2025, vol. 12, issue 1, 453 - 461

RESEARCH ARTICLE

https://doi.org/10.5281/zenodo.15804596

FROM SCARCITY TO ABUNDANCE OF WATER: IMPROVING HYGIENE PRACTICES IN PUBLIC PRIMARY SCHOOLS IN SEMI- ARID TANZANIA

Maria Masumbuko [1]

Joyce Nemes [2]

Huruma Olofea Bwagilo [3]

[1]Ilazo Primary School, Dodoma, Tanzania, mariamasubuko@gmail.com, 0009-0002-2271-1965
[2]Senior Lecturer, Department of Educational Management and Policy Studies, The University of Dodoma Tanzania, Email: joyce.nemes@udom.ac.tz/xusper@yahoo.co.uk, 0000-0001-6843-4751
[3]Lecturer, Department of Psychology and Curriculum Studies, The University of Dodoma, Tanzania **olefeahuruma@yahoo.com**, 0000-0002-8336-3370

Abstract

Proper hygiene practices, handwashing in particular, are essential for the well-being of pupils in schools of which, the availability of adequate amount of water is a critical factor influencing these practices, especially in semi-arid regions. This study explored the hygiene practices as exhibited by pupils in public primary schools in Bahi District, Dodoma, Tanzania where water supply has recently been improved. Utilizing the qualitative methods coupled with the hermeneutic phenomenological case study design, the research highlights several key findings after the data being analyzed thematically subsequently to employing semi- structured interviews with headteachers, Focus Group Discussions with pupils and non-participant observations in three public primary schools as data collection methods and. The presence of multiple water points and enhanced Water- Sanitation and Hygiene (WASH) facilities, significantly increased the frequency of handwashing practices among pupils. Furthermore, the improved water access has led to cleaner and more conducive learning environments, thus the enhanced water availability not only boosts hygiene practices but also fosters a more favorable learning atmosphere. In that regard, insights into the real-life handwashing habits in semi-arid schools can inform policymakers and school administrators about the importance of ensuring adequate WASH facilities in place. Ultimately, the study underscores the necessity for the persistent investment in water accessibility so as to promote healthier learning environments and improve student's outcomes in similar contexts, thereby contributing to the overall well-being of pupils.

Keywords: Pupils, Hygiene practice, Primary school, Semi – arid areas

Introduction

Globally, the availability of water within the school environment is considered a crucial component for pupil hygiene, well-being, and an effective teaching and learning process (Barasa et al., 2015; Waruingi, 2015; Kutsyuruba et al., 2015; Ohwo, 2019; Charnley, 2022; Mtimkulu, 2022; Melaku & Addis, 2023). This is especially evident in schools located in semi-arid areas, where water scarcity can significantly affect the daily operations of school activities, pupils' hygiene practices, health, learning environments, and learning outcomes (Abdi, 2021; Akanzum & Pienaah, 2023; Gatundu, 2023; Sharma et al., 2024).

In semi-arid areas, the limited availability of water has been a significant factor hindering pupils' access to proper handwashing facilities and practices (Waruingi, 2015). Several studies have identified the lack of water as a barrier to handwashing practices among public primary school pupils (Mnyiri, 2014; Dlamini, 2017; Anyango,

2019; Charnley, 2022; Godana et al., 2023; Kourouma et al., 2024). In recent years, global initiatives, such as Sustainable Development Goal number 6, emphasize that every human being, including pupils in semi-arid areas, should have access to clean and safe water by 2030.

Bahi District in Tanzania is one such semi-arid area that has faced acute water scarcity, as evidenced by studies carried out by Matata et al. (2019), Myeya and Mulungu (2021), as well as Godfray and Tembo (2024), and Msilu et al. (2024). However, in recent years, the government of Tanzania has made efforts to improve water supply in the Dodoma region, where Bahi District is located. Since 2020, the Bahi District Urban Water and Sanitation Authority (DUWASA) has taken over water supply management; thus, the current water supply in the district is estimated to be 97% (DUWASA, 2024)

Despite the improvement of water access in the study area, previous studies in Tanzania have focused on issues such as qualitative assessments of the Mikono Safi intervention schools, which were not located in the semi-arid area like Bahi district (Okello et al., 2019); exploration of water access and usage among farmers (Matata, 2019; Myeya, 2021) and the impact of water access on livestock (Mfinanga et al., 2023). In the view of that, none of these studies have specifically examined the best handwashing practices among pupils in Bahi district, where water supply has been improved. Thus, this study aims at filling the gap leading to the main research objective which is to explore "From Scarcity to Abundance: Improving Hygiene Practices in Primary Schools of Semi-Arid Tanzania." The study is important as it provides practical insights on how pupils practice hygiene in schools when there is abundant water of which can be applied in other areas with similar environments.

