016). Refined sugary foods are strongly linked to caries (Gupta et al., 2013; Moynihan, 2016).

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Studies show higher caries rates in those with elevated free sugar intake from sources like cakes, biscuits, sucrose, sweetened beverages, and 100% fruit juices (Moynihan, 2016). Poor oral hygiene is also an established risk factor, with the American Dental Association recommending brushing at least twice daily with fluoride toothpaste (Kahar et al., 2019). Additionally, socio-economic status, insufficient oral health education, and detrimental habits influence caries development (Gathecha et al., 2012).

Dental caries is a major global public health issue and the most widespread non-communicable disease (NCD). The 2015 Global Burden of Disease study ranked it first for permanent tooth decay (2.3 billion affected) and 12th for primary tooth decay (500 million children) (Moynihan, 2016). The WHO average DMFT index is 3, but significant variations exist. Some places have minimal DMFT versus the WHO standard, while others have higher DMFT values. In developing countries, untreated caries drive adulthood caries severity. Teeth with caries or other conditions often get extracted when painful, partly due to low dentist density (1 per 150,000 people). This makes dental services hard to access (Moynihan, 2016).

Dental caries remains a global pandemic with differing occurrences and severity based on sociocultural practices and socioeconomics (Gathecha et al., 2012). Developing countries face high rates of untreated decay and extractions due to limited dental access. The disease remains a major global health challenge, requiring socio-culturally appropriate interventions.

There is limited data on dental caries concerning sugary food intake in Mbeya, with most studies focused on children aged 2-4 years (Mwakayoka et al., 2017). Previous research (Masumo et al., 2012; Matee et al., 1994) examined early childhood caries and factors in under 3s. Since dental caries affects children differently across ages (Braimoh et al., 2014), more studies are needed in various locations and WHO age groups to address risk factors.

Previous studies were conducted among adolescents in the Maasai (Simangwa et al., 2018) and 12-year-olds in Dar es Salaam (Mwakatobe & Mumghamba, 2007). However, systematic research is required to generate valuable data for planning oral healthcare and services per population. This study helps provide data the Tanzanian Ministry of Health can use to determine problem severity and implement control measures in this area. The findings will benefit authorities in tailoring regional oral health services and planning.

Methods
Study area
Mbeya region is located in the southern highlands of Tanzania and is named after its capital city, Mbeya. As the largest city in the region, Mbeya serves as the administrative centre. The Mbeya region covers approximately 62,420 square kilometres and has a population of 2,343,754, with 1,123,828 males and 1,219,926 females (URT, 2022). Agriculture is the predominant economic activity in Mbeya, with major crops including coffee, tea, maize, and beans. Other key social and economic activities include trade, small-scale farming, tourism and livestock rearing.

Study design
A community-based cross-sectional study was conducted among healthy adults in Mbeya, Tanzania.

Study population
The study participants included all adult males and females living in Mbeya. The inclusion criteria were for all male and female adults residing in Mbeya. The exclusion criteria were adults with mental disabilities, speech impairments or hearing difficulties and adults who were uncooperative or declined to participate.

Sample size estimation

The estimated minimum sample size was 168. The sample size was calculated using the Kish formula (Wiegand, 1968) obtained from the average prevalence of dental caries in different studies, p = 12.5% = 0.125 (Carneiro et al., 2011; Mashoto et al., 2010; Simangwa et al., 2018). The margin of error allowed was 0.05% and a 95% confidence interval (Z=1.96) was used.

Sampling technique

The investigation team was stationed in several selected wards located mainly in urban areas. Random sampling was used to select participants in selected wards. Primary data was used in this study.

Data collection

The questionnaire was used for data collection. The questionnaire was originally developed in English and then translated into Swahili. Open-ended and closed-ended questions were asked in Swahili to participants, with responses translated into English. Information on oral health practices and dental caries risk factors was gathered through interpersonal conversations. Oral cavity physical examinations were also conducted to assess oral cleanliness and dentition status. Oral cleanliness was evaluated based on visible plaque presence. Dentition status was classified by the number of decayed, filled, and missing teeth due to caries. The questionnaire had three sections. The first collected participant demographics like gender, age, and residence. The second assessed dental caries risks such as oral hygiene, cariogenic diet frequency, use of mouthwash and fluoride toothpaste. The third section documented results from oral cavity examinations on dentition status (WHO, 2013).

Data analysis

Data collected was imported to Microsoft Excel version 2019 and analysed using SPSS version 23. Frequency tables and figures were then generated and descriptive statistics were presented. The association between the frequency of sugary food intake and dental caries was tested using logistic regression analysis and χ2-test at a significant level of p=0.05.

Ethical consideration

The study was approved by the University of Dar es Salaam, Mbeya College of Health and Allied Science Research Ethical Clearance Sub-Committee (Ref No.: 2018-04-13276). Permission to conduct the study was taken from Mbeya Regional administration. Confidentiality and privacy of participants' information were observed. Names and other identifying information were not included.

Results

Demographic characteristics

Our study included 168 participants ranging in age from 19 to 79 years. The average age of the respondents was 39 years old, with a standard deviation of 14.5. The largest proportion of participants were between 29 and 38 years old (n=50, 29.8%), followed by those between 19 and 28 years old (n=48, 28.6%). There were more female participants (n=97, 57.7%) than male (n=71, 42.3%). The smallest age group represented was 69 to 79 years old, with only 7 participants (4.2%) in this range (Table 1).

Table 1: Demographic characteristics of the study participants (N=168)

Demographic characteristics		Frequency (n)	Percent (%)
Gender	Males	71	42.3%
	Females	97	57.7%
Age group	19 – 28	48	28.6%
	29 – 38	50	29.8%
	39 – 48	30	17.9%
	49 – 58	19	11.3%
	59 – 68	14	8.3%
	69 – 79	7	4.2%

Oral hygiene practice

Of the 168 study participants, 166 (98.8%) reported brushing their teeth, while only 2 (1.2%) did not brush at all. Of those who brushed, 111 (66.1%) brushed once daily, 36 (21.4%) brushed twice daily and 21 (12.5%) did not brush daily. The majority (159 or 94.6%) used commercial toothbrushes and toothpaste, while 9 (5.4%) used other methods like chewing sticks, charcoal or fingers without toothpaste. Most participants (159 or 94.6%) used toothpaste and only 9 (5.4%) did not. All participants reported consuming sugary foods or snacks. However, 143 (85.1) ate these more than three times per day, while just 25 (14.9%) ate them less than three times daily. After eating sugary snacks, 141 participants (83.9%) did not brush their teeth afterwards, while only 27 (16.1%) sometimes brushed post-snack.

Table 2: Frequency of oral hygiene practice among adults in Mbeya, Tanzania

	Response	Frequency (n)	Percent (%)
Do you brush your teeth?	Yes	166	98.8%
	No	2	1.2
How many times a day?	Not daily	21	12.5%
	Once per day	111	66.1%
	Twice daily	36	21.4%
What instrument do you use to brush your teeth?	Toothbrush	159	94.6%
	Others	9	5.4%
Are you using toothpaste during brushing?	Yes	159	94.6%
	No	9	5.4%
Are you using mouthwash after brushing?	Yes	9	5.4%
	No	159	94.6%
Do you eat sugary food or snacks?	Yes	168	100%
	No	0	0.0%
If yes, how many times a day?	Less than three times	25	14.9%
	More than three times	143	85.1%
Do you brush your teeth after eating sugary food or snacks?	No	141	83.9%
	Sometimes	27	16.1%

Relationship between frequency of sugary food intake and decayed or caries teeth

Out of 168 participants, 126 (75%) had decayed teeth, while 42 (25%) had no decay. 120 (71%) had no filled teeth, and 48 (29%) had fillings. 54 (32.1%) were missing teeth due to decay, while 114 (67.9%) had no missing teeth from decay. Of the 25 (14.9%) who consumed sugary snacks less than three times daily, 14 (8.3%) had dental caries and 11 (6.5%) did not. Of the 143 (85.1%) who ate sugary snacks more than three times daily, 112 (66.7%) had dental caries and 31 (18.5%) did not. There was a significant association between sugary snack frequencies and dental caries (X_2 = 5.655, p=0.017). Reduced toothbrushing frequency was associated with increased decay (COR 2.839 at 95% CI 1.172-6.873, p<0.05) (Table 3, Figures 1 and 2).

Table 3: Frequency of sugary food intake and tooth decay status by gender and age groups

Demographic characteristics	Frequency of sugary food intake per day	Teeth decay status		Total (n/%)	X² (p-value)
		No decay	Decayed		
Gender					
Males	Less than three times	2 (2.8%)	13 (18.3%)	15 (21.1%)	0.693 (0.405)
	More than three times	13 (18.3%)	43 (60.6%)	56 (78.9%)	
Females	Less than three times	9 (9.3%)	1 (1.0%)	10 (10.3%)	21.415 (0.000)
	More than three times	18 (18.6%)	69 (71.1%)	87 (89.7%)	
Total	Less than three times	11 (6.6%)	14 (8.3%)	25 (14.9%)	5.655 (0.017)
	More than three times	31 (18.4%)	112 (66.7%)	143 (85.1%)	
Age group					
19–28	Less than three times	1 (2.1%)	4 (8.3%)	5 (10.4%)	0.045 (0.833)
	More than three times	7 (14.6%)	36 (75.0%)	43 (89.6%)	
29–38	Less than three times	3 (6.0%)	4 (8.0%)	7 (14.0%)	2.658 (0.103)
	More than three times	7 (14.0%)	36 (72.0%)	43 (86.0%)	
39–48	Less than three times	0 (0.0%)	2 (6.7%)	2 (6.7%)	0.779 (0.377)
	More than three times	8 (26.7%)	20 (66.7%)	28 (93.3%)	
49–58	Less than three times	3 (15.8%)	2 (10.5%)	5 (26.3%)	0.148 (0.701)
	More than three times	7 (36.8%)	7 (36.8%)	14 (73.7%)	
59–68	Less than three times	4 (28.6%)	1 (7.1%)	5 (35.7%)	10.080 (0.001)
	More than three times	0 (0.0%)	9 (64.3%)	9 (64.3%)	
69–79	Less than three times	0 (0.0%)	1 (14.3%)	1 (14.3%)	0.467 (0.495)
	More than three times	2 (28.6%)	4 (57.1%)	6 (85.7%)	
Total	Less than three times	11 (6.6%)	14 (8.3%)	25 (14.9%)	5.655 (0.017)
	More than three times	31 (18.4%)	112 (66.7%)	143 (85.1%)	
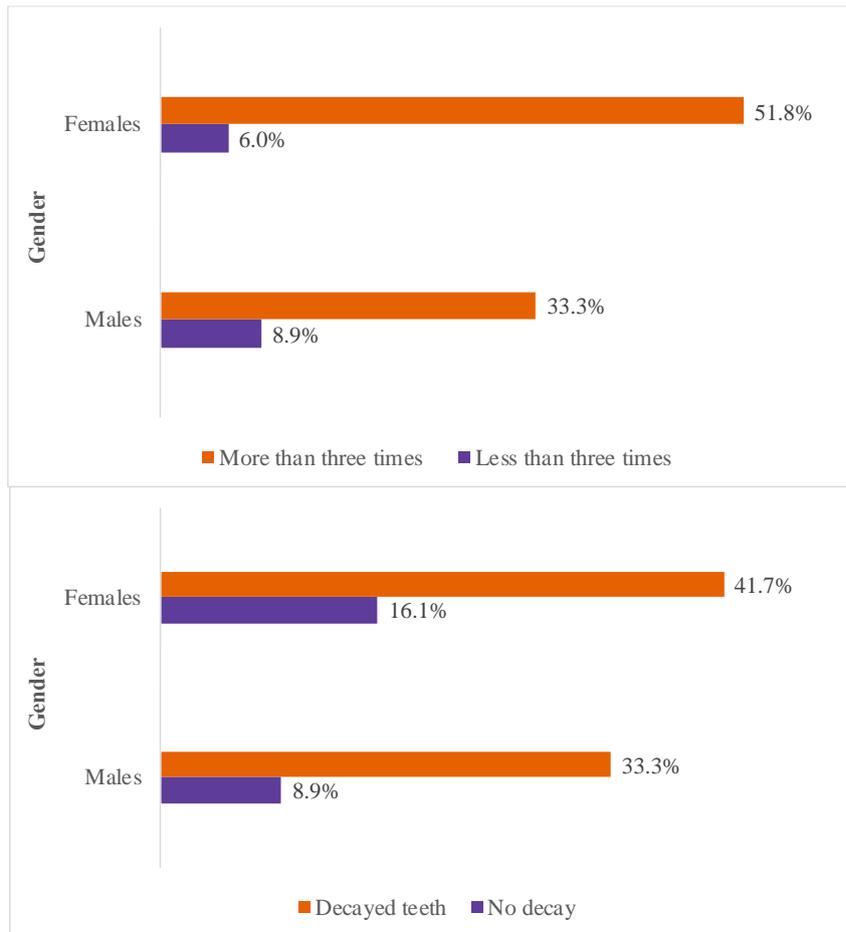
Figure 1: Gender and frequency of sugary food consumption in relation to dental caries.
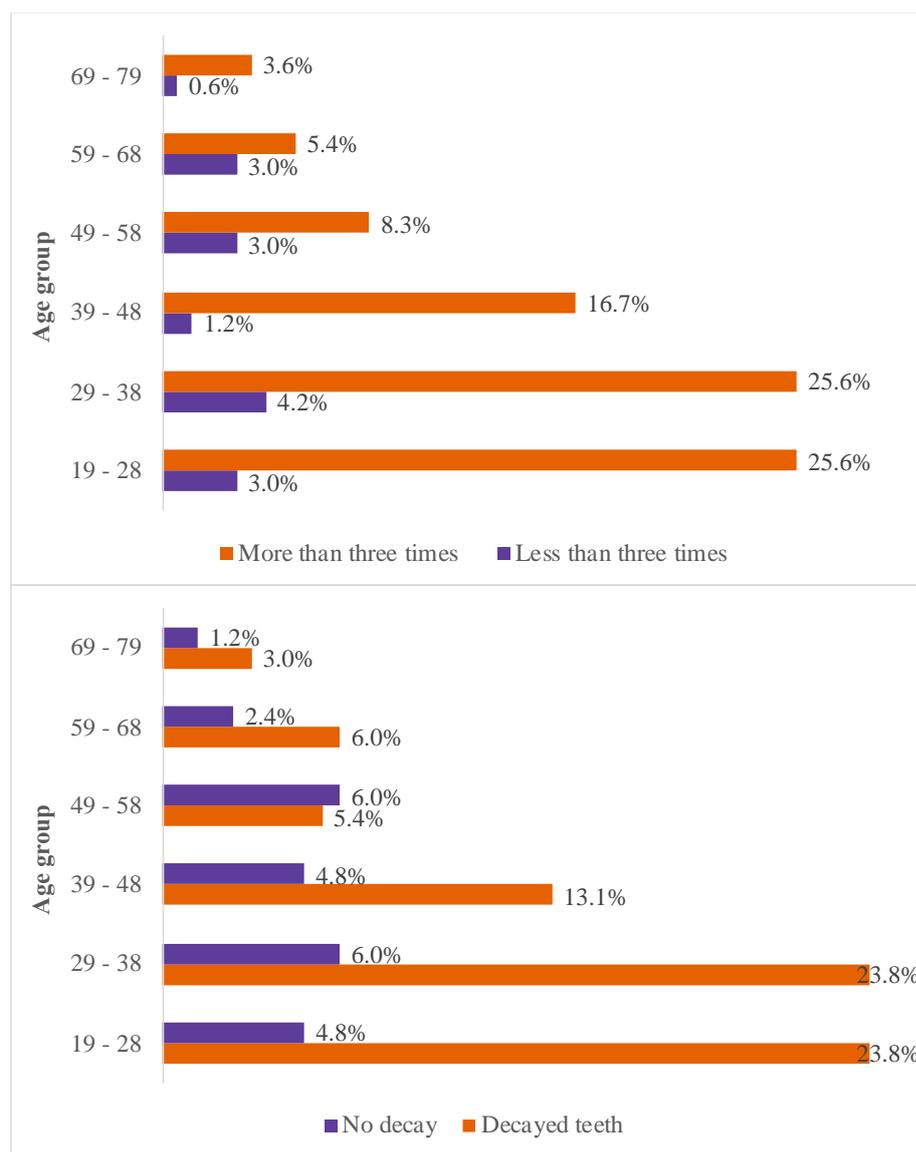
Figure 2: Age group and frequency of sugary food consumption in relation to dental caries

Mean DMFT Value

The mean decayed, missing, and filled teeth (DMFT) score for study participants was 1.45 (± 0.45). The decayed component (DT) contributed the most to the DMFT value, accounting for 95.2% or 1.75 of the mean DMFT, indicating some study participants with multiple teeth complications. Missing teeth accounted for 1.32 and filled teeth accounted for 1.28 of the mean DMFT value. Looking at DMFT scores by gender, females had a higher mean DMFT of 0.75, while males had a lower mean DMFT of 0.6.

Discussion

The findings from this study suggest that most participants (98.8%) reported brushing their teeth and using commercial toothpaste, which is positive for maintaining good oral hygiene. However, it is concerning that a large number of participants brushed only once daily, which may be insufficient to prevent tooth decay and other dental issues. Additionally, a small percentage used unconventional brushing methods like charcoal and fingers without toothpaste, which is worrying. This study showed little difference in oral hygiene practices compared to a previous cross-sectional study among adults in Misungwi district, Tanzania. In that study, most participants also used

toothpaste while brushing (82.7%), but less than half (46.4%) brushed twice or more daily (Nyorobi et al., 2018). Proper brushing technique and frequency is essential to remove plaque and prevent decay. In general, while toothbrushing habits were fairly positive, the low frequency and inadequate methods in a subset of participants highlighted the need to promote proper toothbrush and toothpaste use and brush at least twice daily for optimal oral health.

An important finding from this study is that nearly all participants reported consuming sugary foods or snacks, with the majority eating these more than three times daily. This high sugar intake is concerning, as it can lead to tooth decay and other health issues. Moreover, it is alarming that most participants did not brush after eating sugary foods, a crucial time when teeth are vulnerable to plaque and decay. Brushing immediately after sugary foods can help remove bacteria and prevent buildup. Similar studies have shown that natural sugars and refined carbs increase decay risk, supporting the link between sugary diets and dental caries (Gupta et al., 2013). Research in Nigeria also found that adults consuming around 2 grammes of sugar daily had dental caries in half their permanent teeth after decades of exposure (Sheiham & James, 2014). The frequent sugary snack intake and lack of post-snack brushing demonstrate the need for education on limiting sugar consumption and proper oral hygiene habits to protect against tooth decay.

The study reveals concerning findings about the high prevalence of dental caries among participants. A large majority (75%) had decayed teeth, with over half missing teeth due to decay. A positive association was found between sugary food frequencies and increased DMFT scores, regardless of gender, aligning with other research (Bernabé et al., 2014; Sheiham & James, 2014). Our findings were similar to a study at a Regional Referral Hospital in Musoma, Tanzania, showing dental caries as the predominant oral disease correlating with dietary patterns and oral hygiene (Singh et al., 2014). This highlights the urgent need for improved oral health education and preventive measures to address the population's high tooth decay rates. Furthermore, increased sugary food intake was significantly associated with more dental caries. Those eating sugary foods/snacks over three times daily had a higher decay likelihood than less frequent consumers. This finding emphasises reducing sugar intake as a key preventive approach for tooth decay.

Additionally, the study found that participants who brushed less frequently had a higher decay risk. This emphasises the importance of regular brushing and good oral hygiene in preventing caries. Another notable finding was that most with dental caries left decayed teeth unfilled rather than undergoing extraction. This indicates a lack of access to dental care and highlights the need to improve access to dental services to address decay and oral health issues. Overall, the study highlights the urgent need for enhanced oral health education, preventive efforts, and access to dental care to tackle the high incidence of tooth decay in this community. Reducing sugar consumption, maintaining oral hygiene, and obtaining timely dental treatment are key to preventing and managing dental caries. The high rate of unfilled cavities also underscores the importance of improving access to professional dental services for managing tooth decay and related problems. A multi-pronged approach is needed to promote oral health at individual and community levels.

The study indicated that the mean DMFT value of the participants was 1.45, which is considered relatively low compared to some other communities. However, the majority of the DMFT score was attributed to the decayed component, which accounted for 95.2% of the mean DMFT value. This percentage contribution was due to individuals with decayed teeth. Some of their teeth are filled and some suffer recurrence of tooth decay after filling. Our study also noted the interaction between some data because one individual had multiple teeth complications. This finding suggests that dental caries is the participants' most prevalent oral health problem. The missing and filled teeth components of DMFT value were relatively low, indicating that tooth extraction and restoration were not the primary reasons for tooth loss among the participants.

This finding may be due to a lack of access to dental services or poor dental health-seeking behaviour among the participants. Interestingly, the study revealed that females had a slightly lower mean DMFT value than males, indicating better oral health among females. This finding is

consistent with previous studies showing that females tend to have better oral health habits than males (Singh et al., 2014). However, further research is needed to explore the factors contributing to gender differences in oral health.

Our study had some limitations worth acknowledging. First, the scope was restricted to randomly selected adults living in urban areas where the investigation team was located. As done in previous work, no comparisons could be made between rural and urban populations. This focused geographic area was necessitated by limited funding and time constraints for conducting the research. Additionally, we examined fewer variables compared to previous studies in this domain. For example, our analysis did not include participant education level as a potential factor.

This narrower set of variables was another compromise imposed by resource limitations. While restricted to these aspects, this study still provides valuable initial insights into dental caries prevalence among adults in the region. Further research with a broader and more diverse participant sample and a more extensive set of variables would allow for deeper understanding and robust comparisons across geographic residence and socio-economic factors. Building on the groundwork from this study, future work can continue to elucidate the complex interplay between demographic, socio-economic and health factors related to dental caries.

Conclusion

Despite most participants having good oral hygiene practices, our study revealed concerning data about oral hygiene habits, sugar consumption and the high prevalence of dental caries. While most reported brushing with toothpaste, the low brushing frequency and improper methods among some highlight the need to promote proper brushing techniques and twice-daily brushing. The frequency of sugary foods and inadequate post-snack brushing demonstrated the importance of limiting sugar and brushing after consumption.

The high rate of decayed teeth and the association between sugary diets and increased caries indicates an urgent need for preventive efforts and improved access to dental services. Reducing sugar intake and maintaining diligent oral hygiene are critical for preventing tooth decay. The findings underscore the value of oral health education, preventive measures and expanding access to dental care to combat the population's substantial dental caries burden. A multi-faceted approach is imperative to promote oral health through enhancing individual habits, services and community-level interventions.

Author contributions

DD and CNM designed the study. DD conducted and contributed to data analysis. DD and CNM interpreted the data. 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 financial and non-financial competing interests.

Availability of data and material

All data generated or analysed during this study is included in this published article.

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Histomorphological and biochemical changes in the liver tissue following adjuvant treatment with *hypoxis hemerocallidea* and Antiretroviral Drugs in diabetic rats

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Abstract
Introduction: Highly Active Antiretroviral Therapy (HAART) has been used in the management of people living with Human immunodeficiency virus (HIV). However, the long-term effects cause diabetes and result in liver damage. Similarly, *Hypoxis hemerocellidae* (*H.h*) has been used traditionally to treat diseases including HIV and Diabetes. The study aimed to investigate the effects of aqueous extract of H.h on the liver cytoarchitectonic in diabetic experimental animals under antiretroviral therapy.
Methods: Thirty-six (36) adult male Sprague-Dawley rats were used and divided into 6 groups namely: A (control), B (diabetic) received distilled water, C (diabetic + 50mg/kg, *H.h*), D (diabetic + HAART), E (diabetic + HAART+ 250 mg/kg VIt C), F (diabetic + HAART + 50mg/kg of *H.h*). Blood glucose levels, Body weight, oxidative stress markers and liver histomorphology of the experimental animals were measured and analyzed.
Results: The blood glucose levels of animals administered with *H.h* were significantly reduced compared with diabetic control. Group E had significantly reduced blood glucose levels compared with other treated groups D and F. There is a significant reduction of AST in group C and E compared to other groups D and F. Group F showed a significant reduction in MDA and an improvement in GSH compared to other treated groups except group E. Histologically, H& E and PAS staining revealed an improvement in groups C and F compared to the diabetic-treated groups.
Conclusion: This study demonstrated that *H.hemerocallidae* mitigated the metabolic effect of HAART in diabetic rats. Still, the antidiabetic and antioxidant effects, in combination with antiretroviral therapy need further investigation at different doses.

Keywords: *Hypoxis hemerocallidea*, HIV and HAART, Diabetes Mellitus, Liver

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Introduction

The Human Immunodeficiency Virus (HIV) and acquired immunodeficiency syndrome (AIDS) pandemic remains the biggest socio-economic challenge that is facing the world at large, affecting mostly the young and economically productive population(Drimie et al., 2002). Despite the availability of various anti-viral medications, the need for new antiretroviral agents continues to increase because the existing medications do not provide a complete curation and cause serious side effects(Geronikaki et al., 2016). Many HIV/AIDS patients receiving fixed-dose combination drugs: Efavirenz (EFV), Emtricitabine (FTC), and Tenofovir disoproxil fumarate (TDF) become glucose intolerant and insulin resistant, leading to diabetes mellitus associated with liver damages(Morse & Kovacs, 2006). Type 2 diabetes mellitus (T2DM) associated with long-term use of combined antiretroviral therapy (cART) has since become a major cause of morbidity and mortality. More so, diabetes mellitus and cART long-term use raise the risks of non-alcoholic liver disease(Mohamed et al., 2016; Soriano et al., 2008).

In parts of Africa continent including South Africa, the use of herbal medicine for the management of HIV is common due to the high-cost effectiveness of providing HIV treatment(Kankara et al., 2022). Recently, the South African government promoted the use of *H. hemerocallidea* (commonly called African potato) for the treatment of HIV and associated symptoms(Ismail et al., 2017; Mills et al., 2005). The herbs of *H. hemerocallidea* have long been used by Africans as a traditional medical treatment for various diseases and have been the subject of several scientific studies(Mlilo & Sibanda, 2022).

The medical plant *H. hemerocallidea* has been reported to boost the immune system of HIV-positive patients (Matyanga et al., 2020). The extract of *H. hemerocallidea* was reported to reduce high blood pressure, prostate hypertrophy, adult-onset diabetes, and HIV/AIDS-related conditions(Ojewole, 2006; Rahman et al., 2022). Biomedical studies have revealed that the extracts possess anti-inflammatory, antineoplastic, antioxidant, antidiabetic, and anti-viral properties in vivo and in vitro(Olasile et al., 2018). Hypoxoside is an active phytochemical component of *H. hemerocallidea* converted by the action of β glucosidase enzyme to Rooperol which has potent pharmacological properties relevant to cancer, inflammations, and HIV(Olarewaju et al., 2022).

Another study also reported that H. *hemerocallidea* significantly reduced serum cholesterol and improved liver fat(Hovenkamp et al., 2008).

As a result of these claims, there is paucity in the literature suggesting the effects of *H. hemerocallidea* might attenuate the toxicities of the liver associated with HAART and diabetes.

Thus, this study aimed to investigate the potential effects of *Hypoxis Hemerocallidea* on the cytoarchitectonic properties of the liver in Streptozotocin-induced diabetic Rats treated with antiretroviral therapy.

Materials and methods

Drugs

A single dose of Odimune/HAART (containing efavirenz (EFV) 600 mg, emtricitabine (FTC) 200 mg, and Tenofovir (TDF) 300 mg) was obtained from Pharmed Ltd., Durban, South Africa. Vitamin C (250 mg/kg) and Glucose strips purchased from Lichro Chemical And Laboratory Supplies were also used.

Plant

Hypoxis hemerocallidea is commonly known as African potato, a genus of the Family Hypoxidaceae (Drewes et al., 1984). The fresh corms of *H. hemerocallidea* were purchased from a local herb-selling shop in Umbilo Road, Durban, KwaZulu-Natal.

Extraction of *Hypoxis hemerocallidea*

The corms were authenticated at the Department of Life Science, Westville Campus, University of KwaZulu-Natal, Durban, South Africa. *Hypoxis hemerocallidea* corms were chopped into small pieces and air-dried at room temperature. The dried corms were powdered in a warring blender. Four hundred (400 g) of the powdered corms were soaked in 5 litres of water for 72 hours. The mixture was then filtered, and the filtrate was evaporated at 600 °C using a vacuum rotary evaporator. The wet residue was freeze-dried and stored until ready to use. The powdered extracts obtained contain the bioactive compound hypoxosithe de, sitosterol(Albrecht et al., 1995; Laporta et al., 2007).

Animals

Thirty-six (36) adult male Sprague-Dawley rats maintained at the Biomedical Resources Unit (BRU) Animal Facility of the University of KwaZulu-Natal were used. They were supplied with rat feed and water ad libitum, except on days preceding serum assays when they were only allowed access to water 12 hours prior to venipuncture. All the rats were housed in plastic cages (2 rats/cage) having dimensions of 30 x 20 x 13 cm and softwood shavings were employed as bedding in the cages. They were maintained under standardized animal house conditions (temperature: 18-22°C; light: approximately 12 h light per day; humidity: 50-55%) with ethical guidelines adhered to regarding the care and maintenance of the animals as detailed in the National Institute of Health (NIH) Guidelines for the Care and Use of Laboratory Animals (Health, 1985).

Grouping of Animals and Dosage of Test Agents/Treatment

The animals were divided into six (6) groups consisting of 6 rats each. The testing agents were administered daily via oral route with an oral cannula after diabetes was induced using single dose intraperitoneal injection of STZ (65 mg/kg of body weight) in 0.9% NaCl with 100 mM sodium citrate buffer (pH 4.5) (ref) and the treatment lasted for eight (8) weeks. Daily monitoring of the animals including weekly weight and blood glucose was recorded.

Group A = negative controls received distilled water
Group B = diabetic control received citrate buffer
Group C = Diabetic + 50 mg/kg of aqueous extracts of *Hypoxis hemerocallidea* only
Group D = Diabetic + single dose of HAART only
Group E = Diabetic + single dose of HAART and 250 mg/kg of vitamin C
Group F = Diabetic + single dose of HAART+ 50 mg/kg of *hypoxis hemerocallidea*

Body weight, Blood glucose level, and animals' general well-being

Daily monitoring of the animal's general well-being was carried out in accordance with the Humane Endpoint score sheet. In addition, the blood glucose level and weight difference were measured and recorded weekly. The whole experiment was conducted over a period of 56 days.

Biochemical analyses

Blood samples were analyzed for biochemistry (oxidative stress biomarkers), glutathione [GSH], malondialdehyde [MDA], alanine aminotransferase [ALT], aspartate aminotransferase [AST] (Sher & Hung, 2013).

Histopathological Studies

Livers were washed in saline and fixed in 10% neutral buffered formalin for 24 hours. The samples were transferred to a 70% ethanol solution. Ascending grades of alcohol were then used to dehydrate the

samples and xylene was used as a clearing agent. The samples were immersed in molten paraffin wax at 58°C to 62°C. The prepared blocks were cut into slices of 5 μm) using a microtome (Microtome HM 315, Walldorf, Germany) and stained with hematoxylin and eosin (H&E) stain.

Additionally, the periodic acid-Schiff (PAS) staining technique was used to detect the presence of polysaccharides (e.g., glycogen) and mucosubstances (e.g., glycoproteins, glycolipids, and mucins) in rat liver tissues. The PAS technique is mostly used to evaluate the thickness of the glomerular basement membrane (GBM) in renal disease. The sections were viewed and photographed using an Olympus light microscope (Olympus BX, Tokyo, Japan) with an attached camera (Olympus E-330, Olympus Optical Co. Ltd., Tokyo, Japan).

Statistical Analysis

All results are presented as the mean ± standard error of the mean (SEM). One-way analysis of variance (ANOVA) followed by Turkey's posthoc test was performed using GraphPad Prism version 5.00 for Windows (GraphPad Software, La Jolla, California, USA), in accordance with the SPSS. Comparisons with $p < 0.05$ were considered statistically significant.

Ethical Approval

The study protocol was approved by the University of KwaZulu-Natal Animal Ethics Committee (AREC/ 010/016PP). The animals received humane care in accordance with the Principle of Laboratory Animal Care of the National Medical Research Council and the Guide for the Care and Use of Laboratory Animals of the National Academy of Sciences.

Results

Hypoxis hemerocallidea effect on total body weight

 Results from Table 1 showed a significant difference (P<0.05) in the body weight of the experimental animals. It revealed a significant decrease in body weight of diabetic rats when compared to their initial and final body and with group A (negative control, non-diabetic group). Body weight of rats in groups administered with *H. hemerocallidea* increased steadily from initial to final weight and improved significantly (p<0.05) when compared with group B (positive control, diabetic rats without treatment). The rats in group D (HAART and Diabetes) had a significant reduction in body weight when compared with group B (diabetic control).

Table 1: Body weight difference in experimental animals

Groups	BW initial (g)	BW final (g)	BW diff (g)
A	280 ± 11	365.5 ± 19.86	85.5
B	270 ± 22	220 ± 19.13*	50.0
C	250 ± 13	280 ± 35	40
D	280 ±16	205 ± 29.43**	32
E	270 ± 7.1	340 ± 31**	30

F	254 ± 26.74	320 ± 34.94**	66

Data are shown as the mean ± SEM; p<0.05* vs Group A, p<0.05** vs Group B, BW= body weight of rats. Group A: normal control; Group B: diabetic control; Group C: diabetic group fed with 50 mg/kg of *H. hemerocallidea*; Group D: diabetic group fed with HAART; Group E: diabetic group fed with HAART + Vitamin C; Group F: diabetic group fed with HAART and 50 mg/kg of *H. hemerocallidea (H.h)*.

Hypoxis hemerocallidea effect on serum glucose levels in STZ-induced diabetic rats.
Results from Table 2 showed a significant difference (p<0.05) in the blood glucose level of the rats. Table 2 showed a significant increase in blood glucose levels of group B (diabetic control) when compared with group A (non-diabetic). The groups administered with 50 mg/Kg H.h had a reduction in the blood glucose levels compared to diabetic control. Notably group E had a significant in blood glucose level compared with diabetic control. There is a significant reduction of AST in groups C and E compared to other groups D and F (HAART and Diabetic).

Table 2: Blood glucose and biochemical parameters (ALT and AST) in the experimental groups

GROUPS	FINAL BLOOD GLUCOSE (mmol/L) (Mean±SEM)	ALT (U/L) (Mean±SEM)	AST (U/L) (Mean±SEM)
A	4.7 ± 0.6	57 ± 1.6	72 ± 7.1
B	25 ± 3.8*	94 ± 9.8	120 ± 12*
C	22 ± 1.6	87.0 ± 4.0	52 ± 10**
D	23 ± 1.4	88 ± 1.2	92 ± 9.0
E	21 ± 0.97**	88 ± 0.94	58 ± 4.5**
F	22 ± 2.9	88 ± 1.2	65 ± 9.8**

Data are shown as the mean ± SEM; p<0.05** vs Group B and p<0.05* vs Group A, AST=alanine amino aspartate, ALT= alanine aminotransferase. Group A: normal control; Group B: diabetic control; Group C: diabetic group fed with 50 mg/kg of *H. hemerocallidea*; Group D: diabetic group fed with HAART; Group E: diabetic group fed with HAART + Vitamin C; Group F: diabetic group fed with HAART and 50 mg/kg of *H. hemerocallidea (H.h)*.

Hypoxis hemerocallidea effect on the oxidative stress markers (MDA and GSH).
The results from Table 3 showed a significant increase in MDA (p<0.05) of rats in diabetic group B (diabetic) when compared to control group A (non-diabetic). MDA level was significantly decreased in group F (Diabetic + HAART + 50 mg/Kg) compared to diabetic group B. Notably, Group F showed a significant reduction in MDA and an improvement in GSH compared to other treated groups except for Group E (Diabetic + HAART + Vit C).

Table 3: Oxidative stress markers (MDA and GSH) in the experimental groups.

