Assessment of School Environmental Health Conditions in Governmental Primary Schools: A Cross-Sectional Study in El-Obeid City, North Kordofan State, Sudan

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ABSTRACT

Ensuring environmental health in schools is vital for promoting student well-being and learning outcomes, particularly in under-resourced rural settings. However, evidence on environmental health conditions in Sudanese schools is limited. This study aimed to assess the school environmental health conditions in governmental primary schools in El-Obeid City, North Kordofan State, Sudan. Sixteen governmental basic schools were surveyed. A cluster random probability sampling technique was used to select schools. A structured checklist form was used for data collection. Data were managed and analyzed using descriptive statistics within a cross-sectional framework. Final results were presented and interpreted in tables.The results showed that 93% of schools were located at a suitable distance from public services, pollution, and noise. All school buildings were deemed acceptable. Fifty percent of schools had poor ventilation. Fifty percent of schools had access to reliable sources of clean and safe water. Latrines were available in 75% of schools. None of the schools had hand-washing facilities or soap for hand washing. Approximately 43.7% of schools burned solid waste directly. About 56.3% of schools had a canteen or cafeteria. There was a complete absence of hand-washing facilities in all schools and a lack of solid waste disposal services provided by local authorities. Urgent improvements are needed in sanitation and waste management.

ABSTRAK

Menjaga kesehatan lingkungan di sekolah sangat penting untuk mendukung kesejahteraan dan hasil belajar siswa, terutama di daerah pedesaan yang kurang terlayani. Namun, bukti mengenai kondisi kesehatan lingkungan di sekolah-sekolah Sudan masih terbatas. Studi ini bertujuan untuk menilai kondisi kesehatan lingkungan sekolah di sekolah dasar negeri di Kota El-Obeid, Negara Bagian Kordofan Utara, Sudan. Sebanyak enam belas sekolah dasar negeri disurvei. Teknik pengambilan sampel probabilitas acak kluster digunakan untuk memilih sekolah. Formulir daftar periksa terstruktur digunakan untuk pengumpulan data. Data dikelola dan dianalisis menggunakan statistik deskriptif dalam kerangka potong lintang. Hasil akhir disajikan dan diinterpretasikan dalam bentuk tabel. Hasil menunjukkan bahwa 93% sekolah berada pada jarak yang sesuai dari layanan publik, sumber polusi, dan kebisingan. Semua bangunan sekolah dinilai layak. Sebanyak 50% sekolah memiliki ventilasi yang buruk. Sebanyak 50% sekolah memiliki akses terhadap sumber air bersih dan aman yang andal. Jamban tersedia di 75% sekolah. Tidak ada satu pun sekolah yang memiliki fasilitas cuci tangan atau sabun untuk mencuci tangan. Sekitar 43,7% sekolah membakar sampah padat secara langsung. Sekitar 56,3% sekolah memiliki kantin atau kafetaria. Terdapat ketiadaan total fasilitas cuci tangan di semua sekolah dan tidak adanya layanan pengelolaan sampah padat dari otoritas lokal. Perbaikan mendesak dibutuhkan dalam hal sanitasi dan pengelolaan limbah.

GRAPHICAL ABSTRACT

Keyword
environmental health
hand disinfection
schools
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INTRODUCTION

Schools are essential for young people to acquire knowledge, socio-emotional skills, including self-regulation, resilience, and critical thinking skills that provide the foundation for a healthy future (World Health Organization, 2021). The school environment plays a pivotal role in the retention and learning outcomes of students. The availability of proper facilities is a prerequisite for creating a healthy environment in a school (UNESCO & Open Society Foundations, 2020). The school environment is a natural entry point for reaching children and adolescents with health education, health promotion, and health services. Schools present the ideal ecosystem for students to learn from peers and learn from role models, such as teachers and heads of schools (Indian Ministry of Health, 2018). Poor indoor environmental conditions can affect a child's health; dirt, allergens, chemicals, and other contaminants can trigger or further aggravate allergies and illnesses (Kumar et al., 2023).

There are millions Sudanese children of school age who face many health risks, such as malaria, respiratory infections, and other diseases (Ali & Khamees, 2025). In Sudan, various health and psychosocial issues significantly impede school performance among children and adolescents. Mental health services for children remain severely limited, with only a small fraction of schools offering any mental health support. This lack of coordination between child and adolescent mental health services and educational institutions hinders the overall well-being and learning capabilities of students (Abdalhai et al., 2023). Additionally, the prevalence of malnutrition due to socioeconomic factors such as poverty and food insecurity further exacerbates health issues, contributing to poor academic outcomes (Abu-Fatima et al., 2020).

The impact of violence, conflict, and socioeconomic disparities also plays a crucial role in diminishing educational attainment. Reports indicate that those in rural areas face greater challenges in accessing educational resources, leading to higher dropout rates and decreased performance compared to their peers in more stable regions (Ahmed et al., 2022).

Educational and rearing activities by teachers would not be useful and efficient in the absence of safe water, toilets, enough and suitable space, tools and equipment, and a proper garbage and sewage collection system. Additionally, students may become infected to with a variety of infectious diseases, diarrhea, and parasitic infections (Nezhad et al., 2016). Therefore, common areas, desks/tables, doorknobs and handles, and drinking fountains should be kept clean and periodically sanitized. Classrooms can also take steps to clean and sanitize to help prevent the transmission of infectious diseases. In classrooms with young children, toys should be cleaned and sanitized regularly, especially if the toys are soiled or placed in a child's mouth (Ahmid et al., 2022).

