

# The Impact of Rural Electrification on Healthcare Service Delivery: A Case Study of Nyasa District, Tanzania

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## **Abstract**

*This study examines the impact of rural electrification on healthcare service delivery in Nyasa District, Tanzania. The research employs a cross-sectional design to gather data from 350 respondents, including healthcare workers, small business owners, and farmers, using structured questionnaires. Descriptive analysis and thematic analysis were utilized to evaluate both quantitative and qualitative data. The findings indicate that rural electrification has significantly enhanced healthcare services by enabling extended clinic operating hours, supporting the use of essential medical equipment, and improving emergency care services, particularly during the night. Additionally, respondents reported that electrification has greatly improved the storage of temperature-sensitive medicines and vaccines, reducing spoilage and ensuring the availability of critical medical supplies. Despite these positive outcomes, challenges such as inconsistent electricity supply persist, affecting service delivery in some areas. The study concludes that rural electrification plays a vital role in improving healthcare accessibility and quality in underserved areas. However, to fully realize the potential benefits, there is a need for further investment in sustainable energy solutions, improved infrastructure, and capacity building for healthcare workers. These efforts will help ensure that electrification initiatives continue to support healthcare service delivery and improve health outcomes in rural communities.*

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## **1. Introduction**

Rural electrification is a cornerstone of sustainable development, especially in improving healthcare services in developing countries (Dimoso and Andrew, 2021). Access to electricity is essential for the operation of modern healthcare systems, supporting everything from basic lighting and refrigeration of medicines to the functioning of advanced medical devices and emergency care (Adair-Rohani et al., 2013). However, many rural areas, particularly in sub-Saharan Africa, continue to face substantial challenges in achieving reliable electricity access, which in turn hampers the provision of adequate healthcare services (De Souza et al., 2014). This issue is especially pronounced in remote regions like Nyasa District in Tanzania, where healthcare facilities struggle with inconsistent power supply, severely limiting their capacity to provide essential health services.

Electricity plays a pivotal role in healthcare by enabling medical facilities to maintain cold chains for vaccines, operate life-saving equipment, and ensure the availability of critical care services around the clock (Vidler et al., 2016; Spiegel et al., 2011). Yet, across much of rural Africa, power shortages continue to plague healthcare delivery, exacerbating already strained health systems (Mangipudi et al., 2020). The absence of reliable electricity has been shown to negatively affect maternal health, emergency obstetric services, and neonatal care, with rural health centers often unable to provide basic yet critical services (Turnbull et al., 2016). Consequently, rural electrification has become a focal point of development strategies aimed at improving health outcomes and reducing mortality rates in underserved regions (Swanson et al., 2017).

Despite global efforts to increase rural electrification, the results have been uneven. In South Asia, for example, countries like India have made significant strides in expanding electricity access, particularly through the adoption of decentralized renewable energy solutions, such as solar power, which have been instrumental in remote areas (Aklin et al., 2016). Studies in India have demonstrated that mobile healthcare delivery services have been enhanced by improved electricity access, allowing rural healthcare providers to extend their reach and improve the quality of care (De Souza et al., 2014). Similarly, rural electrification projects in South Africa have been shown to positively impact employment and community health services, underlining the broader socio-economic benefits of electrification (Dinkelman, 2011).

In sub-Saharan Africa, rural electrification has been recognized as a key strategy to strengthen healthcare systems. Countries like Ghana and Uganda have seen improvements in healthcare delivery, particularly in rural health facilities, through electrification projects that aim to ensure continuous power supply (Javadi et al., 2020). However, despite these successes, many African countries continue to face significant barriers, including high infrastructure costs, inadequate maintenance, and financial constraints that limit the long-term sustainability of electrification efforts (Troeger et al., 2017). These challenges underscore the need for more robust, context-specific research on how electrification impacts healthcare service delivery in rural areas (Kushner et al., 2010).