Literature Review

The Concept of Hygiene Practices

Hygiene practices are essential for maintaining body cleanliness and a healthy environment, thus preventing the transmission of infectious diseases like diarrhea and cholera (Taylor et al., 2015; Meher & Nimonkar, 2018; Potgieter, 2019; Challa et al., 2022; Velleman et al., 2023). Maintaining good hygiene is crucial for the well-being of pupils and the overall socio-economic development of families and the nation at large (Meher & Nimonkar, 2018; Kutsyuruba et al., 2015; Ohwo, 2019; Charnley, 2022; Mtimkulu, 2022). Nevertheless, in semi-arid areas, the scarcity of water can pose challenges to maintaining proper hygiene practices in schools.

Water Availability and Hygiene Practices in Semi-Arid Regions

Semi-arid regions, such as Bahi District in Tanzania, have been historically facing acute water scarcity due to geographical factors as well as the impacts of climate change (Herrera-Pantoja & Hscock, 2015; Perrin et al., 2012; Morante-Carballo, 2022). The water scarcity has negatively impacted various aspects of life in the society, including livestock and crop production, energy production, industrial activities and access to health services (Perrin et al., 2012; Morante-Carballo, 2022). In recent years, the Tanzanian government has made efforts to improve water supply in Dodoma region that aims at enhancing not only domestic, industrial, agricultural and health uses but also to provide a healthy and conducive teaching and learning environment in schools ((DUWASA, 2024)

Improving Water Availability and Hygiene Practices in Schools

Studies have highlighted the challenges faced by schools in semi-arid regions such as, Nigeria and Ghana in maintaining proper hygiene practices due to water scarcity. They have shown that, the adequacy and maintenance of sanitation facilities, as well as the availability of water, are crucial in promoting handwashing and the proper use of sanitation facilities by students (Miya et al., 2023; Duah, 2024; Mbula et al., 2024; Sugita, 2022).

Despite the importance of good hygiene practices, many pupils still do not practice them while they are in the school compound. Statistics have revealed that, by 2020, approximately half of the global population had insufficient safe sanitation facilities (WHO, 2019). Besides, studies have also shown that, handwashing practices with soap and water can significantly reduce the risk of diarrheal episodes and acute respiratory infections diseases (Rabie & Curtis, 2006; Anyango, 2019; Oladeji et al., 2020; Swarthout et al ,2020).

Given the recent improvements in water supply in Bahi District, there was a need to explore how this has impacted pupils' hygiene practices in the area. While previous studies in Tanzania have focused on other regions and on water access and usage among farmers and livestock (Okello et al., 2019; Matata, 2019; Myeya, 2021; Mfinanga et al., 2023), there is limited literature on the best handwashing practices among pupils in Bahi District. In that manner, this study has aimed at investigating how the transition from water scarcity to water abundance has influenced hygiene practices in primary schools in Bahi District located in Dodoma region in Tanzania.

Method

The study Location, Research Approach and Design

The study was conducted in Bahi district, Dodoma region, as this district has recently experienced the improved water supply, with an estimated rate of water supply equivalent to 97% (DUWASA). This study employed a qualitative research approach to explore how hygiene practices are maintained by the primary school population in their school campus. The approach was apt since it enabled the researcher to observe the school settings, including the presence of handwashing facilities with soap, the condition of toilets, classrooms, offices and school gardens, as well as to elicit participants' views on hygiene practices through observation, focus group discussions and interviews in the visited schools. Moreover, as explained by Field-Springer (2020) and Lim (2024), qualitative research allows researchers to study problems in their natural social settings, witnessing people's actions, lived experiences and how they make meaning of their experiences.

Besides, the study employed a hermeneutic phenomenological case study design, examining three primary schools where the presence of water taps, handwashing facilities and cleaning supplies were observed including the condition of toilets, classrooms and offices. This design was selected since, as described by Yin (2009), it allows the use of multiple data collection methods, leading to a more comprehensive understanding of the research problem.

Participants

The participants included three headteachers, three health teachers and primary school pupils from the three schools selected. Head teachers were included because they were the in-charge of schools who oversee the schools' day to day activities including how pupils are utilizing sanitation facilities accordingly. Besides, they were responsible in making sure water bills are paid and sanitation facilities are maintained appropriately. Health teachers were included as they were the in-charge of health-related issues, including hygiene practices. Moreover, pupils were included in order to air their views and experiences on the improved water supply and hygiene practices in their schools since they were available in school during the acute shortage of water period and when their schools had an access to the improved water facilities.

Sampling Approach

Purposive sampling was used to select three primary schools implementing the Water, Sanitation, and Hygiene (WASH) program, three headteachers, three health teachers and 30 pupils (ten from each school). The selected pupils included the head boy and head girl, two environmental prefects (one boy and one girl) and class leaders (class monitor and monitress) from Standards 5, 6 and 7. This sampling technique was chosen for its practicality and efficiency in gathering data from a large group within the constraints of time and resources (Ames et al., 2019).