Groups	MDA (µm)	GSH (µm)
A	5.50 ± 3.19	8.26 ± 1.75
B	21.19 ± 7.01*	5.27 ± 0.24*
C	15.05 ± 16.19*	8.25 ± 2.09**
D	16.19 ± 19.95*	6.27 ± 0.67
E	5.32 ± 2.86**	5.00 ± 0.74*
F	5.70 ± 0.52**/***	5.01 ± 0.44*

Data are shown as the mean ± SEM; $p < 0.05$* vs Group A, $p < 0.05$** vs Group B, $p < 0.05$*** vs Group C. GSH= reduced glutathione, MDA= malondialdehyde. Group A: normal control; Group B: diabetic control; Group C: diabetic group fed with 50 mg/kg of *H. hemerocallidea*; Group D: diabetic group fed with HAART; Group E: diabetic group fed with HAART + Vitamin C; Group F: diabetic group fed with HAART and 50 mg/kg of *H. hemerocallidea*.

Histopathology of liver sections
Figure 1: Hematoxylin and Eosin (H & E) stain showed in group A (non-diabetic) of liver histoarchitecture with central vein within hepatocytes well-arranged. The outlines of hepatocytes and sinusoidal spaces were clearly seen in Fig. 1. Similarly, Figure 6: In (Group F), the liver of diabetic Sprague-Dawley rats treated with HAART and 50mg/kg H. *hemerocallidea* H & E stains showed normal cytoarchitecture of the hepatocyte. Groups C and D showed mild steatosis in the Hepatocyte central vein similar to that of rats in group B (Diabetic). Group E (HAART and 250mg/kg of Vitamin C) showed occluded central vein of occlusion and vacuolization of the hepatocyte.

Periodic acid–Schiff (PAS) stain showed a various degrees of glycogen deposition of liver sections (Fig. 2). PAS, showed slight glycogen deposits in the histoarchitecture of the liver in groups B (diabetic), group C (*50 mg/kg* H. hemerocallidea) and group F (HAART + H. hemerocallidea) showed deeply stained hepatocytes glycogen compared.
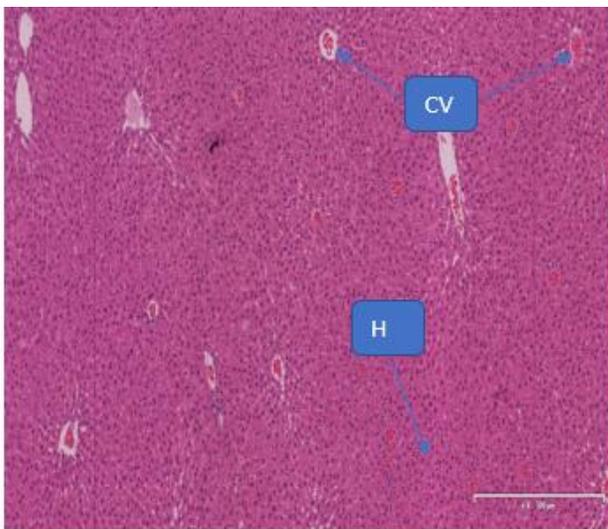
FIGURES

**Figure 1:** Photomicrograph of liver cross sections of Sprague-Dawley rats stained with H&E.
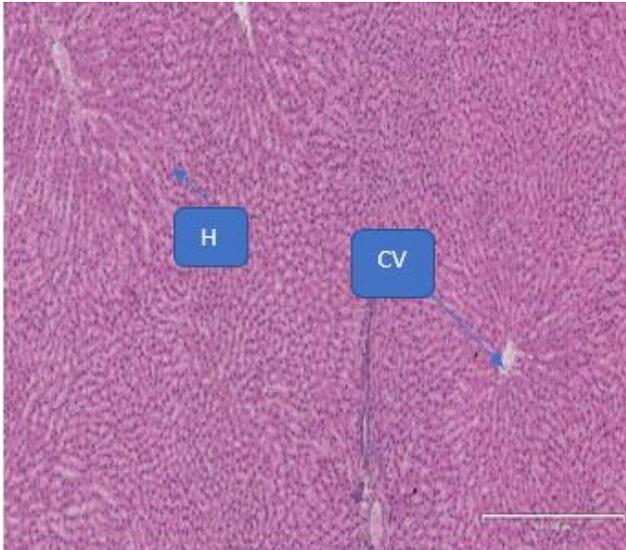
Group A (non-diabetic and untreated). *Note normal Histoarchitecture with hepatocyte and central vein*
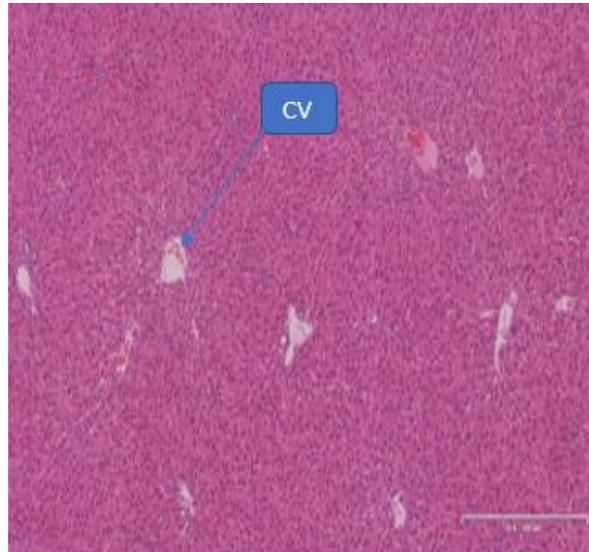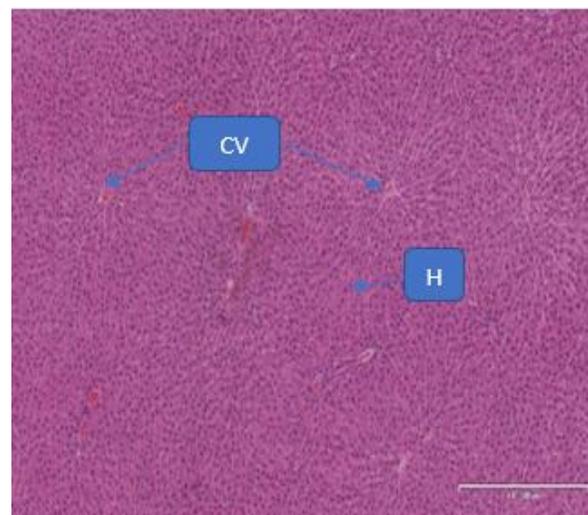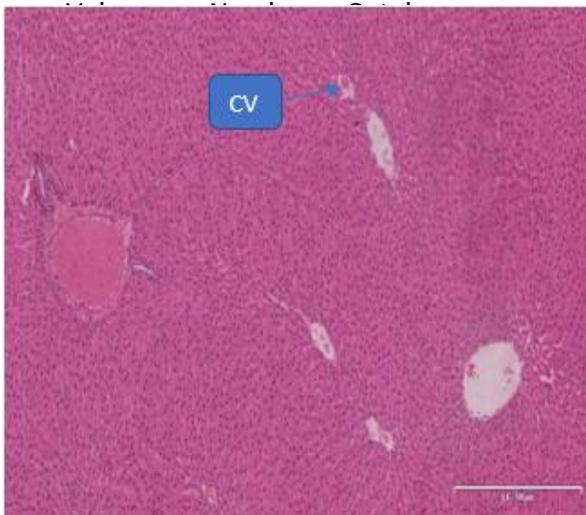

Group B (diabetic untreated). *Note: mild steatosis hepatocyte and central vein*

Group C (diabetic and treated with 50 mg/kg H. hemerocallidea only). Note: Normal hepatocyte and central vein with mild steatosis
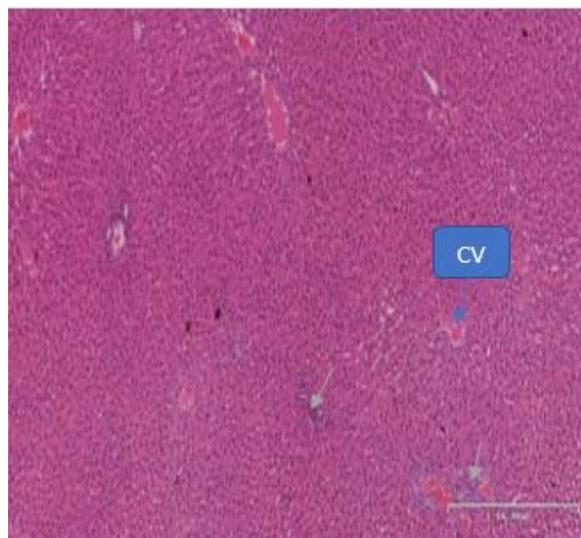
Group D (Diabetic treated with HAART only) Note: mild steatosis of central vein.

Group E (diabetic and treated with HAART and 250mg/kg Vitamin C). Note: histoarchitecture has occluded central vein and vacuolization of hepatocyte


Group F (Diabetic treated with HAART and 50mg/kg H. hemerocallidea). Note: Normal cytoarchitecture of hepatocyte

Sections labeled (Group A to F). The normal architecture of hepatocellular cords sinusoidal spaces and central vein is observed in control group A and diabetic group F. Note the presence of hepatic steatosis (shown in arrow) in diabetic group B and diabetic groups E and D (mild to severe), accompanied by occluded central vein in groups B, D, and E.
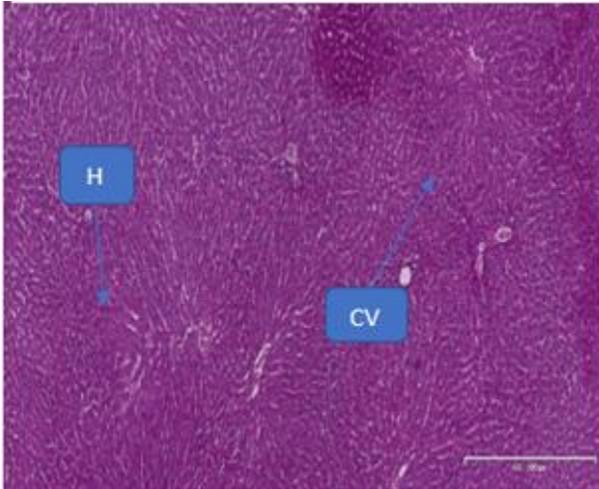Keys: CV=central vein, H=hepatocytes

Figure 2: Photomicrograph of liver cross sections of Sprague-Dawley rats stained with PAS.
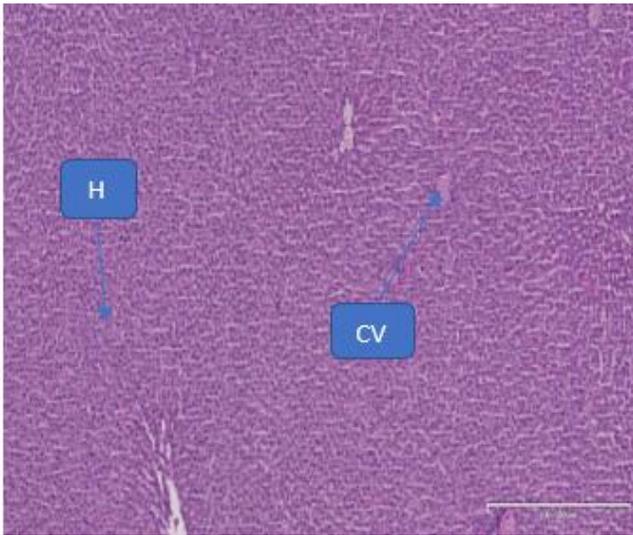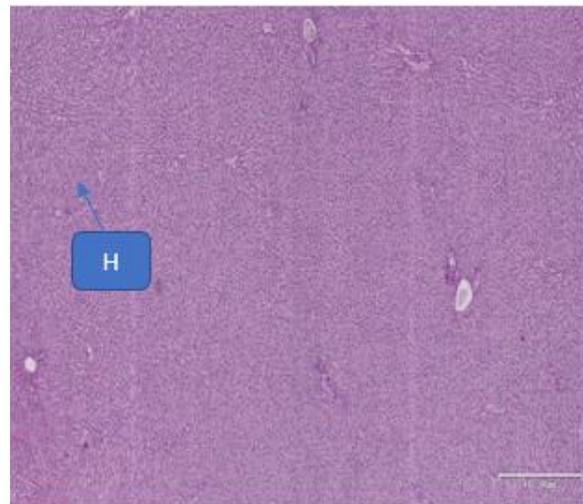

Group A (non-diabetic and untreated). *Note: normal central vein, hepatocyte and sinusoids.*
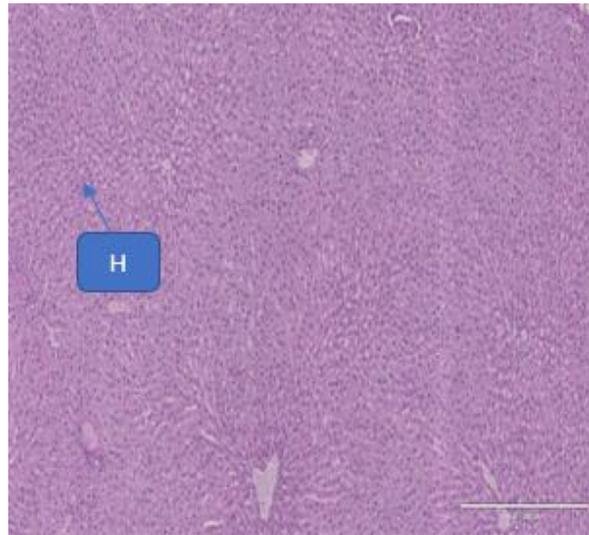
Group B (diabetic and untreated). *Note: occluded central vein with distorted sinusoids and central vein. Glycogen deposits were*
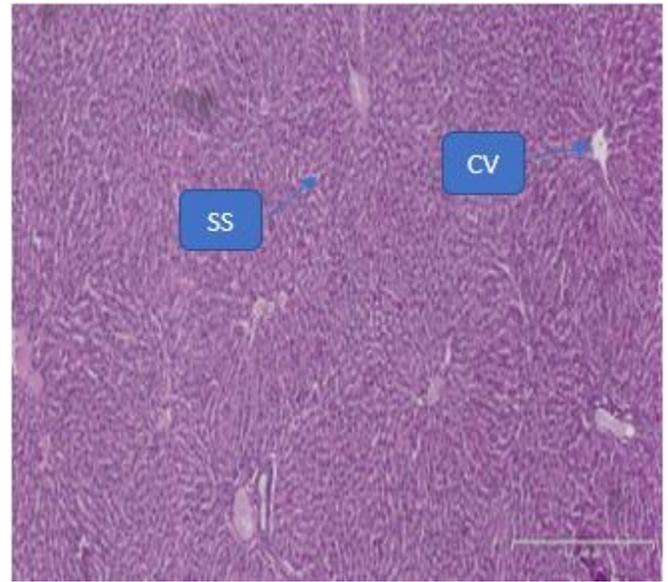

Group C (treated with 50mg/kg H. hemerocallidea). Note: normal central vein with mild steatosis seen and

Group D *(*Diabetic treated with HAART only*). Note: distorted central veins and devoid glycogen deposits in the histology.*
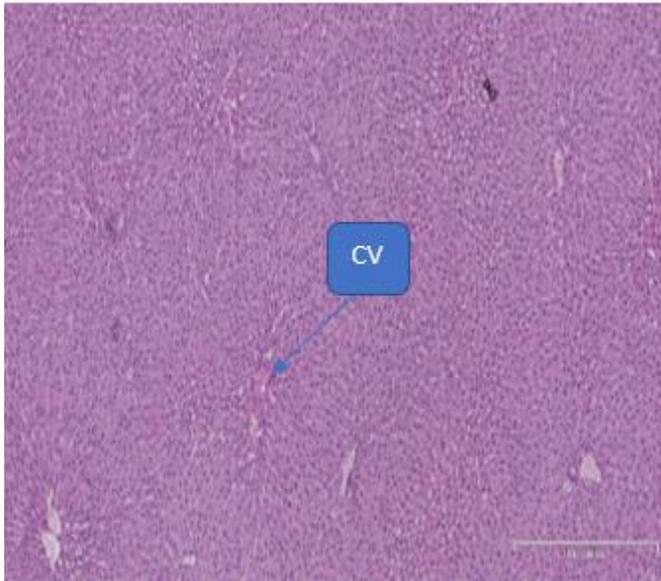
Group E *(diabetic and* treated with HAART and 250mg/kg of Vitamin C*). Note: visible glycogen deposits on the cytoplasm of the cells.*

Group F *(diabetic and* treated with HAART and low dose of 50 mg/kg of *H. hemerocallidea). Note: Normal central vein and normal hepatocytes infiltrated with mild glycogen. between the enlarged sinusoid.*

Figure 2: Photomicrographs of liver sections stained with PAS. Normal architecture in control group A and diabetic group F. Note the presence of glycogen deeply stained by PAS in groups A (non-diabetic) and C (50 mg/kg of *H. hemerocallidea)* compared with Group B, D, and E with poorly stained PAS for glycogen. Keys: CV=central vein, H=hepatocytes, Glycogen

Discussion

In many high-income countries, the use of HAART has been associated with a dramatic decline in HIV-associated morbidity and mortality(Pallipamu et al., 2023). Despite this unquestionable success, the prevalence of drug-induced metabolic complications such as DM and insulin resistance has substantially increased (Lawal et al., 2021; Organization, 2007). Moreover, it has been reported that liver diseases are the major complications and leading cause of death in type 2 diabetic people living with HIV(Kalligeros et al., 2023; Verna, 2014). This is so, despite the introduction of various conventional drugs. Due to the high cost of providing treatment and treating its complications, the use of herbal medicine is increasingly encouraged as it has proven to mitigate toxic effects of HAART regimens (Kankara et al., 2022). Medicinal plants possess potent therapeutic metabolites that have been linked to their medicinal values or their activities. The corms of *H. hemerocallidea* are rich in phytosterols (β-sitosterol) and hypoxide, and these two compounds have been postulated to be responsible for their antidiabetic and antioxidant effects(Oguntibeju et al., 2016).

Metabolic disorders such as T2DM affect the whole body, causing changes in body weight (Gluckman et al., 2008). In the current study, experimental rats in diabetic control group B and treated group D respectively, showed significant weight loss compared to the negative control group A (non-diabetic). This corresponds to the previous study carried out by Oguntibeju, who mentioned that rapid

weight loss in DM was due to uncontrolled catabolism of structural proteins as a compensatory response to abnormal carbohydrate metabolism. Furthermore, groups C and F (treated with *H. hemerocallidea*) demonstrated moderate gain throughout the experiment compared to positive control group B (diabetic and untreated) and the rest of the treatment groups: D (treated with HAART only), and E (treated with HAART and Vitamin C). This agrees with the study by Elshawesh (Elshawesh, 2015). who reported that there was no significant gain in body weight of healthy rats and rats treated by *H. hemerocallidea*.

Streptozotocin (STZ) induced DM results in chronic hyperglycemia(Ghasemi & Jeddi, 2023; Lawal et al., 2019). Fasting blood glucose levels within the range of 4.0 to 5.9 mmol/L are considered normal(American Diabetes Association, 2010). Our findings revealed that blood glucose levels remained high in group B (diabetic control) and in treatment groups C, D, E, and F compared to group A. However, treatment groups C, D, E, and F showed lower blood glucose levels compared to the positive control group B. There was a significant blood sugar lowering effect from low dose *H. hemerocallidea*, as also reported by other authors(Bates et al., 2000; Elshawesh, 2015) who found markedly lower fasting glucose in *H. hemerocallidea* treated diabetic rats compared to untreated DM rats.

Diabetes mellitus is associated with several liver abnormalities, such as abnormal glycogen deposition and abnormal elevated hepatic enzymes(Mohamed et al., 2016). The normal value of ALT ranges between 5 to 38 U/L for both males and females. The pathological effects of insulin resistance and hyperglycemia on hepatic tissue are indicated by elevated serum hepatic enzymes(Oguntibeju et al., 2016). To quantify abnormalities in liver function, the serum aminotransferase level was used. In this study, there was no significant difference in ALT level in group C (*H. hemerocallidea)* compared to other groups A, B, D, E, and F (P<0.05). The previous study by Saligram(Saligram et al., 2012), reported a high incidence of elevated ALT in patients with newly undiagnosed T2DM, suggesting that the onset of the liver abnormalities is associated with dysglycemia, which may precede diagnosed T2DM. A study by Oguntibeju(Oguntibeju et al., 2016), reported a significant reduction in serum levels of ALT in the diabetic group when treated with *H. hemerocallidea* extract, in contrary to this present study that showed no significant difference.

Aspartate transaminase (AST) found abundantly in the liver is released into the bloodstream following liver injury. Elevated levels of transaminases can reveal hepatic disease or organ damage(Sookoian & Pirola, 2012). It was found that the levels of AST in positive control group B were significantly higher than in negative control group A. However, AST levels were significantly reduced in treatment groups C (treated with *H. hemerocallidea*), E (HAART and Vitamin C), and F (HAART and *H. hemerocallide*a) compared to control group B (diabetic positive control). The results suggested *H. hemerocallidea* possesses a protective effect on the liver cell. The study by Oguntibeju(Oguntibeju et al., 2016), reported a non-significant reduction in AST in the diabetic group fed with *H. hemerocallidea* when compared to the diabetic control group, which supports our results in this current study.

Oxidative stress has been considered as a conjoint pathological mechanism contributing to the initiation and progression of liver injury. Drug-induced oxidative stress in the liver may result in severe liver diseases, such as Non-alcoholic fatty liver disease (NAFLD)(Li et al., 2015). The present study showed elevated markers of lipid peroxidation (MDA) in diabetic groups B (P < 0.05) (untreated diabetic rats) but the reduction in diabetic treatment group C (*H. hemerocallidea*) and with a significant reduction in groups E (HAART and Vitamin C) and F (HAART and *H. hemerocallidea*) compared to normal control group A. Previous study by Vuppalanchi (Vuppalanchi et al., 2011), reported an increase in free radicals leading to the overproduction of MDA. However, Jordaan(Jordaan, 2015), reported a significant decrease when the diabetic group treated with *H. hemerocallidea* was compared with diabetic control, which corroborates with the current study results.

Antioxidant enzymes, such as reduced-GSH, are part of the defense system in the body, which assists in scavenging free radicals(Jordaan, 2015). The results of this study revealed that the levels of GSH

in control group B (untreated diabetic rats) and treatment groups C and D were reduced when compared to control group A. The findings in our study are in line with the previous study that reported a significantly reduced hepatic GSH concentration in diabetic controls when compared with other treatment groups (Oguntibeju et al., 2016). The results of this study revealed that GSH levels, in treatment groups C (diabetic rats treated with *H. hemerocallidea*), showed a significant increase when compared with diabetic group B (Diabetic), group E (treated with HAART AND Vitamin C), and F (treated with HAART and *H. hemerocallidea*). Our findings also revealed non-significant decrease when compared to D (treated with HAART). Our results are supported by the findings of Jordaan(Jordaan, 2015), who also reported a significant increase ($p < 0.05$) in GSH levels in *H. hemerocallis-treated* groups when compared to the diabetic group. This result suggests that *H. hemerocallidea* possesses an antioxidant property.

Histoarchitectonic properties of the liver were closely monitored by histological techniques of H&E and special stains. In patients with T2DM, the prevalence of NAFLD is as high as 70%(Ighodaro & Akinloye, 2018; Richard & Lingvay, 2011). Hepatic steatosis is one of the first indicators of liver disease and is common in patients with T2DM(Hazlehurst et al., 2016). H & E liver B, C, D, and E showed mild steatosis while groups F treated with HAART and *H. hemerocallidea)* showed moderate hepatocyte similar to group A(control) (Fig. 1). In line with this study (Julián et al., 2015), reported that there were no histological features of NASH or lobular/portal inflammation present in their study, although moderate steatosis seen in the treated group.

Hyperglycemia is characterized by the presence of glycogen between hepatocytes(Diniz et al., 2020; Soon & Torbenson, 2023). In PAS, glycogen deposits were observed, moderately in the histoarchitecture of the liver in experimental groups C (Fig. 2) when compared with control group A and other treated groups B, D, E and F. Study by Azu(Azu et al., 2016), supported the findings in this study in which the PAS-stained sections revealed the presence of glycogen in the healthy tissues and poorly stained in diabetic tissue.

Conclusion

This study has demonstrated that the antioxidant and antidiabetic effects of *H.hemerocallidae* mitigated the long-term metabolic effect of antiretroviral therapy in the liver tissue of diabetic Sprague Dawley rats. Still, these protective effects in combination with antiretroviral therapy need further investigation at different doses.

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Conflict of interest disclosure:
The Authors have no conflict of interest to declare.

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Eating habits and physical exercise patterns among undergraduate nursing students at Muhimbili University of Health and Allied Sciences, Tanzania: A cross-sectional study

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Abstract

Background: Globally, overweight and obesity affect over one-third of the global population and it is projected that by 2030 obesity will affect more than half of the world population. The current burden of overweight and obesity is attributed to high rates of unhealthy eating and physical inactivity as it had also been revealed in Tanzania. The substantially increased prevalence of malnutrition at young ages is associated with a high incidence of non-communicable diseases in the young population and ultimately increased premature deaths.

Objectives: This study aimed to assess eating habits, physical exercise patterns, and the overweight/obesity status among undergraduate students at the Muhimbili University of Health and Allied Sciences (MUHAS).

Methods: A quantitative cross-sectional study was conducted between January and March 2022 by employing a stratified sampling technique to recruit 232 undergraduate nursing students. A self-administered questionnaire and anthropometric measurements were used to obtain data which were finally analyzed using SPSS version 25.

Results: The prevalence of overweight/obesity was 20.2%. Approximately 43% of the participants were physically inactive, with a higher proportion among females compared to males p=0.001. Male participants were more likely to perform physical exercises for a longer duration ($\geq$ 30 minutes per day) compared to female participants, p=0.008. The consumption of more than three meals per day was associated with an increased odds of being overweight/obese than the consumption of three meals or less per day (OR: 3.11; 95%CI: 1.11-8.73). Similarly, the average long duration of sleeping per day (eight hours or more) was associated with an increased odds of being overweight/obese than sleeping less than eight hours per day (OR: 2.08; 95%CI: 1.06-4.11).

Conclusions: The findings revealed high rates of unhealthy eating habits, physical inactivity patterns and a significant prevalence of overweight/obesity. This indicates a need for developing actionable interventions and national health programs to promote healthy eating habits and physical activity, particularly among university students.

Keywords: Eating habits, Physical exercises, Non-communicable diseases, Nursing students, Obesity, Tanzania

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Introduction

Globally, there has been a substantial increase in the prevalence of overweight and obesity among young adults over the last few decades (Lacent Gastroenterology Hepatology, 2021). In 2016, the World Health Organization (WHO) report showed that about 2 billion (39%) adults aged 18 years and older were overweight. Of these more than 650 million (13%) were obese (Lacent Gastroenterology Hepatology, 2021). Recent studies in Africa showed that 18.4% of women and 7.8% of men in the continent live with obesity (GBD 2019 Diseases and Injuries Collaborators, 2020). The study conducted among adolescents in the Kilimanjaro region, Tanzania obtained that 25% of the participants were overweight while 6.1% were obese (Nicholaus et al., 2020). Further, a community-based study conducted in Dar es Salaam, Tanzania revealed that 34.8% of the participants were overweight and 32.8% were obese (Pallangyo et al., 2020).

Eating habits, sleeping, and physical exercise patterns are the major determinants of overweight and obesity (Peltzer et al., 2014). Poor eating habits and physical exercise patterns are significant risk factors for chronic illnesses (GBD 2016 Risk Factors Collaborators, 2017). Recently, the burden of Non-Communicable Diseases (NCDs) such as diabetes, cardiovascular diseases, osteoarthritis, and cancers has been increasing among the young population (GBD 2019 Diseases and Injuries Collaborators, 2020). Annually, NCDs lead to about 41 million deaths each year, equivalent to 71% of all deaths globally (GBD 2019 Diseases and Injuries Collaborators, 2020).

According to the WHO recommendations, adolescents and adults between the ages of 18 to 64 years should perform physical activities for at least 150 minutes of moderate-intensity aerobic physical activities throughout the week, or perform at least 75 minutes of vigorous-intensity aerobic physical activities throughout the week, or an equivalent combination of both moderate- and vigorous-intensity activities (Bull et al., 2020). While previous studies reported that eating habits and physical exercise patterns differ in different population groups (Benaich et al., 2021; Nicholaus et al., 2020), the study conducted in Ethiopia showed that 69.3% of the female participants and 74.3% of the male participants were physically active (Tesfaye et al., 2020). However, in Tanzania, the study obtained that 88.3% of the study participants were physically inactive and that skipping breakfast and regular fast food consumption were among the significant predictors of obesity (Pallangyo et al., 2020).

University life is a critical period where most students make changes in their eating habits and overall lifestyle habits due to their busy and demanding class schedule (Peltzer et al., 2014; Tok et al., 2018; Wright et al., 2015). Hence, due to the changing environmental exposure, university students tend to establish new lifestyles that are different from those practised at their homes and high schools and this may predispose them to unhealthy meal patterns and unhealthy lifestyle behaviours which are the risk factors for NCDs (Hailu et al., 2021). Studies report that a large proportion of university students are at increased risk of chronic illnesses like obesity due to their poor dietary habits, sleeping patterns, and physical inactivity (Hailu et al., 2021; Okeke et al., 2020; Peltzer et al., 2014). The study conducted in Nigeria among medical university students revealed that the majority of the students believed that physical exercise is important for health although only 3.8% of the participants were performing physical exercises for 3-5 days (Okeke et al., 2020).

In Saudi Arabia and Romania studies revealed that more than two-thirds and more than a half of the university students were physically inactive respectively (Al-shehri et al., 2017; Anton-Păduraru et al., 2021). Furthermore, unhealthy eating habits and alarming prevalence of overweight and obesity among university students had been disclosed previously in some settings (Anton-Păduraru et al., 2021; Yousif & Kaddam, 2019). In Tanzania, previous studies concerning eating habits and physical exercise patterns have been focused on school-aged children, high school adolescents, and the community (Nicholaus et al., 2020; Pallangyo et al., 2020) while forgetting university students who are at increased

risk for unhealthy eating, physical inactivity and NCDs (Peltzer et al., 2014). This calls for a need to conduct a study among university students in Tanzania to add up in the knowledge gap concerning eating habits, physical exercises pattern and nutrition status. Therefore, this study aimed to assess the eating habits, physical exercise patterns, and association with the overweight/obesity status among undergraduate nursing students at the Muhimbili University of Health and Allied Sciences (MUHAS).

Methods
Study design and setting
The study employed a quantitative cross-sectional design to assess the eating habits, physical exercise patterns, and association with the overweight/obesity status among undergraduate nursing students at MUHAS from January to March 2022. The approach was objective in nature and helped in collecting original data from the study participants at a single point in time.

MUHAS is a public health and allied sciences university located at Ilala city Municipal in Dar es Salaam, Tanzania. The university has five schools (school of medicine, school of nursing, school of public health and social sciences, school of pharmacy, and school of dentistry) providing undergraduate and postgraduate studies. Undergraduate degree enrollment are in the fields of Medicine (MD), Nursing (BScN), Dentistry (DDS), Pharmacy (BPharm), Environmental Health Sciences (BScEH), Science in Radiotherapy (BRTT), Medical Laboratory Sciences (BMLS), Midwifery (BScM), Anesthesia (BScNA), Biomedical Engineering (BME), Physiotherapy (BScPT). During this study, MUHAS had a total of 3,861 students of which 420 were first to fourth year undergraduate nursing students

Study population and eligibility criteria
This study involved a population of undergraduate nursing students at MUHAS. All undergraduate nursing students at the MUHAS aged 18+ years were included while students who were pregnant and those who were on special weight loss or weight gain programs were excluded.

Sampling technique
A stratified random sampling technique was used to recruit the study participants. The year of study among undergraduate nursing students at MUHAS was used as strata, and then a simple random sampling method was used for each year of study to obtain the sample size required. The variation in the number of undergraduate nursing students in different years of study was considered in sampling by the proportional distribution of the final sample size among the four strata. Finally, first-year students contributed 24.2% of the estimated sample size. The second-year and third-year students contributed 23.0% and 30.0% respectively, and the fourth-year of study contributed 22.5% of the total sample size.

Sample size determination
We used a single proportion formula to estimate the minimum required sample size given as $[N= (Z)^2 \times p(1-p)/e^2]$, where N is the minimum required sample size, and p is the prevalence of overweight/obesity among university students due to poor dietary habits and physical inactivity (16.4%) based on a previous study conducted in Morocco (Benaich et al., 2021). Furthermore, e is the margin of error or precision (5%), and Z is the standard normal value (1.96) corresponding to a 95% CI. After adding a 10% proportion of non-response, the estimated sample size was 232 undergraduate nursing students.

Data collection tool

A well-structured self-administered questionnaire developed after a review of previous related literatures (Al-shehri et al., 2017; Anton-Păduraru et al., 2021; Hailu et al., 2021; Tok et al., 2018), and modification based on study objectives was employed for gathering information from the study participants. The questionnaire was developed in English language and composed of close-ended questions and short answer questions. The questionnaire had a total of 14 items in three parts. Part one had questions on the socio-demographic characteristics and anthropometrics of the participants, part two had questions concerning participants' eating habits, and part three contained questions regarding participants' physical exercise patterns. A panel of experts in the fields of nursing research, education, and nutrition assessed the content validity of the questionnaire.

Anthropometric measurements including weight, height, and body mass index were carried out according to the protocol of the International Society for the Advancement of Kinanthropometry (Karupaiah, 2018). Body weight (kg) and height (cm) were measured by using an electronic scale (Seca 750, Germany; 150+0.1 kg) and a stadiometer (Seca, Germany; 200+0.1 cm) respectively. The body mass index (BMI) was determined as the ratio of the body weight (kg) value divided by the square value of height (m) and further used to categorize participants' nutritional statuses (Weir & Jan, 2023).

Data collection procedure
Before data collection, four research assistants were recruited to assist in the data collection procedure from the study participants. These research assistants were members from each year of study and were currently working as class representatives in their respective classes (years of study). They were trained before the data collection exercise to familiarize them with the study objectives, study methodology, data collection tool, and study protocol, and much emphasis was on the importance of signing consent, confidentiality, and ethical procedures while respecting the participant's decision to participate or not participating in the study. Data were collected from participants in each of the strata (year of study) by research assistants under the supervision of the principal investigators of this study. After obtaining the informed consent, and completion of the questions concerning socio-demographic information, each participant who was willing to proceed with the study had their weight and height measured and recorded by research assistants.

Validity and reliability of the tool
As part of quality control, a pilot study was done on 10% of the sample size who were finally excluded from the actual study sample. A reliability test was performed by calculating the reliability coefficient (Cronbach's alpha), and its values for eating habits and physical exercise patterns parts were 0.810 and 0.772 respectively. These findings indicate a good reliability level for the tool with the studied sample. Moreover, analysis of the pretest results guided appropriate modifications of the tool before the data collection procedure for the actual study.

Ethical consideration
The ethical clearance for this study was obtained from the MUHAS Research and Ethics Committee with reference number DA.25/111/01B/119. Permission to conduct the study was obtained from MUHAS administration with reference number MU/DOS/16/08/2022. Written informed consent was sought and obtained from all participants. Confidentiality of participants' information was strictly maintained. To further maintain confidentiality, no identifiers were in the questionnaire. Participation was fully voluntary, and the participants were informed of the freedom to withdraw from the study at any stage if they so desired without any penalty.

Data management and analysis

The data were entered and analyzed by IBM Statistical Package for Social Sciences (SPSS Version 25.0). Descriptive statistics using frequencies, percentages, means, median, interquartile range, and standard deviations were computed and data were then presented in tables. A Pearson Chi-square test with the Fisher exact approximation was used to determine the association between categorical variables. Logistic regression analyses were performed to identify the significant factors associated with overweight/obesity. The test of significance was performed using a 95% confidence interval, and the level of significance was set at a p-value < 0.05.

Results
Socio-demographic characteristics
In total, 232 undergraduate nursing students were recruited in this study. Of which 213 participants responded completely giving a response rate of 91.8%. The age of the participants recruited ranged from 19 to 40 years with a mean (±SD) age of 24.0 (±4.0) years. The majority (171; 80.3%) of the participants were in the age group of 19-25years. Nearly two-thirds of the participants (132; 62.0%) were male giving a male-to-female ratio of about 2:1. Regarding the year of study, 64 (30.0%) participants were third-year students (Table 1).