In Tanzania, the Rural Energy Agency (REA) has been a critical driver in expanding electricity access, particularly in underserved regions such as the Nyasa District (Karim et al., 2020). While the REA has made considerable progress in extending electricity to rural areas, many health facilities in these regions still struggle with inconsistent power supply due to poor infrastructure

and limited financial resources (Mulinge & Mwangi, 2023). This inconsistency undermines the ability of healthcare facilities to deliver services effectively, particularly in emergency care, maternal health, and the management of communicable diseases (Oketch et al., 2022). Consequently, the health outcomes in these rural communities remain suboptimal, highlighting the need for further investments and sustainable solutions in rural electrification (Swanson et al., 2017).

A systematic review of electricity access in health facilities across sub-Saharan Africa has found that inconsistent power supply is one of the major barriers to improving healthcare delivery in rural areas (Adair-Rohani et al., 2013). Health facilities that rely on unreliable power sources often face disruptions in service delivery, affecting everything from surgical procedures to routine patient care (Spiegel et al., 2011). This problem is compounded by the high cost of alternative power sources, such as diesel generators, which are both environmentally unsustainable and financially burdensome for low-income communities (Kushner et al., 2010).

Understanding the impacts of rural electrification on healthcare services in regions like Nyasa District is crucial for addressing these challenges. This study aims to investigate how access to reliable electricity can enhance healthcare service delivery in rural Tanzania, with a particular focus on maternal and emergency care services. By exploring the successes and challenges of rural electrification projects in Nyasa District, this research will contribute to filling a critical gap in the current understanding of how consistent electricity access influences healthcare outcomes in rural, underserved communities. The findings will provide valuable insights for policymakers and development practitioners seeking to design more effective and sustainable electrification initiatives in similar contexts (Javadi et al., 2020).

Therefore, while rural electrification holds great promise for improving healthcare services in developing countries, particularly in sub-Saharan Africa, significant challenges remain. Efforts to expand access to electricity must be paired with investments in infrastructure, maintenance, and capacity-building to ensure the sustainability of these projects (Karim et al., 2020). This study will provide much-needed data on the impacts of rural electrification in Nyasa District, offering recommendations on how to optimize these initiatives to improve healthcare service delivery and, ultimately, health outcomes in rural Tanzania.

## **2. Theoretical framework**

Modernization Theory, originally developed in the 1950s, offers a comprehensive framework for understanding the role of technological advancements, such as rural electrification, in driving social and economic development. Robert N. Gwynne, among other scholars, highlighted the transformative potential of technology in modernizing societies, particularly in developing regions. Central to this theory is the idea that as societies adopt new technologies, such as electricity, they experience profound changes across multiple sectors, including healthcare. In this context, rural electrification serves as a powerful catalyst, enabling healthcare systems to function more efficiently by powering essential medical equipment, extending clinic hours, and improving the overall quality of care.

According to Modernization Theory, societal progress is intrinsically linked to infrastructure development, with electrification acting as a critical enabler for modernization. The availability of

electricity in rural areas is not merely about lighting homes or businesses but is pivotal for the healthcare sector. For instance, reliable electricity supports the refrigeration of vaccines and medicines, ensuring the efficacy of immunization programs, which are vital for preventing communicable diseases (Adair-Rohani et al., 2013). Moreover, electricity enables healthcare facilities to use advanced diagnostic equipment and perform life-saving procedures such as surgeries, which are often impossible in facilities without power (Spiegel et al., 2011).

In the case of the Nyasa District, modernization theory helps elucidate the transformative potential of rural electrification on healthcare services. As electricity becomes more accessible, health facilities in this rural area are better equipped to provide critical services, such as maternal and child health, emergency care, and chronic disease management (Dinkelman, 2011). Electrification allows healthcare providers to extend their working hours, ensuring that care can be provided at all times, particularly during emergencies (Swanson et al., 2017). It also facilitates the operation of technologies necessary for diagnostics and patient monitoring, thus enhancing the overall capacity of healthcare services in the region.

However, Modernization Theory also emphasizes that technological advancement alone is not sufficient to bring about comprehensive social and economic development. While rural electrification is a fundamental component of modernizing healthcare services, it must be accompanied by other critical factors. These include well-maintained infrastructure, an adequate supply of medical resources, trained healthcare personnel, and supportive policies that ensure the efficient use of electricity and other technological tools in healthcare settings (Javadi et al., 2020). Without these complementary elements, the full potential of electrification to improve health outcomes may not be realized.