Data Collection Methods

Data were collected through semi-structured interviews with headteachers and school health teachers, guided by an interview guide developed by the researcher. Focus group discussions were carried out to the selected pupils to elicit their views on hygiene practices. Non-participant observation was also carried out to witness the handwashing practices, including hand wash points, pupils' handwashing behaviors, cleaning of school toilets as well as classrooms and watering the school gardening.

Data Analysis and Ethical Considerations

The collected data were subjected to thematic analysis, following the six steps suggested by Braun and Clarke (2024): data familiarization, code generation, theme searching, theme reviewing, theme defining and theme reporting. Besides, Ethical considerations were observed throughout the study. The researcher obtained research clearance from various authorities, including the University of Dodoma, the Dodoma Regional Administrative Secretary (RAS), Bahi District Administrative Secretary (DAS) and Bahi Town Executive Director (TED). Informed consent was obtained from the participants and the use of anonymity and acknowledgment of sources were ensured.

Data Presentation and Discussion

This section presents and discusses the key findings as collected from the field. The study revealed several important themes related to how the improved water availability has enabled and enhanced hygiene practices in public primary schools within Bahi District.

Practices of Frequent Hand Washing Practices

The availability of water points in schools has significantly increased the frequency of hand washing practices among pupils. In the three public primary schools visited; the researcher observed a notable difference in the number of washing points available. School A had 10 washing points, while School B had 6 washing points in the school campuses. Data from the headteachers and pupils indicate that, the construction of the washing points has improved hygiene practices among the pupils.

As one headteacher commented,

"My school has constructed quite a good number of water points which are significant in contributing to the improvement of hygienic practices and the overall pupil's health, due to the availability of more than one washing points" (Interview, Headteacher from School B, December, 2023).

The pupils also appreciated for having multiple washing points in their school by stating that

"We wash our hands any time we want because we have many washing points at our school, which makes it simple for everyone to practice hand washing. All this has been due to the availability of water facilities to support reliable water supply in our school" (FGD with pupils from School B, December, 2023).

The data from both School A and School B indicate that, the availability of WASH facilities has facilitated the increase of hand washing practices among pupils leading to the improved hygiene and a more conducive learning environment. As one headteacher mentioned,

"The availability of water in my schools has brought about great changes to my pupils. This blessing has made WASH practices to be well implemented since pupils wash their hands before and after using the toilet thus averting and reducing the incidence of disease outbreaks" (Interview, with the headteacher from School A, December 2023).

Another headteacher echoed similar sentiments, stating that:

"We thank the government for the construction of water taps for the supply of enough water in our school since it has promoted health and hygiene practices in the entire school. Besides the frequent flow of water in our school has promoted the regular hand washing practices and on the other hand it has also made the learning environment cleaner unlike when they were no water" (Interview with the headteacher from School B, December 2023).

The findings from the observation also revealed that, the schools have the washing points which make it easy for pupils to practice hand washing before and after using the toilets. Thus, the findings of this study align with the existing literature on the importance of water supply in promoting hygienic practices in schools, particularly in semi-arid regions. Similar to the studies conducted in other semi-arid areas, such as Nigeria's Almajiri schools (Miya et al., 2023) and Ghana's Sunyani East Municipal (Duah, 2024), the limited availability of water was previously a significant barrier to proper handwashing practices among pupils in Bahi District of Tanzania (Miya et al., 2023; Duah, 2024). However, the current study demonstrates that, the improved water supply in Bahi District, facilitated by the government's efforts, has led to a notable increase in the frequency of hand washing practices among public primary school pupils.

The data collected from the two primary schools in Bahi District indicate that, the availability of multiple washing points has made it easier and more convenient for the pupils to practice hand washing regularly. This study findings align with the findings from Kenya that emphasized the need for adequate and well-maintained sanitation facilities, as well as the availability of water, to promote handwashing and proper use of sanitation facilities by students (Mbula et al., 2024). In contrast to the previous studies in Tanzania that focused on water access and usage among farmers and livestock (Okello et al., 2019; Matata, 2019; Myeya, 2021; Mfinanga et al., 2023), this study provides insights into the best handwashing practices among pupils in Bahi District, where water supply has been improved.

Frequent hand washing practices are vital for diseases prevention, as asserted in the study by Fianko and Gawu (2020) who emphasized that, while hand washing with soap is crucial, many schools in Ghana still lack adequate facilities and practices and the study by Desye, (2021) who insisted on pandemic and water, sanitation and hygiene: impacts, challenges and mitigation strategies. Similarly, Benja (2021) noted the importance of having accessible water and hand washing stations in schools. On the other hand, lack of resources contributes to an increased absenteeism in developing countries, particularly during menstruation, especially when there are inadequate girl friendly sanitation facilities (Habtegiorgis et al, 2021; Nasiry, 2024).