Table 1: Socio-demographic characteristics of the study participants (N=213)

Variables	n(%)
Age, Mean(SD) (in years)	24.0(4.0)
Age group	
19-25	171(80.3%)
≥ 26	42(19.7)
Sex	
Male	132(62.0)
Female	81(38.0)
Year of Study	
1st year	52(24.4)
2nd year	49(23.0)
3rd year	64(30.0)
4th year	48(22.5)

Prevalence of overweight/obesity
On the anthropometric measurements, the median body weight of the participants was 60.0 kg (Interquartile range (IQR) = 11.0 kg); the mean height was 1.654 m (SD =0.082). The median BMI was 22.8 kg/m^2 (IQR = 4.1 kg/m$^{2)}$. According to WHO ("Obesity: Preventing and Managing the Global Epidemic. Report of a WHO Consultation.," 2000) BMI categorization, the majority 157(73.7%) of the

participants were in the normal weight category. 36 (16.9%) and 9 (3.3%) participants were in the overweight and obese categories, respectively. The prevalence of overweight/obesity among the study participants was 20.2%, and it was higher among males compared to females (23.5% vs. 14.8%). However, no significant BMI status differences were observed between males and females (Table 2).

Table 2: Distribution of the study participants according to BMI status (N=213)

WHO International BMI Classifications					
BMI (kg/m²)	BMI category	Male	Female	Total	*p*-value
		n=132	n=81(%)	n=213(%)	
< 18.5	Underweight	6(4.5)	7(8.6)	13(6.1)	0.256
18.5-24.9	Normal weight	95(72.0)	62(76.5)	157(73.7)	
25.0-29.9	Overweight	25(18.9)	11(13.6)	36(16.9)	
≥ 30.0	Obese	6(4.5)	1(1.2)	7(3.3)	
	Total	132(100)	81(100)	213(100)	
< 25.0	Underweight/normal weight	101(76.5)	69(85.2)	170(79.8)	0.160
≥ 25.0	Overweight/obese	31(23.5)	12(14.8)	43(20.2)	

Eating habits

The majority 147(69.0%) of the participants (68.2% of males and 70.4% of females) reported consuming breakfast always. Among the participants who consumed breakfast always, more than half 84(57.1%) of them (57.8% of males and 57.8% of females) reported consuming it at 08:00 AM and before. The majority 196(92.0%) of the participants (92.4% of males and 91.4% of females) reported consuming three or fewer main meals per day. Lunch was the largest meal consumed per day by nearly two-thirds, 136(63.8%) of the participants (64.4% of males and 63.0% of females). More than half, 120(56.3%) of the participants reported sleeping for less than eight hours. Concerning the length of overnight fasting, the majority, 153(71.8) of the participants (72.7% of males and 70.4% of females) reported overnight fasting for 12 hours or less (Table 3).

Table 3: Eating habits (N = 213)

Item	All n=213 (%)	Male n=132(%)	Female n=81(%)	*p*-value
Always consume breakfast				
Yes	147(69.0)	90(68.2)	57(70.4)	0.762
No	66(31.0)	42(31.8)	24(29.6)	
Time for consuming breakfast				
≤ 08:00 a.m.	84(57.1)	52(57.8)	32(56.1)	0.845

> 08:00 a.m.	63(42.9)	38(42.2)	25(43.9)	
Number of main meals consumed per day				
≤ 3 meals	196(92.0)	122(92.4)	74(91.4)	0.799
> 3 meals	17(8.0)	10(7.6)	7(8.6)	
Largest meal consumed per day				
Lunch	136(63.8)	85(64.4)	51(63.0)	0.884
Dinner	77(36.2)	47(35.6)	30(37.0)	
Average sleep duration				
< 8 hours	120(56.3)	74(56.1)	46(56.8)	0.917
≥ 8 hours	93(43.7)	58(43.9)	35(43.2)	
Average length of overnight fasting				
≤ 12 hours	153(71.8)	96(72.7)	57(70.4)	0.710
> 12 hours	60(28.2)	36(27.3)	24(29.6)	

Physical Exercises Pattern

Among the participants in this study, the majority 122(57.3%) of them reported performing regular physical exercises. Male participants were more likely performing regular physical exercises 88(66.7%) compared to female participants 34(42.0%), p = 0.001. Concerning the days per week for adhering to regular physical exercises, the majority 81(66.4%) of the participants (69.3% of males and 58.8% of females) reported three days or more. Male participants were more likely to spent 30 minutes per day or more on physical exercises compared to female participants, p = 0.008 (Table 4).

Table 4: Physical Exercises Pattern (N=213)

Item	All	Male	Female	p-value
	n=213	n=132	n=81	
Perform regular physical exercises				
Yes	122(57.3)	88(66.7)	34(42.0)	**0.001**
No	91(42.7)	44(33.3)	47(58.0)	
Days per week for performing physical exercises				
< 3 days	41(33.6)	27(30.7)	14(41.2)	0.217
≥ 3 days	81(66.4)	61(69.3)	20(58.8)	
Length of time for performing physical exercises per day				
< 30 minutes	27(22.1)	14(15.9)	13(38.2)	**0.008**

≥ 30 minutes	95(77.9)	74(84.1)	21(61.8)

Association between BMI Statuses and their Eating Habits and Physical Exercises Patterns.

Table **5** shows the association between the study variables obtained from logistic regression analyses. The study participants who consumed more than three meals per day were three times more likely to be overweight/obese than those who consumed three meals or fewer per day (OR: 3.11; 95%CI: 1.11-8.73; *p* = 0.031). Also, the study participants who slept eight hours or more per day were two times more likely to be overweight/obese than those who slept less than eight hours per day (OR: 2.08; 95%CI: 1.06-4.11; *p* = 0.034). No significant association observed between physical exercise patterns with BMI status (overweight/obesity) (*p* > 0.05) (
Table **5**).

Table 5: Logistic regression analysis of BMI Statuses and their Eating Habits and Physical Exercises Patterns (N = 213)

Variable	Non-overweight/obese n=170	Overweight/Obese n=43	OR	95% CI	*p*-value
Consume breakfast always					
Yes	115(67.6)	32(74.4)	I		
No	55(32.4)	11(25.6)	0.72	0.34-1.52	0.392
Time for consuming breakfast					
≤ 08:00 a.m.	67(58.3)	17(53.1)	I		
> 08:00 a.m.	48(41.7)	15(46.9)	1.23	0.56-2.71	0.604
Number of main meals consumed per day					
≤ 3 meals	160(94.1)	36(83.7)	I		
> 3 meals	10(5.9)	7(16.3)	3.11	1.11-8.73	**0.031***
Largest meal consumed per day					
Lunch	108(63.5)	28(65.1)	I		
Dinner	62(36.5)	15(34.9)	0.93	0.46-1.88	0.847
Average sleep duration					
< 8 hours	102(60.0)	18(41.9)	I		
≥ 8 hours	68(40.0)	25(58.1)	2.08	1.06-4.11	**0.034***
Average length of overnight fasting					
≤ 12 hours	122(71.8)	31(72.1)	I		

> 12 hours	48(28.2)	12(27.9)	0.98	0.47-2.07	0.966
Perform regular physical exercises					
Yes	95(55.9)	27(62.8)	I		
No	75(44.1)	16(37.2)	0.75	0.38-1.49	0.414
Days per week for performing physical exercises					
< 3 days	34(35.8)	7(25.9)	I		
≥ 3 days	61(64.2)	20(74.1)	1.59	0.61-4.15	0.341
Length of time for performing physical exercises per day					
< 30 minutes	21(22.1)	6(22.2)	I		
≥ 30 minutes	74(77.9)	21(77.8)	0.99	0.36-2.78	0.990

OR: odds ratio; CI: confidence interval; I, reference category; *significant association at p < 0.05

Discussion

Unhealthy eating habits and poor physical exercise patterns have been attributed to an increase in the global prevalence of NCDs like obesity, diabetes, and hypertension. Recent studies have shown a gradual increase in the burden of NCDs in young adults and the ultimate increase in premature deaths. Studies that have been done in different settings concerning eating habits, physical exercise patterns, and lifestyle behaviors of university students have revealed controversial results, although most of these studies show that the majority of the university students have been engaging in consuming unhealthy diets, sedentary lifestyles and other unhealthy lifestyle behaviors (Al-shehri et al., 2017; Anton-Păduraru et al., 2021; Okeke et al., 2020). Our study aimed to assess the eating habits, physical exercise patterns, and association with overweight/obesity status among undergraduate nursing students at the Muhimbili University of Health and Allied Sciences.

The median BMI of the participants in the present study was 22.8 (IQR = 4.1) Kg/m^2 with 16.9% (18.9% male; 13.6% female) and 3.3% (4.5% male; 1.2% female) of the participants being overweight and obese respectively. The prevalence of overweight/obese was 20.2% (23.5% male; 14.8% female). This is consistent with the findings of other studies conducted previously among university students in different settings, whereby the prevalence of overweight and obese was revealed higher among males compared to females (Alkazemi, 2019; Benaich et al., 2021; Peltzer et al., 2014). A study conducted among university students from 22 LMICs obtained that 22.0% (24.7% male; 19.3% female) were overweight/obese (Peltzer et al., 2014).

However, the present study's prevalence estimates remain lower compared to that estimated by other studies (Oyindasola & Alabi, 2020; Tok et al., 2018; Wright et al., 2015). For instance, a study conducted among university students in Nigeria obtained a prevalence estimate of overweight and obesity of 31% and 9.3%, respectively (Oyindasola & Alabi, 2020). Furthermore, a study conducted in Kenya reported a higher prevalence of overweight (26.4%) but a lower prevalence of obesity (1.4%) compared to our study (Mogeni & Ouma, 2022). These differences may be due to the significant effects on weight and height statuses that ethnicity/race and socioeconomic status disparities could have

among the participants from different countries (Peltzer et al., 2014) and the same country (Wattelez et al., 2021). The increasing prevalence of overweight/obesity among university students may be attributed to the unhealthy eating, physical activity and lifestyle behaviours adopted during the university period.

The European Guidelines on cardiovascular disease prevention in clinical practice recommend that for healthy dietary habits, three main meals should be consumed per day, and should always include breakfast (Perk et al., 2012). The present study revealed that 31.0% of the participants were not consuming breakfast always. Similarly, 25% of the participants of the study were conducted in Poland (Likus et al., 2013), and 38% of the undergraduate students at Najran University, Saudi Arabia (Al-shehri et al., 2017) were skipping breakfast. Inconsistent with the current study findings, the higher percentages of skipping breakfast have been obtained by the studies conducted in Southeastern Nigeria, whereby 68.1% of undergraduate students were skipping breakfast (Okeke et al., 2020), and Northeastern Romania, whereby 60.53% of the participants were skipping breakfast (Anton-Păduraru et al., 2021). However, the current study revealed no association between skipping breakfast and BMI status like other previous studies (Horikawa et al., 2011; Pallangyo et al., 2020; Wright et al., 2015), the habit of skipping breakfast has been associated with an increased prevalence of overweight/obesity. For instance, a study conducted in Tanzania by Pallangyo et al. obtained that participants with overweight/obese significantly skipped breakfast compared to those who had normal weight (Pallangyo et al., 2020).

The differences in habitual taking or skipping breakfast may be due to the variation in socio-economic statuses and the class schedules among the participants. The present study obtained that 57.7% of the participants consumed three main meals daily, 34.3% of them consumed less than three main meals daily, and 8.0% of the participants consumed more than three main meals daily. Similar findings were obtained from the study by Tok Chen Yun et al. conducted at Universiti Brunei Darussalam which shows that among the university students, 52.5% of them consumed three meals daily, 33.3% of them consumed less than three meals daily, and 14.2% of them consumed more than three meals daily (Tok et al., 2018). Likewise, the studies done in Kilimanjaro Region, Tanzania (Nicholaus et al., 2020), Nigeria (Okeke et al., 2020), and Northeastern Romania (Anton-Păduraru et al., 2021) indicated similar findings to the current study.

The largest consumed meal per day reported by the participants in the present study was lunch (63.8%), for both males (64.9%) and females (63.4%). Similar findings were obtained from the study conducted among medical university students in Romania (Pop et al., 2021). However, breakfast was the second largest meal among female participants (Pop et al., 2021), the current study shows that none of female students considered breakfast as a largest meal. Furthermore, the present study indicates that 56.3% of the participants were sleeping for an average of less than eight hours per day. Besides, the average sleeping duration of medical students in Romania shows consistent findings (Pop et al., 2021). Likely, spending more hours studying and night shift clinical rotations might be the reason for the few hours spent sleeping by university students in the health field.

The current study findings show that 57.3% of the participants were performing regular physical exercises. Similarly, a study conducted by Anton-p et al. shows that 55.07% of the participants were engaging in regular physical exercises (Anton-Păduraru et al., 2021). The lower findings of the current study were obtained from the study conducted in Poland (Likus et al., 2013) in which only 40% were physically active. Furthermore, the study done in Ethiopia indicated lower performance in regular physical activities among the students compared to the presented study findings (Hailu et al., 2021). However, Benaich et al. reported that 74.4% of Moroccan university students were physically active (Benaich et al., 2021) which is higher than our findings.

The duration of engagement in physical activities per week among the participants in the current study was more than three days per week for 66.4% of the participants. The study by Hailu et al. shows a lower duration of performing physical exercise per week compared to the present, as only 7.4% of the participants engaged in regular physical exercises at least three times per week (Hailu et al., 2021). This study also revealed that the average length of performing physical exercises per day was 30 minutes or more for 77.9% of the participants. Inconsistent findings were obtained in Nigeria where the majority (55.1%) of the students who performed regular physical exercises spent less than 30 minutes (Okeke et al., 2020) and Universiti Brunei Darussalam (Tok et al., 2018).

The difference in university schedules and space for performing physical exercise might be the justification for this variation. The male participants in this study were more likely to perform regular physical exercises compared to female participants. A similar finding was obtained from the previous studies (Fagaras et al., 2015; Hailu et al., 2021; Pop et al., 2021). Inconsistently, Kenyan female students commonly undertake regular physical exercise compared to male students (Mogeni & Ouma, 2022). Furthermore, the male participants in the current study spent a long time performing physical exercises than female participants. Likewise, males had a longer duration of physical exercise than females (Fagaras et al., 2015).

Another study conducted in Morocco among university students also reported increased physical activities and time spent in physical activities among male students compared to female students (Benaich et al., 2021). Even though many previous studies (Peltzer et al., 2014; Tesfaye et al., 2020; Vilchis-gil et al., 2015) have indicated a significant association between physical activities and BMI status, the present study revealed no association between physical exercises pattern and overweight/obesity. Similar to studies conducted among Moroccan university students (Benaich et al., 2021) and Caribbean undergraduate students (Wright et al., 2015).

This study revealed that the consumption of more than three main meals per day was three times associated with an increased risk for overweight/obesity. Similarly, the study conducted at Universiti Brunei Darussalam revealed a significant association between BMI and the number of meals daily (Tok et al., 2018). Besides, the study conducted in Mexico revealed consistent findings (Vilchis-gil et al., 2015). The increase in calories with the increase in the number of meals consumed per day is the possible explanation for this association. An average sleeping duration of eight hours or more was two times associated with an increased risk for overweight/obesity. Inconsistent with our findings, a study conducted in Mexico found that sleeping hours were less among obese participants (Vilchis-gil et al., 2015). Although, a study conducted in Morocco found no association between sleeping hours and overweight/obesity (Benaich et al., 2021).

Study limitations
This study was limited to undergraduate nursing students from one university, and thus generalization of the findings to other populations in other settings should be undertaken cautiously. Furthermore, participants' information about eating habits in the present study was based on the frequency of consumption of food items without much consideration of food quantity and food content.

Conclusion and recommendations
The current study revealed unhealthy eating habits, physical inactivity, and significant prevalence of overweight/obesity among the study participants. Furthermore, the study obtained the significant predictors of overweight/obesity among the participants. These findings depict a relatively alarming future public health burden of NCDs attributed to unhealthy eating habits, physical inactivity, and unhealthy lifestyle behaviors in young ages.

These findings call for the elaboration and implementation of more tailored university-based healthy lifestyle promotion programs that will serve as a sustainable and optimal way for university students to adopt healthful lifestyles during their university tenure. It is also imperative to formulate focused-counseling services and seminars at university campuses to enrich students with the awareness, support, and empowerment needed for them to make informed choices concerning lifestyles that affect their health. Additionally, this study findings highlight a need for national wide studies and more qualitative studies to explore the barriers among university students in adopting healthy eating habits and physical exercise patterns which will guide in the development of tangible interventions to reduce their risks of developing NCDs.

Authors' contributions
RAG conceived the study, participated in its design, collected the data and analyzed the data, and prepared the first draft. EZC conceived the study, participated in its design, collected the data and analyzed the data, and prepared the first draft. VFK conceived the study, participated in its design, collected the data and analyzed the data, and prepared the first draft. RHK and FBR participated in the conception and design of the study and involved in providing a critical review of the manuscript. All authors read and approved the final manuscript.

Declaration
Competing interests
The authors declare that they have no competing interests.

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Authors' contributions
RAG, EZC & VFK conceived the study, participated in its design, collected the data and analyzed the data, and drafted a manuscript. RHK & FBR participated in the conception and design of the study and was involved in providing a critical review of the manuscript. All authors read and approved the final manuscript.

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Technical Efficiency of Health Systems in African Least Developed Countries

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Abstract
Background: Motivated by the fact that between 20-40% of health expenditure around the world is wasted due to inefficiencies the magnitude of these efficiencies/inefficiencies is unknown for African least developed countries (African LDCs). The objective of this study is to estimate the technical efficiency of the health systems in 29 African Least Developed Countries for the 2008-2018 period.
Method: Using the output-oriented Data Envelopment Analysis based on the Variable Returns to Scale assumption, panel data on the input variables including domestic general government health expenditure, domestic private health expenditure, external health expenditure and out-of-pocket expenditure, as well as the output variables including life expectancy at birth, maternal mortality ratio, under-five mortality rate, and infant mortality rate, were taken from the World Health Organization and World Bank.
Results: Findings of the study showed that between 2008 and 2018, 16 African LDCs were technically efficient, while 13 were not. The highest benchmarks for technically inefficient countries were Madagascar (12 peers), Senegal (7 peers), Eritrea and Ethiopia (7 peers), and Rwanda (1 peer).
Conclusion: The practices of nations with technically efficient health systems can serve as benchmarks for nations with technically inefficient health systems. African LDCs also needed to increase their domestic general government health expenditure, domestic private health expenditure, external health expenditure and out-of-pocket health expenditure to increase their infant survival rate.

Keywords
Technical Efficiency; Data Envelopment Analysis; Health Systems; African LDCs.

Background

According to Behr and Theune (2017), the assessment of technical efficiency is becoming a significant area of ongoing interest in health economics literature. This is because on a global scale, more demands have been placed on countries to use their health resources efficiently and avoid wastages in the era of low levels of health financing and financial hardships (Novignon, 2015). Most least developed countries, especially those in Africa are struggling with providing health services to their populations because of the increasing budgetary restrictions (Hsu, 2014; Mirmirani & Lippmann, 2004). The lack of adequate health financing has negatively affected health outcomes in African LDCs because of their excessive reliance on external health funding, private health funding, and out-of-pocket payments (Tindimwebwa et al., 2018).

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Mohamadi et al. (2020) and Hsu (2014) suggest that increasing health expenditure is the only way countries can improve their health outcomes and achieve health-related sustainable development goals. Novignon (2015) disagrees and argues that since most of the health policy debates in several African LDCs focus on cutting or generating more funds for the health sector, raising health expenditures in African LDCs alone may not significantly improve health outcomes if the efficient use of these funds is low. Thus the efficient use of health expenditure has been singled out as one of the ways to expand fiscal space for health while containing rapidly escalating costs for health which is a key policy challenge for African LDCs (Masri & Asbu, 2018).

Studies have assessed the technical efficiency of health systems of countries from several groupings like the group of 12 countries (Mirmirani & Lippmann, 2004), the Organization for Economic Cooperation and Development countries (OECD) (Behr & Theune, 2017; Seddighi et al., 2020), European countries (Asandului et al., 2014; Storto & Gončiaruk, 2017), African countries (Gupta & Verhoeven, 2001), World Health Organization (WHO) countries (Kumbhakar, 2010) and Commonwealth independent states (Mirzosaid, 2011). The theoretical literature for these studies is based on the theory of production which is also adopted for this study (Førsund, 2018; Yawe, 2006). According to the theory of production a country's health system "produces" outputs by combining inputs while the connection between inputs and outputs is demonstrated by the production function (Wagstaff, 1986). In the analysis of the technical efficiency of health systems following Koku (2015), the concept of Pareto efficiency is adopted where a given production technology dominates another if the former production is better with respect to at least one input or one output and is not worse for any input or output. This is because, in the estimation of the technical efficiency of health systems, we are not interested in the feasible productions but rather the "best efficient" frontiers (Kleine, 2004). Wagstaff (1986) also suggests that similar to the case of consumption activities, it is better to consider a "bundle of health inputs comprising of various forms of health expenditure and a bundle of outputs" rather than looking at a single input.

Using a variety of inputs like health expenditure, number of physicians, number of midwives, number of hospital beds, number of magnetic resonance imaging machines, level of education, and the non-immunized rate (Behr & Theune, 2017; Cetin & Bahce, 2016; Seddighi et al., 2020; Storto & Gončiaruk, 2017) and outputs like life expectancy, infant survival rate, adult survival rate, and healthy life years at birth (Cetin & Bahce, 2016; Popescu et al., 2014; Storto & Gončiaruk, 2017). Using several estimation techniques like DEA (Asandului et al., 2014; Kim & Kang, 2014; Popescu et al., 2014), free disposable hull (Afonso & Aubyn, 2005), value efficiency analysis (González et al., 2010) and regression analysis (Evans et al., 2001), these studies have established variations in the technical efficiencies of health systems. The majority of these studies simply consider the inputs and outputs as a "given" yet Madhanagopal and Chandrasekaran (2014) state that this is not good because some inputs and outputs included in the analysis may reduce the efficiency power resulting in biased results. The value addition and originality of the study are based on the choice of the best input and output combinations before the adoption of the DEA methodology (Wagner & Shimshak, 2007). It is on the basis of this using data from the World Bank (2021) and WHO (2019), that this study seeks to investigate the technical efficiency of health systems in African LDCs from 2008 to 2018.

Methods
Unit of analysis and variables
The unit of analysis or Decision Making Unit (DMU) is an African LDCs with focus on its health system (Kirigia et al., 2007). The WHO (2000) defines a health system as "a combination of activities whose primary objective is to promote, restore, or sustain health." According to Papanicolas et al. (2013) the

majority of duties of health ministries are very similar to this broad definition which encompasses planning health services as well as promoting health and preventing disease.

Table 1: Input and Output variables used in the study

No	Variable	Definition
Inputs		
1	Domestic General Government Health Expenditure	This is the public expenditure on health from domestic sources per capita expressed in current USD.
2	Out-of-pocket health Expenditure	This is health expenditure through out-of-pocket payments per capita in USD. Out-of-pocket payments are spending on health directly out of pocket by households in each country.
3	Domestic Private Health Expenditure	This is the current private expenditures on health per capita expressed in current USD. Domestic private sources include funds from households, corporations and non-profit organizations. Such expenditures can be either prepaid to voluntary health insurance or paid directly to healthcare providers.
4	External Health Expenditure	This is the current external expenditure on health per capita expressed in current USD. External sources are composed of direct foreign transfers and foreign transfers distributed by the government encompassing all financial inflows into the national health system from outside the country.
Outputs		
1	Life Expectancy at Birth	Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.
2	Maternal Mortality Ratio	The maternal mortality ratio is defined as the number of maternal deaths during a given time period per 100,000 live births during the same time period. It depicts the risk of maternal death relative to the number of live births and essentially captures the risk of death in a single pregnancy or a single live birth.
3	Under five Mortality Rate	The probability of a child born in a specific year or period dying before reaching the age of five, if subject to age-specific mortality rates of that period
4	Infant Mortality Rate	Infant mortality rate is the probability of a child born in a specific year or period dying before reaching the age of one, if subject to age-specific mortality rates of that period.

Source: Authors compilation based on World Bank (2021) and WHO (2019)

Twenty-nine African LDCs including: Burkina Faso, Gambia, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Senegal, Sierra Leone, Togo, Burundi, Djibouti, Eritrea, Ethiopia, Madagascar, Malawi, Mozambique, Rwanda, Uganda, Sudan, Lesotho, Tanzania, and Zambia, are considered for this study based on the United Nations Conference on Trade and Development (2020) and the availability of data.

　　　Following Hadad et al. (2013); Çelik et al. (2017); Ibrahim et al. (2019); Masri and Asbu (2018); Behr and Theune (2017); Retzlaff-Roberts et al. (2004) and Mohamadi et al. (2020), four inputs are outputs are considered for this study. Because the production of health at a macro level is difficult the health outcomes are used as health outputs (Çelik et al., 2017; Ng, 2008; Peacock et al., 2001). Table 1 shows the input, and output data and their definitions that are taken from the World Bank (2021) and WHO (2019). According to Zhou et al. (2020) and Ibrahim et al. (2019) to conform to isotonicity and

devise variables that capture good health outcomes in infants, mothers and children under five years, the Infant Mortality Rate (IMR); Maternal Mortality Ratio (MMR) and under-five mortality rate (U5MR) values are converted to infant survival rate (ISR) ($ISR = (1000 - IMR) / IMR$), maternal survival ratio (MSR) ($MSR = (1000 - MMR)/MMR$) and under five survival rate (U5SR) ($U5SR = 1/U5MR$).

Choice of the best input and output combinations
To select the best input and output combinations, correlation analysis recommended by Cetin and Bahce (2016); Yawe (2006) and Kizza (2012) is used. Following Cetin and Bahce (2016) input and output combinations that are highly correlated and significant are redundant and dropped from further analysis of the technical efficiency of health systems. In contrast, the input/output combinations that provide the highest average technical efficiency are chosen for the final DEA model (Kizza, 2012; Yawe, 2006).

Test for endogeneity for the most preferred model
Endogeneity according to Santín and Sicilia (2017) and Cordero et al. (2013), occurs when the technical efficiency scores are strongly correlated with any one input. According to Dhaoui (2019), correlation analysis is used to test for potential endogeneity in the context of the technical efficiency of health systems (Orme & Smith, 1996).

Theoretical Model
The theoretical model for the technical efficiency of health systems in African LDCs is based on the best practice frontier from the theory of production (Alexander et al., 2003; Lionel, 2015; Lovell et al., 1994). The "best-practice" frontier, according to Alexander et al. (2003), is a piece-wise linear envelopment of the health inputs and health output data that serves as a benchmark for comparison and identifying African LDCs with most efficient health systems. African LDCs operating on the frontier have technically efficient health systems, where as those operating of the frontier have technically inefficient health systems. Following Lionel (2015), s^t is the technology that transforms inputs into outputs. This technology can be modelled by the output possibility set in equation (1):

$$P^t(x^t) = \{y^t : (x^t, \ y^t) \epsilon S^t\} \ t = 1, \dots, T \tag{1}$$

Where $P^t(x^t)$ is the collection of health output vectors that consume no more than the bundle of resources indicated by the resource vector x^t, during period t. The best practice frontier is estimated as the upper bound of the output possibility set $P^t(x^t)$. $P^t(x^t)$ is estimated by assuming that the sample set is made up of $j = 1, \dots, J$ countries' health systems, each using $n = 1, \dots, N$ resources, X_{jn}^t, during period t, to generate $m = 1, \dots, M$ health outputs, Y_{jm}^t, , in period t. The piece-wise linear envelopment of the input possibility set is:

$$P^t(x^t) = \Big\{ y^t : X_n^t \leq \sum_{j=1}^{j} Z_j x_{jn}^t, \quad n = 1 \dots N$$

$$\sum_{j=1}^{j} z_j y_{jm}^t \ m = 1 \dots M$$

$$\sum_{j=1}^{j} z_j = 1$$

$$z_j \geq 0, \ j = 1 \dots j \Big\} \tag{2}$$

Where z_j indicates the weighting of each of the health systems. The output-based efficiency score for each country's health system for period t can be derived as

$$F_0^t(x_j^t, y_i^t) = max\{\theta \ such \ that \ \theta y^t \ \in \ p^t(x^t)\} \ Where \ F_0^t(x_j^t, y_i^t) \geq 1 \tag{3}$$

This suggests that a county's health output vector, y^t, is located on the best practice frontier or technically efficient frontier when equation (3) has a value of one. However, if equation (3) has a value less than one, the health system must be classified as technically efficient relative to best-observed practice.

Empirical Model

The DEA model a linear programming tool, is used to estimate the technical efficiency of health systems in Africa LDCs (Novignon, 2015). According to Hadad et al. (2013) and Dhaoui (2019), DEA is preferred because it can incorporate multiple inputs and outputs and is not constrained by a particular production function or error distribution. Following Anton (2013), DEA represents a linear non-parametric method used to estimate the technical efficiency of a homogenous set of DMUs. Assuming that there are n DMUs, each with m inputs and r outputs, the relative technical efficiency score of a test DMU q is obtained by solving equation (4).

$$E_q = \frac{\sum_{i=1}^{r} u_i y_{iq}}{\sum_{j=1}^{m} v_i x_{jq}} \rightarrow max$$

$$E_q = \frac{\sum_{i=1}^{r} u_i y_{iq}}{\sum_{j=1}^{m} v_i x_{jq}} \leq 1, q = 1,2, \cdots n \tag{4}$$

The most widely used DEA models are Charnes, Cooper and Rhodes (CCR) model by Charnes et al. (1978) and Banker, Charnes and Cooper (BCC) model by Banker et al. (1984). The CCR model has an input orientation and assumes that production follows a constant return to scale (CRS) while the BCC model has an output orientation and assumes that production follows a variable return to scale (VRS). According to Farrell (1957) both the CCR and BCC models are carried on and are expanded on the concept of "technical efficiency". A DMU is considered to be technically efficient if it lies on the efficient frontier. DMUs below the frontier are considered to be technically inefficient.

According to Anton (2013) technical efficiency can be evaluated from the perspective of either the input orientation or output orientation. In an input-oriented model, the goal is to minimize the use of inputs in order to maintain the current level of outputs constant while in the output-oriented model, the aim is to maximize the outputs with the given level of inputs. In line with Ahmed et al. (2019) and Retzlaff-Roberts et al. (2004), the output-oriented model is used in this study because it emphasizes increasing output without altering the quantity of inputs used. The objective of the output oriented DEA model is to maximize the efficiency score E_q in equation (4). The output-oriented DEA model according to Ahmed et al. (2019) is specified as follows:

$$Max \; E_q = \sum u_i y_{iq} + \mu \tag{5}$$

Subject to constraints

$$\sum_{i=1}^{m} v_i + y_{iq} = 1 \tag{6}$$

$$\sum_{r=1}^{j} u_i + y_{iq} - \sum v_j x_{jq} + \mu \leq 0, \; q = 1, \ldots, n \tag{7}$$

$$u_i, v_j \geq \varepsilon > 0$$

$$\mu > 0, \mu = 0, \; \mu < 0,$$

Where;

E_q = efficiency of the $q - th$ DMU,

y_{iq} = output i produced by DMU q

x_{jq} = input j produced by DMU q

u_i = weight given to output i

v_j = weight given to input j

ε is a constant which makes all weight of inputs and outputs positive.

For every DMU the model determines the input weight (v_j) and output weight (u_i) that maximize its efficiency scores (E_q). μ >0 defines Increasing Returns to Scale (IRS), μ=0 defines Constant Returns to Scale (CRS), and μ<0 defines Decreasing Returns to Scale (DRS). In general, a DMU is technically efficient if it obtains a score of 1 from DEA model. Otherwise, the DMU is considered to be technically inefficient.

Data Analysis
The DEA model is estimated using DEAP version 2.1 a DEA Program developed by Coelli (1996). The STATA version 15 by StataCorp (2015) is used for the pre-estimation techniques (choice of the best input/output combinations and checking for endogeneity issues regarding the technical efficiency of health systems).

Results
Descriptive Statistics
There is variation among the chosen inputs and outputs for various Africa LDCs (see Table 2).

Table 2: Descriptive statistics of the input and output variables (n=29) from 2008–2018

Variable	Observations	Mean	Std. Dev.	Min	Max
Inputs					
Domestic General Government Health Expenditure	319	14.273	16.633	0.927	89.079
Domestic Private Health Expenditure	319	20.959	17.611	2.182	147.569
External Health Expenditure	319	11.774	9.137	1.121	74.705
Out of Pocket Health Expenditure	319	18.098	16.253	1.825	139.601
Outputs					
Under Five Survival Rate	319	0.013	0.007	0.005	0.046
Maternal Survival Ratio	319	1.438	1.587	-0.405	8.259
Life Expectancy at Birth	319	59.056	4.901	43.384	68.7
Infant Survival Rate	319	17.453	5.422	7.734	35.63

Source: Author

The minimum and maximum amounts for domestic general government health spending were 0.927 and 89.097 million US dollars, respectively, while the minimum and maximum amounts for external health spending were 1.121 and 74.705 million US dollars. The difference between domestic private health spending and out-of-pocket medical expenses is even greater, with minimum and maximum values of 2.182 and 1.825 million US dollars and 139.601 and 147.569 million US dollars, respectively. For the health outputs, the average life expectancy at birth is 59.056 years, with a range of 43.384 to 68.7 years. With minimum values of 0.005, -0.405, and 7.734 and maximum values of 0.046, 8.259, and 35.63, respectively, the average under-five survival rate, maternal survival ratio, and infant survival rate are 0.013, 1.438, and 17.453, respectively.

Choice of Input and Output Combinations
To determine the interrelationships between various input and output variables, the Pearson's correlation matrix for the input and output variables in Table 3 is calculated.

DEA Model Specifications
Several input/output combinations for three (3) DEA model specifications based on the output orientation and VRS assumption are presented in Table 4 in light of the results of the Pearson's correlation matrix in Table 3. Only two outputs and all inputs are included in the DEA Model 1. Under

five survival rate and maternal survival rate are dropped from DEA Model 1 as outputs because they have a strong significant positive correlation ($r = 0.837 > 0.5,\ p < 0.001$).

Table 3: Pearson Correlation Matrix of Inputs and Output Variables (n=29), 2008 – 2018

	Under Five Survival Rate	Maternal Survival Ratio	Life Expectancy at Birth	Infant Survival Rate	Domestic General Government Health Expenditure	Domestic Private Health Expenditure	External Health Expenditure	Out of Pocket Health Expenditure
Under Five Survival Rate	1							
Maternal Survival Ratio	0.837***	1						
Life Expectancy at Birth	0.0660	0.118*	1					
Infant Survival Rate	0.0771	0.0760	0.775***	1				
Domestic General Government Health Expenditure	-0.0820	0.117*	-0.0772	-0.0474	1			
Domestic Private Health Expenditure	0.187***	0.190***	0.0602	-0.0832	0.357***	1		
External Health Expenditure	0.404***	0.442***	-0.113*	0.0689	0.0658	-0.0780	1	
Out of Pocket Health Expenditure	0.168**	0.122*	0.0411	-0.104	0.282***	0.980***	-0.0911	1

*Note: * p < 0.05, ** p < 0.01, *** p < 0.001 indicates 5%. 1% and 0.1% significance level*
Source: Author

Table 4: DEA Model Specifications for different input/output combinations

Variables / Model	1	2	3
Inputs			
Domestic general government health expenditure	X	X	X
Domestic private health expenditure	X	X	
External health expenditure	X	X	X
Out of pocket health expenditure	X	X	
Outputs			
Under five survival rate		X	X
Maternal survival ratio		X	X
Life expectancy at birth	X		X
Infant survival rate	X		X

Source: Author

DEA model 2 has two outputs and all inputs. DEA model 2's outputs life expectancy at birth and infant survival rate are dropped due to their strong significant positive correlation ($r = 0.775 > 0.5$, $p < 0.001$). DEA Model 3 only has two inputs and four outputs. Due to their significant positive correlation ($r = 0.980 > 0.5$, $p < 0.001$), domestic private health expenditure and out-of-pocket health expenditure inputs were dropped for DEA Model 3.