For example, in regions where healthcare workers lack the necessary training to operate advanced medical equipment, the benefits of electrification may be limited (Troeger et al., 2017). Similarly, inadequate policies or weak healthcare infrastructure can prevent facilities from maximizing the potential of the electricity available to them. In Tanzania's Nyasa District, the challenges of poor infrastructure, inconsistent electricity supply, and insufficient financial resources continue to impede the full realization of the benefits of rural electrification on healthcare services (Kushner et al., 2010).

Thus, while Modernization Theory positions rural electrification as a driver of both social and economic development, it also highlights the importance of a holistic approach. Electrification must be paired with strategic investments in healthcare infrastructure, capacity-building, and policy reform to maximize its impact. In alignment with this theoretical perspective, rural electrification should be seen not only as a means of powering healthcare services but as part of an integrated development strategy that strengthens healthcare systems, improves service delivery, and ultimately leads to better health outcomes (Aklin et al., 2016).

In conclusion, Modernization Theory provides a valuable lens through which to understand the impacts of rural electrification on healthcare services in regions like Nyasa District. It underscores the significant potential of electricity to enhance healthcare but also calls attention to the need for a broader, integrated approach. Such an approach must include investments in healthcare infrastructure, the training of personnel, and the development of effective policies that ensure the

sustainable and efficient use of technology in health services. Through this lens, rural electrification is recognized as a vital yet insufficient element on its own, requiring complementary efforts to achieve lasting improvements in health outcomes.

### **3. Empirical review**

Research on rural electrification has increasingly highlighted its critical impact on healthcare access and overall community well-being, particularly in developing nations where energy access is often limited. Numerous studies have demonstrated that rural electrification significantly enhances healthcare service delivery, contributing to better health outcomes and improved social and economic conditions.

For instance, Mudi (2020) explored the influence of rural electrification on healthcare access and the subsequent effects on the well-being of micro and small enterprise owners in Kenya. The study's primary goal was to assess how rural electrification enhances healthcare services and, in turn, improves household welfare. Using a cross-sectional descriptive survey design, Mudi targeted 172,554 small enterprise proprietors across eight counties and selected a sample of 418 participants. The study collected data through a pilot-tested questionnaire, and regression analysis revealed a moderate positive correlation between healthcare access and household well-being. This relationship underscored the critical role of electricity in improving healthcare services, which positively affected economic stability, education, and health within rural households. Mudi (2020) ultimately recommended policies aimed at universal electricity access for rural healthcare facilities, emphasizing the importance of infrastructure that supports health service delivery, aligning with findings by Adair-Rohani et al. (2013) on the importance of reliable electricity in healthcare facilities.

In a broader context, Khogali (2022) conducted a systematic review of the effects of electrification on healthcare facilities in Low- and Middle-Income Countries (LMICs). Using the World Health Organization's Health Facility Assessment modules, the study assessed how access to electricity improved healthcare outcomes such as antenatal care, vaccination rates, emergency services, and general healthcare provision. A key finding from Khogali's review was that renewable energy, particularly solar power, significantly enhanced health services in LMICs by facilitating better refrigeration for vaccines, extending clinic hours, and enabling emergency services to be provided at night. However, Khogali (2022) also identified unreliable electricity as a major barrier to optimal healthcare service delivery, especially in rural and remote areas where healthcare facilities depend heavily on consistent power supply. This finding echoes the challenges noted by Asamoah et al. (2023) in Ghana, where solar energy has proven instrumental in improving maternal healthcare outcomes, but inconsistent power supply continues to hinder broader healthcare improvements.

Similarly, Acharya and Patel (2022) analyzed the impact of rural electrification on healthcare services in developing nations, emphasizing that access to reliable electricity is crucial for improving healthcare infrastructure. Their research concluded that rural electrification leads to improved health outcomes by powering essential medical equipment and supporting continuous healthcare delivery. These improvements are particularly noticeable in maternal and neonatal care, where consistent electricity ensures the availability of essential services such as safe deliveries, vaccine storage, and emergency care.