This study therefore, highlights the positive impacts of increased water points on hand washing practices in two public primary schools in Bahi District, Tanzania. Observations revealed that, School A, with 10 washing points and School B, with 6 as pointed out by the study participants, facilitated frequent hand washing among pupils, significantly enhancing hygiene practices. This study, aligns with existing literature, which underscores the necessity of water supply in promoting hygienic practices, especially in semi-arid regions. The findings indicate a shift from previous challenges related to limited water access, emphasizing the vital role of the government initiatives in improving health and hygiene in schools. Ultimately, the study illustrates that, adequate water and sanitation facilities are crucial in fostering a healthier learning environment and preventing illness, particularly among vulnerable populations.

Maintaining Cleanliness of School Environments

The findings indicate that, schools in Bahi District benefit from a conducive environment due to the availability of water for cleaning toilets, washing hands and maintaining classrooms tidiness. School health teachers emphasized the importance of water in sustaining a clean school environment. One teacher from School A asserted that, "*Nowadays, our school environment is clean, especially the toilets, classrooms and all areas surrounding the school due to the availability of water, which makes daily cleaning effective*." *(An Interview with a teacher from School A, December, 2023)*

Pupils expressed similar sentiments by stating that, *"We enjoy school life and our school attendance has increased. We live in a clean campus with clean toilets and classrooms and we have water throughout the day for daily activities. Frankly speaking, I feel safe and happy studying here, which helps us achieve high academic performance". (FGD with Pupils in School C December, 2023)*

The observations confirmed the implementation of WASH practices in public primary schools visited due to the cleanliness of the school campuses, particularly in toilets and classrooms which depicts that pupils effectively use water in toilets and classrooms are regularly mopped, contributing to an attractive learning environment.

The study findings align with the existing literature on the importance of water supply in promoting hygiene practices in schools, especially in semi-arid regions. Studies in Nigeria and Ghana have similarly highlighted the positive impacts of improved water access on hygiene and cleanliness (Miya et al., 2023; Duah, 2024). The results underscore the critical role of water in maintaining a clean learning environment while recognizing the improvements from the government initiatives. Besides, the study findings highlight the need for continued efforts to enhance cleaning practices and optimizing water usage, ensuring the long-term sustainability of these benefits for pupils' health and safety.

Enhancing Gardening and Outdoor Spaces

The study findings indicate significant improvements in school gardens and outdoor open spaces, which remain vibrant and attractive even during drought conditions. Effective water supply has allowed schools to keep their gardens green and one school has begun planting vegetables, enhancing the area's aesthetics and being a source of nutritious food.

A headteacher from School A remarked, *"Sometimes, we use a small amount of water for watering the garden, especially the flowers and vegetables. It makes our school environment look attractive and thus feeling proud of our surroundings." (An interview with the Head teacher from School B, 2023).* Similarly, pupils expressed their appreciation for the gardens by stating that*, "We love our school premises for their attractive outlooks coupled with an attractive area surrounding us, which is favorable for teaching and learning process because of the fresh air from the garden and trees."(FGD with pupil from School A, 2023)*

Besides, the observational data confirmed that, schools with reliable water supply create conducive environments for teaching and learning process. Thus, effectively maintaining gardens decorated with flowers, trees and vegetables, ensuring that the spaces remain appealing even in dry spells. Both headteachers and pupils recognize how access to water has transformed their school environments, allowing for the nourishment of diverse flora and enhancing overall aesthetics of the school campuses.

The Clemson University project highlights the value of water access in improving school gardens and outdoor milieus (Byrd et al., 2007). This synergy strengthens the case for sustainable and engaging school settings. Girmay et al. (2023) asserted that, low availability of WASH services hampers cleanliness and hygiene reinforcing the critical role of clean water in fostering a conducive learning environment. This study findings illustrate that, improved water supply has dual benefits of effective WASH services for health and educational outcomes.

Additionally, the study by Malberg Dyg and Wistoft (2018) highlights how school gardening programs promote students' well-being by fostering positive emotions associated with outdoor milieus. The proactive measures recommended by Girmay et al. for enhancing WASH services are evident in the practices observed in the studied schools. The effective maintenance of gardens not only beautifies the environment but also boosts educational engagement, aligning with Sustainable Development Goals and pointing up the need for ongoing improvements in WASH practices to achieve better educational outcomes and healthier school milieus.

Pupils' Appearance and Punctuality

The study findings indicate that, pupils in public primary schools with reliable water access appear neater than those in schools where pupils must bring water from home. In schools with inadequate supply water, pupils often arrive dirty and wet after splashing water on themselves or touching unclean surfaces.

One health teacher pointed out that, "*Our pupils nowadays look neat and smart since they no longer carry water from home as it was in the past, which rendered them to look dirty. This change has boosted their comfort and learning abilities and aspiration" (An interview with the headteacher from School A, 2023).* Another teacher echoed this sentiment by stating that, *"The neatness of our pupils has significantly improved. They arrive at school*

clean and smart, highlighting the impact of water access on both appearance and performance" (An interview with the health teacher from School B, 2023).