Three (3) DEA models are estimated in Table 5 showing technical scores based on the VRS technical efficiency scores and differ depending on the model specification. DEA Model 1 was the most preferred model because it had a mean technical efficiency score of 0.944 with a total of 16/29 countries on the production frontier. DEA Models 2 and 3 came next, with mean technical efficiency scores of 0.741 and 0.935, respectively, and 14/29 and 12/29 countries on the production frontier.

Table 5: Technical efficiency for three (3) selected DEA models

Country/DMU	Model 1 vrste	Model 2 vrste	Model 3 vrste
Angola	0.847	0.702	0.867
Benin	0.947	0.421	0.951
Burkina Faso	0.89	0.539	0.894
Burundi	1	1	0.938
Central African Republic	1	1	0.801
Chad	1	1	1
Democratic Republic of Congo	1	1	1
Djibouti	0.943	0.81	0.968
Eritrea	1	0.717	1
Ethiopia	1	1	1
Gambia	0.958	0.444	0.954
Guinea	1	1	1
Guinea-Bissau	0.856	0.505	0.871
Lesotho	0.692	0.35	0.7
Liberia	0.94	0.472	0.96
Madagascar	1	1	1
Malawi	1	0.454	0.838
Mali	0.885	0.339	0.885

Mauritania	1	1	1
Mozambique	1	1	0.857
Niger	1	1	0.964
Rwanda	1	1	1
Senegal	1	0.465	1
Sierra Leone	0.791	1	1
Sudan	1	1	1
Togo	1	1	1
Uganda	0.878	0.331	0.887
Tanzania	0.912	0.577	0.926
Zambia	0.845	0.365	0.854
Mean	**0.944**	**0.741**	**0.935**
Number on Frontier	**16**	**14**	**12**

Note: vrste = technical efficiency from VRS DEA: Source: Author

Test for endogeneity for the most preferred model: DEA Model 1
Table 6 presents pearsons correlation results between the inputs and technical efficiency scores of model 1.

Table 6: Pearson correlation between inputs and Technical efficiency scores of Model (1) for Africa LDCs(n=29) from 2008 to 2018

Inputs	Technical efficiency scores
Domestic general government health expenditure	-0.30447
Domestic private health expenditure	-0.12302
External health expenditure	-0.30551
Out of pocket health expenditure	-0.13614

Source: Author

Table 6's findings show that there isn't a strong correlation between technical efficiency scores and input variables. As a result, DEA Model 1 is suitable for further analysis because it does not have an endogeneity issue. Table 7 presents the findings of the most preferred model.

Technical Efficiency of health systems of Africa LDCs
The results in Table 7 show that between 2008 and 2018, sixteen African LDCs (Burundi, Central African Republic, Chad, Democratic Republic of the Congo, Eritrea, Ethiopia, Guinea, Madagascar, Malawi, Mauritania, Mozambique, Niger, Rwanda, Senegal, Sudan, and Togo) had technically efficient health systems, while thirteen (Angola, Benin, Burkina Faso, Burkina Faso, Djibouti, Gambia, Guinea Bissau, Lesotho, Liberia, Mali, Sierra Leone, Uganda, Tanzania, and Zambia) had technically inefficient health systems.

Table 7 Technical efficiency scores of Africa LDCs(n=29) for model 1 from 2008 to 2018

Country/DMU	crste	vrste	Returns to Scale
Angola	0.716	0.847	Decreasing Returns to Scale
Benin	0.628	0.947	Decreasing Returns to Scale
Burkina Faso	0.532	0.890	Decreasing Returns to Scale
Burundi	0.970	1	Increasing Returns to Scale
Central African Republic	0.855	1	Increasing Returns to Scale
Chad	1	1	-
Democratic Republic of Congo	1	1	-
Djibouti	0.696	0.943	Decreasing Returns to Scale
Eritrea	1	1	-
Ethiopia	1	1	-
Gambia	0.753	0.958	Decreasing Returns to Scale
Guinea	1	1	-
Guinea-Bissau	0.454	0.856	Decreasing Returns to Scale
Lesotho	0.321	0.692	Decreasing Returns to Scale
Liberia	0.595	0.940	Decreasing Returns to Scale
Madagascar	1	1	-
Malawi	1	1	-
Mali	0.587	0.885	Decreasing Returns to Scale
Mauritania	1	1	-
Mozambique	1	1	-
Niger	1	1	-
Rwanda	0.849	1	Decreasing Returns to Scale
Senegal	1	1	-
Sierra Leone	0.586	0.791	Decreasing Returns to Scale
Sudan	1	1	-
Togo	1	1	-
Uganda	0.404	0.878	Decreasing Returns to Scale
Tanzania	0.604	0.912	Decreasing Returns to Scale
Zambia	0.278	0.845	Decreasing Returns to Scale
Mean	0.787	0.944	

Note: vrste = technical efficiency from VRS DEA, crste = technical efficiency from CRSDE, Source: Author

Peer Count, Peers, Peer Weights for Africa LDCs
To further understand the technical efficiency scores for the preferred Model 1 in Table 7, Table 8 presents the peer counts, peers and peer weights. According to Kizza (2012) African LDCs forming the efficiency reference set are known as peer groups for the inefficient African LDCs. This means that the efficiency reference set comprises of African LDCs that are relatively efficient and act as models to the inefficient African LDCs (Kizza, 2012). Angola should 100% benchmark the policies of Senegal. Benin should bench mark 80.5% of the policies of Madagascar and 19.5% of the policies from Ethiopia.

Table 8: Results of the Peer Count, Peers and Peer Weights

Country/DMU	Peer count:	Peers			Peer weights		
Angola	0	Senegal			1		
Benin	0	Madagascar	Ethiopia		0.805	0.195	
Burkina Faso	0	Eritrea	Madagascar		0.026	0.974	
Burundi	0	Burundi			1		
Central African Republic	0	Central African Republic			1		
Chad	0	Chad			1		
Democratic Republic of Congo	0	Democratic Republic of the Congo			1		
Djibouti	0	Senegal	Madagascar		0.437	0.563	
Eritrea	4	Eritrea			1		
Ethiopia	4	Ethiopia			1		
Gambia	0	Eritrea	Madagascar	Rwanda	0.42	0.454	0.126
Guinea	0	Guinea			1		
Guinea-Bissau	0	Senegal	Madagascar		0.422	0.578	
Lesotho	0	Senegal	Madagascar		0.475	0.525	
Liberia	0	Madagascar	Ethiopia		0.809	0.191	
Madagascar	12	Madagascar			1		
Malawi	0	Malawi			1		
Mali	0	Madagascar	Ethiopia		0.571	0.429	
Mauritania	0	Mauritania			1		
Mozambique	0	Mozambique			1		
Niger	0	Niger			1		
Rwanda	1	Rwanda			1		
Senegal	7	Senegal			1		
Sierra Leone	0	Madagascar	Ethiopia		0.165	0.835	
Sudan	0	Sudan			1		
Togo	0	Togo			1		
Uganda	0	Senegal	Madagascar		0.406	0.594	
Tanzania	0	Eritrea	Senegal	Madagascar	0.227	0.186	0.588
Zambia	0	Senegal	Eritrea	Madagascar	0.099	0.19	0.712

Source: Author

Burkina Faso should benchmark 2.6 % of Eritrea's policies and 97.4 % of Madagascar's policies. Djibouti is eligible for 43.7% of Senegal's policies and 56.3% of Madagascar's policies. The Gambia can use and bench mark 42% of Eritrea's policies, 45.4% of Madagascar's policies and 12.6% of Rwanda's policies. Senegal's policies are appropriate and should act as benchmarks for both Guinea-Bissau and Lesotho at 42.2% and 47.5%, respectively, while Madagascar's policies are appropriate and should act as benchmarks for both countries at 57.8% and 52.5%. In comparison, 19.1%, 42.9%, and 83.5% of Ethiopia's

policies are appropriate benchmarks for Liberia, Mali, and Sierra Leone, respectively, while 80.9%, 57.1%, and 16.5% of Madagascar's policies should act as benchmarks for Liberia, Mali and Sierra Leone. Tanzania and Zambia should each benchmark 58.8% and 71.2% of Madagascar's policies, respectively, as well as 22.7% and 19% of Eritrea's policies as well as 18.6% and 9.9% of Senegal's policies. Uganda, should benchmark 40.6% of Senegal's policies and 59.4% of Madagascar's policies.

The countries that provided highest bench marks for inefficient countries to consider were Madagascar (had highest peer count of 12), Senegal (peer count of 7), Eritrea and Ethiopia (peer counts of 7) and Rwanda (peer count of 1).

Input and Output Slacks needed to make inefficient countries Efficient

According to Tindimwebwa et al. (2018), African LDCs that where 100 percent efficient (see Table 7) neither needed to reduce their inputs or increase their outputs thus had zero input and output slacks while inefficient African LDCs had input and output slacks as seen in Table 9. As per the requirement to increase health financing in accordance with SDG 3 (United Nations, 2017).

Results from Table 9 indicate that for Angola, Benin, Burkina Faso, Djibouti, Guinea Bissau, Lesotho, Liberia, Mali, Sierra Leone, and Uganda to increase their infant survival rate by 7.981, 5.036, 4.898, 4.739, 6.109, 2.838, 5.759, 4.817, 6.5, and 0.135 per 1000 live births the following input increments are necessary. Increases in domestic general government spending of 67.883, 1.322, 18.291, 0.034, 2.574, 25.828 and 5.981 million USD are required in Angola, Burkina Faso, Djibouti, Gambia, Guinea Bissau, Lesotho, and Tanzania, respectively while a total of 18.501, 6.793, 0.876, 12.259, 14.593, 24.255, 18.141, and 13.261 million USD should be added to the domestic private health expenditures of Angola, Benin, Gambia, Liberia, Mali, Sierra Leone, Uganda, and Zambia, respectively.

It is necessary for Angola, Benin, Burkina Faso, Djibouti, Gambia, Guinea Bissau, Lesotho, Liberia, Mali, Sierra Leone, Uganda, Tanzania, and Zambia to increase their external health expenditure in by 0.186, 3.015, 6.336, 1.74, 18.685, 5.617, 7.857, 2.842, 1.986, 1.182, 7.811, 4.376, and 18.371 million USD, respectively. While out-of-pocket expenditures for Angola, Benin, Burkina Faso, Djibouti, Guinea Bissau, Lesotho, Liberia, Mali, Sierra Leone, Uganda, Tanzania, and Zambia all need to increase by 8.95, 6.694, 0.992, 3.478, 1.95, 1.282, 12.698, 15.193, 24.78, 9.988, 1.903, and 10.485 million USD, respectively.

Table 9: Input and Output Slacks needed to make inefficient Africa LDCs Efficient. Country/DMU	Inputs				Outputs	
	Domestic General Government Health Expenditure	Domestic Private Health Expenditure	External Health Expenditure	Out of Pocket Health Expenditure	Life Expectancy	Infant Survival Rate
Angola	67.883	18.501	0.186	8.95	0	7.981
Benin	0	6.793	3.015	6.694	0	5.036
Burkina Faso	1.322	0	6.336	0.992	0	4.898
Burundi	0	0	0	0	0	0
Central African Republic	0	0	0	0	0	0
Chad	0	0	0	0	0	0
Democratic Republic of Congo	0	0	0	0	0	0
Djibouti	18.291	0	1.74	3.478	0	4.739
Eritrea	0	0	0	0	0	0
Ethiopia	0	0	0	0	0	0
Gambia	0.034	0.876	18.685	0	0	0
Guinea	0	0	0	0	0	0
Guinea-Bissau	2.574	0	5.617	1.95	0	6.019
Lesotho	25.828	0	7.857	1.282	0	2.838
Liberia	0	12.259	2.842	12.698	0	5.759
Madagascar	0	0	0	0	0	0
Malawi	0	0	0	0	0	0
Mali	0	14.593	1.986	15.193	0	4.817
Mauritania	0	0	0	0	0	0
Mozambique	0	0	0	0	0	0
Niger	0	0	0	0	0	0
Rwanda	0	0	0	0	0	0
Senegal	0	0	0	0	0	0
Sierra Leone	0	24.255	1.182	24.78	0	6.5
Sudan	0	0	0	0	0	0
Togo	0	0	0	0	0	0
Uganda	0	18.141	7.811	9.988	0	0.135
Tanzania	5.981	0	4.376	1.903	0	0
Zambia	0	13.261	18.371	10.485	0	0
Mean	**4.204**	**3.748**	**2.759**	**3.393**	**0**	**1.68**

Source: Author

For Africa LDCs to increase their infant survival rate by an average of 1.68 per 1000 live births they needed to increase their domestic general government health expenditure by 4.204 million USD, domestic private health expenditure by 3.748 million USD, external health expenditure by 2.759 million USD, and out-of-pocket health expenditure by 3.393 million USD.

Discussion

This study reports variations in the technical efficiency of health systems of African LDCs. African LDCs with technically efficient health systems like Eritrea, Ethiopia, Madagascar, Malawi, Senegal and Togo had good health outcomes while those like the Central African Republic, the Democratic Republic of Congo, Chad and Guinea had poor health outcomes despite having technically efficient health systems. Similar findings were reported by authors such as Çelik et al. (2017), Dhaoui (2019) and Retzlaff-Roberts et al. (2004), who established that efficiency results can be observed between countries with good health outcomes and those with poor health outcomes. Burundi, the Central African Republic, Chad, the DRC, Eritrea, and Guinea were among the Africa LDCs with technically efficient health systems despite having low levels of health spending, while Lesotho, Djibouti, Angola, and Zambia had technically inefficient health systems despite having high levels of health spending. This is in line with the findings of Behr and Theune (2017), Sinimole (2012) and Alexander et al. (2003), who noted high levels of inefficiencies among nations that spent a lot of money on health and efficiencies among nations that spent low amounts.

Countries like Madagascar, Senegal, Eritrea and Ethiopia with technically efficient health systems were benchmarks for countries with technically inefficient health systems. Those with good health outcomes in terms in infant survival rate and life expectancy (Madagascar, Senegal, Eritrea, Ethiopia and Rwanda) were reference countries for countries with poor health outcomes. This is in disagreement with the findings of Cetin and Bahce (2016) who established that that OECD countries which produced poor health services with fewer inputs such as Chile, Mexico and Turkey were found to be reference countries for other countries with much better health outcomes.

It was also established that African LDCs need to increase their domestic general government health expenditure, domestic private health expenditure and external health expenditure to realize increase in their infant survival rates. These results concur with those of Ahmed et al. (2019), who also suggested that increasing health expenditures particularly domestic general government health expenditure was associated with better health outcomes particularly a rise in the infant survival rate.

Conclusion

Health expenditure wastages exist/don't exist in some African LDCs. African LDCs with efficient health systems are benchmarks for African LDCs with inefficient health systems. Increments in domestic general government health expenditure, private health expenditure, external health expenditures and out of pocket health expenditures are associated in increase in infant survival rates. It is on the basis of the findings that the study calls for increased domestic general government and domestic private health expenditures health expenditures, this can be done through private public partnerships to promote universal access to health care. Inefficient Africa LDCs can also benchmark the practices of efficient Africa LDCs to improve the performance of their health systems.

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Epistaxis: Prevalence and severity among Hypertensive patients attending District hospital in Tanzania

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Abstract

Background: Epistaxis is one of the common ENT emergency conditions. Most of the time the bleeding is self-limited, but can be life-threatening. Serious spontaneous epistaxis may reveal underlying true hypertension in about 43% of patients with no previous history of hypertension. It can result from several causes and hypertension is among the aggravating factors.

Objective: The study aimed to determine the prevalence and severity of epistaxis among hypertensive patients.

Material and method: This study was a prospective cross-sectional study conducted from October 2021 to April 2022 involving a total of 196 adult patients with hypertension at a district hospital in Tanzania. A consecutive sampling technique was employed and structured questionnaires were used to collect data. Data entry was performed using SPSS version 25 and a P value of <0.05 was considered statistically significant.

Result:196 patients aged above 30 years were recruited, the majority of the patients were females (63%) and males were only (37%). The Prevalence of epistaxis was found to be lower among patients with hypertension aged below 40 years which accounted for 4.2%. However, patients aged 51-60 had a high prevalence of epistaxis (41.7%). The overall prevalence of epistaxis among hypertensive patients was found to be (12.2%) of which (62.5%) were females and (37.5%) were males. Furthermore, in this study, it was found that the severity of epistaxis among hypertensive patients was mild to moderate with (2%) of patients who required nasal packing. In this study (1%) of patients had mild epistaxis and (2%) had moderate epistaxis but no patients were found to have severe epistaxis as per the epistaxis severity score (ESS) by Jeffrey B. Hoag (Score tool).

Conclusion and recommendation: Epistaxis can result from several local and systemic conditions. Hypertension is one of the systemic causes of epistaxis among our patients which is still prevalent in our settings, however slightly low as compared to the previous studies. Females have a higher occurrence of epistaxis compared to males and the most common age group involved are patients in the fifth and sixth decades. Likewise, in terms of severity, most of the time is mild to moderate. The healthcare providers managing these groups of patients should also evaluate the co-existence of the two disorders for a better outcome of treatment.

Keywords: Prevalence, adults, epistaxis, severity, hypertension.

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Background

Epistaxis comes from the Greek word "epistazein" which means, "bleed from the nose" and is a combination of the two words: "epi" meaning "upon" and "stazein" meaning "to drip". It is common and is seen in all age groups: children, adults, and older people. It often presents as an emergency. Epistaxis is a sign and not a disease per se and an attempt should always be made to find any local or systemic cause. It has been estimated that up to 60% of individuals in the population had at least one episode of epistaxis throughout their lifetime with 6% of those with epistaxis seeking medical attention, with 1.6 in 10,000 requiring hospitalization (Viehweg et al.2006, Chalya et al.2011).

Two classifications of epistaxis exist, Anterior and posterior based on bleeding sites. Anterior epistaxis originates from little's area and occurs when blood flows out from the front of the nose with a patient in a sitting position and posterior epistaxis originates from Woodruff's plexus, Mainly the blood flows back into the throat. Anterior epistaxis is more common than posterior epistaxis and it accounts for more than 80% of the cases (Wilkins et al.2006).

Figure: Blood supply of lateral wall of the nasal cavity and nasal septum
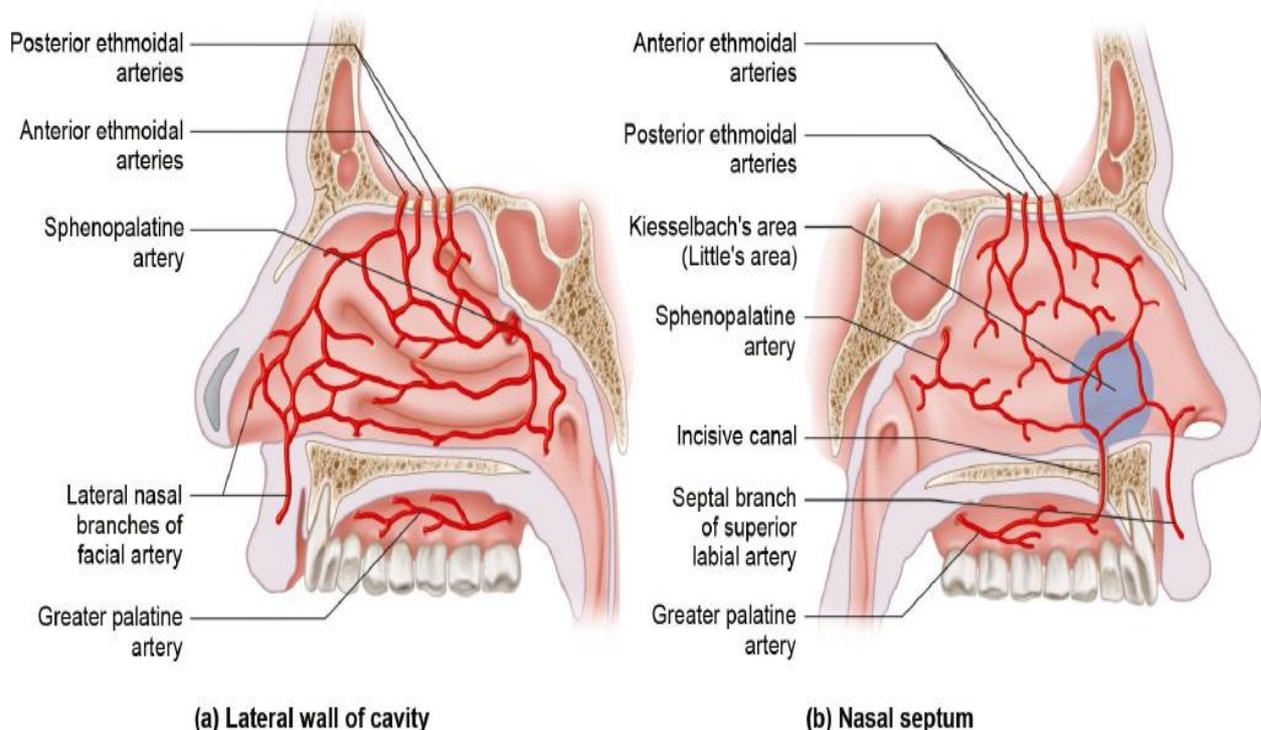
Adopted from https://plasticsurgerykey.com/nasal-cavity-and-paranasal-sinuses/#c016_f006

In hypertension, the pathophysiology of serious spontaneous epistaxis remains unclear. It mainly occurs in elderly patients 60-70 years with a history of hypertension, in about 50% of cases. Serious spontaneous epistaxis may reveal underlying true hypertension in about 43% of patients with no previous history of hypertension. Serious spontaneous epistaxis probably results from several combinations of causes however hypertension is among the burden for epistaxis (Aurellie et al.2011, Byun et al.2020, Sambo et al.2014, Isezuo et al.2008).

Understanding the prevalence of epistaxis is very important, as this will help us to lay more effort into the management of our patients. Likewise knowing its severity from its local or systemic causes will alert us to taking important precautions to serve our patients.

It is known that 60% of the population experience a nosebleed at once, One-tenth of these patients eventually seek medical advice/intervention, and 0.16% will need hospitalization (Passali et al.2020, Al et al.2020). The prevalence of epistaxis in hypertension globally is between 24% and 64% (Dvid et al.2020), however previous studies show that; in Tanzania the prevalence is 15% (Abraham et al.2017). This causes a great burden among hypertensive patients when epistaxis occurs, and it brings challenges in controlling bleeding (Lee et al.2020). In Tanzania, few studies are done regarding the prevalence of epistaxis in hypertension. In addition, they did not study the relationship between HTN and the severity of epistaxis. There are no recent studies on the severity of epistaxis in hypertensive patients which have been done. Therefore, this creates a knowledge gap and opens a chapter for this study on the prevalence and severity of epistaxis among hypertensive patients attending a District hospital in Tanzania. This study will help clinicians who deal with patients with epistaxis to check and monitor hypertension to get quick and good control of epistaxis to prevent long hospital stay and the mortality which can arise, also it creates awareness to the hypertensive patients so that they take early precautions when nose bleeding occurs.

Method
Study design, settings, and population
This was a cross-sectional study conducted at a District Hospital in a hypertensive clinic from October 2021 to April 2022.A consecutive sampling technique was used. All patients who met the inclusion criteria were enrolled in the study until the required number was reached. Patient selection was done where all diagnosed hypertensive patients aged 18 years and above were recruited by the attending nurses before patients see the attending physician and at this stage, selected patients signed the informed consent form. The sample size was calculated using Fisher's formula using the prevalence from the study done previously in Tanzania where the prevalence was 15% and the estimated size was 189 whereas the enrolled study participants were 196.

Data collection technique
A structured questionnaire was used to take socio-demographic characteristics, history, severity of epistaxis and confirmation of hypertensive status. The medical history was obtained from the patient files. From the history the severity of epistaxis was scored using Epistaxis severity score tool.

Study Tools
Questionnaires and Epistaxis severity score tool by Jeffrey B Hoag

Data analysis
Using SPSS version 25, descriptive statistics were used to describe data on the prevalence and severity of epistaxis among hypertensive patients. The chi-square test was used to assess the association between demographic, comorbidity, and severity of epistaxis in hypertension. The p-value < 0.05 was considered statistically significant.

Ethical approval
Ethical clearance was obtained from the MUHAS Institutional Review Board. Permission to conduct the study was sought from the Medical officer in charge at the Hospital and consent was obtained from all study participants before enrollment.

Results

Demographic characteristics of the study population

A total of 196 patients with hypertension attending the clinic were involved in the study, the majority of them were females (63%) and males (37%). The study included all adult patients 18 years and above. In this study the youngest participant was 21 years old and the oldest was 79 years old, a large proportional of study participants were aged 51-60 (43.9%), where (43.9%) were females and (43.8%) were males.

Table1: Demographic characteristics of the study population

Age Groups	Sex		Total (%)
	Female (%)	Male (%)	
31-40	6 (4.9)	1(1.4)	7(3.6)
41-50	23(18.7)	5 (6.8)	28(14.3)
51-60	54(43.9)	32 (43.8)	86(43.9)
61-70	32(26.0)	26(35.6)	58(29.6)
71 and above	8 (6.5)	9(12.3)	17(8.7)
Total	123(63)	73(27)	196 (100.0)

Prevalence of epistaxis among study participants by age and sex

Among the 196 recruited participants the prevalence of epistaxis was12.2 %. Males were less affected as compared to females by 37.5% and 62.5% respectively. The prevalence of epistaxis was lower among patients below 40 years (4.2%) while being higher among patients 51-60 years of age (41.7%) followed by patients aged 61-70 years (29.2%).

Table 2: Prevalence of epistaxis among study participants by age and sex

		Epistaxis		
		Yes (%)	No (%)	Total (%)
Sex	Female	15(62.5)	108(62.8)	123(62.8)

	Male	9(37.5)	64(37.2)	73(37.2)
	Total	24(12.2)	172(87.8)	196(100.0)
Age	31-40	1 (4.2)	6 (3.5)	7(3.6)
	41-50	4(16.7)	24 (14.0)	28(14.3)
	51-60	10(41.7)	76 (44.2)	86(43.9)
	61-70	7(29.2)	51(29.7)	58(29.6)
	71 and above	2 (8.3)	15(8.7)	17 (8.7)
	Total	24 (12.2)	172 (87.8)	196 (100)

Severity of epistaxis

By using the epistaxis severity score, it was found that most hypertensive patients who had epistaxis had mild to moderate severity. In this study, 1% of the study participants had mild epistaxis, and (2%) had moderate epistaxis. During the study period, no hypertensive patient was found to have severe hypertension Table 3.

Table 3: Epistaxis severity score (ESS) by Jeffrey B. Hoag (Score tool)

Epistaxis		Frequency	Percent
	NO	172	87.8
	YES		
Severity	No severity (0 score)	18	9.2
	Mild (score 1-4)	2	1.0
	Moderate (score 5-7)	4	2.0
	Severe (score 8-10)	0	0
	Total	196	100.0

Discussion

The study aimed to determine the prevalence and severity of epistaxis among hypertensive patients. In a study population of 196 participants, the overall prevalence of epistaxis was found to be (12.2%). A study done by Abraham et al found that the prevalence of epistaxis in hypertensive patients was (15%), and in a similar study by Gilyoma et al, the prevalence was (17.3%), although the findings are nearly similar, there is a slight decline in prevalence possibly because of the differences in the study methodology, sample size and the inclusion criteria (Abraham et al 2017,Gilyoma et al 2011).

In this study, the prevalence of epistaxis among females was higher compared to males with male to female ratio of 1:2 which differs from a study by Gilyoma et al, where males were affected twice than females (2.7:1) (Gilyoma et al 2011, Mwai). The prevalence of epistaxis in this study according to age group was found to be high among patients in their fifth and sixth-decade of life compared to the lower age. This is similar to other studies done previously (Awuah et al.2012,

Sambo et al.2014, And et al.2008). The reason behind this possibly elderly age and other comorbidities may be a contributing factor for epistaxis rather than hypertension itself.

This study found that the severity of epistaxis among hypertensive patients was mild to moderate (2%). This is different compared to a study which found the severity to increase by (7%) (Shresthal et al.2015). A similar study in Saudi Arabia showed the severity was high by (13%) (Sarhan et al.2014). The reasons for these variations are not known however, other local and systemic causes apart from hypertension by itself may increase the severity.In this study, it was also found that among these patients who had mild to moderate epistaxis, 2% of them required nasal packing. This is different compared to a similar study done previously which found posterior nasal packing was 16.66%, endoscopic cauterization of SPA was 2.38%, and 5.95% required blood transfusion (Parajuli et al.2005)

Conclusion

Epistaxis as one of the Otorhinolaryngological emergencies and hypertension is one of the aggravating factors among patients in our setting. Females have a higher prevalence of epistaxis compared to males and the most common age group involved are patients in their fifth and sixth decades of life. The severity of epistaxis in hypertensive patients was noted to be mild to moderate. Clinicians should be aware of the link between hypertension and epistaxis All patients with epistaxis should be checked for hypertension and those with hypertension should be educated on preventive measures for epistaxis

Authors' contributions

ER and MM conceived the study. ER and MM collected data, performed analysis and data interpretation. ER and MM drafted and revised the manuscript. All authors read and approved the final manuscript.

Competing interests

The authors declare no competing interests

Availability of data and material

All data generated or analyzed during this study are included in this published article

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Spatial relationship between urban expansion and distribution of healthcare facilities in Morogoro municipality, Tanzania

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Abstract
Background: The majority of the world's uninsured population, 1.3 billion individuals, reside in developing countries. Location disparity is a characteristic of the distribution of healthcare facilities in metropolitan regions of developing countries like Tanzania. Spatial variation in urban expansion and population growth are critical factors influencing *the* establishment and distribution of healthcare facilities in urban areas.
Methods: Statistical regression techniques can be used to describe the relationship between the variables. To achieve the study's goal, a variety of techniques were used to evaluate the spatial relationship between urban growth and the distribution of healthcare services. Remote sensing data provides massive amounts of spatial data on urban expansion. Population projection and population density indexes were used to determine population growth. Using Morogoro Municipality as a case study, Geographically Weighted Regression was applied to facilitate efficient spatial assessment of t*he* relationship between urban expansion and distribution of healthcare facilities.
 Results: The result shows that from 1990 to 2020 built-up increased from 3.9% to 18.9% of the total urban area of Morogoro Municipality while non-build class decreased from 96.1% to 81.9% of the total urban area of Morogoro Municipality. The overall coefficient determination R^2 was 0.599, 0.34 and 0.07 for the study period 2010-2020, 2000-2010 and 1990-2000 respectively showing that the explanatory power of variables urban expansion and population density was increasing with time.
Conclusion: The spatial relationship link of urban expansion and distribution of healthcare facilities in Morogoro Municipality within 30 years' study period implies that there has been a progressive relationship between urban expansion and distribution of healthcare facilities during 1990-2000 there was a weak relationship same for 2000-2010 while 2010 -2020 exhibited a moderate relationship

Keywords: Urban expansion, Healthcare facilities, Distribution, Relationship, Geographically Weighted Regression

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Introduction

Urban expansion and its consequences on infrastructure provision in cities of developing countries have drawn the attention of many scholars due to various reasons. Informal urban expansion is characterized by lack of service infrastructure such as health care, poor physical accessibility to water supply (Acheampong *et al.,* 2017). The underlying fear is how a government can mobilize resources to meet the rapidly growing demand. Urbanization is the process by which settlements grow in population, size, and economic activity over time (Jacobs, 1969). The emergence and growth of cities and big regions have historically been attributed to the concentration of population and economic activities or agglomeration theory (Henderson, 2002).

One of the most significant results of population agglomeration in urban centers is urban growth (Sumari *et al.*, 2019). Rapid and often unplanned urbanization leads to conditions that affect human health in a negative way (Rezaee, et al., 2021). Poverty, environmental problems and increasing population demands that outstrip available service capacity are some of these conditions (Moore et al., 2003). Urban expansion in developing countries leads to increased pressure on existing healthcare facilities if additional facilities are not provided for the growing population. However the investment in healthcare infrastructure has been historically low (Reddy *et al.,* 2011).The distribution of most healthcare facilities in urban areas of developing countries is characterized by location disparity and concentrated in one location than the other. Various studies have already been done on urban expansion and distribution of healthcare facilities for decision making in different sectors (Ntuli *et al.*, 2020; Acheampong *et al.*, 2017).

However little has been done on assessment of urban expansion and population in relation to growth of health facilities to overcome location disparity and geographic inequities within urban areas to strengthen health service delivery. Spatial variation in urban expansion and population growth are critical factors influencing establishment and distribution of healthcare facilities in urban area, (Sumari *et al.,*2020). The importance of healthcare infrastructure allocation is often undermined and overlooked leading to slow progress of the healthcare sector in most developing countries (Travis *et al.,* 2004). Statistical regression and correlation approaches have traditionally been used to describe the relationship between variables (Yang *et al.,* 2006; Zhang *et al.,* 2006).

So it very importance to assess the spatial relationship among these variables urban expansion and distribution of healthcare facilities so as to know variations in distribution of health service. Thus, health resources are allocated to meet the demands of urbanisation and population increase. Recently, there have been significant advancements in geospatial technology-based techniques that allow urban planners and managers to study and monitor urban conditions and growth (Sumari *et al.*, 2020). Several techniques for analyzing urban expansion include spatial index (SI), annual expansion rate (AER), urban expansion twitter model (UET), landscape expansion index (LEI)), urban expansion intensity index (UEII) and urban expansion differentiation index (UEDI) (Terfa *et al.*, 2020). These are among the recent techniques for urban expansion determination (Jiao *et al.*, 2015, 2018; Liu *et al.*, 2010; Viana *et al.*, 2019).

Several techniques have been used to analyse the relationship among different aspects concerning spatial visualization, including geographically weighted regression (GWR) and ordinary least square (OLS) regression (Brunsdon *et al.,* 2012; O'Sullivan, 2003). GWR has the capability of spatially displaying the parameter estimates and coefficient of determination regarding all variables in a raster surface and vector map respectively for easy and quick visual interpretation of relationships and detected spatial patterns (Fotheringham, 2009). For example, used the Geographically Weighted Regression (GWR) which is a spatial statistical technique that shows variations in relationships between predictors and outcome variable over space (Lu *et al.*, 2014).

The authors used the model to establish relationships between urban expansion and population .This model has revealed the growth relationship among three variables e.i urban expansion, population density and healthcare facilities. Despite the importance of knowing the relationship among urban expansion, population density and healthcare facilities, little has been done on assessment of urban s expansion and population in relation to growth of health facilities to overcome location disparity and geographic inequities within urban area to strength better health service delivery in Tanzania regions including Morogoro region. The purpose of this study was to therefore to assess the spatial relationship between urban expansion and distribution of healthcare facilities within a 30 year study period in Morogoro Municipaliy.