Another notable study by Chen, Chindarkar, and Xiao (2019) in rural Gujarat, India, found that reliable electricity had a significant effect on health facilities, health information systems, and the utilization of child and maternal health services. Their research highlighted the importance of electricity in ensuring that healthcare facilities can operate diagnostic equipment, maintain health records electronically, and provide round-the-clock care. The study found a strong positive correlation between consistent electricity and increased healthcare service utilization, which parallels findings by Asamoah and Danso (2023) in Ghana, where solar energy played a crucial role in improving healthcare outcomes in rural areas.

Further research by Hassanpour and Wali (2021) provided a global perspective on rural electrification and healthcare access, noting that the availability of electricity in health facilities directly correlates with improved health outcomes, particularly in emergency care and vaccine storage. This aligns with the findings of Kumar et al. (2014), who identified supply-side barriers, including inconsistent electricity, as critical constraints on maternity care services in rural India.

While many studies emphasize the positive effects of rural electrification on healthcare services, they also point to significant challenges. Adamu and Osei (2022), for example, identified the high costs of infrastructure development and maintenance as barriers to achieving reliable electrification in healthcare facilities in Africa. Their research underscores the importance of long-term investment in sustainable energy solutions to address these challenges. Mangipudi et al. (2020) echoed this sentiment, calling for data-driven investments in reliable and sustainable energy sources, such as solar power, to enhance healthcare service delivery in sub-Saharan Africa.

Javadi et al. (2020) conducted implementation research on sustainable electrification in rural healthcare facilities in Ghana and Uganda, finding that while electrification improved healthcare services, challenges such as poor maintenance, inadequate funding, and a lack of trained personnel limited its effectiveness. Similarly, Nagpal (2021) emphasized the critical role of electricity in emergency care and vaccine storage, identifying power outages as a significant impediment to healthcare delivery in rural areas.

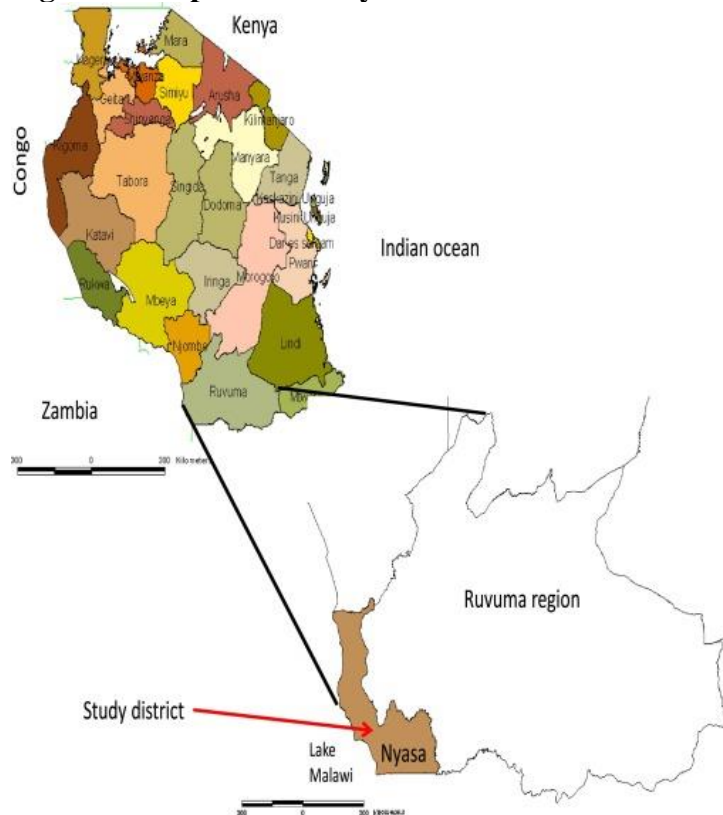
These empirical studies collectively underscore the vital role of rural electrification in enhancing healthcare services and improving overall community well-being. Both Mudi (2020) and Khogali (2022) demonstrate the need for stable, reliable electricity to improve healthcare outcomes, highlighting the cascading benefits that electrification brings to health systems and rural communities. Their findings align with broader research on rural energy access, such as the work by Acharya and Patel (2022) and Chen et al. (2019), which provides robust evidence of the strong linkage between electrification and healthcare delivery in developing regions.