Besides, pupils also expressed their feelings by saying, *"We are grateful for the government's initiatives of constructing the water pipeline and thereafter the availability of water taps in our school. Now we come to school without carrying water, thus being clean and not dirty and wet as we often arrived at school in the past" (Focus group discussion from School B, 2023).*

The overall study findings demonstrate that, access to water directly contributes to the cleanliness of pupils, enhancing their comfort and confidence in the classroom. Global initiatives by organizations such as WHO and UNICEF emphasize the importance of water, sanitation and hygiene (WASH) facilities in schools so as to foster inclusive and effective teaching and learning environments (UNICEF, 2018). The global initiatives are contrary to what is happening in Kakamega Municipality Division, in Kenya, in which, the relationship between water availability and student's cleanliness is evident, with lack of reliable water sources linked to poor hygiene practices and health outcomes (Barasa et al., 2015; Mensah et al., 2022).

To improve WASH conditions, the Ministry of Education, Science and Technology should support schools by providing necessary facilities and fund related activities. Moreover, establishing student's WASH clubs and sanitation brigades can promote the sustainability of WASH initiatives in public schools in Tanzania.

Thus, supporting studies reinforce the study findings with the connection between water availability and student well-being. For instance, Freeman et al. (2012) showed that, WASH interventions in Kenyan schools reduced absenteeism and enhanced hygiene practices, while Jasper et al. (2012) noted that, inadequate WASH facilities negatively affected students' dignity and focus and thus leading to absenteeism, students' drop out and poor academic performance. However, Garn et al. (2013) pointed out that, water access alone is insufficient without educational programs, underscoring the need for WASH clubs in schools. The UNICEF (2018) report further confirms that, improved water access correlates with enhanced student well-being globally.

This study therefore suggests that, addressing basic infrastructure needs, such as water access, should be a priority for educational authorities aiming at creating conducive teaching and learning environments, particularly in resource-limited settings. Future research should investigate whether improvements in student's cleanliness leads to measurable gains in academic performance, as noted by teachers observing enhanced learning capacities.

Conclusions

This study aimed at exploring the hygiene practices of public primary school pupils in semi-arid area of which the findings revealed several key insights: First, the availability of multiple water points and WASH facilities has significantly boosted the frequency of hand washing practices among pupils. Second, the improved water supply has contributed to cleaner and more conducive learning environments, with well-maintained toilets, classrooms and surrounding areas. Third, headteachers and teachers have been instrumental in promoting and modeling hand washing practices, fostering a positive culture around hygiene among pupils. Fourth, the schools have effectively implemented hygiene practices through the provision of essential water points and WASH facilities. Finally, the government's efforts to enhance water availability in the Bahi District have created a more supportive community environment for health and sanitation.

Besides, this study is significant as it sheds light on the real-life hygiene habits of pupils in semi-arid schools, an area not extensively covered in the existing literature. The insights acquired can guide policymakers and school administrators in similar regions to prioritize adequate water supply and WASH facilities, ultimately fostering healthier and more effective learning environments. However, the study's scope was limited to two primary schools in Bahi District which may restrict the generalizability of the findings. Moreover, it did not investigate the long-term sustainability of the improved water access and its ongoing impact on hygiene practices. In that regard, future research should include a broader sample across Bahi District and other semi-arid regions in Tanzania. On the other hand, longitudinal studies would also be beneficial to assess the lasting effects of enhanced water accessibility on pupils' hygiene practices and the overall academic performance.

References

Abdi, F. M. (2021). *Effect of hygienic physical environment on educational output in selected public primary schools in Wajir county, Kenya* (Doctoral dissertation, Kenyatta University).

Akanzum, J., & Pienaah, C. K. (2023). Review of the effects of adequate sanitary facilities on the participation and performance of the school girl child in Ghana. *ISABB Journal of Health and Environmental Sciences, 8*(1), 1–14. https://doi.org/10.5897/ISAAB-JHE2021.0073

Anyango, M. J. (2019). *Water, sanitation and hygiene practices as predictors of diarrhoea occurrence among school age children in Ganze Sub County, Kenya* (Doctoral dissertation, JKUAT-COHES).

Attah, J. S., Stanley, H. O., & Immanuel, O. M. (2023). Assessment of Sanitation Practices among the Students in Selected Public Secondary Schools in Port Harcourt, Nigeria. *Int. J. Path. Res*, *12*(5), 1-9.

Barasa, F. M., Christine, W., Nathan, S., Mustafa, B., George, S. A., Odini, V. A., ... & Abwajo, J. O. (2015). State of sanitation and hygiene of public primary schools in Kakamega municipality, western Kenya. *International Research Journal of Public and Environmental Health*; http://dx.doi.org/10.15739/irjpeh.041.

Benja, T. (2021). *Factors Associated with Hand Washing Practices among Secondary School Students in Ndorwa East Constituency in Kabale District* (Doctoral dissertation, Kabale University).

Braun, V., & Clarke, V. (2024). Thematic analysis. In *Encyclopedia of quality of life and well-being research* (pp. 7187-7193). Cham: Springer International Publishing.