Materials and methods
Description of study area
The study area was Morogoro Municipality which is one of the nine districts in Morogoro Region including Kilosa, Ifakara, Kilombero, Malinyi, Mvomero, Gairo, Ulanga, Morogoro municipality and Morogoro Rural. Morogoro region occupies 221492 populations that are approximately 13.7% of the total populations of Morogoro region. The municipality is the capital of Morogoro region and it covers 540 km² which has 28 Wards (URT, 2012).
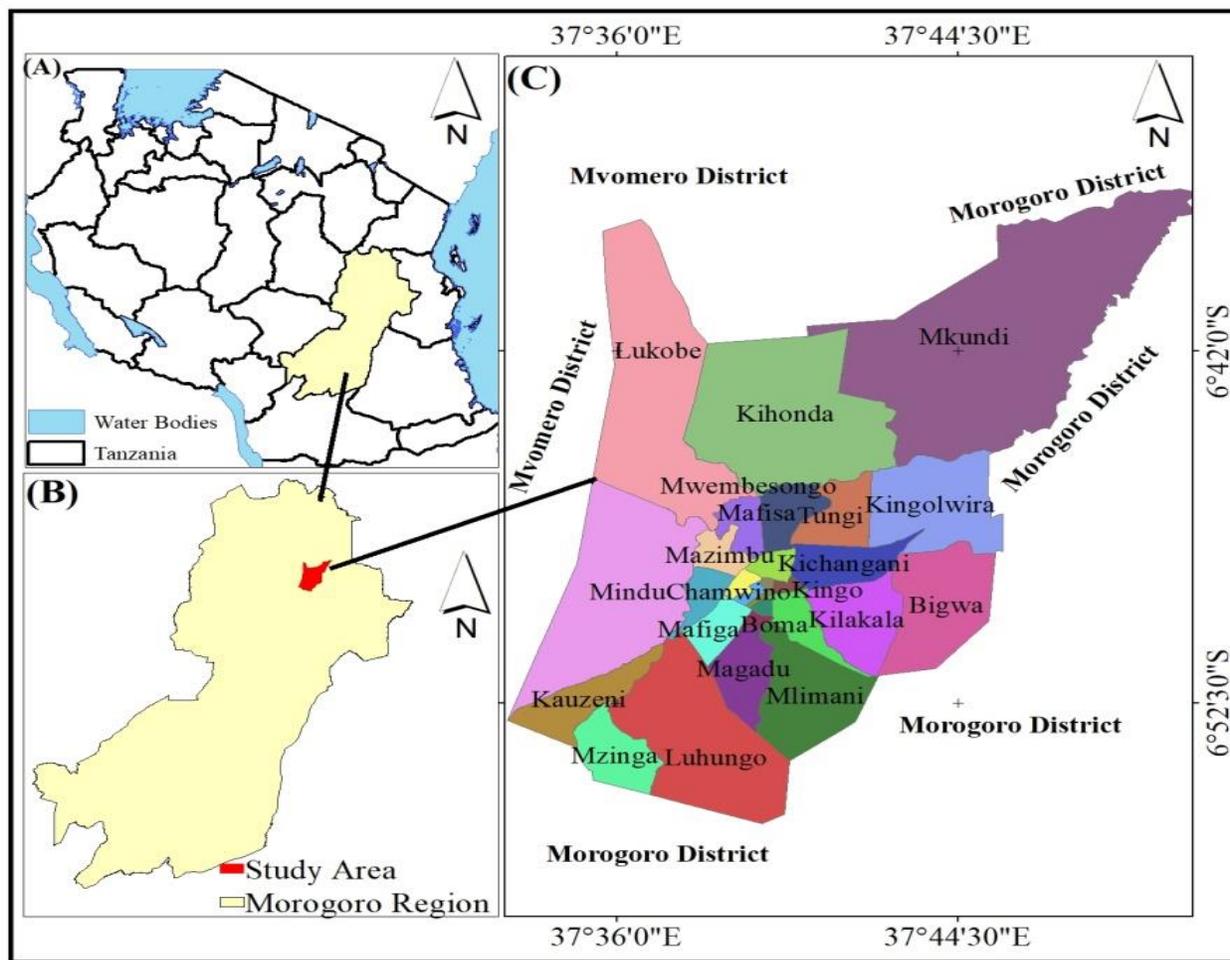

Figure   2.1: Location Map of Morogoro Municipality

Data collection and analysis procedures.
The data collected and analysis of this study will base within 30 years period from 1990 to 2020.

Image acquisition and processing.
The images of the study area and respective dataset were acquired from the United States Geological Survey Earth-Explorer (USGS EE) website. Data sets included Landsat collection 1 level 1, Landsat 4-5 TM C1 Level 1, Landsat 7 EMT+C1 Level 1 and Landsat 8 OLI/TIRS C1 Level 1. Downloaded images had several bands which were composed by using Arc GIS Software, whereby Landsat 4-5 TM C1 Level1, Landsat 7 EMT + C1 Level band 1 to band 7, and Landsat 8 OLI/TIRS C1 Level 1 bands 1 to band 7 and band 10 were combined together by using Composite Bands tool in ArcGIS Program. The composed images were then clipped based on the study area and processed together to create a single raster dataset so that they can be managed, viewed, and queried as show in Figure 2.2.

The Landsat images were acquired for 1990 (TM data), 2000 (ETM+ data), 2010 (ETM+ data), and 2020 (OLI data). All Landsat images were obtained from http://earthexplorer.usgs.gov/ website of United States Geological Survey (USGS)) from the path/row number 167/065. ENVI version 5.3 was used for image classification, with ERDAS Imagine version 2014 for accuracy assessments and ArcGIS version 10.3 for image data processing, visualization, and map generation. All images were registered to UTM coordinate system with WGS 84 datum zone 37 South for consistency, after that the images were clipped based on the boundary of the study area.
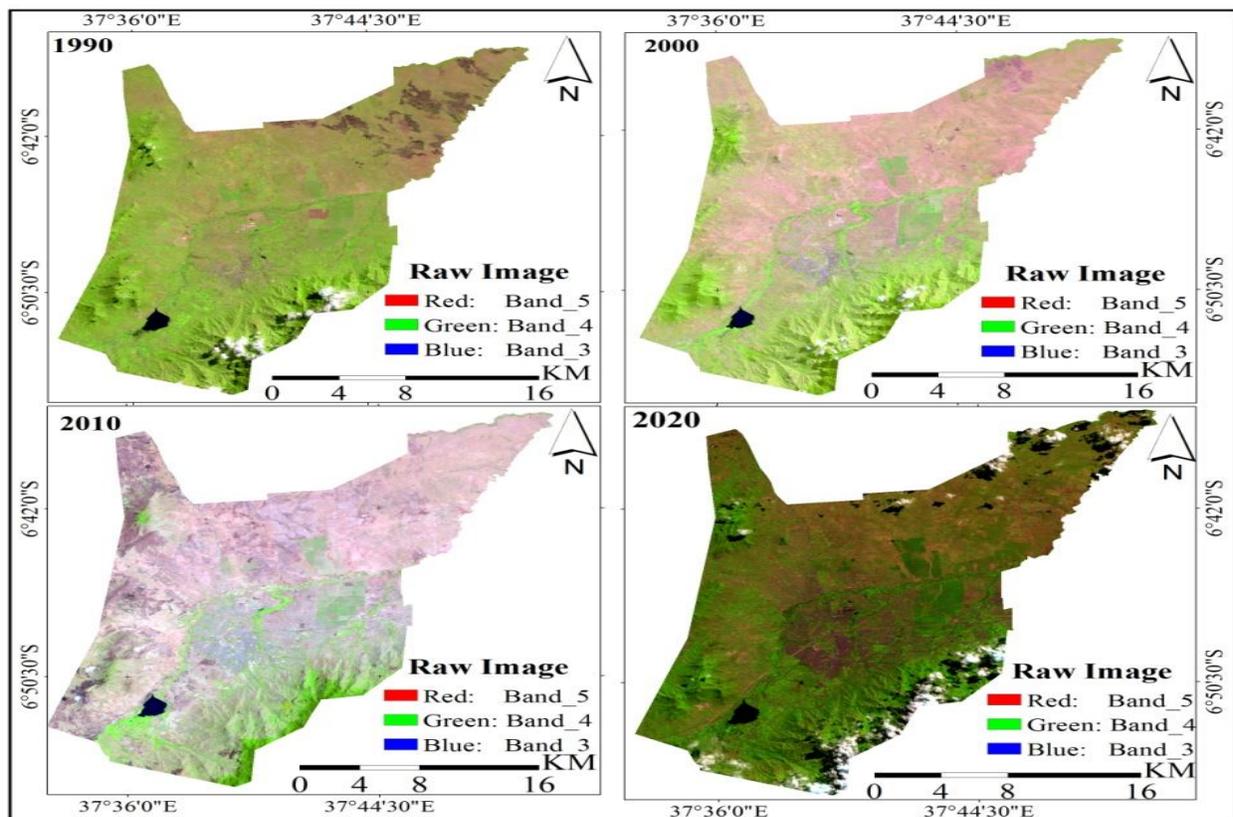

Figure 2.2: Clipped raw images from 1990 to 2020 of the study area

Image classification

The technique of categorizing all pixels in an image or raw remotely sensed satellite data to get a particular set of labels or land cover themes is known as image classification (Gómez-Chova et al., 2017; Weng and Lu, 2009). According to Lu et al. (2004), the major steps of image classification may include Choice of a suitable classification method. In this study supervised classification method was selected for classifying images of different periods from 1990-2000, 2000-2010 and 2010-2020 (10 years in each category) in to two categories, i.e., built-up area and un-built up area classes. Ten years for each category is considered appropriate as it is virtually impossible to determine urban expansion.

Geographically weighted regression

Geographically Weighted Regression (GWR) is a spatial statistical technique that shows variations in relationships between predictors and outcome variable over space (Lu et al., 2014; Mennis, 2006). This technique was developed by Cleveland (1979). Other techniques for the analysis of spatial relationships also have recently emerged (Oshan et al., 2019). The GWR model can be expressed as;

$$y_i = \beta_{IO} + \sum_{k=1}^{m} (\beta_{ik} x_{ik} + \varepsilon_i)$$

……………………………………………….. (1)

Where: y_i is the dependent variable at location i; χ_{ik}, is the kth independent variable at location i; m is the number of independent variables; β_{io}, is the intercept parameter at location i; β_{ik}, is the local regression coefficient for the independent variable at location i; and ε_i is the random error at location.

The weight field allows some features to be more important in the model calibration process than others. Primarily useful when the number of samples taken at different locations varies, values for the dependent and independent variables are averaged, and places with more samples are more reliable (should be weighted higher). The number of samples is used as weight field so that locations with more samples have a larger influence on model calibration than locations with fewer samples (Khayyun *et al.*, 2019).

In this study, urban expansion and population density were used as independent variables, and were determined within 30 years from 1990 to 2020 in three categories of 10 yearly intervals. Healthcare facilities were thus used as a dependent variable and weighted 1-3, with hospital being weighted as 3, health centre as 2 and dispensary as 1. So each urban expansion category was analysed with 3 weighted fields (hospital, health centers and dispensary).The first experiment involved the use of a single variable, urban expansion as the only explanatory variable for the regression analysis whilst for the second experiment the second explanatory variable, population density of individual wards was added. This technique was applied in GIS environment whereby the spatial statistic tool in ArcGIS 10.5 was used to analyze the relationship between urban expansion and distribution of healthcare facilities.

Population data

Population data was very important in calibration of the GRW model where population density was used as an independent variable in the second test experiment. In this study population data was projected for the years 1990-2000, 2000-2010 and 2010-2020 based on the 1988 and 2012 population and growth rate date from National Bureau of statistics and was used to calculate population density in the study area. Sarker (2001) used the discrete model with modification of the growth rate which is not constant. They the population of Bangladesh for the period 1976-2093 and obtained a parabolic profile. In many cases, for a small population one may use the discrete model as:

$$p\,t = p\,0\,(1+r)t$$

………….…………………………………..….…………………………… (2)

Where $p\,0$ = current population; $p\,t$ = population after time t; r = growth rate.
Population density is a measurement of the number of people in an area. Population density is calculated by dividing the number of people by the area. Population density is usually shown as the number of people per square kilometre (Shawky, 2016). The formula for population density is expressed as:

$$Dp = \frac{N}{A}$$

…………………………………………………   ………………………………………………… (3)

Whereby Dp = population density N= total population A= total land area covered by population

Ethical considerations
Ethical clearance was obtained from Morogoro region commission (Ref. No: AB.175/245/01/98) and Morogoro district commission (Ref.No.AB210/249/01/163) .The permission to conduct the study at all health facilities in Morogoro municipality was obtained from Morogoro Municipal director department of health (Ref. No R.10/MMC-99/167). All of health officers in each health facilities received information about the study while on duty, and they were provided with information on the potential risks and benefits of participating.

Results
Urban expansion
Spatial distribution of the built-up extent and urban growth from 1990 to 2020 are depicted in (Figure 3.1). Built-up growth tended to expand outward towards all directions but mainly in the north-west.
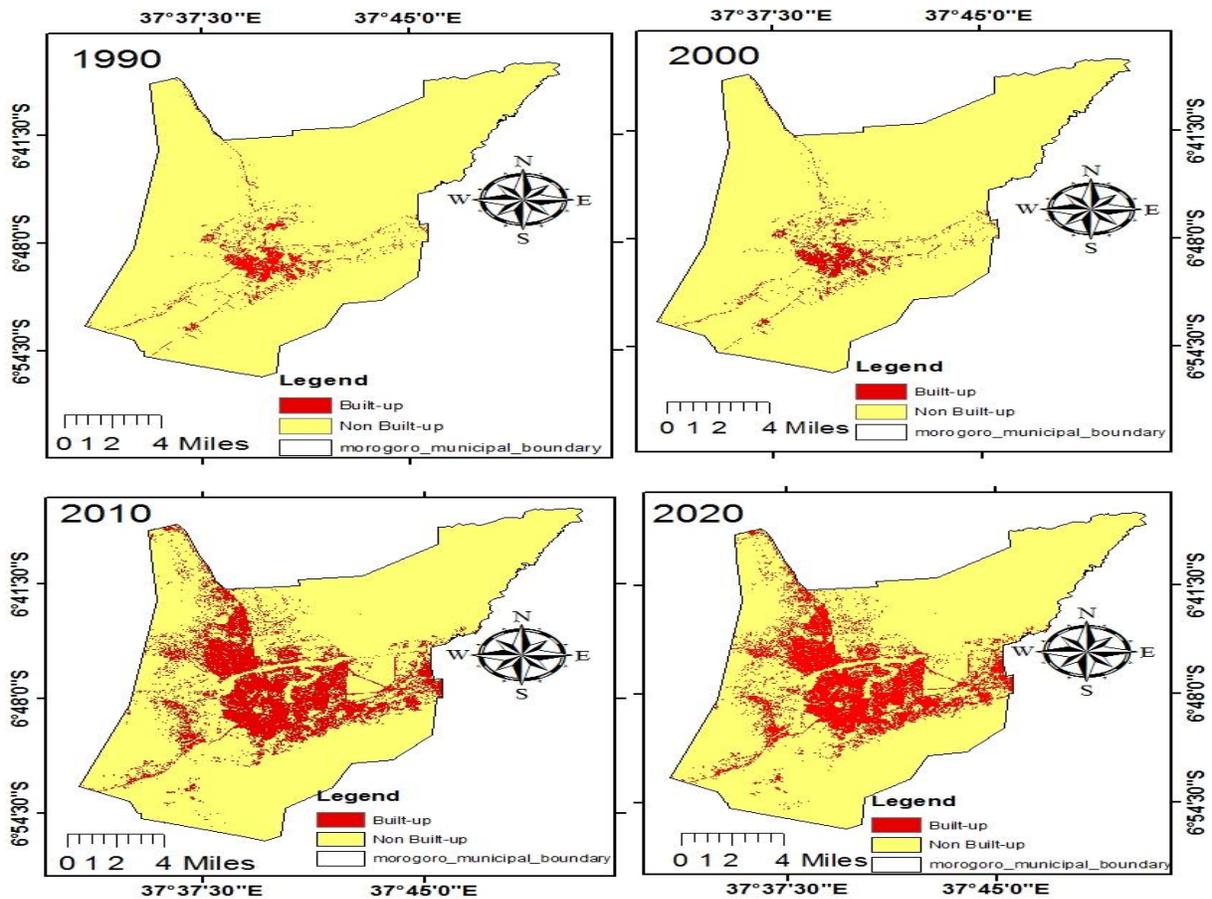
Figure 3.1: Urban expansion in Morogoro Municipality from 1990 to 2020

Table 3.1: Percentages of Urban expansion of Morogoro Municipality from 1990 to 2020

LAND CLASSES	1990 %	2000 %	2010 %	2020 %
Built-up	3.9	4.8	6.6	18.1
Non Built-up	96.1	95.2	93.4	81.9

Result of Geographically Weighted Regression (GWR)
Table 3.2 shows the results the first experiment show that the sum of residual squares for 2000-2010 study period was 8.68, meaning that the model in 2000-2010 time period fits best to explain the impacts of the explanatory variable.

Table 3.2: Estimation results of the first experiment of the GWR model

Parameters	Study Period			
	1990-2020	2010-2020	2000-2010	1990-2000
Intercept	1.462993	0.359536	0.37457	0.884869
UEII	0.05368	4.74364	1.20196	-0.37818
Standard Error	1.082025	1.340375	0.34003	0.767835

Local R²	0.000002	0.12174	0.0196	0.001669
R²	0.190326	0.172987	0.01967	0.00177
Adjusted R²	0.066255	0.121235	-0.01814	-0.0367
Bandwidth	0.091704	0.188664	2.65453	2.654526
Residuals Squares	99.561045	76.17383	8.68293	23.3871

A new variable (Population density) was added in the second experiment for the analysis of the urban expansion and distribution of the healthcare facilities in Morogoro Municipalilty to check for the relative strength of the variable. In this study, population density of individual wards referred to the total number of residents in a particular ward per unit area of that ward in square meters. Table 3.3 shows the results for the estimation of healthcare facilities in Morogoro Municipality using a combination of two variables, i.e, population density and urban expansion intensity index of the individual wards.

Table 3.3: Estimation results second experiment of the GWR model

| Parameters	Study Period			
	1990-2020	2010-2020	2000-2010	1990-2000
Intercept	-0.855557	-1.81851	-0.0988	1.228856
UEII	0.14514	4.4483	1.78074	-0.68966
Population Density	-0.03897	0.17084	0.06856	-0.06464
Standard Error	0.132302	0.107593	0.13071	0.59598
Local R²	0.06314	0.193746	0.17858	0.064879
R²	0.552046	0.598565	0.35564	0.065146
Adjusted R²	0.349671	0.414784	0.17108	-0.09782
Bandwidth	0.091704	0.091704	0.14965	2.654526
Residuals Squares	55.082297	36.97507	5.70721	21.90229
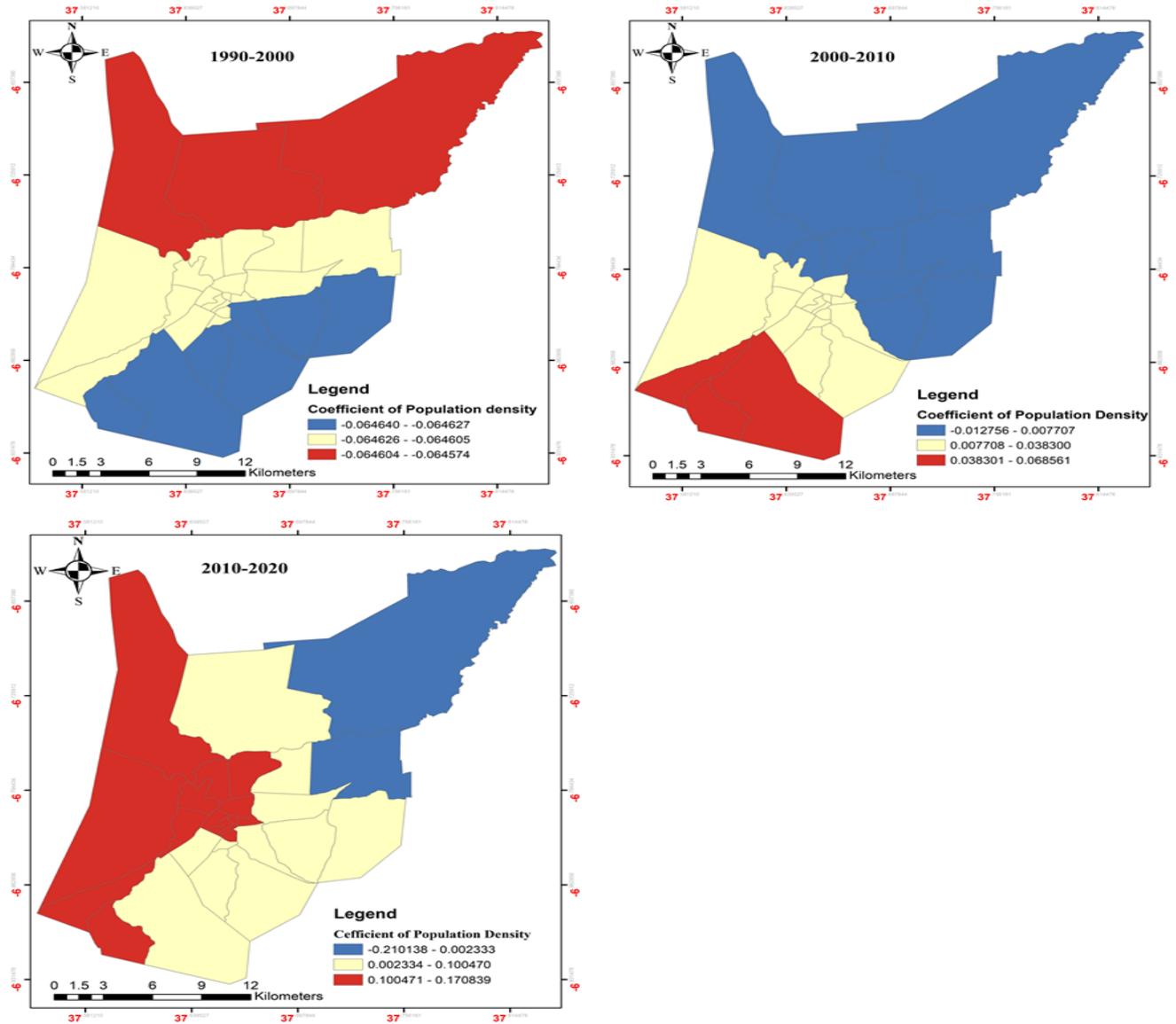
Figure 3.1: Regression coefficients of population density and healthcare facilities for different time periods
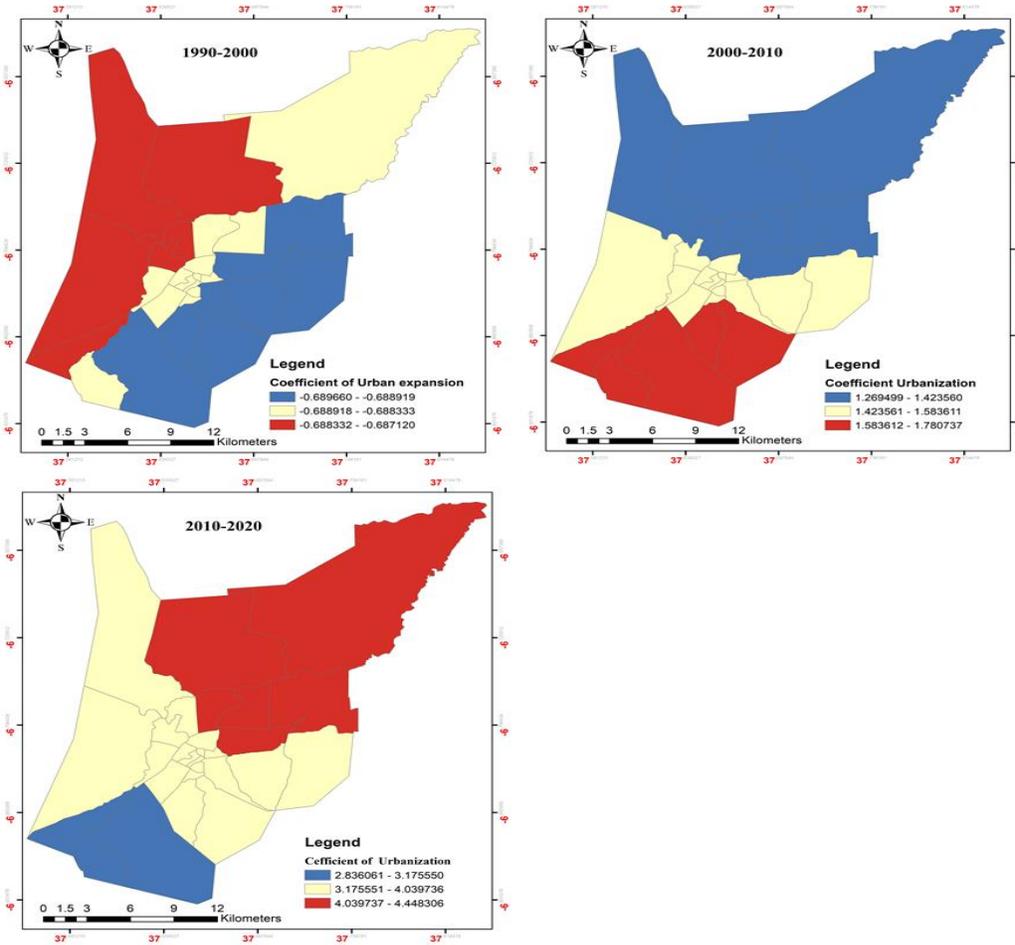
Figure 3.2: Regression coefficients of urban expansion and healthcare facilities for different time periods

As for the urbanization in **Figure 3.3** below, the greatest regression coefficients of urban expansion for the three study periods are -0.689, 1.7807 and 4.448 for the 1990-2000, 2000-2010 and 2010-2020 study periods respectively. This output implies that the impact/explanatory power of urbanization on the development of health facilities is increasing progressively

Discussion

Urban expansions

Morogoro Municipality has experienced tremendous and very rapid urbanization. In 1990 to 2020 built-up increased from 3.9% to 18.9% of the total urban area of Morogoro municipality while non built up LULC class decreased from 96.1% to 81.9% of the total urban area of Morogoro municipality (Table 3.1). Spatial distribution of the built-up extent and urban growth from 1990 to 2020 are depicted in (Figure 3.1). Built-up growth tended to expand outward towards all directions but mainly in the north-west

Geographically Weighted Regression model

The first experiment for the estimation of healthcare facilities in Morogoro Municipality using the explanatory variable urban expansion intensity index for different study periods from 1990 to 2020. From the table 3.2 GWR gives the coefficients of determination of Morogoro Municipality in the

different study periods. The coefficients of determination which is for the entire 1990-2020 study period was 0.19. In this study coefficients of determination for the estimation using urban expansion as an explanatory variable are 0.17, 0.019 and 0.0017 for the time periods 2020-2010, 2000-2010 and 1990-2000 respectively, which shows that the explanatory power of urban expansion on the distribution of healthcare facilities is increasing over time. Residual Squares are the sum of residual squares of difference between the observed y and the estimated y in our GWR model.

The overall coefficients of determination for this prediction were 0.599, 0.36 and 0.07 for the time periods 2010-2020, 2000-2010 and 1990-2000 respectively indicating that the explanatory power of the variables urban expansion and population density on the distribution of healthcare facilities has been increasing over the years for the study period. Using urban expansion intensity index and the population density of individual wards as the explanatory variables, the resultant model fits the best for the 2000-2010 time periods which has only 5.71 residual squares (the lowest number among the time periods). Sumari *et al.* (2019) explains the significant relationship between urban expansion of Morogoro Municipality and population increase.

In second experiment The GWR model gives the results of regression coefficient of each explanatory variable for each ward in Morogoro Municipality considering their spatial distribution. The coefficient of determination of population density in the three time periods showed a slow increase y from 1990-2000 to 2000-2010 (-0.06457 to -0.01275) but rose exponentially in 2010-2020 (-0.21013) (Fig. 3.2). This shows that the explanatory power of population density on the development of the healthcare facilities constructions was increasing with time during the study period. This output implies that the explanatory power of urban expansion on the development of healthcare facilities is increasing progressively.

Rahman and Smith (2000) only a handful of academic location and allocation studies in developing nations have claimed implementation of their results since location decision are usually taken by local elected leaders or government officials. Therefore it is essential that we consider national healthcare policies and guidelines while attempting to bridge the gap in spatial distribution of healthcare infrastructures. However, central and local governments have often been negligent in the development of healthcare facilities (Patel *et al.,* 2003) which led to weak relationship between urban expansion and distribution of healthcare facilities. In order to balance the supply and demand for healthcare facilities, there is need for concerted effort to alleviate the service quality and distribution concern about the existing situation (Rahman and Smith, 2000).

Also has been observed that in developing countries healthcare facilities in urban area 27% of the population concentration about 75% of healthcare infrastructure and other health resource (Patil *et al.,* 2002).The GWR model gives the results with the regression equation and coefficient of each explanatory variable for each ward in Morogoro municipal considering their spatial location. The greatest coefficient of population density in the three study periods was increasing slowly from 1990-2000 to 2000-2010 (-0.06457 to 0.068561) but rise exponentially in 2010-2020 (0.170839) (Figure 3.2). This shows that the impact/explanatory power of population density on the development of the health instructions is increasing with the time in the study period.

Conclusion
In this study GWR model was experimented twice to explain the spatial relationship between urban expansion and distribution of healthcare facilities in Morogoro Municipality. The GWR tool produces a variety of outputs. In the first experiment coefficients of determination for the estimation using urban expansion as an explanatory variable were 0.17, 0.019 and 0.0017 for the time periods 2020-2010, 2000-

2010 and 1990-2000 respectively, which shows that the explanatory power of urban expansion on the distribution of healthcare facilities is increasing over time.

In the second experiment where an additional variable (population density) was included, the overall coefficients of determinations for this prediction were 0.599, 0.34 and 0.07 for the time periods 2010-2020, 2000-2010 and 1990-2000 respectively indicating that the explanatory power of variables urban expansion and population density was increasing with time over the years of the study period. This implies that during 1990-2000 there was weak relationship same for 2000-2010 while 2010-2020 experienced moderate relationship. Within the 30 year study period it's shown that there is progressive growth of relationship between variables i.e., urban expansion and distribution of healthcare facilities from weak in 1990 to moderate relationship in 2020.

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Prevalence and risk factors associated with *Schistosoma haematobium* infection among school pupils in an area receiving annual mass drug administration with praziquantel: a case study of Morogoro municipality, Tanzania

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Abstract

Background: There is a scarcity of accurate data on *Schistosoma haematobium* infection on country-specific prevalence despite mass drug administration over the years. Prevalence estimates for the number of people infected and the number at risk of infection must still be made based on calculations of limited prevalence survey data at the country level. This study aimed to fill in the gap of data on prevalence in an urban setting that has been receiving mass drug administration with praziquantel and determine the risk factors associated with *S. haematobium* infection among school pupils.

Method: A cross-sectional, stage-wise random sampling survey of *S. haematobium* infection, factors influencing its transmission and mass drug administration with praziquantel were studied among primary school pupils in Morogoro Municipality. A semi-structured questionnaire was used to collect data on risk factors, and urine samples were collected from pupils and examined for *S. haematobium* eggs and macro and microhematuria. Results were analyzed using SPSS version 12.0.

Result: The overall prevalence rate of *S. haematobium* infection was found to be 32.5% (95% CI, -3.1- 5.6%) in the ten schools that were sampled. It was observed that 228/884 (25.8%) of the pupils had low infection intensity and 82/884 (9.3%) had high infection intensity. The total number of pupils that had *S. haematobium* infection was 287, where 116 (40.42%) of them had micro-hematuria. The proportion of students that did receive praziquantel in the last general distribution was found to be 14.3% while 25.8% of the students had low infection intensity and 9.3% had high infection intensity across all age groups. Whereby 3.96% of pupils that received praziquantel in the last general administration also had *S. haematobium* infection (OR 0.77, 95% CI 0.5-1.2) The risk factors associated with *S. haematobium* infection were playing, bathing, fishing in rivers and helping parents work in rice fields (p –value<0.001).

Conclusion: The prevalence and intensity are high enough to cause re-infection. Still, more effort is needed to enforce mass praziquantel administration among primary school pupils, alternative water sources for recreational activities, provision of proper latrines and further studies needed to explore the risk factors.

Keywords: *Schistosoma haematobium*, mass-drug administration, urinary schistosomiasis, primary school children

Introduction

Schistosomiasis remains one of the most prevalent parasitic infections in the world, whereby, as of 2021 estimates showed that at least 251.4 million people required preventive treatment (WHO, 2020). *Schistosoma haematobium* causing urogenital schistosomiasis is among the water-borne neglected tropical diseases associated with significant morbidity and mortality in tropical and subtropical areas (Grimes et al., 2014).

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People are infected when schistosomes are transmitted during contact with fresh water contaminated with human excreta containing parasite eggs. A snail host must be present in the water to allow the parasite to complete its life cycle. It is particularly linked to agricultural and water development schemes. Groups at risk for schistosomiasis are preschool-aged children (pre-SAC), school-aged children (SAC), adults in certain occupational groups, women who are in contact with infected water for domestic activities and entire communities in high-risk areas (WHO, 2020). Preventive treatment is required to be repeated over several years, to reduce and prevent morbidity. However, preventive chemotherapy for schistosomiasis, where people and communities are targeted for large-scale treatment, is only required in 51 endemic countries with moderate-to-high transmission (Engels et al., 2002; WHO, 2020).

In Tanzania, schistosomiasis prevalence is estimated at 51.5% whereby, approximately 23.2 million people were estimated to have schistosomiasis in 2011 (Mazigo et al., 2012) however, no recent country prevalence has been estimated. Urogenital schistosomiasis is endemic at varying transmission levels in all administrative regions and districts in the country (Mazigo et al., 2012). *S. haematobium* worms' dwell within the veins draining the main pelvic organs, including the bladder, uterus, cervix and rarely in the gastrointestinal organs (Santos et al., 2021). In the infectious stage of the parasite, larvae cercariae that emerge from freshwater snails infect humans through direct skin penetration. The worms migrate into the circulation, mature and lodge within the venous plexus of the bladder, where they reproduce, and females release eggs. The released eggs provoke granulomatous inflammation and the primary organ affected is the ureter (Warren et al., 1967).

The developed lesions lead to the formation of sandy patches, ulcerations and polypoid lesions in the bladder and ureters, resulting in hematuria, obstructions of urine flow, calcified bladder wall and cancer (Hatz et al., 1998; King, 2001; Santos et al., 2021). Common early signs include dysuria, proteinuria, and hematuria (Hatz et al., 1998; King, 2001). Epidemiological and clinical studies conducted in part of Tanzania mainland (McMahon, 1967; Poggensee et al., 2000; Sarda et al., 1985; Scheich et al., 2012; Zumstein, 1983) and the islands of Zanzibar (Forsyth & MacDonald, 1965, 1966; G. Macdonald & Forsyth, 1968; M. Macdonald, 1968; Rudge et al., 2008; Stothard et al., 2002), have reported high prevalence of *S. haematobium* and different types of morbidities associated with urogenital schistosomiasis across all age groups and gender.

Mass drug administration (MDA) targeting SAC within the school environment campaigns were initiated in numerous endemic areas, Tanzania included (World Health Organization, 2013). There is indeed evidence that the impact of treatment on morbidity decreases with age and that repeated treatment in the early stages of life has a long-lasting effect on morbidity at a later by preventing chronic sequel in adulthood (Engels et al., 2002). Parasitological data are used to determine the eligibility of an area for MDA based on the endemicity level (Sturrock et al., 2009; WHO, 2006). Although the intensity of schistosome infection has greater relevance to transmission dynamics and morbidity (Dye, 1991), the prevalence of infection, based on microscopic examination of schistosome eggs in stool or urine samples, remains the most widely used indicator of infection status and is employed by WHO in making recommendations for control (Clements et al., 2006). However, mapping using parasitological data on SAC and primary school children is still very limited and despite years of MDA in the country, there is limited information on post-MDA geographical prevalence for many of the endemic districts (Ministry of Health Tanzania, 2010).

Over the years, Morogoro region has been implementing MDA with Praziquantel (PZQ) to primary school pupils (PSPs) as the main intervention for the control of schistosomiasis (Ministry of Health Tanzania, 2010). Yet prevalence and intensity of urinary schistosomiasis in Morogoro municipality are not available and no post-MDA prevalence has been assessed. The risk factors associated with schistosomiasis transmission; potentially infected water with cercariae and inadequate sanitation and hygienic practices continue to supplement the circle of re-infection and no studies have been carried out to reassess their role in transmission. There is a gap in the area of linking MDA with praziquantel, post-MDA prevalence and associated risk factors among SAC in an area of urban setting. Data from urban settings is needed to aid in the implementation and

evaluation of interventions control of *S. haematobium* infections causing urogenital schistosomiasis. The current study aimed to address this gap and determine the prevalence and intensity of urinary schistosomiasis and the factors associated with its transmission.

Method
Study area
The study was conducted in Morogoro municipality within the Morogoro Urban District. Morogoro Urban District is one of the six districts of the Morogoro Region of Tanzania. Morogoro Municipality has of population of 471,407 people and has a variety of water sources including, shallow wells, constructed or improved traditional pipe water systems, streams and rivers, dams, and bore holes (National Bureau of Statistics, 2020). Mass drug administration with praziquantel and albendazole to SAC is implemented in Morogoro municipal (Neglected Tropical Diseases Program Tanzania, 2023).

Study design
This was a cross-sectional study in which a semi-structured questionnaire was used to generate information on visible hematuria, water contact patterns, hygiene or sanitary practices and MDA with praziquantel. The target of the study population was primary school pupils of all age groups from the public primary schools in the Morogoro municipality.