Generally, while rural electrification presents a transformative opportunity for improving healthcare delivery, particularly in LMICs, significant challenges remain. The findings of these studies provide a solid foundation for further research and policy development aimed at maximizing the healthcare benefits of electrification in remote and underserved communities. The research highlights the need for integrated approaches that include not only infrastructure development but also capacity-building, financial investment, and policy reform to ensure the sustainability and long-term impact of electrification projects on healthcare services.

#### 4. Methodology

This study was conducted in Nyasa District, Tanzania, focusing on the impact of rural electrification on healthcare services. A quantitative research approach was employed to systematically collect and analyze numerical data related to healthcare improvements resulting from electrification. The target population comprised 4,320 household heads across five selected wards, with a sample size of 350 respondents determined using Yamane's formula. Stratified random sampling was used to ensure representation of different geographic and socio-economic groups. Data collection was carried out using semistructured questionnaires with Likert scale questions, designed to assess participants' perceptions of the effects of electrification on healthcare services, such as extended healthcare center hours, access to medical equipment, and improved emergency care. The collected data were analyzed using descriptive statistics via SPSS to examine the impact of rural electrification and healthcare services. Moreover, thematic analysis were used to triangulate quantitative results with the qualitative results. Validity was ensured through pilot testing of the questionnaire, and reliability was confirmed using Cronbach's alpha to measure internal consistency. Ethical considerations, including informed consent, confidentiality, and adherence to ethical guidelines set by relevant authorities, were strictly observed throughout the research process, ensuring participants' rights and privacy were fully respected.

**Figure 1: Map of the study area**



Source: The map has been extracted from Shonyela et al. (2017)

## 4. Findings

### 4.1 Description of respondents characteristics

The demographic characteristics of the 350 respondents in Table 1 provide valuable insight into the population surveyed and the diversity of perspectives represented. Gender distribution among the respondents is fairly balanced, with 51.43% male and 48.57% female participants. This near-equal representation of both genders suggests that the findings of the study reflect a broad cross-section of the community's experiences and perspectives on rural electrification and its impact on healthcare services.

In terms of age, the majority of respondents fall within the 31-40 years age group, comprising 34.29% of the sample. This is followed by the 18-30 years group, which represents 28.57% of respondents. The 41-50 years group accounts for 24.29%, while those above 50 years make up 12.86% of the respondents. The age distribution suggests that the study captures a wide range of experiences, with a focus on individuals in their prime working years who are likely to be more engaged with both the healthcare system and economic activities influenced by rural electrification.

The education levels of the respondents vary, with 34.29% having completed secondary education, followed by 28.57% with tertiary education. A significant portion, 25.71%, has completed primary education, while 11.43% have no formal education. This distribution highlights the diversity in educational backgrounds, which could influence respondents' understanding of healthcare services and rural electrification's role in improving those services. The substantial proportion of respondents with secondary or tertiary education suggests that many are well-equipped to provide informed opinions on the issues explored in this study.

**Table 1: General characteristics of respondents**

Characteristic	Categories	Frequency (n)	Percentage (%)
Gender	Male	180	51.43
	Female	170	48.57
Age Group	18-30 years	100	28.57
	31-40 years	120	34.29
	41-50 years	85	24.29
	Above 50 years	45	12.86
Level of Education	No formal education	40	11.43
	Primary education	90	25.71
	Secondary education	120	34.29
Occupation	Tertiary education	100	28.57
	Healthcare workers	110	31.43
	Small business owners	95	27.14
	Farmers	90	25.71
Years of Residence in Area	Other	55	15.72
	Less than 5 years	75	21.43
	5-10 years	120	34.29
	More than 10 years	155	44.28

Occupation-wise, healthcare workers form the largest occupational group, making up 31.43% of the respondents. Small business owners account for 27.14%, followed by farmers at 25.71%, and



15.72% identifying as belonging to other professions. This occupational distribution is significant because it includes a large number of healthcare professionals who are directly involved in the delivery of healthcare services, as well as individuals engaged in small-scale enterprises and farming, whose livelihoods may also be impacted by the availability of electricity and improved healthcare access.