Byrd, R. K., Haque, M. T., Tai, L., McLellan, G. K., & Knight, E. J. (2007). Designing a children's water garden as an outdoor learning lab for environmental education. *Applied Environmental Education and Communication*, *6*(1), 39-47. https://doi.org/10.1080/15330150701319859.

Challa, J. M., Getachew, T., Debella, A., Merid, M., Atnafe, G., Eyeberu, A., ... & Regassa, L. D. (2022). Inadequate hand washing, lack of clean drinking water and latrines as major determinants of cholera outbreak in Somali region, Ethiopia in 2019. *Frontiers in public health*, *10*, https://doi.org/10.3389/fpubh.2022.845057.

Charnley, J. W. (2022). *An investigation of the driving factors affecting children's water, sanitation and hygiene (WASH) behaviours in East New Delhi primary schools* (Doctoral dissertation, Newcastle University).

de Morais, N. G., de Lima, L. F. F., Leite, I. D. S., de Santana, M. M., Torres, R. T., da Silva, J. W., ... & Nunes, E. S. (2021). High prevalence of protozoan infections: a permanent cycle in a brazilian semi-arid peripheric area. *Revista de Patologia Tropical/Journal of Tropical Pathology*, *50*(3), 233-245. https://doi.org/10.5216/rpt.v50i3.68335.

Desye, B. (2021). COVID-19 pandemic and water, sanitation, and hygiene: impacts, challenges, and mitigation strategies. *Environmental Health Insights*, *15*, 11786302211029447. https://doi.org/10.1177/11786302211029.

Dlamini, N. M. (2017). *Investigating the Influence of Water Scarcity on the Well-being of Some Primary School Learners in the Lubombo Region of Swaziland* (Doctoral dissertation, University of KwaZulu-Natal, Edgewood).

Duah, H. (2024). The level of implementation of water, sanitation, and hygiene (WASH) practices among the public basic schools in Ghana. *Journal of Water, Sanitation and Hygiene for Development*, *14*(9), 780-793. https://doi.org/10.2166/washdev.2024.307.

DUWASA. (2024). Annual Report 2024.

Fianko,, J. R., & Gawu, J. A. (2020). Evaluation of hand hygiene behaviour in basic schools in Ghana: A case study of the Ablekuma Central Municipality in the Greater Region of Ghana. *Health Education Research*, 35(5), 362–375. https://doi.org/10.1093/her/cyaa017.

Field-Springer, K. (2020). Reflexive embodied ethnography with applied sensibilities: methodological reflections on involved qualitative research. *Qualitative Research*, *20*(2), 194-212. https://doi.org/10.1177/1468794119841.

Freeman, M. C., Greene, L. E., Dreibelbis, R., Saboori, S., Muga, R., Brumback, B., & Rheingans, R. (2012). Assessing the impact of a school-based water treatment, hygiene and sanitation programme on pupil absence in Nyanza Province, Kenya: a cluster-randomized trial. *Tropical medicine & international health*, *17*(3), 380-391. **https://doi.org/10.1111/j.1365-3156.2011.02927**.

Garn, J. V., Greene, L. E., Dreibelbis, R., Saboori, S., Rheingans, R. D., & Freeman, M. C. (2013). A cluster-randomized trial assessing the impact of school water, sanitation and hygiene improvements on pupil enrolment and gender parity in enrolment. *Journal of water, sanitation and hygiene for development*, *3*(4), 592-601. https://doi.org/10.2166/washdev.2013.217.

Gatundu, G. W. (2023). *Influence of school environment on academic self-concept among primary school pupils in informal settlements of Kibra Sub-County, Nairobi County, Kenya* (Doctoral dissertation).

Girmay, A. M., Weldegebriel, M. G., Mengesha, S. D., Serte, M. G., Weldetinsae, A., Alemu, Z. A., ... & Tollera, G. (2023). Factors influencing access to basic water, sanitation, and hygiene (WASH) services in schools of Bishoftu Town, Ethiopia: A cross-sectional study. *Discover Sustainability, 4*(1), 5. https://doi.org/10.1007/s43621-023-00122-0.

Godfray, G., & Tembo, M. M. (2024). Assessment of ground water potentiality in semi-arid area of central Tanzania. implication from geology and geomorphology of the dodoman supergroup. *Geology, Ecology, and Landscapes*, *8*(2), 165-184. https://doi.org/10.1080/24749508.2022.2109833..

Godana, T., Esho, T., & Karama, M. (2023). Evaluating Implementation Status of the National Guidelines for Covid-19 Hygiene and Sanitation in Primary Schools of Marsabit County, Kenya.

Habtegiorgis, Y., Sisay, T., Kloos, H., Malede, A., Yalew, M., Arefaynie, M., ... & Adane, M. (2021). Menstrual hygiene practices among high school girls in urban areas in Northeastern Ethiopia: A neglected issue in water, sanitation, and hygiene research. *PLOS ONE, 16*(6), e0248825. https://doi.org/10.1371/journal.pone.0248825.