Sample size estimation
Ten out of fifty-six primary schools were multistage random sampled in which a minimal number of 778 was required to be sampled. A total of 884 students ended up being sampled.
The minimum sample size was obtained using the following formula:

$$n = (1.96/ w) 2 p (1-p)$$

Where: n = sample size (minimum sample size)
W = margin of error on P (3%) = 0.03
p = the highest prevalence of S. *haematobium* that had been found to infect primary school children in the study area (86%) = 0.86.
Therefore; n = (1.96/0.03) 2 0.86(1-0.86) = 512
This was a stage-wise random sampling, therefore calculated variance inflation factor (f) is 1.5: 514(f) = 514 * 1.5 = 768, when added 10% for missing data, dropout or non-response the sample size was 845.
The minimum calculated sample for this study was 845 primary school pupils. We interviewed 884 pupils from ten schools.

Sampling procedure
Two-stage random sampling was used to select participants who were interviewed using a semi-structured questionnaire. During sampling, a sampling frame of all public primary schools located in the municipality was obtained from the Municipal Education Officer. Using a list of all public primary schools in the Municipality, the name of each of the primary schools in the municipality was written on a separate piece of paper and then assembled in one box for sampling. A simple random sampling was applied by picking ten pieces of paper with the names of ten primary schools. After selecting the schools, the names of pupils were obtained from the daily attendance book by random sampling. All identified pupils from the daily attendance and who agreed to participate were included in the study. Pupils who were identified and agreed to participate but were absent at the time of the study were excluded. The refusal to participate was respected and replaced by other pupils from daily attendance who agreed to participate.

Data collection

A semi-structured questionnaire was used to generate data from the pupils. Immediately after interviewing the pupils, the next step was to collect urine specimens in which screwed plastic containers marked with an identification number were provided to each of the sampled pupils to collect a fresh urine sample. Pupils were instructed to collect about 10 millilitres of fresh urine specimens respectively. The pupils received thorough instructions on how to collect a sufficient amount of urine. Urine samples were collected between 10.00 a.m. and 2.00 p.m., a convenient time for high egg output. Ten pupils at a time were allowed at once to go for urine sample collection to make sure that they did not find an opportunity to share their urine samples. The collected urine sample was mixed with 2 milliliters of 10% formaldehyde to prevent bacteria growth and eggs hatching then were placed in a cold box immediately after collection. The samples were taken to the laboratory for examination on the same day. In brief, 10 ml from each sample of urine was passed through a millipore filter (12 μm polycarbonate filter), and the filter then was placed on a glass slide for quantitative examination of *S. haematobium* eggs under a light microscope (x40 objective lens). Those found with one or more eggs were recorded as infected and the number of *S. haematobium* eggs present in each preparation were counted and recorded.

Data management and analysis

Data was entered during and after data collection, coded and classified to adjust for any missing information. The primary data was entered into Microsoft Excel and then transferred to and analyzed using SPSS Version 12.0. Frequency tables and cross-tabulation were produced where appropriate and a logistic regression model was applied to identify explanatory variables that have a significant role in influencing dependent variables. Moreover, an association was made for the independent and dependent variables using a significance level set at $p = 0.05$. The mean prevalence of schistosomiasis allows a district to be classified as follows: non-endemic (0%), low (< 10%), moderate (10% to < 50%), or high (> 50%) risk (World Health Organization, 2014). The number of eggs per filter was counted, and the infection intensity was classified as light (<50 eggs/10 ml of urine) or heavy (≥50 eggs/10 ml of urine), as defined by the World Health Organization ("Prevention and Control of Schistosomiasis and Soil-Transmitted Helminthiasis.," 2002).

Ethical clearance

Ethical approval was obtained from the Senate Research and Publications Committee, and the Institutional Review Board of the Muhimbili University of Health and Allied Sciences (MUHAS) (Ref. MU/PGS/SAEC/Vol. IV/200). Permission to conduct the study in Morogoro Municipality was obtained from the Municipal Education Officer who issued written permission to the sampled schools. Written and verbal consent was obtained from the participants and their parents/guardians. During the survey arrangements were made with the nearest public health centre or dispensary for the possibility of treating children who were found to have urinary schistosomiasis.

Results

Background characteristics of the study area

The main water body identified in the area was the Morogoro river. This river runs across the study area. This was considered as a potentially infected water body even though there were no snails sampled from this river in the study. Sewage systems were observed to have outlets into the river and the major human water contact sites were identified. Water contact sites were observed to be regular swimming, bathing, fishing and crossing points for the pupils. Other various points on the river were used for washing, and collecting water for gardening. Other sites were not fully observed due to poor infrastructure.

Demographic characteristics

The study involved a total of 884 pupils who were interviewed and their urine was screened for *S. haematobium* infection. In the schools sampled, the majority of students were from Kalakaua Primary School (16%), this was due to their willingness to participate in the study (Table 1). All school children sampled were from standard one to standard seven, females were 459 (51.9%) and males 425 (48.1%) with a mean age of 10.9 years (SD=2.4) for males and 10.6 (SD=1.7) years for Females.

Table 1: Distribution of pupils according to their schools. (N=884)

Name of school	N (%)
Bungo	117 (13.2)
Chamwino	133 (15.0)
Kilakala	141 (16.0)
Kiwanja cha ndege	70 (7.9)
Mchikichini	75 (8.5)
Mkwajuni	64 (7.2)
Mtawala	70 (7.9)
Mwembesongo	63 (7.1)
Mwere	90 (10.2)
Uhuru	61 (6.9)

Prevalence of S. haematobium among school pupils in the study population

The overall prevalence rate of *S. haematobium* infection was found to be 32.5% (287 pupils out of 884 (95% CI, -3.1- 5.6%) in the ten schools that were sampled. Furthermore, the prevalence was then analyzed within the age groups, whereby, in the age group 6-8 years only 35% had *S. haematobium* eggs, followed by the age group 12-14 years with 34.97%, 9-11 years with 30.95% and least infected was age group 15-16 years with 21.64% (Table 2).

Table 2: Prevalence of S. haematobium infection among age groups

	Age groups			
	6-8 years	9-11 years	12-14 years	15-16 years
With eggs in urine	35 (35%)	147 (30.95%)	100 (34.97%)	5 (21.74%)
Without eggs in urine	65 (65%)	328 (69.05%)	186 (65.03%)	18 (78.26%)
Total	100	475	286	23

Prevalence was again analyzed within each sex group. Within the male group, only 33.88% had *S. haematobium* eggs in their urine and 31.15% in the female group (Table 3).

Table 3: Prevalence of *S. haematobium* by sex in the study population

	Sex of Pupil	
	Male	Female
With eggs in urine	144 (33.88%)	143 (31.15%)
Without eggs in urine	281 (66.12%)	316 (68.85%)
Total	425	459

Intensity of S. haematobium among school pupils in the study population

It was observed that 228/884 (25.8%) of the pupils had low infection intensity and 82/884 (9.3%) had high infection intensity. Further analysis was done on the pupils with *S. haematobium* infection (eggs) only. When the level of intensity was analyzed among age groups, the high infection intensity was observed in age group 6-8 years (35.14%), followed by age group 9-11 years (26.19%), age group 12-14 (24%) and age group 15-16 years (20%) (Table 4).

Table 4: Intensity of *S. haematobium* infection by age among students with infection

	Age groups			
	6-8 years	9-11 years	12-14 years	15-16 years
Low infection	24 (64.86%)	124 (73.01%)	76 (76%)	4 (80%)
High infection	13 (35.14%)	44 (26.19%)	24 (24%)	1 (20%)
Total N (%)	37	168	100	5

Furthermore, the level of intensity was then calculated within sex groups, results showed that in males, high infection intensity was 31.54% while in females was 23.18% (Table 5).

Table 5: Intensity of *S. haematobium* infection by sex among students with infection

	Sex of Pupil	
	Male	Female
Low infection	112 (70.44%)	116 (76.82%)
High infection	47 (31.54%)	35 (23.18%)
Total N (%)	159	151

Relationship between blood in urine in the past year and S. haematobium eggs

The study assessed if pupils had observed blood in their urine within the past year at the time of the study. Almost twenty-eight per cent (27.83%) of the pupils observed blood in their urine. The relationship between pupils who urinated blood in the past year and those who were found to have *S. haematobium* eggs in the urine was then analyzed. The odds that a pupil who urinated blood in the past year and had *S. haematobium* eggs was 16.11 more likely than those pupils that did not observe blood in their urine, which was statistically significant (95% CI 11.06%,23.28%, p-value <0.001) (Table 6).

Table 6: Relation between pupils that urinated blood within the past year and *S. haematobium* eggs in their urine.

	S. haematobium eggs in urine	Odds ratio	95% Confidence intervals

Urinated blood in the past year	246 (27.83%)	16.11	11.06 - 23.48

p-value<0.001

Urinating habits of primary school pupils

The study determined that 287 pupils out of the 884 sampled pupils frequently swam in water bodies (rivers, dams, streams, ponds). Further analysis was done to determine the response within the age groups. Generally, most pupils did not urinate in water in all age groups, however, for those that did, in age groups 6- 8 years 34.29% urinated in water while age group 15-16 years was 40% which accounted for only 2 students (Table 7).

Table 7: Urinating habits of pupils who swim in water bodies in the study population

swimming in water bodies where do you urinate	Age groups			
	6-8 years	9-11 years	12-14 years	15-16 years
Urinate in water	12 (34.29%)	61 (41.5%)	29 (29%)	2 (40%)
Urinate out of water	23 (67.71%)	86 (58.5%)	71 (71%)	3 (60%)
Total	35	147	100	5

In instances where toilets were not available to pupils, alternative accommodations were assessed. The answers were analyzed based on the provided options for answers (bushes, rivers. Streams, farms) and 2.38% of pupils urinated in rivers while the majority 95.14% did not pick any of the provided options (Table 8).

Table 8: Alternative areas pupils urinated when are not available at home or school

If toilets are not available where else do you defecate?	
	N (%)
Bushes	12 (1.35)
Rivers	21 (2.38)
Streams	4 (0.45)
Farms	6 (0.68)
Other	841 (95.14)
Total	884 (100)

Risk factors for S. haematobium among pupils in the study population

The risk factors were then analyzed to see the association between those factors and *S. haematobium* infection to see if they contributed to putting a pupil at risk of having *S. haematobium* infection. Those pupils that bath in rivers, ponds, dams or streams were 7 times more at risk of being infected with *S. haematobium* than the pupils that did not bathe in the water bodies. The pupils who played in the water were 3.7 more times at risk of being infected than those pupils who did not play in the water. And those who went fishing were 4 times more at risk of being infected with the parasite than those who did not fish. These above-mentioned risk factors are statistically significant (Table 9).

Table 9: Association between Risk factors of S. haematobium and eggs in pupil's urine

Variable	S. haematobium eggs		Total	Odds ratio	95% CI
	Yes	No			
Sex of respondent					
Male	144 (50.2%)	281 (47.1%)	425 (48.1%)	1.1	0.9-1.5
Female	143 (49.8%)	316 (52.9%)	459 (51.9%)		
Did you take PZQ in the last MDA?					
Yes	252 (87.8%)	506 (84.8%)	758 (85.7%)	1.3	0.8-2.0
No	35 (12.2%)	91 (15.2%)	126 (14.3%)		
Do you like playing in water (not necessarily swimming)?					
Yes	186 (64.8%)	197 (33.1%)	383 (43.4%)	3.7	2.7-5.1
No	101 (35.2%)	399 (66.9%)	500 (56.6%)		
Do you bathe in a river/pond/dam/stream?					
Yes	224 (78.0%)	202 (33.8%)	426 (48.2%)	7	5.0-9.8
No	63 (22.0%)	395 (66.2%)	458 (51.8%)		
Do you go fishing?					
Yes	71 (24.7%)	45 (7.5%)	116 (13.1%)	4	2.6-6.2
No	216 (75.3%)	552 (92.5%)	768 (86.9%)		
Do you help your parents work in rice fields?					
Yes	67 (23.3%)	104 (17.4%)	171 (19.3%)	1.4	1.0-2.1
No	220 (76.7%)	493 (82.6%)	713 (80.7%)		

Primary school pupils carrying S. haematobium eggs and have hematuria in the study population

Pupils who had *S. haematobium* infection (eggs) in their urine were then analyzed for macro-hematuria and micro-hematuria. The total number of pupils that had *S. haematobium* infection was 287, where by 116 (40.42%) of them had micro-hematuria (Table 10).

Table 10: Proportion of pupils with microhematuria and *S. haematobium* infection

Macrohematuria	N
Present	116 (40.42%)
Absent	171 (59.58%)
Total	287

For micro-hematuria, the results showed that 276 (96.17%) of pupils that had *S. haematobium* infection also had red blood cells in their urine, which is an indicator of micro-hematuria (Table 11).

Table 11: Proportion of pupils with microhematuria and *S. haematobium* infection

Microhaematuria	N (%)
RBCs present	276 (96.17)
RBCs not present	11 (3.83)

Total	287 (100)

Praziquantel uptake among pupils in the study area

Out of the 884 students sampled, 126 (14.3%) took praziquantel in the last annual MDA and 758 (85.7%) did not take praziquantel (Table 12).

Table 12: Sex of pupils who took Praziquantel in the last annual administration

Sex	Did you take PZQ in the last MDA?	
	Yes	No
Male	56 (13.2)	369 (86.8)
Female	70 (15.3)	389 (84.70)

PZQ; Praziquantel

The relationship between those pupils who received praziquantel in the last MDA and had *S. haematobium* infection (eggs) was observed. 3.96% of pupils who received praziquantel in the last general administration also had *S. haematobium* infection and the odds of having infection despite taking the drug was 0.77 (95% CI 0.5-1.2) (Table 13).

Table 13: Relationship of Praziquantel intake with the presence of *S. haematobium* eggs in pupil's urine

S. haematobium eggs	Praziquantel uptake			
	Yes	No	OR	95% CI
Absent	91 (10.29)	506 (57.24)	0.77	0.5-1.2
Present	35 (3.96)	252 (28.51)		

Discussion

This study was undertaken two years after the last mass distribution of praziquantel to primary school pupils of Morogoro municipality. At this time all pupils and teachers were aware of the MDA and effort put into controlling urinary schistosomiasis. Schools sampled were ten and from each school, the number of pupils sampled varied. Many pupils sampled were females 459 (51.9%) with a mean age of 10.6 years. From data obtained from the Primary school Municipal Education Office, more female pupils were enrolled in schools compared to males hence a possible explanation as to why there were more female pupils sampled compared to male pupils. The male pupils were 425 (48.1%) and a mean age of 10.9 which is slightly higher than that of females. These mean age falls under the peak age of being at risk of being infected by *S. haematobium* that has been found in other studies such as the one done in Nigerian primary schools whereby both the prevalence and intensity of infection were found to be the highest in children aged 10± 14 years (Ejezie & Ade-Serrano, 1981).

Prevalence and infection intensity of S. haematobium among school pupils

The overall prevalence of *S. haematobium* infection in Morogoro municipality was found to be 32.5% respectively. These findings corroborate the results of previous studies conducted in the country (Brooker et al., 2001; Clements et al., 2006; Mazigo et al., 2022). However, the prevalence obtained in this study is lower compared to the previous prevalence reported in the area of 85% prevalence (Morogoro Municipal Council, n.d.) but confirms that *S. haematobium* is still a disease that needs controlling. The difference in prevalence may be attributed to different seasons when the study was carried out since there is seasonal variation in the transmission of *S. haematobium* infection (Webbe & Jordan, 1966). In addition, it may be due to the ongoing schistosomiasis control initiative of MDA with praziquantel (Ministry of Health Tanzania, 2010).

The overall intensity in this study of *S. haematobium* infection in Morogoro municipality was 35.1% respectively. To understand better the level of infection intensity aggregate it in age and sex groups. Generally, in all age groups, the intensity was low, but notable within the 6-8 years age group, previously reported to be at high risk of infection in other areas (Brooker et al., 2001; Clements et al., 2006; Mazigo et al., 2012, 2022; Sarda et al., 1985) and other countries (Ejezie & Ade-Serrano, 1981; Santos et al., 2021; Umoh et al., 2020) where *S. haematobium* infection is endemic. An earlier report indicated the distribution of schistosomiasis in endemic communities fits a negative binomial curve, with most infected persons harboring low worm burdens and only a small proportion having heavy infections (Mahmond, 2000). This may explain the trend observed in this study. However, the aggregation of worm burden in a small proportion of infected individuals may have multiple explanations including genetic susceptibility (Secor et al., 1996).

In addition, the variation in the intensity of infection depends partially on the different levels of endemicity, the season when the study is conducted, the methods used and, the time, when urine specimens are collected for analysis (Ndyomugyenyi & Minjas, 2001). The age of pupils also factors in when prevalence and intensity are being calculated and in this study the pupils between the ages of 6-11 years old had the high prevalence and intensity. The prevalence and intensity often observed in this age group have been attributed to high human-water contact and exposure to infection (Mazigo et al., 2012).

Hematuria among school pupils

The classical sign of urinary schistosomiasis is hematuria (Carabin et al., 2000; GUYATT et al., 1994). Hematuria is correlated with the intensity of the infection (Wilkins et al., 1979, Mott et al., 1983, Tanner et al., 1983). This study observed a relationship between urinating blood in the past and *S. haematobium* infection. Even though the pupils who urinated blood and were found to have infection were only 27.83% they were 16.1 times more likely to be at risk of getting infected than the pupils who did not urinate blood in the past. The prevalence of microhematuria was 96.17% and that of microhematuria was 40.42% in pupils that had *S. haemotobium* infection.

The study observed an overlap of microhematuria and microhematuria, in infected pupils. Pupils that had macrohematuria were all positive for microhematuria but those with microhematuria were not all positive for macrohematuria. This was a single-day result from the filtration technique to determine hematuria. This has the disadvantage of the inadequacy of a single urine filtration to determine *S. haematobium* eggs. A study done in Ifakara, Tanzania, observed that single-day results were negative despite high intensity (>50 eggs/10ml urine) of infection on other days (Berhe et al., 2004). For those pupils, hematuria was observed but no eggs were detected. This could be explained by other infections such as Urinary Tract Infections, menstrual bleeding in older female pupils and other medical conditions that were not examined in this study. In this study, observation was by the naked eye looking at the various shades of urine whereby there were three options, yellow, light red and dark red and no reagent strips were used.

Another study carried out in the Ilala district, used chemical reagent strips and reported a sensitivity of 84.3% (Ndyomugyenyi & Minjas, 2001). That same study used the history of hematuria as a second sensitive indirect method to identify infected pupils (60.4%), visual observation was the least sensitive (37.7%) but the most specific (91.7%). Therefore, school-based questionnaire methods reporting the occurrence of red urine can also be useful for targeting, or eliminating, areas for treatment where urinary schistosomiasis is likely endemic.

Risk factors for S. haematobium among school pupils

In a study done in Ghana investigating the relationship between water contact habits of males and females to prevalence, observed that among male pupils 41.2% engaged in swimming activities whereas only 29.3% of females were involved. Also 36.7% of the males and 32.6% of the females bathed in a river. Other activities in the water like washing dishes and clothes attracted 22.0% and 38.0% of males and females respectively (JO Awotunde EO Okanla BN Agba, 2002). Recreational

water activities such as swimming and playing in water have been observed to result in more frequent and intensive infection with potentially infective water in Egypt (H Kloos, 1982), South Africa (Kvalsvig & Schutte, 1986) and Tanzania (Landier et al., 2016).

In this study, urinating habits were observed from pupils who went swimming in rivers and those who at one point or another lacked a functioning toilet at home or school and hence urinated in rivers, streams or dams. Among the sampled pupils 41.5% in the age group 9 to 11 years admit to urinating in the water while swimming. Other studies have shown that transmission of urinary schistosomiasis occurs when the infected person urinates in the water bodies which serve as a source of drinking or bathing, thereby introducing eggs which hatch into larvae that infect the snail hosts (Grácio et al., 1992). This study also explored risk factors that might have contributed to the transmission of *S. haematobium*. The pupils who fish, play and/or bathe in rivers, ponds, dams or streams, are more at risk of being infected with *S. haematobium* compared to pupils who did not engage in these activities. These noted risk factors play a role in exposing a pupil to being infected with the parasite and this was observed in other studies such as the one done by Engles and Savoli, that state *S. haematobium* infection is acquired through exposure to unsafe environmental water infested with schistosome larvae (Engels & Savioli, 2006).

Praziquantel uptake among primary school pupils in the study population

The use of chemotherapy in the control of schistosomiasis was advocated a while back but a driving force came when the price of praziquantel was reduced. In addition, as part of the World Health Assembly 54.19 resolution, deworming is firmly on the international health agenda and increasing access to ant-helminthics, particularly in SAC, is a key target promoted by the WHO (Savioli et al., 1997). Over the current years, praziquantel has been distributed to primary school children in Morogoro region. This was taken into consideration in this survey and the results show that 14.3% of students took praziquantel in the last annual distribution in Morogoro Municipal.

According to the Schistosomiasis Initiative Control Program, Morogoro region had the lowest coverage among all regions that received Praziquantel in MDA (Neglected Tropical Diseases Program Tanzania, 2023). The pupils experienced side effects such as fainting that created panic throughout the community hence led to parents refusing their children to participate in the MDA. Those who took praziquantel in the last general distribution and yet had *S. haematobium* infection were few (3.96%) compared to those who did not take praziquantel in the last general distribution (10.29%). The lack of difference may be attributed to the fact that even the students who did agree to have taken the drug in the last general distribution might have lied or they truly did take the drug and managed to stay from contaminated waters.

Praziquantel should still be advocated and distributed since the information about the accuracy of its distribution in the last round in the study area is sketchy. The study was a cross-sectional study that was limited in exploring the seasonal variation in *S. haematobium* transmission and other environmental and genetic factors that influence the prevalence and transmission of this disease.

Conclusions

This study provides an important observation on the status of infection in this urban area of Tanzania and exemplifies the national efforts to advance active participation in schistosomiasis prevention and control activities at the sub-district levels. The study revealed that the prevalence of *S. haematobium* among primary school children in Morogoro municipality was 32.5% and MDA with praziquantel coverage was 14.3%. This study also revealed the risk factors that contributed to *S. haematobium* infection among pupils. Factors such as playing in water, bathing in rivers, ponds, dams or streams, and fishing, were found to have a statistical significance in contributing to *S. haematobium* infection among the pupils. Praziquantel uptake was very low in the study population which was explained by the severe negative side effects the pupils experienced. These

results could be a reflection of other parts of the country in the uptake of MDA, hence, much effort is needed to restore the faith in mass administration of praziquantel.

Complementary integrated control activities, such as environmental management measures, should be planned with other sectors such as agriculture and water resource development programs. It is also important to ensure that any development activity likely to favour the emergence or spread of schistosomiasis and other parasitic diseases is preceded by a proper health impact assessment and accompanied by preventive measures to limit their impact.

Authors' contributions

TEN conceived, collected data, performed analysis, data interpretation and wrote and approved the manuscript.

Competing interests

The author declares that she has no competing interests.

Availability of data and material

All data generated or analyzed during this study are included in this published article.

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Assessment of Bacterial contamination and associated risk factors in pork slaughtered and marketed in urban Tanzania

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Abstract
Introduction: In Tanzania, pork consumption is increasing and become popular in urban areas creating a good market for pigs raised in rural areas. However, little is known regarding the microbial safety of the marketed pork in the country. This study assessed the level of bacterial contamination and contributing factors in pork slaughtered and sold in Arusha, Dar es Salaam and Dodoma Tanzania through Total Viable count, Coliform count, *Escherichia coli* and *Staphylococcus aureus* count.
Methods: A cross-section study was conducted and a total of 90 pork samples were collected from pig slaughter facilities, pork centres and butcheries. Standard methods for microbial analysis in food products (ISO 7218:2007(E)) were used.
Results: It was revealed that all (100%) pork samples had bacteria contamination with an overall mean for total viable count of 5.93±1.50 log CFU/g, and coliform forming unit of 4.30±1.14 log CFU/g. Over 92.2% of the pork samples were contaminated by *E.coli* with a mean count of 3.12±1.33 and *S. aureus* was isolated in more than 84.4% with a mean count of 2.71±1.34 log CFU/g. The mean values were higher than the limit set by Tanzania Standard (TBS/AFDC 22 (5266) P3). In addition, 79.4% of the pork slaughter facilities and selling points surveyed had poor hygiene and lacked safety and quality control measures.
Conclusion: Thus, it may be deduced that the pork carcasses assessed were of poor microbiological quality posing a health risk to pork consumers. To minimize public health risks, food control authorities should ensure effective enforcement of policies and regulations in controlling pig slaughtering and pork marketing in the country. Also, education on hygienic practices for all stakeholders along the pork value chain should be provided.

Keywords: Bacteria contamination, pork, slaughter facilities, food safety, coliform bacteria

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Introduction

Pork is an excellent source of protein, essential fatty acids, minerals, and vitamins needed for human health, but it also supports the growth of numerous microorganisms (Bantawa *et al.,* 2018; Rortana *et al.,* 2021). Principally pork from a healthy pig contains no or very little number of microorganisms, however,   contamination occurs during processing stages such as slaughtering, storage and transportation the source of contamination could be equipment, handlers and knives as well as other environmental sources like air and water (Soepranianondo and Wardhana, 2019; Uzoigwe *et al .,* 2021).

The pork and pork products contaminated with microorganisms pose a health risk to consumers as well as food losses due to spoilage (Pellissery *et al .,* 2020). Globally one-third of foods produced for human consumption is wasted each year (FAO, 2022). Food deterioration, which renders food unfit for consumption, is the main cause of this wastage. Since pork has a moderate pH and a high nutritional and moisture content compared to other food products, it is one of the most perishable foods. Microbiological proliferation is among the main causes of meat deterioration. Meat becomes unfit for human eating when its nutrients are broken down by microbial growth and autolysis, which causes the development of unpleasant smells and odours, the formation of slime, and discolouration (Pellissery *et al .,* 2020). The level of microbiological contamination is a good reflection of hygienic practices in pork handling (Bahir *et al.,* 2022).

About 1.9 million people worldwide die each year from food-borne infections, which are the primary cause of illness in underdeveloped nations (Abebe *et al.,* 2020). Significant underlying issues with food safety are shown by the high prevalence of diarrheal illnesses in many poor countries (WHO, 2022). Recently, food-borne illnesses which are associated with bacterial contamination in food including enterobacteria, *S.aureus* and *Salmonella* spp are becoming a major challenge in most African countries (Smith *et al.,* 2022). Their presence and spread are associated with hygiene and handling practices.

The microbiological profile in pork products is the key criterion for determining the quality and safety of fresh produce (Kurpas *et al.,* 2018). Ideally, pork should be considered wholesome when pathogens of concern are absent or if present should be at a low number depending on the toxin or metabolites produced (Bujang *et al.,* 2018). For raw meat products, safety and quality can be estimated by the use of indicator microorganisms, including Total Coliform Count (TCC), *S. aureus* and *E.coli* count (ECC) (Nurye and Demlie, 2021). Also, Total Viable Count provides an estimate of overall bacterial populations in a pork carcass or cuts. A higher TVC usually relates to poor quality and a reduced shelf life. The Tanzania Bureau of Standard have set the minimum limits for microbial load on pork carcasses to be 4log CFU/g for TVC, 2log CFU/g and completely absent for *S. aureus* and *E.coli* count (TBS, 2022).

In addition, in Tanzania, the Meat Industry Act (2006) provides guidance on meat standards and pork safety at the slaughter and butchery levels, through its emphasis on good premises and operators' hygiene. The absence of properly registered and properly regulated pig slaughter facilities as well as modern pork butchers which operate a hygienic environment brought a concern about the microbial quality and safety of pork marketed in Tanzania. Considering the increase in the consumption of pork in the country, proper hygiene and management for protecting public health and strengthening consumer confidence is required. Thus, all processing conditions are important factors which affect the microbiological quality of pork. To improve the safety of final pork products, more

information on the on microbial status of pork and their risk factors is needed so as measures will be taken to improve processing environment and handling of pork. The current study was conducted to assess the level of bacterial contamination on pork carcasses from different pork slaughter places and pork centres and risk factors contributing to the bacterial contamination.

Material and methods

The study was conducted from February to June 2022 involving 3 major cities in Tanzania namely Dar-es-Salaam, Dodoma, and Arusha with a population of 5,383,728, 3,085,625, and 2,356,255 respectively (NBS, 2022). This was purposively selected as the major market for pigs from rural areas.

The study involved a cross-sectional design with the key informant and snowball sampling technique to collect pork samples from 34 slaughter facilities, 41 butcheries and 15 pork centres. The sample size was obtained based on the availability of the slaughter facilities, butcheries and pork centres. Therefore, a total of 90 pork samples were collected (30 samples per city).

Questionnaires and observational checklists were administered to participants from all 34 slaughter facilities, 41 butchers and 15 pork centres obtained through a key informant and snowball technique. One respondent from each facility, butcher or pork centre was interviewed. The information collected included level of education, accessibility to clean and safe water, health check-up of workers, storage facilities, premises condition, use of protective gear, hygienic status and presence of cold storage facilities. This was used for assessing risk factors contributing to microbial contamination.

Pork samples were collected directly from slaughter facilities, butcheries and pork centres. About 250 grams of pork samples were collected and packed in special sterile packets and labelled accordingly, kept in cool boxes with ice packs and subsequently transported to Sokoine University of Agriculture, College of Veterinary Medicine and Biomedical Sciences Microbiology Laboratory for Bacteriology. Microbiological analysis of pork samples involved the Total Viable Count (TVC), Total Coliform Count (TCC), identification and quantification of *Escherichia coli* and *Staphylococcus aureus* were done according to standard methods for food products (ISO 7218:2007(E)) and colonies were expressed in Log CFU/g. Data was analysed using Statistical Package for Social Sciences (SPSS) version 20.0 (IBM-SPSS Inc., Chicago, USA). All values for microbial parameters were presented as Mean ± SD. Statistical differences between pork samples were determined by one-way ANOVA and Duncan multiple comparison post hoc test; $P < 0.05$ was considered statistically significant.

Results

Risk factors and practices contributing to microbial contamination in pork

The results from the study revealed that majority of slaughter facilities, butcheries and pork centre workers have attained primary education. The facilities for pork sellers had poor adherence to regulation for the slaughter and pork selling points. It was found that facilities/premises layout for all the pork processing and selling environment was poor. Moreover, about (79.4%, n=34) slaughter facilities had poor premises condition followed by pork centres (73.3%, n=15) and majority do not have clean water systems, waste water

drainage systems, toilets as well as waste decomposition pits and no zoning for different processes. Also the study revealed that the requirement of wearing personal protective equipment's (PPEs) such as white coat and gumboots were not followed by majority of the workers since about (73.3%, n=15) and (55.9%, n=34) of slaughter and pork centres workers respectively were not wearing them at working area and even some of them had dirty white coats. Furthermore, the study revealed that (62.3%, n=90) of all the assessed pork production and selling points did not have a cold storage facilities such as freezers for storing and pork were hanged on hooks or stored in plastic buckets (Table 1).

Table 1: Risk factors and practices contributing to microbial contamination in pork

Parameter	Category	Slaughter facilities 34	Butcher 41	Pork centres 15
Education	Informal	9(26.5)	5(12.2)	4(26.7)
	Primary	15(44.1)	18(43.9)	6(40)
	Secondary	10(29.4)	14(34.1)	5(33.3)
	Short training	0(0.0)	3(7.3)	0(0.0)
	College	0(0.0)	1(2.4)	0(0.0)
Facility/Premises condition	Good	7(20.6)	26(63.4)	4(26.7)
	Poor	27(79.4)	26(63.4)	11(73.3)
General hygiene	Clean	8(23.5)	28(68.3)	6(40)
	Dirty	26(76.5)	13(31.7)	9(60)
Wearing PPE	Wearing	15(44.1)	29(70.7)	4(26.7)
	Not wearing	19(55.9)	12(29.3)	11(73.3)
Health check-up of workers	After 3/6 month	6(17.6)	3(7.3)	0(0.0)
	Just once	20(58.8)	30(73.2)	6(40)
	No check up	8(23.5)	8(19.5)	9(60)
Cold facilities	Yes	0(0.0)	30(73.2)	4(26.7)
	No	34(100)	11(26.8)	11(73.3)

Total Viable Count in pork

All pork samples were contaminated with bacteria in which the highest mean values of TVC were on pork samples from selling centres with a mean count of 7.33±1.29 log CFU/g. Although there was no significant difference between contaminations load on pork from pork centres and slaughter facilities (p > 0.05). However the difference in microbial contamination between slaughter facilities, butcheries and pork centres were significant (p < 0.05). The maximum TVC observed was in the sample from retail shop with 8.84 log CFU/g and the minimum count was observed in pork sample from butchery with 3.00log CFU/g (Table 2).

Table 2: Mean values (log CFU/g) for Total Viable Count on pork from different pork slaughtering and selling points

Sampling source	N=90	Mean± SD	Min	Max
Slaughter facilities	34	5.58±1.35[a]	3.07	8.21
Butcheries	41	5.70±1.47[a]	3.00	7.93
Pork centres	15	7.33±1.29[b]	3.69	8.84

The values are expressed as mean± standard deviation (Log CFU/g). The mean values along the same column, with the same letters are not significantly different at P≤0.05. Standards: Total Viable Count (TVC) = ≤ 10^4/g (4log CFU/g)

Coliform count for pork samples

Table 3 shows the mean coliform of pork samples from the three (3) different vending sites. The coliform counts had similar trend with that obtained in Total Viable Count (Table 2). Pork samples from pork centres had the highest coliform counts 5.01±1.20 log CFU/g followed by pork sample from slaughter facilities by 4.95±0.94 log CFU/g while the lowest mean coliform count were observed in sample from butcher with 3.88±1.11 log CFU/g. Significant difference (p < 0.05) were observed between pork sample from pork centres and pork from slaughter facilities and butcher. Results indicated higher number of coliform compared to the minimum allowed limit by TBS.

Table 3: Mean values (log CFU/g) for Coliform Count on pork from different pork slaughtering and selling points

Sampling source	N=90	Mean± SD	Min	Max
Slaughter facilities	34	4.49±0.94[a]	2.85	6.34
Butchers	41	3.88±1.11[a]	2.10	5.85
Pork centres	15	5.01±1.20[c]	2.44	6.89

The values are expressed as mean± standard deviation (Log CFU/g). The mean values along the same column, with the same letters are not significantly different at P≤0.05. TBS limit: Coliform Count (CC) = ≤ 10^2/g (log CFU/g).

Occurrence of *Staphylococcus aureus* and *Escherichia coli* count in pork samples

The prevalence of *S. aureus* and *E. coli* in pork samples were 84.4% and 92.2% respectively (table 3). Pork samples from pork centres and slaughter facilities had higher mean contamination for *S. aureus* count by 3.15±1.58 Log CFU/g and 3.11±1.70 Log CFU/g respectively. Also for *E. coli* count the highest mean contamination were observed in samples from pork centres and butcheries by 3.53±1.37 Log CFU/g and 3.00±1.25 Log CFU/g respectively. However, there was no significant difference (p-value > 0.05 at 95% level) among

the samples from slaughter facilities, butcher and pork centres. Moreover there was a significant difference (p-value< 0.05 at 95% level) for *S. aureus* between pork sample obtained in slaughter facilities and the samples from the other two pork selling site. For *E. coli a* significance difference (p-value< 0.05 at 95% level) was observed between sample from retail pork shops and the other three sources (table 4).

Table 4: Mean values (log CFU/g) for *S. aureus* and *E. coli* count in pork

Sampling source	N=90	*S. aureus* (Mean± SD)	*E. coli* (Mean± SD)
Slaughter facilities	34	3.11±1.70[b]	2.82±1.32 [a]
Butcher	41	2.68±1.01[a]	3.00±1.25[a]
Pork centres	15	3.15±1.58[b]	3.53±1.37 [b]

The values are expressed as mean± standard deviation. The mean values along the same column, with the same letters are not significantly different at P≤0.05. TBS limit: *S. aureus* and *E. Coli* count = absent (0).

DISCUSSION
The study assessed the microbiological quality of raw pork slaughtered and marketed in major cities in Tanzania and associated factors. The findings observed bacterial contamination in pork from all facilities although at different levels which was higher than the allowable level for pork intended for human consumption as per Tanzania Bureau of Standards and International standards, thus questioning its safety to the consumers. It was observed that all slaughtering activities were performed on small and dirty floor which predisposed pork to microbial contamination. The whole pork processing and selling environment was unhygienic which was correlated with poor premises and handling of pork.