Lastly, the duration of residence in the area indicates that the majority of respondents, 44.28%, have lived in the region for more than 10 years, while 34.29% have been residents for 5-10 years, and 21.43% have lived there for less than 5 years. This suggests that most respondents have long-term experience with local conditions, including the state of healthcare services before and after the introduction of rural electrification. This long-term residency provides valuable perspectives on the changes and improvements brought about by electrification in their communities.

Generally, the demographic profile of the respondents demonstrates a well-rounded representation of the community, including a balance of gender, a range of ages, varying educational backgrounds, and a diverse mix of occupations. These characteristics ensure that the study captures a broad range of experiences and insights regarding the impact of rural electrification on healthcare services in Nyasa District.

#### **4.2 Perceived Impact of Rural Electrification on Healthcare Services**

The findings in table 2 underscore the significant positive impact of rural electrification on healthcare services in Nyasa District, aligning with previous research on the subject. The majority of respondents reported that electrification has greatly improved key aspects of healthcare delivery, particularly in terms of extending clinic hours, enabling the use of medical equipment, improving emergency services, and ensuring the proper storage of temperature-sensitive medicines and vaccines.

A significant portion of respondents (71.14%) either agreed or strongly agreed that rural electrification has allowed health centers to extend their operating hours into the evening and night. This finding echoes the observations made by Mudi (2020), who also found that electrification enabled healthcare facilities to operate for longer hours, improving access to medical services for communities. The ability to provide care at night is especially crucial in rural areas where health facilities may be few and far between, as highlighted by Khogali (2022) in their systematic review of electrification impacts in LMICs. The positive perception of extended operating hours reflects a critical enhancement in healthcare accessibility, particularly for emergency cases that require immediate attention outside of normal daytime hours.

Electrification has also facilitated the use of essential medical equipment in rural health centers. The majority of respondents (68.28%) agreed or strongly agreed that electricity enabled the use of equipment such as refrigerators for vaccines and diagnostic machines. This is consistent with findings by Adair-Rohani et al. (2013), who noted that reliable electricity is essential for operating medical equipment critical to maintaining healthcare services. Without electricity, the ability to refrigerate vaccines and conduct diagnostic tests would be severely hindered, as confirmed by the qualitative data. One respondent emphasized how electrification allowed their facility to prevent the spoilage of vaccines, a finding that supports the broader conclusions of Asamoah et al. (2023), who identified the role of solar energy in preserving medicines in rural Ghana.

**Table 2: Response on the impact of rural electrification on healthcare services**

Statement	SD	D	N	A	SA	Mean	Std
Extended operating hours in health centers.	17 (4.86%)	43 (12.29%)	41 (11.71%)	126 (36.00%)	123 (35.14%)	3.84	1.17
Use of medical equipment (e.g., refrigerators).	16 (4.57%)	46 (13.14%)	49 (14.00%)	123 (35.14%)	116 (33.14%)	3.79	1.17
Improved emergency services & surgeries at night.	20 (5.71%)	35 (10.00%)	57 (16.29%)	118 (33.71%)	120 (34.29%)	3.81	1.18
Better storage of medicines and vaccines.	16 (4.57%)	34 (9.71%)	56 (16.00%)	109 (31.14%)	135 (38.57%)	3.89	1.16
Increased health services (maternity care, etc.)	17 (4.86%)	43 (12.29%)	41 (11.71%)	126 (36.00%)	123 (35.14%)	3.84	1.17

Source: Field data (2024)

The use of diagnostic equipment such as X-rays and ultrasound machines has significantly improved healthcare delivery in rural clinics, as noted by a respondent who shared an example of diagnosing pneumonia with an X-ray machine. This aligns with the findings of Chen et al. (2019), who reported that reliable electricity enabled health facilities in rural India to utilize diagnostic machines, reducing the need for patients to travel long distances for basic tests. These improvements in diagnostic capabilities have likely contributed to better health outcomes by enabling earlier and more accurate diagnoses.