Herrera-Pantoja, M., & Hscock, K. M. (2015). Projected impacts of climate change on water availability indicators in semi-arid region of Central Mexico. *Environmental Science and Policy*, (54), 81-89. https://doi.org/10.1016/j.envsci.2015.06.020.

Jasper, C., Le, T. T., & Bartram, J. (2012). Water and sanitation in schools: A systematic review of the health and educational outcomes. *International Journal of Environmental Research and Public Health, 9*(8), 2772–2787. https://doi.org/10.3390/ijerph9082772.

Kourouma, A. (2024). *Factors Associated with Hygiene Behaviours Among Students in Akuse Methodist High School in The Eastern Region of Ghana* (Doctoral dissertation, Ensign Global College).

Kutsyuruba, B., Klinger, D. A., & Hussain, A. (2015). Relationships among school climate, school safety, and student achievement and well-being: a review of the literature. *Review of Education*, *3*(2), 103-135. **https://doi.org/10.1002/rev3.3043**.

Lim, W. M. (2024). What is qualitative research? An overview and guidelines. *Australasian Marketing Journal*, 1-31. https://doi.org/10.1177/14413582241264619.

Matata, P. Z. (2019). *An assessment of climate variability and change adaptation strategies among small sale farmers in semi-arid areas of Tanzania* (Doctoral dissertation, The Open University of Tanzania).

Mbula, S. E., Mulwa, A. S., & Kyalo, D. N. (2014). Access to improved sanitation: Implication for sustainable implementation of hygiene practices secondary schools in machakos county, Kenya. *European Scientific Journal*, *10*(1).

Malberg Dyg, P., & Wistoft, K. (2018). Wellbeing in school gardens–the case of the Gardens for Bellies food and environmental education program. *Environmental Education Research*, *24*(8), 1177-1191. https://doi.org/10.1080/13504622.2018.1434869.

Meher, S., & Nimonkar, R. (2018). A study of hygiene practices among school-going children in a government school in Kolkata. *International Journal of Community Medicine and Public Health, 5*(7), 3102–3105. https://doi.org/10.18203/2394-6040.ijcmph20182655.

Melaku, A., & Addis, T. (2023). Handwashing practices and associated factors among school children in Kirkos and Akaki Kality sub-cities, Addis Ababa, Ethiopia. *Environmental Health Insights*, *17*, https://doi.org/10.1177/11786302231156.

Mensah, A. A., Adei, D., Kuubagr, G., Duah, S. O., & Asibey, M. O. (2022). Operation and sustainability of Water, Sanitation and Hygiene (WASH) in schools: Evidence from a vulnerable and deprived area in Ghana. *Cogent Public Health*, *9*(1), 2140478. ttps://doi.org/10.1080/27707571.2022.2140478.

Mfinanga, F. A., Msuya, C. P., & Madaha, R. (2023). Factors influencing the level of water access for livestock in semi-arid areas of Monduli district, Tanzania. *Tanzania Journal of Agricultural Sciences, 22*(1), 98–113.

Miya, Y. Y., Abdul-Kareem, J., Sa'eed, A., Sarkingobir, Y., Yabo, A. M., & Bello, Z. (2023). Issues affecting Almajiri schools in Nigeria: Water, sanitation, and hygiene (WASH) parameters in Sokoto. *Interdisciplinary Social Studies*, *2*(9), 2387-2396. DOI: https://doi.org/10.55324/iss.v2i9.471

Mnyiri, I. M. (2014). *Effects of drought related factors on pupils' participation in primary schools in Tharaka south sub county, Tharaka Nithi county, Kenya* (Doctoral dissertation, University of Nairobi).

Msilu, S., Majule, A. E., & Perfect, J. (2024). Analysis of rainfall and temperature dynamics (1981 to 2021) in semi-arid central Tanzania. *Ghana Journal of Geography, 16*(2), 84–94.

Morante-Carballo, F., Montalván-Burbano, N., Quiñonez-Barzola, X., Jaya-Montalvo, M., & Carrión-Mero, P. (2022). What do we know about water scarcity in semi-arid zones? A global analysis and research trends. *Water, 14*(17), 2685. https://doi.org/10.3390/w14172685

Mtimkulu, M. G. N. (2022). *Promoting healthy school physical environments to improve learner academic performance: a framework for principals* (Doctoral dissertation, North-West University (South Africa).).

Myeya, H. E. (2021). Vulnerability and responses of smallholder farmers to climate change effects in semiarid areas of Bahi and Kongwa districts, Tanzania. *Tanzania Journal of Science*, *47*(4), 1424-1435. 10.4314/tjs.v47i4.8.

Myeya, H. E., & Mulungu, C. A. (2021). Indigenous and scientific evidence on climate change effects on cereal crops production in semi-arid areas of Central Tanzania. *Tanzania Journal of Agricultural Sciences*, *20*(1), 12-23.