Nearly all pork outlets lacked facilities for hand washing which includes soap and tape water for reducing cross contamination at working area. The poor hygiene of processing and selling environment exposes pork to microbial contamination (Kurpas *et al*., 2018; Uzoigwe *et al*., 2020). This were supported by the high values of microbial loads observed in pork samples. The findings demonstrate that all pork samples were contaminated with bacteria resulting to poor keeping quality for raw pork and predispose consumers to health risk.

It was observed that required hygienic practices in terms of personal hygiene, good manufacturing practices and food safety guidelines were not followed by workers in all pork production chain. This could be caused by lack of knowledge on food safety principles to some personnel who are involved in the slaughtering and selling pork. Similarly, a study by Cook *et al.* (2017) reported the impact of poor hygiene of slaughter and selling facilities on safety of pork marketed in Kenya. Furthermore, poor and unregulated vending areas which operate or sell pork at unhygienic environment reported to dominate the pork marketing system in Tanzania (Fasina *et al*., 2022).

Regarding microbial quality of pork, analysis revealed higher mean contamination for TVC in pork samples from slaughter facilities, butcheries as well as pork centres which exceeded the minimum allowed limit for microbial contamination on pork cuts and carcasses as per TBS/AFDC 22 (5266) P3 guidelines. This could be attributed by poor cleaning and sanitation which were observed in most of the facilities and premises. Also unhygienic handling of pork as well as dirty equipment used in pork preparation, and absence of cold storage facilities at all selling point as also reported by Uzoigwe et al. (2021).   TBS specified the minimum limit for TVC in raw pork to be 4log CFU/g and the higher microbial load beyond the limit makes the pork susceptible to spoilage as well as posing a health risk to consumers (TBS, 2022).

Significance difference in TVC contamination were observed among the samples from slaughter areas and retail pork shops at ($P<0.05$). This could be due to differences in storage time, poor handling as well as lack of cold storage facilities. This provide an alert about safety along pork value chain. The observation are linked to the observed unhygienic processing and handling of pork in addition to absence of separation between clean and dirty operations in all slaughter places (Ray, 2019). Similar other studies reported that poor handling and storage of raw meat increases the chance of contamination and bacterial growth and hence accelerate meat spoilage (Kurpas et al., 2018). Centralization of pig slaughtering and improving sanitary status of the facilities could help to reduce the microbial contamination.

This observation were similar to that of Eke and Elechi, (2021) in Nigeria reported higher bacteria contamination in meat from local retail meat vendors. The high TVC obtained from pork samples is an indication of ineffective and inadequate cleaning practice (Uzoigwe et al., 2021). Unhygienic practices in abattoirs and post-process handling are associated with potential health risk to consumers due to presence ofs pathogens in pork and contaminated equipment (Negash & Olga, 2021). In addition to that, pork were delivered by motorcycles to various retail pork outlets after animals is slaughtered this also could have increased chances of contamination. The contamination during pork sales at retail outlets can happen through contact with contaminated handling tools such as tables, logs, hooks, balances, and knives, buckets insects, air, staff, and even customers (Astill et al., 2019; Samutela et al., 2021)

Coliform organisms are indicator of fecal contamination and hence pathogenic organisms. The study revealed high mean coliform counts in pork from the slaughter areas and pork selling points exceeded the minimum allowed limit by TBS (TBS, 2022). Although the level of contamination varied depending on the nature and hygienic status of the slaughter place or selling point. This means the shelf life of the produced pork could be affected. Also the microbes can be infectious to consumers which can result into foodborne diseases and food loss as consequences of spoilage. According to TBS guidelines, the minimum allowed limit TCC in raw pork should be 2log CFU/g and higher level of coliform contamination are considered unfit for human consumption. Under tropical conditions with temperature which favour the growth of most bacteria, food of animal origin tends to deteriorate more rapidly and become an important vehicle for gastrointestinal infections, thereby endangering consumers' health (Akinro et al., 2009; Ercumen et al., 2020). Higher contamination incidences might be due to poor pork handling practices and lack of knowledge on sources of microbial contamination to pork (Haque et al., (2022).

The study revealed high prevalence for *E.coli* contamination on pork samples where about (92.2%) of the analysed samples. As in case of coliforms count, the highest mean count was observed in samples from slaughter facilities and pork centres. *E. coli is* commonly used as an indicator, whereby its presence in food generally indicates faecal contamination and may also indicate the possible presence of disease-causing pathogens such as bacteria, viruses, and parasites (Puangseree *et al.,* 2021). This result implies that unhygienic pork handling in the slaughtering and pork selling points increases microbial contamination on pork sold in the area. A study along pork value chain in Uganda reported *E. coli* indicating possible cross-contamination (Kungu *et al*., 2017). In other hand, poorly organized production chain and poor sanitary operational procedures practiced by the slaughter personnel that include poor personnel hygiene were some of the factors which contributed to the high microbial load (Kanko *et al.,* 2023). The *E. coli* contamination on pork were against TBS regulatory guideline that prohibit the presence of harmful and spoilage bacteria in food intended for human use.

In this study, the presence of *S. aureus* was also tested as an important microbiocidal parameter. Over 84.4% of the pork samples were contaminated with *S. aureus*. Similar results were reported by Samutela *et al,* (2022) in Zambia. A previously study by Lee *et al.,* (2017) suggested that adherence to personal hygiene practices by food handlers is important in preventing cross contamination in food handling and preparation environment. In order to provide safe and high-quality products for consumers and consequently avoid microbial contamination and loss of products, effective sanitary handling of food meant for human consumption is of the extreme importance.

The occurrence of *S. aureus* isolated in some of pork samples was in consonance with a study done by Pal *et al.* (2016) who reported higher prevalence of *S. aureus* in raw pork. The reason for the high prevalence could be attributed by contamination from the environment and presence of the germs on parts of the handler body such as hands, nose, skin and clothing as a result of poor personnel hygiene at working environment. Other results by Barcenilla *et al.* (2022) have indicated that, poor hygiene and lack of refrigeration during storage enables outgrowth of spoilage and pathogenic microbes and thus a potential source of cross contamination during processing. A study by Nero *et al.* (2022) also reported higher counts for *S. aureus* in their tested samples was influenced by poor sanitary and hygienic practices among handlers. *S. aureus* and some of the coagulase-positive staphylococci species are human pathogens, causing a wide range of clinical signs, including foodborne illness, by its wide range of enterotoxins production (Amoako *et al*., 2020).

Therefore, in order to minimize the health risks associated with *S. aureus* contamination, processor and handlers need to take necessary actions to maintain food safety (Rugna *et al.,* 2021). Maintenance of the proper hygienic conditions during the processing of pork can reduce the prevalence of bacterial contamination in the pork (Nero *et al.* 2022). The bacteria from the contaminated pork may carry antimicrobial resistance traits and thus becoming harder to treat their related diseases as the antibiotic used to treat become less effective (Dadgostar, 2019).

Conclusion and recommendations
The study established higher microbial contamination levels ranging from 3.00 to 8.84 log CFU/g for TVC and 3.88 to 4.95±0.94 log CFU/g for coliform in pork marketed in the three cities exceeding the maximum recommended level in pork intended for human consumption.

 E. coli and *S. aureus* has been isolated in most samples thus questioning the microbiological safety and quality of the pork marketed in the three cities. Poor hygienic conditions of slaughter facilities, butcheries, pork centres, personnel and absence of cold facilities observed to have contributed to the observed high level of microbial contamination

To guarantee pork safety for human consumption, responsible agencies/authorities should ensure adherence to and implementation of regulations, policies, rules, and procedures for sanitary slaughtering and handling of pork along the pork production chain. Furthermore, food control authorities should provide training to pork slaughters and sellers and conducting regular inspection and monitoring of pork slaughtering and selling points to safeguard the public health.

Conflict of interest
The authors declare no conflict of interest.

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Assessment of knowledge on the danger signs of pregnancy among pregnant women at Sinza Palestina Hospital in Ubungo Municipality, Tanzania

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Abstract

Background: The rate of maternal mortality has dropped globally however in some developing countries the rate of decline has been slow. Several efforts have been made to improve maternal health and reduce maternal mortality. Lack of information on danger signs during pregnancy is one of the factors that contribute to maternal mortality. The study aimed to assess knowledge of pregnancy danger signs among pregnant women at Sinza Palestina Hospital in Ubungo Municipality, Tanzania.

Methods: This was a cross-sectional study involving all pregnant women who attended RHC services at Sinza Palestina Hospital in Ubungo Municipality. Socio-demographic characteristics and obstetrics experiences in the last pregnancy, knowledge on danger signs of pregnancy were collected. Data were analysed using the SPSS statistical package. Categorical and continuous variables were summarized and presented in tables and bar charts. Any *p-value* of < 0.05, at a 95% confidence interval was regarded as statistically significant.

Results: A total of 410 pregnant women aged 18 – 46 years, mean age of 27 years were enrolled in this study. Amongst, 66 (16.1%) had low knowledge on obstetric danger signs and associated with age less than 20 years (aOR = 15.3, 95% CI: 4.8 – 48.3, *p–value,* < 0.001), education level (aOR = 27.7, 95% CI: 5.0 – 152, *p–value,* < 0.001**)**, being single (aOR = 3.5, 95% CI: 1.1 – 12.9, *p–value,* < 0.04), parity (aOR = 1.9, 95% CI: 1.1 – 3.4, *p–value,* < 0.02 and less ANC visits (aOR = 2.6, 95% CI: 1.2 – 7.0, *p–value,* < 0.04). Moreover, occupation which was thought to have an association with knowledge of obstetrics danger signs, the association did not reach a statistically significant with *p = 0.44.*

Conclusion and recommendations: In general, the findings of this study, show that the vast majority (83.9%) of pregnant mothers have sufficient knowledge of obstetric danger signs. Vaginal bleeding was the most commonly mentioned obstetric danger while Convulsion and fever were mentioned less. Age and education level of pregnant women, parity and ANC visits were identified as the significant factors for knowledge of obstetric danger signs among pregnant women. We recommend that health education and behavioural change programs to continue be implemented in all health facilities to continue imparting knowledge to all pregnant mothers. Efforts should be directed towards empowering nurse midwives.

Keywords: Obstetrics Danger signs, Antenatal care, Knowledge, Pregnancy

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Background

Although maternal mortality is preventable, specific complications during pregnancy develop in 15% of all pregnant mothers (Mendez and Sawan, 2011). Prolonged/obstructed labour, pregnancy-induced hypertension, maternal infections, maternal hemorrhage and complications of abortions are the main complications during pregnancy and delivery (Say *et al.*, 2014). Ninety nine percent of all maternal death globally occur in developing countries while in Sub-Saharan Africa maternal death is two third of all death (Mendez and Sawan, 2011)(Say *et al.*, 2014).

The rate of maternal mortality have dropped globally however in some of developing countries the rate of decline has been slow (Who, Unicef, Unfpa, 2007). Several efforts have been made to improve maternal health and reduce maternal mortality. These have mainly focused on improving referral systems for emergency obstetric care, improving access to skilled attendants at delivery, and monitoring progress through maternal mortality and morbidity audits (Who, Unicef, Unfpa, 2007). Studies conducted in developing countries in Africa shows that some pregnant mothers are unaware of obstetrics dangers signs. A study conducted at Goba in Ethiopia by *Bogale & Markos*, and Ethiopia by *Hailu & Berhe,* shows that pregnant mothers had low knowledge of obstetric danger signs during pregnancy, child birth and postpartum period. (Bogale and Markos, 2015) and (Hailu and Berhe, 2014) respectively. It signifies that the large proportions of pregnant women are more likely to delay in looking for care.

Another study conducted in Ghana by *Aboringo et al 2014* reveled that community members and health workers were at least knowledgeable on obstetric danger signs. They revealed wide range of obstetric danger signs. Health care providers confirmed that information on obstetric danger signs is offered to all pregnant mothers during ANC visits through pictures placed on the walls in the clinic and at the back of ANC cards; more over through verbal communication (Aborigo, RA Moyer, CA Gupta, M Adongo, PB Williams, J Hodgson, A Allote, P Engmann, 2014).

Similar study on danger signs of pregnancy was conducted in rural Uganda by *Kabakyenga et al 2011*. Results revealed that pregnant women had relatively low knowledge levels on pregnant danger signs. Severe vaginal bleeding was the only danger sign mentioned by majority of the respondents (Kabakyenga *et al.*, 2011). Moreover, in their study *Kabakyenga et al 2011* knowledge level on obstetrics danger sings found to be associated with household assets owned education and age of respondent (Kabakyenga *et al.*, 2011).

Like in other developing countries in African, approximately 75 % of maternal deaths are results of direct causes namely hemorrhage infection, eclampsia, prolonged or obstructed labour and complications of abortion (DHS, 2010). Likewise, death among new-borns occurs due to difficult breathing, prematurity and infections.   Tanzania loses 24 women and 144 new-born babies making a total of 168 lives lost to childbirth per day (DHS, 2010). If more women had access to emergency obstetric and newborn care, fewer would die unnecessarily because of complications during childbirth.

Lack of information on danger signs during pregnancy is one of the factors that contribute to maternal mortality. Maternal mortality and morbidity in Tanzania rated at 454 per 100,000 live births (Mwilike *et al.*, 2018) is associated with delay in search for care. About (26 %) of women are aware of the signs that indicate an upcoming pregnancy complications (Pembe *et al.*, 2009). The low knowledge is due to the limited access health facilities in rural areas; less skilled health personnel that are available in rural areas, but the problem also exists even in urban areas where it is acknowledged to have more health facilities, improved infrastructure and transport.

Irrespective of cost and easier access of health facilities, low level of knowledge is also highly likely caused by inadequate dissemination of information on danger signs at the health facilities

(Mwilike *et al.*, 2018). It contributes to significant delay in seeking health care and compromises the survival of the mothers and expected newborns. This may ultimately result into the persistent high maternal morbidity and mortality rate.

In general, these studies shows that significant proportion of the pregnant women are unaware of obstetric danger signs. This indicates the large proportions of pregnant women who do not have the knowledge are likely to delay in deciding to seek care. Study aimed to assess knowledge on the danger signs of pregnancy among pregnant women at Sinza Palestina hospital in Ubungo Municipality, Tanzania.

Methodology
Study Design
This was a cross sectional study involving pregnant women attending ANC at Sinza Palestina hospital in Ubungo Municipality, Tanzania. The fieldwork took place from July to December 2022 at Sinza Palestina hospital, located in Ubungo Municipal council, Dar es Salaam region in Tanzania. Ubungo Municipal council is an urban area with approximately 1,043,549 populations. The council has 14 wards and 91 streets it covers a total area of 210 km^2. The council has a total of 135 functioning healthcare facilities where 21 of them are public owned health facilities. Out of 135 facilities 58 health facilities provide reproductive and child health services.

Sampling procedure and study participants
All pregnant women who sought ante natal care were selected randomly for participating in the study. The identified women who were eligible to participate in the study were informed about the study and asked for their consent. Study participants were selected using systematic sampling approach which involves dividing the total number of women attending the clinic for ante natal services with estimated sample size to obtain a sampling interval. After obtaining the sampling interval, the first participant was randomly selected, while the subsequent participants were selected systematically .

Data collection methods
Data were collected using self-administered structured questionnaires with closed ended questions. The questionnaires comprise of socio demographic characteristics, experiences in the last pregnancy, knowledge on danger signs of pregnancy. The socio-demographic characteristics section includes age, marital status, education level and occupation; pregnancy characteristics included the number of deliveries, number of pregnancies; experiences during their last pregnancy including whether they attended antenatal care and the number of visits made.

The knowledge section of danger signs comprised general knowledge about danger signs during pregnancy, the recognition of danger signs and where the source of information was. The participants were asked to put a tick to the best option on the questionnaires.

Knowledge about obstetrics danger sings was assessed through a list of danger signs stated in WHO guide for essential practice (Mattock, 2003). A point was given to each correct mentioned danger sign. The list comprises of common nine danger signs during pregnancy, which includes severe vaginal bleeding, reduced fetal movement, fast or difficulty in breathing, convulsions, severe headache with blurred vision, too weak to get out of bed severe abdominal pain, fever, swelling of fingers, face and legs (Mattock, 2003).

Knowledge was categorized into three categories, namely sufficient knowledge, low knowledge and no knowledge. Women who had mentioned 4 or more danger signs during pregnancy were categorized as having sufficient knowledge, those who mentioned 1-3 danger signs were

categorized as having low knowledge; and those who did not mention any danger sign were considered to have no knowledge (Okour, Alkhateeb and Amarin, 2012).

Data analysis

Data coding, entry and analysis was done using Epi Info version 7.2.2.6. Frequency distributions, summary measures (means, median) and measures of variability were used to describe the general characteristics of the study population. The differences and significant of the study were assessed using Chi – square (x^2) tests.

Ethical Consideration

Ethical clearance was obtained from the HKMU Research and Ethical committee. Permission to access study sites was obtained from District Medical Officer of Ubungo and then from Sinza Palestina Medical Officer in charge. Informed consent was obtained from each participant by signing a consent form. Participants were informed on their rights to decline to answer any question or withdrawal from the study. Confidentiality was strictly observed as participants were identified by numbers and not by names. Participants' data were not disclosed to unauthorized people without prior permission from participants themselves and research team. Data reported in the aggregate form as a research report and individual results were reported to individuals or groups that are not concerned.

Results

Socio – demographic characteristics

Four hundred and ten pregnant women enrolled in this study. Majority of the respondents (68.3%) were at the age of 21 – 30 years (range 18 – 46 years) and the median age of the study group was 27. Out of 410 study participants 8.8% (36) and 22.9% (94) belongs to the age group less than 20 and more than 30 years old respectful. (Table 1)

Majority of study participants were married 72.2% (296) and living with their partners while 27.8 (114) were not living with their partners. This includes women who were either; single, separated, divorced or widowed. Almost half (47.3%) of the study participants completed secondary education. Regarding occupation of pregnant mothers participated in this study, majority (63.4%) were doing small business to earn family income while 19.0% (78) and 17.6% 72 were housewife and employed respectful (Table 1).

The obstetric characteristics that were looked at, include parity and ANC visits. More than half (57.6%) of study participants attended antenatal clinic four times or more during their last pregnancy where as 42.4% (174) attended less than four ANC visit. Additionally, majority of the women 58.0% (238) had two to four numbers of deliveries while 42.0% (172) had delivered once as shown in Table 1.

Table 1: Socio – demographic and Reproductive characteristics (N=410)

Variables	Categories	Frequency (N)	Percent (%)
Age			27 (18 – 46)
Age group			
	≤ 20 years	36	8.78
	21 – 30 years	280	68.29
	≥ 31 years	94	22.93
Marita Status			
	Single	102	24.88
	Married	296	72.20

	Separated	12	2.93
Residence			
	Kinondoni	90	21.95
	Ubungo	320	78.05
Religion			
	Christian	244	59.51
	Muslim	166	40.49
Education Level			
	Primary	138	33.66
	Secondary	194	47.32
	College/University	78	19.02
Occupation			
	Business	260	63.41
	Employed	72	17.56
	Housewife	78	19.02
Parity			
	Para one	145	35.40
	Multiparity	265	64.60
ANC Attendances			
	Less than four visit	137	33.41
	More than four	273	66.59
Knowledge on danger Signs during pregnancy			
	Low Knowledge	66	16.10
	Sufficient Knowledge	344	83.90
Sources of Information on danger signs during pregnancy			
	One Source	322	80.50
	Multiple Sources	78	19.50

Knowledge on Danger signs during pregnancy among Pregnant women (N=410)

All women (100%) participated in the study had ever heard about danger signs during pregnancy and the main source of information was from the nurse midwives (89.3%) at health care facilities followed by women who had delivered previously (13.2%) (table 2).

Table 2: Sources of Information on Danger signs during pregnancy (N=410)

Information source	Yes		No	
	Number	Percent (%)	Number	Percent (%)
Nurse Midwives	366	89.27	44	10.73
Other Women	54	13.17	356	86.83
From Medias	42	10.24	368	89.76
Traditional Birth Attendants	2	0.49	408	99.51

Knowledge on obstetric danger signs was categorized into three namely sufficient knowledge, low knowledge and no knowledge. Woman who had mentioned 4 or more danger signs during pregnancy was categorized as having sufficient knowledge, mentioned 1-3 danger signs low knowledge; and not mentioned any danger sign was categorized into no knowledge (figure 1)
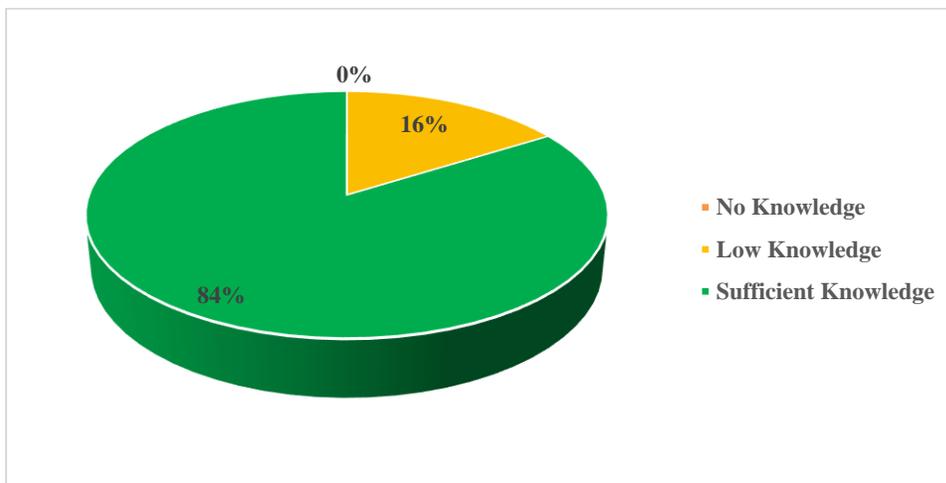

Figure 1: Knowledge on Danger signs during pregnancy (N=410)

When asked to spontaneously mention the danger signs, more than 80% had sufficient knowledge since they were able to mention four and more danger signs correctly. However, 16.1% had low knowledge on danger signs during pregnancy since they were able to mention one to three dangers signs correctly. Moreover, no respondent who was not able to mention even one danger sign correctly. The figure below shows that 66.6% of the respondents aged less than 20 years old exhibit low knowledge regarding obstetrics danger signs. Age has shown to have relationship with knowledge on danger signs during pregnancy ($P= < 0.001$). Furthermore, sufficient knowledge is gained as age increases.
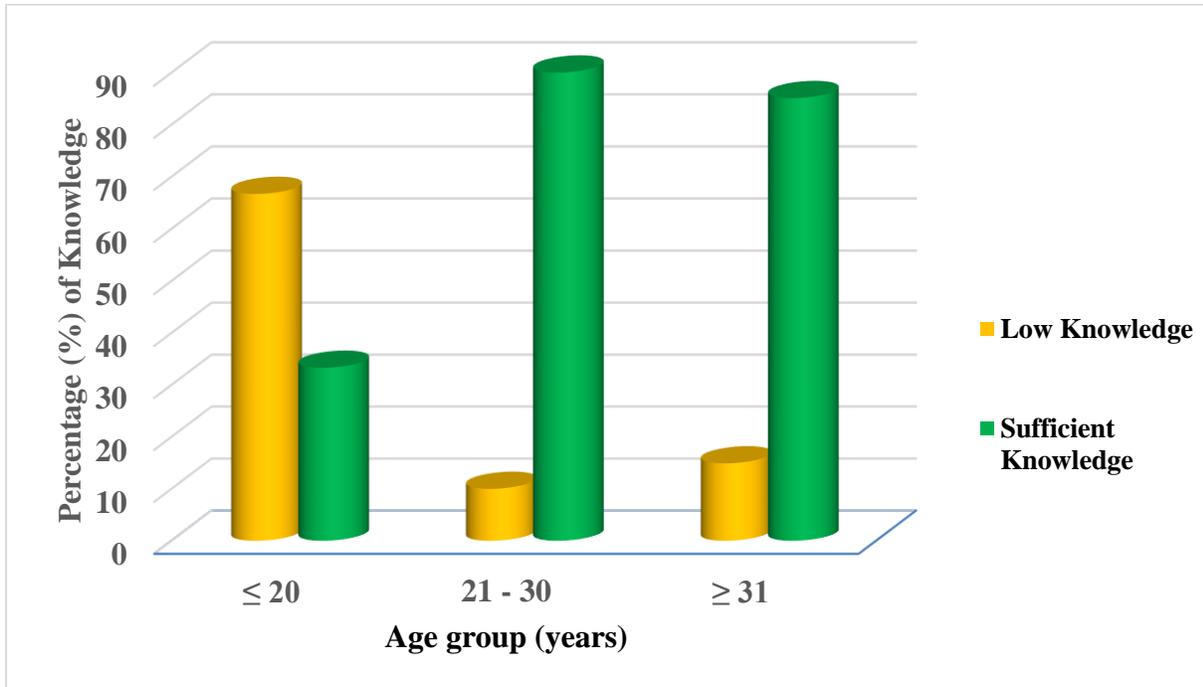
Figure 2:   Knowledge on Danger signs during pregnancy by age group

When asked about danger signs of pregnancy; frequently stated danger signs that may occur during pregnancy as signs for obstetrics complications are severe vaginal bleeding and reduced fetal movement by more than 90%. The least danger signs known by participants are Convulsions and fever (table 3).

Table 3: Knowledge on Danger signs during pregnancy (N=410)

Danger signs during pregnancy	Yes		No	
	Number	Percent (%)	Number	Percent (%)
Severe Vaginal Bleeding	392	95.61	18	4.39
Reduced fetal Movement	370	90.24	40	9.76
Fast or Difficult breathing	358	87.32	52	12.68
Severe headache with blurred vision	358	87.32	52	12.68
DS/Severe abdominal Pain	344	83.90	66	16.10
Swelling of fingers, face or legs	332	80.98	78	19.02
Too weak to get out of bed	328	80.00	82	20.00
Convulsion	298	72.68	112	27.32
Fever	298	72.68	112	27.32

Factors associated with Knowledge on Danger signs during pregnancy (N= 410)
A number of demographics and obstetrics characteristics were significantly associated with odds for low knowledge on obstetrics danger signs in univariate analysis (Table 4). These included age, education level, marital status, parity, Ante natal care attendances and residence. There was no association between Occupation and knowledge on obstetrics danger signs.
In multivariate analysis after adjusting for all significant variables *(p – value <0.05)* from the univariate analyses and the potential confounders; age, education level, marital status, parity, ante natal care

attendances and residence were found to be associated with knowledge on obstetrics danger signs (Table 4).

The independent variable age was statistically significant for the knowledge of danger signs during pregnancy. Women aged 20 years and less had 15.3 higher odds for low knowledge on obstetrics danger signs (aOR = 15.3, 95% CI: 4.8 – 48.3, $p – value$, < 0.001) as compared to a women aged 30 years and above. Similarly, women aged 20 to 30 years were less likely to have low knowledge on obstetrics danger signs as compared to women aged 30 years and above. However, the association is not statistically significant.

Participants who had primary and secondary education had higher odds (aOR = 27.7, 95% CI: 5.0 – 152, $p – value$, < 0.001) and (aOR = 13.1, 95% CI: 2.6 – 67, $p – value$, < 0.001) respectful for low knowledge on obstetrics danger signs as compared to women who had college or university level of education. Compared to married women, separated women had 3.5 times the odds for low knowledge on obstetrics danger signs (aOR = 3.5, 95% CI: 1.1 – 12.9, $p – value$, < 0.04).

Regarding occupation, housewives were more likely to have low knowledge for danger signs compared to employed women although this association did not reach a statistically significant with $p = 0.44$. Additionally, parity and antenatal clinic attendances were associated with knowledge on obstetrics danger signs. Women who attended antenatal clinic less than four times during their last pregnancy and women who had one delivery were almost two to three times higher the odds for low knowledge for obstetrics danger sings compared to their counterparts (aOR = 1.9, 95% CI: 1.1 – 3.4, $p – value$, < 0.02) and (aOR = 2.6, 95% CI: 1.2 – 7.0, $p – value$, < 0.04) respectful. Participants residing in Kinondoni Municipality were 2.3 times the odds for low knowledge on danger signs as compared to participants residing in Ubungo municipality (aOR = 2.3, 95% CI: 1.1 – 4.6, $p – value$, < 0.02).

Table 4: Factors associated with Knowledge on obstetrics danger signs (N= 410)

| Variables | Knowledge on danger Signs | | | | | | | |
| | Low | | Sufficient | | Crude OR | | Adjusted OR | |
	No	(%)	No	(%)	OR (95% CI)	P – Value	OR (95% CI)	P – Value
Age (Years)								
≤ 20	24	66.7	12	33.3	11.4	4.6 – 27.9	**< 0.001**	15.3	4.8 – 48.3	**< 0.001**
21 – 30	28	10.0	252	90.0	0.6	0.3 – 1.3	0.19	0.8	0.4 – 1.6	0.50
≥ 31	14	14.9	80	85.1	1.0				
Education Level								
Primary	34	24.6	104	75.4	12.4	2.9 – 53.2	**< 0.001**	27.7	5.0 – 152	**< 0.001**
Secondary	30	15.5	164	84.5	6.9	1.6 – 27.8	**< 0.001**	13.1	2.6 – 67.5	**< 0.001**
Tertiary*	2	2.6	76	97.4	1.0				
Marital Status								
Single	24	23.5	78	76.5	2.1	1.2 – 3.7	**0.01**	1.5	0.7 – 3.3	0.09
Separated	4	33.3	8	66.7	3.4	1.2 – 11.8	**0.04**	3.5	1.1 – 12.9	**0.04**
Married	38	12.8	258	87.2	1.0				
Occupation								
Housewife	18	23.1	60	76.9	1.9	0.8 – 4.4	0.15	0.7	0.2 – 1.9	0.44
Business	38	14.6	222	85.4	1.1	0.5 – 2.2	0.87	0.6	0.2 – 1.5	0.29
Employed	10	13.9	62	86.1	1.0				
Parity								

Para One	32	22.1	113	77.9	1.9	1.1 – 3.3	**0.01**	2.6	1.2 – 7.0	**0.04**
Multiparity	34	12.8	231	87.2	1.0				
ANC attendances									
< 4 Visits	32	23.4	105	76.6	2.1	1.3 – 3.7	**0.004**	1.9	1.1 – 3.4	**0.02**
≥ 4 visits	34	12.5	239	87.5	1.0				
Residence									
Kinondoni	20	25.6	58	74.4	2.1	1.2 – 3.9	**0.01**	2.3	1.1 – 4.6	**0.02**
Ubungo	46	13.9	286	86.1	1.0				

Key: * - College/University; CI – Confidence Interval; No – Number; OR – Odds Ratio; % - Percentage; YRS – Years, ANC – Ante Natal Care

Discussion
Results shows that, among all women at Ubungo municipality, 84% of women had sufficient knowledge on danger signs during pregnancy. This is contrary with results of studies from other parts of Africa which show an overall low awareness of maternal danger signs (Mwilike *et al.*, 2018), (Maseresha, Woldemichael and Dube, 2016a), (Akililu Solomon, 2015). This is thought to be due to majority of women (%) attended antenatal clinics for more than four visit where they obtained information about obstetrics danger sings from nurse midwives. Antenatal attendance influences knowledge of obstetrics danger signs (Hibstu and Siyoum, 2017).

On the other hand in this study about 95% of the study participants identified vaginal bleeding as a leading danger sign during pregnancy which was higher than the findings in other studies Tanzania (81%) (Mwilike *et al.*, 2018), Ethiopia (75.4%) (Hibstu and Siyoum, 2017), and Guatemala (31.0%) (Fonseca-becker and Schenck-yglesias, 2004). This variation might be due to socio-cultural difference, difference in implementation of relevant health intervention programs such as provision of antenatal care and delivery services, study design and location differences as they were all community surveys (Mwilike *et al.*, 2018), (Hibstu and Siyoum, 2017).

Significant association was observed concerning advanced age. It was found that knowledge of obstetric danger signs was more likely to increase among women above 30 years old. This finding is similar to studies conducted in Tanzania, Ethiopia and Enugu State Nigeria, (Mwilike *et al.*, 2018), (Hibstu and Siyoum, 2017), (C. Agunwa, 2015) respectively. It might be explained that as elder women not only own better knowledge of obstetric danger signs in this age group but also, they are psychologically and physically ready to accept information on danger signs (Hibstu and Siyoum, 2017).

Higher education level, was found to have a significant association with being knowledgeable about obstetric danger signs during pregnancy, This agrees with a study conducted by *Pembe et al* from Tanzania and (Hibstu and Siyoum, 2017), (Maseresha, Woldemichael and Dube, 2016b) from Ethiopia where they found that women who attended secondary and above were more likely to be knowledgeable on obstetric danger signs compared to women without formal education (Pembe *et al.*, 2009), (Hibstu and Siyoum, 2017), (Maseresha, Woldemichael and Dube, 2016b) respectively.
This could be explained by fact that educated women might be more empowered and have more autonomous decisions making in accessing own health service information needed to act on ANC advice about obstetric danger signs (Bintabara, Mpembeni and Mohamed, 2017).

Mothers who had four and above ANC follow-ups had sufficient knowledge on obstetric danger signs compared to women who had less than four ANC visit. This finding agrees with studies conducted elsewhere (Pembe et al., 2009, (Bililign and Mulatu, 2017). This could be expected in that, having more visits before delivery thereby increasing chances of being educated on obstetric danger signs (Emeh *et al.*, 2021).

Similarly, having more than one deliver is the most important predictive factors for knowledge on obstetric danger signs. Women who had more than one delivery had higher the odds for sufficient knowledge for obstetrics danger sings compared to their counterparts. Similar findings were reported by (Bolanko *et al.*, 2021) where they found that, women with a greater number of deliveries were more knowledgeable of obstetric danger signs than primigravida (Bolanko *et al.*, 2021). This could be explained by the fact that some of them might have experienced obstetric complications during their previous pregnancy and childbirth which are an important source of their information (Bolanko *et al.*, 2021).

Conclusion

In general, the findings of this study, shows that vast majority (83.9%) of pregnant mothers have sufficient knowledge on obstetric danger signs. Vaginal bleeding is the commonly mentioned obstetric danger while Convulsion and fever mentioned less. However, age and education level of pregnant women parity and ANC visits were identified as the significant factors for knowledge of obstetric danger signs among pregnant women. Furthermore, knowledge about danger signs during pregnancy has been found not to have a significant relationship with occupation or marital status.
The findings provided insight information on women's knowledge about danger signs in the study area, which could help in designing appropriate interventions and as a base for further exploratory studies in other parts of the country.

Recommendations

The study has shown there is higher antenatal clinic attendance and Nurse Midwives being the main source of information on obstetric danger signs. It is therefore recommended that health education and behavioral change programs be continued implemented in all health facilities to continue imparting knowledge to all pregnant mothers. Efforts should be directed towards empowering nurse midwives thorough continuous professional development.

Factors such as shortages of staff and inadequate medical supplies can be reduced by producing an adequate number of health professionals. Moreover, provisions of posters and banners that have messages about danger signs during pregnancy which is prepared in simple terms for easy understanding even among illiterate people.

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Factors associated with delays in seeking Paediatric Dental Care in Tanzania

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Abstract:

Background: Seeking dental care services among Tanzanian children is usually done responding to pain or potentially painful outcomes of advanced oral lesions**.** The situation implies untimely dental consultation inhibiting quality dental care for these children. This study aims to assess the duration taken to seek dental care, determine the proportion of delay to seek care and identify the dental setting and socio-demographic characteristics that could explain the delays.

Methods: Cross-sectional study involving 312 child dental patient-escort pairs at the university paediatric dental clinic in Tanzania. Structured questionnaires and clinical examination forms were used as means for collecting data. Frequency distributions, cross-tabulations and binary logistic regression were conducted. These provided proportions, tested for the presence and magnitude of associations between delay in seeking care and socio-demographics plus oral health-related behaviours.