The study also found a favorable perception of the role of electrification in improving emergency services and surgeries during nighttime hours, with 68% of respondents agreeing or strongly agreeing on this point. The ability to perform surgeries and provide emergency care after dark was previously constrained by a lack of reliable lighting, as reported by respondents in the qualitative section. The capacity to provide these critical services at night is particularly important in rural areas where transfer to larger facilities may not be feasible. Acharya and Patel (2022) similarly highlighted the essential role of rural electrification in improving healthcare outcomes by enabling emergency services, especially for maternal and child health.

The highest level of agreement in the study was on the impact of electrification on the proper storage of medicines and vaccines, with 69.71% of respondents affirming its positive effect. The findings align with Boniface (2020), who stressed the importance of reliable electricity for maintaining the cold chain required for vaccines and certain medications in rural areas. This aspect of electrification is critical for the success of vaccination programs and the treatment of chronic conditions like diabetes, as one respondent noted. The ability to store temperature-sensitive medicines has a direct impact on healthcare quality, ensuring that patients receive effective treatments.

Finally, the study highlighted the perceived impact of electrification on the overall availability of health services, such as maternity care and disease treatment. A large majority of respondents (71.14%) agreed or strongly agreed that electricity access has expanded healthcare services. This supports the findings of Adamu and Osei (2022), who noted that rural electrification enables healthcare facilities to offer a broader range of services, thus improving healthcare outcomes in

rural areas. The availability of consistent electricity allows for continuous service provision, which is especially critical for maternity care, as emphasized by Asamoah and Danso (2023).

The results of this study strongly indicate that rural electrification plays a crucial role in expanding and improving healthcare services in Nyasa District, Tanzania. These findings align with the broader literature, such as Mudi (2020), Khogali (2022), Anasel et al., (2024), and Asamoah et al. (2023), which consistently demonstrate the transformative impact of electrification on rural healthcare infrastructure. The high levels of agreement across all measured dimensions suggest that respondents overwhelmingly perceive rural electrification as beneficial to healthcare delivery, particularly in emergency services, maternal care, and the storage of medical supplies.

However, the presence of some disagreement and neutrality in the responses highlights that while the overall impact is positive, challenges remain. As Adamu and Osei (2022) pointed out, the sustainability of electrification projects and the consistency of electricity supply are key issues that need to be addressed. The variability in responses, as shown by the standard deviations, suggests that while many healthcare facilities benefit from electrification, others may still face challenges related to inconsistent power or infrastructure limitations.

In addition to the quantitative data gathered from the closed-ended questions, the study included open-ended responses to gain a more detailed understanding of the effects of rural electrification on healthcare services in Nyasa District. These qualitative responses complement the quantitative findings, providing concrete examples of how electrification has enhanced healthcare delivery, lengthened operating hours, and facilitated the use of essential medical equipment. The following quotes from respondents illustrate and support the closed-ended results.

One respondent noted,

*"Since electricity was introduced in our health center, it has changed the way we provide care. Before, we could only treat patients during the day because once the sun went down, there was no reliable source of light. We had to rely on kerosene lamps, which were not only dim but also dangerous in some cases. Now, with electricity, we are able to treat patients much later into the evening, and this has especially helped with emergency cases. Minor surgeries that used to be postponed or transferred to larger hospitals can now be done here, even after dark. For example, we had a woman come in labor at night, and thanks to the electrified lighting, we could safely deliver her baby here without having to send her far away."*

This response highlights how rural electrification enabled the extension of operating hours in local health centers, directly improving access to healthcare, particularly in emergency situations. The respondent emphasizes how the availability of electricity has allowed them to provide critical services during the night, which was previously impossible due to the lack of reliable lighting. The capacity to conduct minor surgeries and handle childbirth at night is especially impactful in rural areas where alternative health services might be hours away.

The findings imply that electrification plays a crucial role in expanding healthcare services in rural areas, particularly for emergency and nighttime care. Continued investment in providing electricity to rural health centers can enhance healthcare accessibility and improve patient outcomes in these underserved communities.