Nasiry, F. (2024). *Exploring the Impact of lack of Wash facilities on Girls' Education and Health in Higher Secondary Schools in Afghanistan* (Doctoral dissertation, AUW).

Ohwo, O. (2019). Status of water, sanitation and hygiene facilities in public secondary schools in Yenagoa, Nigeria. *World Journal of Social Sciences and Humanities, 5*(3), 176–183. https://doi.org/10.12691/wjssh-5-3-7

Okello, E., Kapiga, S., Grosskurth, H., Makata, K., Mcharo, O., Kinungh'i, S., & Dreibelbis, R. (2019). Factors perceived to facilitate or hinder handwashing among primary students: a qualitative assessment of the Mikono Safi intervention schools in NW Tanzania. *BMJ open*, *9*(11), https://doi.org/10.1136/bmjopen-2019-030947.

Oladeji, O., Farah, A. E., Hassan, A., Ayanle, M., & Ali, Y. M. (2020). Rapid assessment of indirect effect of handwashing campaign during COVID-19 risk communication and community engagement on diarrhoea and respiratory illness among children under five in Jijiga Town of Somali Region of Ethiopia. *Journal of Advances in Medicine and Medical Research, 32*(19), 11–19. https://doi.org/10.9734/JAMMR/2020/v32i1930663.

Olatunji, R. W., & Thanny, N. T. (2020). Availability and adequacy of WASH facilities in secondary schools in Lagos State, Nigeria. In *E3S Web of Conferences* (Vol. 211, p. 01023). EDP Sciences. https://doi.org/10.1051/e3sconf/202021101023.

Perrin, J., Ferrant, S., Massuel. S., Dewandel, B., Marechal, J.C., Aulong, S., & Ahmed, S. (2012). Assessing water availability in a semi-arid water shed of Southern India using a semi-distributed model. *Journal of Hydrology*, (461), 143-155 https://doi.org/10.1016/j.jhydrol.2012.07.002

Potgieter, N. (Ed.). (2019). *The relevance of hygiene to health in developing countries*. IntechOpen.

Rabie, T., & Curtis, V. (2006). Handwashing and risk of respiratory infections: a quantitative systematic review. *Tropical medicine & international health*, *11*(3), 258-267. **https://doi.org/10.1111/j.1365-3156.2006.01568.x**.

Selya, N. Y., Dimoso, P., & Mgale, Y. J. (2023). Exploring the adoption and impact of conservation agriculture among smallholder farmers in semi-arid areas: Evidence from Chamwino District, Tanzania. *Research on World Agricultural Economy, 4*(2), 47–61. https://doi.org/10.36956/rwae.v4i2.801.

Sharma, M. K., Adhikari, R., Khanal, S. P., Acharya, D., & van Teijlingen, E. (2024). Do school water, sanitation, and hygiene facilities affect students' health status, attendance, and educational achievements? A qualitative study in Nepal. *Health Science Reports, 7*(8), e2293. https://doi.org/10.1002/hsr2.2293.

Sugita, E. W. (2022). Water, Sanitation and Hygiene (WASH) in Japanese elementary schools: Current conditions and practices. *Pediatrics International*, *64*(1), e15062. **https://doi.org/10.1111/ped.15062**.

Swarthout, J., Ram, P. K., Arnold, C. D., Dentz, H. N., Arnold, B. F., Kalungu, S., Lin, A., Njenga, S. M., Stewart, C. P., Colford, J. M., Null, C., & Pickering, A. J. (2020). Effects of individual and combined water, sanitation, handwashing, and nutritional interventions on child respiratory infections in rural Kenya: A cluster-randomized controlled trial. *American Journal of Tropical Medicine and Hygiene, 102*(6), 1286–1295. https://doi.org/10.4269/ajtmh.19-0779.

Taylor, D. L., Kahawita, T. M., Cairncross, S., & Ensink, J. H. (2015). The impact of water, sanitation and hygiene interventions to control cholera: a systematic review. *PLoS one*, *10*(8), https://doi.org/10.1371/journal.pone.0135676.

UNICEF. (2018). Drinking water, sanitation and hygiene in schools: global baseline report 2018.

Velleman, Y., Blair, L., Fleming, F., & Fenwick, A. (2021). Water-, sanitation-, and hygiene-related diseases. In R. A. Meyers (Ed.), *Encyclopedia of Sustainability Science and Technology* (pp. 1–31). Springer Science+Business Media. https://doi.org/10.1007/978-1-4939-2493-6_547-3

Yin, R. K. (2009). *Case study research: Design and methods* (Vol. 5). Sage.

Waruingi, R. N. (2015). Determinants of water, sanitation and hygiene related morbidity among primary school children in Mathare informal settlement, Nairobi county, Kenya. *Master's thesis, School of Public Health, Kenyatta University*.

World Health Organization. (2019). *Progress on household drinking water, sanitation and hygiene 2000-2017: special focus on inequalities*. World Health Organization.http://hdl.handle.net/123456789/8282.