Results: Over two-thirds (68.6%) of the participants were delayed to seek dental care with 45.2% being brought more than a month since the parents were informed or noted the child's oro-dental complaint. A higher proportion of children who were delayed attended school and had mothers who were employed. The nature of the dental visit and requiring the use of physical stabilization retain the statistical significance with the odds of delay being higher among children who have had a previous dental visit (OR =1.8 95% CI 1.1,3.0) and those who were not physically stabilized during the procedure (OR=0.5 95% CI 0.3,1.0).

Conclusion: Delay in seeking care was common with the majority of children being presented to the dental clinic more than a month after being aware of the child's complaint. Socio-demographics had minimal influence on observed delay for care as it were for the role of dental setting factors.

Keywords: Delay, seeking, dental care, children

Background

Consultation with healthcare professionals is often stimulated by the detection of somatic information that is deemed to be beyond personal control and so in need of medical or dental attention. Dental care services are intended to address both curative and preventive aspects of dental diseases and conditions, the success of which depends on prompt consultation (Agbor et al. 2018; United Republic of Tanzania 2020).

Due to complexities within health-seeking behaviour people tend to take longer time than necessary to seek help from a healthcare professional (HCP) (Abegaz et al., 2019; BaniHani et al., 2021; Oo et al. 2020). The time taken in the process may results in a delay; which is referred to as

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patient delay and is implied as time taken between a patient's initial discovery of symptoms and first consultation with a HCP for those symptoms. The timing of consultations with HCPs has implications on individuals' health, quality of treatment to be offered, treatment options, prognosis of the disease, cost of healthcare services and quality of life (Abegaz et al., 2019; Agbor et al. 2018; BaniHani et al., 2021; Mhalu et al., 2019)

Delay in seeking dental care in child with dental problems, it may result into difficulties in behaviour management, necessitate invasive dental procedure in first visit and create negative attitude towards dental care services (Agbor et al., 2018; BaniHani et al., 2021; Shao et al., 2016). Therefore, timely dental consultation in children is critical for quality and appropriate dental intervention.

Delays in dental consultation can be due to several factors; accessibility to dental care services, cost of treatment, lack of awareness for the need of treatment and possible treatment options as well as socio and cultural reasons (Agbor et al., 2018; BaniHani et al., 2021). The delay may as well be a result of the nature of dental diseases being mostly chronic in nature, since interaction between causative factors and host tend to be modifiable by human behaviours and lifestyle. Delays in children may further be caused by child's sense of dependency for; cost of care, perception of symptoms and decision to whether to seek care for the child or not (Abegaz et al., 2019).

Dental care services in Tanzania are provided mainly in public health facilities alike other medical services and warranted government subsidy for health care (United Republic of Tanzania 2020). Furthermore, both medical and dental care services for under-five years' old children and those with special health care needs are granted with exemption for care. Despite the government efforts seeking dental care services is usually due to pain or potentially painful outcome of advanced oral lesions and not for preventive care (Shao et al., 2016; Owibingire et al.,2018).

Toothache and other causes of orofacial pain are the most common reasons for seeking dental care services among dental patients in African region (Agbor et al., 2018; Ocwia et al., 2021; Owibingire et al.,2018).The mutual observation from studies in the African region is that; a substantial proportion of patients with orofacial pain /toothache tend to take at least one month since the onset of the symptoms to the time they present at the dental facility (Ibikunle et al. 2020; Ikpefan et al., 2020; Msolla et al., 2019).

Studies on the role of socio-demographic factors on patients' delay to seek for care have reported varying observations. Paediatric dental patients' delay in seeking care in Jordan and Brazil was reported to be associated maternal profession, education level and family income while lack of association was noted for child's gender and age as well as parental employment status among South African children (BaniHani et al., 2021; Mukhari-Baloyi et al., 2021.; Soares et al., 2021).

Therefore, this study aimed to assess delay in seeking dental care and determine the role of parental and child's socio-demographic factors as well as their oral health related behaviours as attributes of reported delay in paediatric dental patients attending a university dental clinic in Tanzania.

Materials and Methods

It was a health facility based cross-sectional study, involving paediatric dental patients and their escorts. The patients were attending a university dental clinic (MUHAS-Dental) for various oro-dental diseases/conditions. The dental patients in this clinic are aged 0-12 years hence escorted by their parents/guardians, their older sibling or other relatives to be a legal guardian during the dental visit. To be included into the study a child dental patient had to be complaining of any oro-facial related condition and be escorted by a legal guardian or parent. Solicited patients and children with special health care needs were excluded from the study.

The sample size was estimated assuming that; the proportion of children who delay to seek dental care being 50%, standard normal variant (Z) set at 5% and absolute precision (d) was 0.05. Therefore, a total of 384 paediatric dental patient-escort pairs were expected as a minimal sample

for the study. Using a systematic random sampling design based on MUHAS's patient's clinical registration system numbers, every paediatric dental /orthodontic patient with DB number ending with odd number was invited to participate in the study.

Data were collected using an interview of a semi-structured questionnaire in Kiswahili language and dental clinical examination. The questionnaire was piloted in the same clinic before use for validity and content clarity. It inquired on children's and parents' socio-demographics, oral health related behaviours, time taken by the parent before seeking dental care and the main reason for seeking dental care. Routine dental patient clinical examination was conducted to ascertain type of a presenting dental condition.

The dependent variable was delayed seeking dental care in a child dental patient. It was operationalized as duration taken since the child first reported an oro-dental complaint to the day he/she was brought to the dental clinic. A child was considered to have delayed seeking dental care when he/she was brought more than one week since reporting acute pain or more than one month since reporting/noticing asymptomatic changes such as tooth discoloration or decay. The independent variable includes; socio-demographic variables which were personal information of the participants that have implication to oral health and seeking dental care in a child. This included data on educational level and occupation of the parents, who lives with child, mode of dental services payment and schooling state as well as child's age and sex. The dental setting related factors were information on; previous dental visit, nature of presenting dental condition (primary diagnosis on the day of visit), child requiring stabilization and nature of the dental treatment procedure offered.

Data were processed and analysed using computer software program SPSS version 20.The data were transformed for analysis purposes as follows; parents' highest level of education into primary education or below and secondary education or higher, mother's occupation into day worker/pet business and employed/have large scale business, mode of dental services payment into cash and health insurance/exempted, child's age into younger than six years and six years or older, schooling status into not attending school and attending school. Furthermore, transformation was done to determine the delayed seeking dental care as those who had reported to have sought care a week after child reporting acute pain of orofacial region and those sought care more than a month after noting a painless sign.

Type of dental condition was transformed into non-acute pain related condition (neoplasm, malocclusion, dental development disorders and others) and pain related condition (dental caries involving the pulp, caries confined to crown, post-operative complications and orofacial infections). The dental setting factors were transformed as; Frequency of dental visit having a previous dental visit was categorized as being first visit or had a previous, nature of dental condition into none pain and pain related condition, nature of dental procedure as non-invasive and invasive and whether child requiring physical stabilization as did not apply or applied.

Regarding statistical analysis; frequency distribution was carried out to determine the prevalence of children who were delayed to seek dental care, proportion of the oral health related behaviours, and type of dental conditions. Cross tabulation were performed for association between delay in seeking care and the child's and parental socio-demographic factors as well as oral health related behaviours presented in proportions and chi-square statistics. Binary logistic regression presented in odds ratios and 95% confidence interval (CI) was conducted for the behaviours and socio-demographic factors that had statistical significance association with delayed seeking dental care. The level of significance was be set at $p<0.05$.

Results
A total of 312 out of 384 targeted paediatric-escort pairs participated in the study, resulting into a participation rate of 81.3%. A larger proportion of the participating children were; aged six years or older (71.8%), attending school (87.8%) and had parents with secondary education or above (72.7% mothers and 74.2% fathers). In terms of health payment modes for dental services; more than two

thirds (67.9%) had health insurance or were exempted to pay for the services as per the Tanzanian government policy (Table 1).

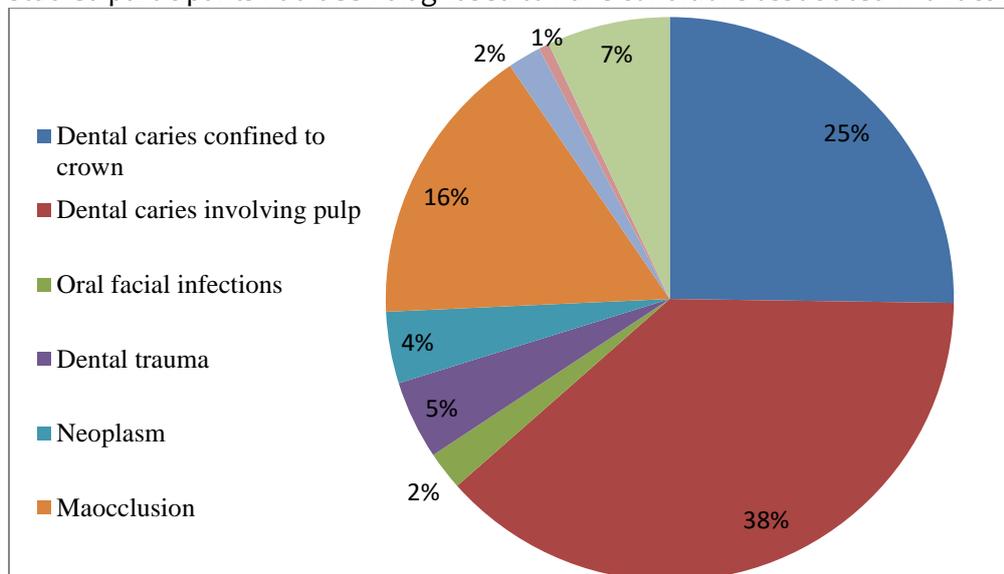**Table 1: Frequency distribution of participants' socio-demographic characteristics**

Variable	Categories	%(n)
Age	Five years or younger	28.2 (88)
	Six years or older	71.8 (224)
Sex	Female	48.7 (152)
	Male	51.3 (160)
Child's schooling state	Not attending school	12.2 (38)
	Attending school	87.8(274)
Father's highest educational attainment	Primary or below	25.3 (79)
	Secondary or higher	74.7 (233)
Mother's highest educational attainment	Primary or below	27.6 (86)
	Secondary or higher	72.4 (226)
Mother's occupation	Day worker/pet business	48.7 (152)
	Employed/large business	51.3 (180)
Mode of payment for dental services	Cash	32.1 (100)
	Health insurance/exempted	67.9 (212)

The overall percentage of the paediatric dental patients who were delayed for dental attendance amounted to over two thirds (n=214, 68.6%). Specifically; 45.2% sought dental care more than a month since the parents were informed or noted the child's dental complaint while less than 20% of all the participants were brought within three days (Figure 1).
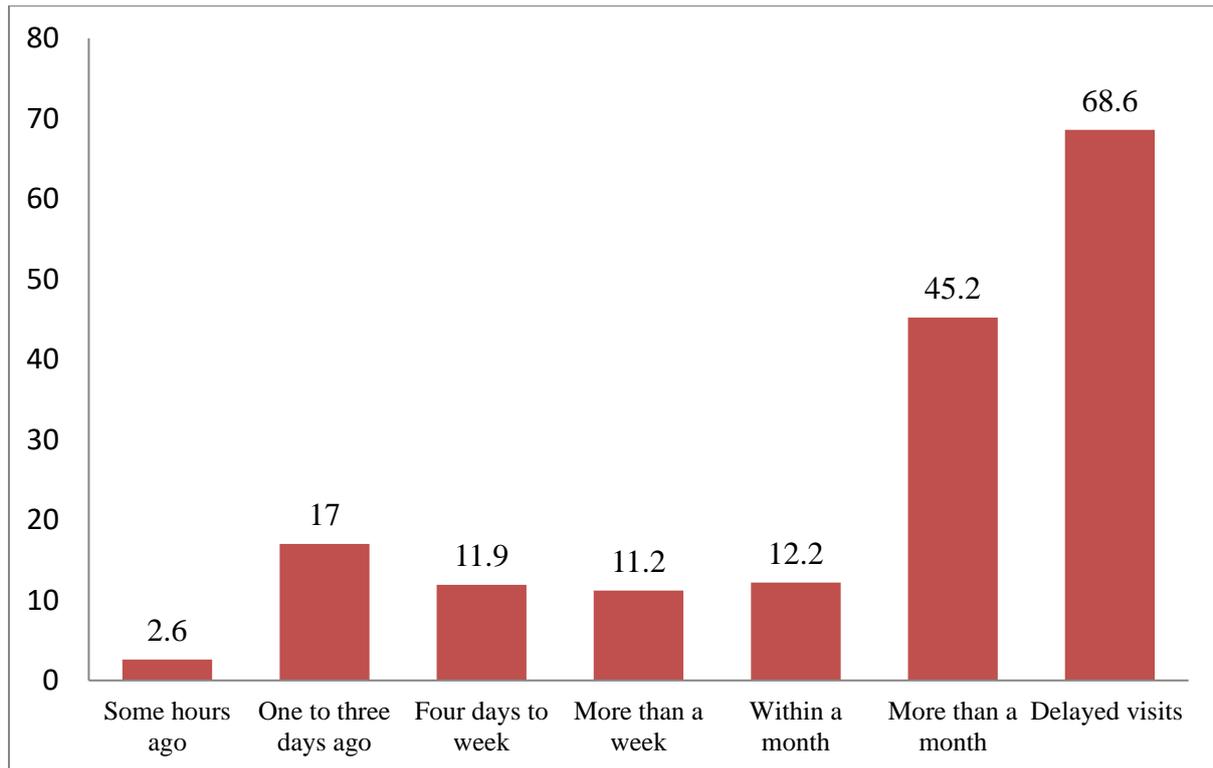
Figure 1: Frequency distribution of times taken by parents since informed/noted oral health complaint of their children to a visit

Regarding clinical diagnosis that called for the current dental visit; dental caries involving the pulp was the most common while postoperative complications and other orofacial infections were the least (1.0 and 2%, respectively). Dental caries related conditions accounted for over two thirds of all diagnosed conditions in these paediatric dental patients (Figure 2). Overall, 71.2 % (222) of the studied participants had been diagnosed to have conditions associated with acute pain.

Figure 2: Frequency distribution of participants' type of dental condition

The socio-demographic distribution of participants for delayed seeking dental care revealed that; higher proportion of the six years or older, females, those whose parents had primary education or below, whose mothers were employed or had large business, the ones living with both parents, those attending school and who pay by cash were delayed to seek dental care than their counter

parts. However, only those who children reported to be attending school (71.2 vs 50.0%) and whose mother were employed or have large scale business (73.8 vs 63.2%) showed a statistically significance differences in proportions, Table 2.

Table 2: Distribution of participants who delayed to seek dental consultation by socio-demographic factors

Variable	Categories	%(n)	P-value
Age	Five years or younger	62.5 (55)	
	Six years or older	71.0 (159)	0.146
Sex	Female	70.4 (107)	
	Male	66.9 (107)	0.503
Father's highest educational attainment	Primary or below	70.9 (56)	
	Secondary or higher	67.8 (158)	0.611
Mother's highest educational attainment	Primary or below	66.3 (57)	
	Secondary or beyond	69.5(157)	0.588
Mother's occupation	Day worker/pet business	63.2 (96)	
	Employed/large business	73.8 (118)	0.044
Child schooling state	Not attending school	50.0 (19)	
	Attending school	71.2 (195)	0.008
Mode of payment for dental services	Cash	69.0 (69)	
	Health insurance/exempted	68.4 (145)	0.915

The distribution of participants who delayed seeking dental care by the dental services related factors display statistical significant differences for all the studied factors. It was such that significantly higher proportions of participants who delayed to seek dental care were; those who had a previous dental visit, those diagnosed of having a non- pain related dental condition, had received non- invasive dental procedure and were not physical stabilized during procedure (Table 3).

Table 3: Distribution of participants' who delayed to seek dental consultation by dental services related factors

Variable	Categories	% (n)	p-value
Frequency of dental visit	First visit	64.3 (119)	
	Had previous visit	74.8 (95)	0.05
Nature of dental condition	None pain condition	76.7 (69)	
	Pain related condition	65.3 (145)	0.05
Nature of dental treatment offered	None invasive treatment	74.2 (151)	
	Invasive treatment	63.4 (161)	0.026
Physical stabilization applied	Did not apply	71.4 (187)	
	Had to be applied	54.0 (27)	0.013

Table 4, depicts adjusted ORs and 95% CI for delay in seeking dental consultation by socio-demographics and dental services related factors. Age and sex of the child, mother's occupation and child's schooling state were entered in the first step, providing a model fit of Nagelkerke's R^2 = 0.042, model chi-Square 9.4, df = 4 p < 0.051. When the dental services related factors were added in the second step improved the fit of the model to Nagelkerke's R2 = 0.075, model *chi square* = 16.98, *df* = 6, p < 0.023. In this second model; nature of the dental visit and requiring the use of physical stabilization retain the statistical significance with odds of delay being higher among children who have had previous dental visit (OR =1.8 95% CI 1.1,3.0) and those who were not physically stabilized during procedure (OR=0.5 95% CI 0.3,1.0).

Discussion

Timely dental consultation to oral health facilities for care is a key to quality care for children in dentistry while delay in dental seeking care in children is considered as a sign of child dental neglect (Kvist et al., 2018). This study was performed to assess the duration taken to seek dental care, determine the proportion of those who delay to seek care and identify behavioural and socio-demographic characteristics that could explain for the delays found. It was a health facility cross-sectional study of children attending a university dental clinic for various oro-dental complaints. The results are; delay in seeking dental care among the paediatric dental patients was substantially high with more than two thirds reporting to have sought care more than a week since the child reported to have acute oro-dental pain.

Socio-demographically, the study participants were mostly from socio-demographical advantaged families; whereby majority of their parents had secondary education or higher and had health insurance. Participants being from socio-demographically advantaged families are expected to favour prompt seeking for dental care. This observation is comparable to that of a previous study done in the same settings (Shao et al., 2016).

The observation that most parents/guardian reported to have taken more than a month to seek dental care since a child reported or notified of the dental complaint is of concern to both the dentists as well as the child. A month or so living with oro-dental pain in a child is considered as the parents being neglectful and renders complications in provision of appropriate and quality dental care to the child dental patient (Kvist et al., 2018). The findings are in concurrence with that of BaniHani et al., 2021 among Jordanian children where most children were taken to a dentist more than two weeks since reporting the pain. Furthermore, comparative findings have been reported in adult population in African studies that substantial proportion of patients with oro-facial pain /toothache tend to take at least one month since the onset of the symptoms to the time they present at the dental facility (Ibikunle et al., 2020; Ikpefan et al., 2020; Msolla et al., 2019).

Dental caries was the dominant primary diagnosis arrived at and unfortunately a higher percentage had dental caries associated with acute pain rather that painless caries states. The findings are inline to a previous study by Kusekwa & Kikwilu, 2011 whereby 79.0% of the adult Tanzania dental patients sought oral care due to pain from advanced caries lesions. Likewise, Olatosi et al., 2019 in Nigeria reported that, 33.1% of all paediatric dental patient attending dental clinic had pain and dental caries was is common diagnosis. Acute dental pain in children deters the dental management of a child; where invasive procedure such as extraction as the first dental experience may render to behaviour management problems and in future negative attitude towards dental treatments.

In the current study, essential parents' socio-demographics (education levels and having health insurance) did not reveal statistical significant association with delay in seeking dental care in children. However, the direction was that of delayed children being from socio-demographically disadvantaged families. Parents' socio-economic factors affect children's access to care and health seeking behaviour. The lack of significant association could have been a result of the parental socio-demographics playing an indirect role to health seeking behaviours. The observation is contrary to a study by Soares et al., 2020 among Brazilian children where delay in first dental visit was higher among children from socio-demographically disadvantage families such as mother with low schooling level or lacked health insurance.

However, children whose mothers were employed/had large scale business and those attending school were significantly delayed to seek dental consultation. A decision to consult for dental services may be influenced by the second party namely; the mother's employee and child's school authority. Comparable observation was reported among Jordanian paediatric dental patients that; skilled mothers delayed to seek care for their children compared to their counterpart (BaniHani et al., 2021; Mukhari-Baloyi et al., 2021). It is a in a way contrary with the general expectations that utilization of dental services to be higher among socio-economically advantaged adults and children.

The effect of dental services related factors to children's delayed in seeking dental were noted on the frequency of dental visit, with higher proportion of those who had a previous visit being delayed than the ones visiting for the first time could be explained by possible unpleasant dental experience. In the same tone; the fact that higher percentage of children with non-pain related conditions were delayed to seek dental care than those with acute pain could be due to lack of not urgency perceived by parents in situation of non- pain related condition. This is supported by findings that oro-dental pain related complaints are the most common reason for dental visit in African region and cause of emergency dental consultation in Europe (Agbor et al., 2018; Martens et al., 2018; Ocwia et al., 2021).

The higher odd for delay in seeking care among the participants who had a previous dental visit imply that they were not motivated or informed sufficiently during their previous visit on importance of prompt dental care seeking. The results are comparable with those by Lutfiyya et al., 2019 whereby delayed seeking care was associated with having last dental visit for longer than 12 months ago. Furthermore, the unlikelihood of applying physical stabilization during dental procedure among participants who were delayed seeking care is contrary to the expectations, where a child in pain will not be ease managed with universally acceptable techniques. Possible children in acute pain are prescribed with antibiotic and ant pain then being recalled in follow-up visit with subsided pain for definitive dental procedures.

Further studies are suggested to be conducted in dental primary health care facilities versus university dental clinic, where most of the children with orofacial conditions are first presented to provide the generalizability of the findings. Additionally; studies should assess complications associated with dental management of delayed children such as their behaviours during dental visits using well validated and reliable instrument.

Conclusion:
Delay for seeking care was common with majority of children being presented to dental clinic more than a month since being aware of the child's complaint. Socio-demographics had minimal influence to observed delay for care as it were for the role of dental services related factors. The delayed children were most likely those who previous visited a dental clinic and were unlikely to require application physical stabilization behaviour management technique during dental care.

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Preconception prevalence of iron, Vitamin B 12 and Folate deficiencies among women of reproductive age in a Nigerian population

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Abstract
Background: Maternal healthcare is an index of national healthcare coverage. Gestational anaemia is reportedly prevalent in Nigeria mainly due to nutritional deficiency and malaria infection. Considerable effort has been directed towards addressing these challenges among pregnant women. However, preconception care is yet to be routinely practised in our locality. It is possible that lack of preconception care, especially with regards to assessment of nutritional status, could be contributing to a gestational health crisis, thus necessitating due investigation.
Methods: This study enrolled 360 women of reproductive age at the University of Calabar Teaching Hospital in southern Nigeria between November 2021 and April 2022. Simple random sampling was used to recruit consenting subjects to be part of the survey where structured questionnaires were administered. Guided by their responses, subjects who were neither on supplements at the time of the study nor in the practice of taking supplements prior to pregnancy were purposively enrolled. Blood samples were collected from each participant for assays of iron, Vitamin B12 and folate by enzyme-linked immunosorbent assay method and measurement of haemoglobin concentration by automation. Data analysis to derive frequencies and Student's t-test comparison of means was carried out using SPSS 22.0.
Results: Folate deficiency was the least at 8.9%, followed by Vitamin B12 deficiency at 14.2% and Iron deficiency at 42.5%. Anaemia was observed to be 31.1% within the studied population. Iron deficiency alone dominated in the observed distribution pattern of the assessed deficiencies Co-deficiency of all three measured parameters stood at 4.4%.
Conclusion: Deficiencies of iron, vitamin B12 and folate are prevalent at the preconception stage in the study area. So, also, is anaemia even though the severity may be considered mild. Women in the study area are at risk of pre-existing anaemia and nutritional deficiency prior to pregnancy. Routine preconception care including assessment of nutritional status is therefore recommended in the study locality.

Key words: Preconception, maternal health, anaemia, nutritional deficiency

Introduction
Maternal healthcare is symbolic in the general healthcare system at a national level as it represents basic healthcare coverage, while maternal mortality has become an important health indicator for national socioeconomic status (WHO, 2022; Edem *et al.,* 2021). Moreso, maternal healthcare by extension proactively caters for infant health.

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This dynamic relationship is readily observed in the adverse consequences of poor maternal nutritional status on the outcome of pregnancy including but not limited to low birth weight, neonatal anaemia and neural tube defect (Rogne *et al.,* 2017; Gernand *et al.,* 2016; Breyman, 2015; Van Sande *et al.,* 2013; Lindsay *et al.,* 2012).

In circumstances of planned pregnancy, assessment of baseline biomedical parameters aids possible interventions such as micronutrient fortification where necessary. Largely confined to cases challenged with infertility, preconception care as part of maternal healthcare is yet to be routinely practised in resource-poor societies as we have in Nigeria (Ojifinni & Ibisomi, 2020).

Pregnancy remains the prompting factor for which most women intentionally enrol for maternal healthcare, and even at this, previous reports from within the study locality have revealed a trend of late antenatal enrolment (Ndem *et al.,* 2021; Egbe *et al.,* 2018).

Gestational anaemia is reportedly prevalent in Nigeria with rates well over 60% (Adewara *et al.,* 2014; Ezugwu *et al.,* 2013). Among the many contributing factors to this anaemia, nutritional deficiency and malaria parasitaemia rank high to which national programmes have been employed towards effective control of these maladies (Akwiwu *et al.,* 2019). Strategies such as routine provision of supplements and distribution of insecticide-treated bed nets during antenatal visits are some of the specific actions taken to improve maternal health during pregnancy (Adaji *et al.,* 2019; Esu *et al.,* 2018; Fleming *et al.,* 1986).

Notwithstanding, maternal morbidity and mortality are yet to be fully addressed (UNICEF, 2016). Reasons advanced for this, particularly with respect to anaemia, include challenges with sustaining intervention programmes and literacy levels in rural areas of the country (WHO, 2019; Akwiwu *et al.,* 2019; Harika *et al.,* 2017). There is also a possibility that lack of preconception care, especially with regards to assessment of nutritional status, could be contributing to gestational health crisis.

It is obvious from the cited literature that iron, vitamin B12 and folate deficiencies stand at the forefront of implicated nutritional deficiencies with poor pregnancy outcome. While these variables have been assessed within the Nigerian pregnant women population, there is paucity of data at the preconception stage among women of reproductive age. This study sought to bridge this gap by looking into the prevalence of iron, vitamin B12 and folate deficiencies among women of reproductive age accessing contraceptive services at the family planning unit of a tertiary health institution in Southern Nigeria. The significance of this study is to highlight the prevalence of common nutritional deficiencies in preconception state among Nigerian women.

Materials and methods

The present study was conducted at the University of Calabar Teaching Hospital, Calabar Nigeria. The centre is a tertiary health facility located in the foremost metropolitan city of Calabar in Southern Nigeria. The sample size was determined (t^2 x p(1-p)/ m^2) using the anaemia prevalence of 55% reported for Nigerian non-pregnant women (WHO, 2021). This cross-sectional descriptive study enrolled 360 women accessing family planning services at the hospital between November 2021 and April 2022. Ethical approval was obtained from the Health and Research Ethics Committee (UCTH/HREC/33/532) of the University of Calabar Teaching Hospital. Informed consent was obtained from each participant enrolled in the research and confidentiality was maintained by using assigned codes instead of names during sample and data analyses. Consenting study participants were 21 years old and above.

A Two-step sampling technique was used for subject selection. A simple random approach was used to recruit consenting subjects to be part of the survey where

structured questionnaires were administered. Guided by their responses, subjects who were neither on supplements at the time of the study nor in the practice of taking supplements prior to pregnancy were purposively enrolled for blood sample collection. Bio-data and information on the use of supplements, parity and average daily meal consumption were obtained from the administered structured questionnaire.

The blood sample was collected from each enrolled subject. Serum ferritin was analysed using a Human Ferritin ELISA kit obtained from BioCheck, Inc South San Francisco, USA. Serum levels of vitamin B12 and folate were also assayed by ELISA method using AccuDiag™ ELISA Kit (Diagnostic Automation/ Cortez Diagnostics, Inc. USA) while haemoglobin concentration was measured using automated haematology analyser Sysmex K2–2IN (Sysmex Corporation, Japan). Data analysis to derive frequencies and Student's t-test comparison of means was carried out using SPSS 22.0. A 95% confidence level was set for statistical significance.

Results

Socio-demographic characteristics of the study participants are presented in Table 1. These non-pregnant women were mostly aged 31-40 years, followed by those aged 41-50 years. The lowest number were those between the ages of 21 to 30 years. The study participants had appreciable levels of literacy and were distributed across occupational categories including civil service and self-employment as well as those who were housewives. Most of them lived on a family income of 200-500 USD monthly. Those in the habit of eating twice daily were slightly more than those who ate thrice daily, while multiparous women were more than the primiparous ones.

Table 1. Socio-demographic characteristics of study participants

Variables		Number n = 360	Percentage 100%
Age			
21-30		69	19.2
31-40		182	50.5
41-50		109	30.3
Educational Level			
Primary		0	0
Secondary		212	58.9
Tertiary		148	41.1
Occupation			
Civil servants		121	33.6
Housewives		102	28.3
Self-employed		137	38.1
Family income			
<200 USD		133	36.9
200-500 USD		176	48.9
>500 USD		51	14.2
Average number of meals Per day			
One meal		0	0
Two meals		186	51.7
Three meals		174	48.3

Parity			
Primiparous		168	46.7
Multiparous		192	53.3

Prevalence rates of assessed deficiencies are shown in Tables 2 and 3. Folate deficiency was the least at 8.9%, followed by Vitamin B12 deficiency at 14.2% and Iron deficiency at 42.5% was the highest. Generally, the present study recorded anaemia to be 31.1% within the studied population (Table 2). Considering the pregnancy cut-off value (110g/L) for haemoglobin concentration, 11.9% of the studied population fell below this mark already in a preconception state (Table 3).

Table 2. Prevalence rates of anaemia, folate and vitamin B12 deficiencies within the studied population

Parameter	Cut off value	Total No.	No. of Pregnant Women with Deficiency	%
Folate	6.8nmol/L	360	32	8.9
Vitamin B12	148pmol/L	360	51	14.2
Iron	10µg/L	360	153	42.5
Anaemia	120g/L	360	112	31.1

Table 3. Severity of anaemia within the studied population

Haemoglobin concentration	Cut off value	No. of Pregnant Women with Deficiency n = 360	%
	100-109g/L	43	11.9
	110-119g/L	69	19.2
Anaemic	<120g/L	**112**	**31.1**
Non-anaemic	≥120g/L	**248**	**68.9**

Iron deficiency alone dominated in the observed distribution pattern of the assessed deficiencies (Table 4). At a prevalence of 35.8%, it constituted more than half of the total deficiencies recorded (129/193). Co-deficiency of all three measured parameters stood at 4.4%. Again, folate deficiency was at the bottom of the list with its sole deficiency recorded at 0.8%.

Table 4. Distribution of single and co-deficiencies within the studied population

Parameter	No. of Pregnant Women with Deficiency n = 360	%
Folate alone	3	0.8
Vitamin B12 Alone	24	6.7
Iron alone	129	35.8
Folate & B12	13	3.6
Folate & Vitamin B12 & Iron	16	4.4
Folate & Iron	0	0
Vitamin B12 & Iron	8	2.2
Total	193	53.5

Mean values of the measured parameters were compared on the basis of parity as well as an average number of meals consumed daily as shown in Tables 5 and 6. Primiparous subjects had significantly higher mean values compared to multiparous participants. Similarly, subjects with an average daily consumption of 3 meals had a significantly higher value than others who reported daily consumption of 2 meals.

Table 5. Impact of parity on the measured parameters

Parameters	Primiparous Subjects n = 168	Multiparous Subjects n = 192	p-Value
Folate (nmol/L)	15.48±4.97	10.09±5.23	0.001
Vit B12 (pmol/L)	324.01±85.85	216.73±97.27	0.001
SF (µg/L)	33.81±23.14	15.73±25.93	0.001
Hb (g/L)	125.46±5.95	117.24±9.44	0.001

Table 6. Impact of average daily number of meals on the measured parameters

Parameters	Subjects on 3 meals per day n = 174	Subjects on 2 meals per day n = 186	p-Value
Folate (nmol/L)	16.84±5.01	8.64±2.92	0.001
Vit B12 (pmol/L)	351.37±77.66	187.67±7.13	0.001
SF (µg/L)	40.13±28.25	9.22±11.17	0.001
Hb (g/L)	127.66±4.99	114.93±7.38	0.001

Discussion

The prevalence of general anaemia in this study was 31.1%. The observed prevalence for iron and vitamin B12 deficiencies were 42.5% and 14.22% respectively, while that of folate deficiency was 8.9%. Apparently, nutritional deficiencies and anaemia are prevalent in the study area beyond the heightened pressure from gestational demands. The observed value of 31.1% for anaemia is lower than the national estimation of 55% but comparable to the global prevalence of 29.6% (WHO, 2021).

It is interesting to note that even among pregnant women in the study locality, a previous study recorded 47.8% anaemia; an observation that is attributable to rich vegetable consumption in the area (Ndem *et al.*, 2021). Furthermore, multiparity and inadequate meal consumption resulted in significantly lower values of the measured parameters. Interestingly, there is a campaign for maternal health in Nigeria in line with the global sustainable development goals (WHO, 2022; UNICEF, 2016).

Much of the strategies for realising this, however, have been directed towards ensuring optimal antenatal coverage and family planning for healthy spacing of childbirth. Regarding the former, prescription and provision of nutritional supplements on a routine basis have long been adopted for healthy pregnancy outcomes. More specifically, a measurable outcome of this fortification drive is the improvement of erythrocytic indices and invariably the reduction of gestational anaemia. So far, preconception anaemia and deficiency states have not received much attention in the study area and could hold the potential of addressing gestational anaemia and its toll on both maternal and infant health.

Additionally, iron deficiency was observed to be about 3 (2.99) times higher than vitamin B12 deficiency and more than 4 (4.78) times higher than folate deficiency among the studied population. This finding places the need for iron supplementation at the top of the list for nutritional intervention within the studied population with regard to the measured parameters. At a point when these subjects could have become pregnant without any recourse to their nutritional state, 11.9% of them were already below the haemoglobin concentration level

(110g/L) used as a cut-off for gestational anaemia. A significant proportion (of 19.2%) had haemoglobin concentration levels between the range of 110-119 g/l which though passes the gestational anaemia cut-off point is still considered anaemic for non-pregnant women.

In all, this study recorded 31.1% preconception maternal anaemia prevalence in Calabar, Nigeria. More than half (53.5%) of the studied population had at least a deficiency of iron, vitamin B12 or folate, while 4.4% had co-deficiency of all three screened parameters. The prevalence of iron deficiency ranked highest in all cases of categorisation among the measured parameters and was in fact higher than the prevalence of anaemia. Iron contributes to erythropoiesis in the haemoglobinisation of developing red cells, thus serving as an important index in the study of the red cell population. A deficiency of stored iron precedes anaemia, making it a marker for early detection of a potential anaemic state (Akwiwu *et al.,* 2019; Harika *et al.,* 2017; Fleming *et al.,* 1986).

Becoming pregnant with either pre-existing anaemia or nutritional deficiency can be quite risky as studies have reported a higher association of birth defects with nutritional deficiencies particularly early in pregnancy (Pafici, 2016; Sukuma *et al.,* 2016; Eke *et al.,* 2016; WHO, 2015). In resource-poor settings such as Nigeria, healthcare coverage is inadequate and the populace is largely passive. Previous studies in this locality had observed late enrolment of pregnant women for antenatal care as well as late commencement of supplement intake which in turn impacts adversely on maternal health (Alfred *et al.,* 2021; Ndem *et al.,* 2021; Egbe *et al.,* 2018).

The efforts to address maternal health issues during pregnancy would be more beneficial if approached proactively. Thus, it may be necessary to drive nutritional fortification as women access family planning services, particularly for women with multiple parity and irregular daily meal consumption. Being a cross-sectional study to determine prevalence, this study had the limitation of not following up on the subjects over time. Future studies could adopt a longitudinal study design that would monitor subjects to the point of conception and beyond.

Conclusion

The present study concludes that deficiencies of iron, vitamin B12 and folate are prevalent at the preconception stage in the study area. So also, is anaemia even though the severity may be considered mild. Multiparity and inadequate meal consumption impact adversely on the measured parameters. These findings imply that the studied population is at risk of nutritional anaemia at the preconception stage. Thus, there is a need for routine preconception assessment of nutritional status in the study locality.

Conflict of Interest
The authors declare no conflict of interest.

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