Similarly, another respondent supported this by saying,

*"Before we had electricity, we couldn't store certain medicines and vaccines because they needed to be kept cool, and we didn't have any way to refrigerate them. There were times when vaccines were spoiled because they got too warm, or we simply couldn't order them because we knew we didn't have the capacity to store them properly. Now, with the power supply, we have refrigerators and storage units that keep the medicines at the right temperature. This has been a huge help in preventing spoilage and ensuring that we can give our patients the treatments they need. For instance, during the last vaccination drive, we were able to keep all the vaccines safe and administer them without any issues. It has also improved the way we store medicines for chronic conditions like insulin for diabetes patients."*

This response emphasizes the critical role that rural electrification plays in enabling health centers to preserve vital medical supplies such as vaccines and temperature-sensitive medicines. The respondent explains how the availability of electricity for refrigeration has allowed the health center to prevent spoilage of essential supplies and provide better care to patients. The ability to store vaccines properly ensures that immunization programs can run more effectively, contributing to better public health outcomes.

The findings imply that rural electrification is essential for improving healthcare infrastructure, particularly in relation to the storage of medicines and vaccines. Ensuring reliable electricity for medical equipment and storage facilities is key to maintaining the quality of healthcare in rural areas. Health centers that have access to power can safely store life-saving medicines and carry out essential vaccination programs without the fear of losing supplies due to temperature fluctuations.

In addition, one more respondent added,

*"Our clinic used to be limited in terms of the types of tests and treatments we could provide because we didn't have a stable source of power for the medical equipment. We couldn't run diagnostic machines, so patients often had to travel long distances to get their tests done, which delayed treatments. Now, with electricity, we are able to run tests on patients using equipment that requires power, such as X-rays, ultrasound machines, and lab testing machines. This has made a huge difference in our ability to diagnose conditions early and provide better, more accurate treatments. For instance, just the other day, we diagnosed a case of pneumonia using the X-ray machine, which we could not have done before. The patient received immediate treatment, which likely prevented their condition from worsening."*

This statement underscores the long-term benefits of rural electrification in enhancing diagnostic capabilities in healthcare centers. The respondent notes how access to electricity has enabled the clinic to use diagnostic machines, improving the accuracy of diagnoses and the quality of treatment. The ability to run tests such as X-rays and ultrasounds locally eliminates the need for patients to travel to larger, distant facilities, thereby speeding up treatment and improving health outcomes.

The findings imply that rural electrification not only expands basic healthcare services but also elevates the quality of care by enabling the use of essential medical technology. Continued support for electrification projects in rural health centers can greatly improve healthcare delivery, making advanced diagnostic tools more widely available and contributing to better health outcomes.

## **5. Conclusions**

The study concludes that rural electrification has a significant and positive impact on healthcare services in Nyasa District, Tanzania. Access to electricity has enabled health facilities to extend operating hours, utilize essential medical equipment, improve emergency care services, and preserve temperature-sensitive medicines and vaccines. These improvements have not only increased the accessibility of healthcare services but have also enhanced the overall quality of care provided in rural areas. While the majority of respondents perceive rural electrification as beneficial, challenges remain, particularly with the consistency of electricity supply in some areas. These findings highlight the transformative role of electrification in supporting rural healthcare systems and improving health outcomes, especially in underserved communities. However, for the full benefits of electrification to be realized, continuous efforts are needed to address the challenges associated with power supply and infrastructure limitations.

To further improve the impact of rural electrification on healthcare services, several recommendations are proposed. First, it is essential to invest in reliable and sustainable energy solutions, such as renewable energy sources, to ensure that health facilities have consistent access to power. Second, strengthening infrastructure and establishing effective maintenance programs will be crucial in ensuring that electrification initiatives are sustainable and can support healthcare services in the long term. Third, capacity building and training programs should be implemented for healthcare workers to ensure they can effectively operate and maintain the medical equipment powered by electricity. Fourth, expanding electrification projects to other underserved areas will help to replicate the positive outcomes seen in Nyasa District, providing more rural populations with improved healthcare services. Finally, governments and stakeholders should focus on policy reforms and financial support to facilitate the scaling up of electrification initiatives, ensuring that healthcare facilities are equipped with the necessary resources to provide high-quality, uninterrupted services to rural communities.

By adopting these recommendations, stakeholders can enhance the effectiveness of rural electrification in improving healthcare delivery, leading to better health outcomes and increased access to essential services in rural areas.

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