In environments where people do not practice good hygiene, they are not protected from feces and are exposed to germs that cause diarrhea and acute respiratory diseases. These two illnesses are major killers of young children and are the primary illnesses affecting school-aged children (Lin et al., 2021). To promote a healthy school environment that is conducive to learning, supports individual and family differences, and promotes personal growth, wellness, and healthy relationships, schools can adopt supportive policies and procedures (Nezhad et al., 2016).

Previous studies carried out in different countries; in Iran, it appeared that the classroom walls in 31.4% of schools had unacceptable health conditions, and another structural problem consisted of the lack of latching windows in 73.25% of schools (Nezhad et al., 2016). In developing and developed countries, schools often lack adequate water and sanitation services, with associated potential detrimental effects on health and school attendance (Sharma & Adhikari, 2022). A study conducted in Khartoum showed that 6.8% of schools were without excreta disposal facilities, and 46.7% had no col-

Table 1
Assessment of the school physical environment

Variables	Frequency	Percentage
Is the school space sufficient for future expansion?		
Yes	10	62.50%
No	6	37.50%
Are the buildings made of fixed materials?		
Yes	16	100%
No	0	-
Is the school in the a spatial position?		
Yes	9	56.30%
No	7	43.70%
Does the school building protect students from harsh conditions?		
Yes	10	62.50%
No	6	37.50%
Is the general hygiene of the school good?		
Yes	9	56.30%
No	7	43.70%

lection program for solid waste. The primary schools in Khartoum have different forms of sanitation facilities, but these are generally inadequate. Most basic schools in Sudan lack international standards due to the limited budgets allocated to education and health, in addition to the fact that most of the newly established schools have been adopted by community initiatives. Therefore, they are being built contrary to standards recommended by the World Health Organization and local school health laws. Hence, the study was conducted to assess the school environmental health in governmental basic schools, in El-Obeid City, North Kordofan State.

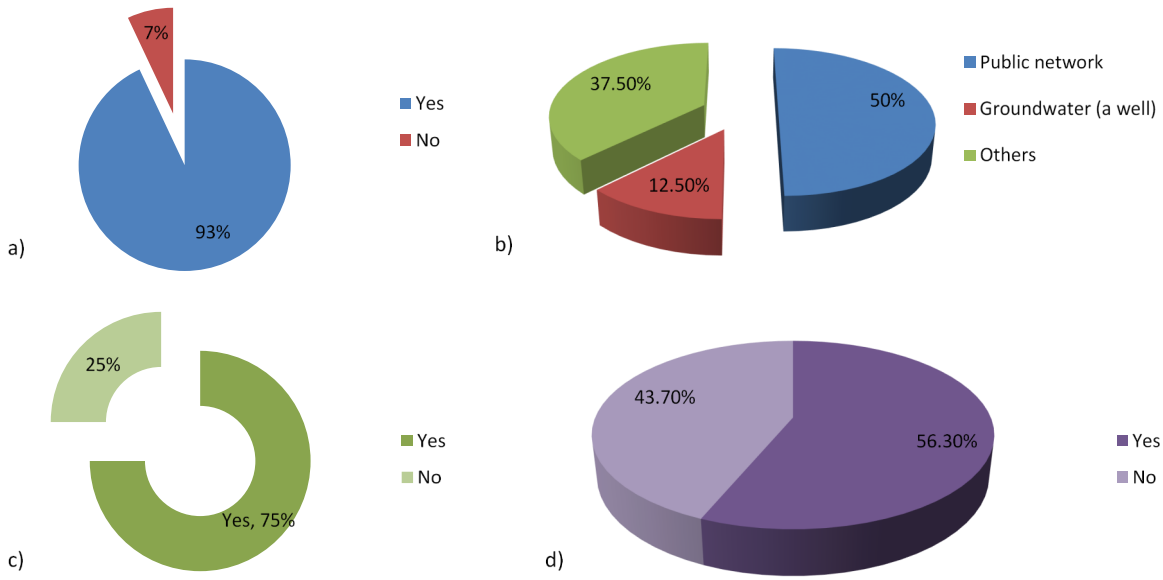
METHODS

This institutional cross-sectional descriptive study employed an observational technique suitable for collecting data from the study population at a single point in time. The study was conducted over a 12-month period to assess the environmental health of governmental basic schools in El-Obeid City, North Kordofan State, Sudan. El-Obeid City is among the few locations in Sudan where formal education was first established. Khortaqt Secondary School is one of the most distinguished national schools in Sudan, alongside other academic and technical institutions. The total number of basic schools in the city is estimated to be 141. El-Obeid City also hosts numerous higher education institutions, including the University of Kordofan, the University of the Holy Qur'an, Omdurman Islamic University, Sudan Open University, El-Obeid Technical College, the Academy of Health Sciences, Arous Al-Remal College, Sheikan College, North Kordofan College, and the College of Developmental and Technological Sciences.

The final sample size (n = 19) was determined using a standard sample size formula, based on an initial calculation of $n_0 = 22$ (Decharat & Pan-in P., 2019), with a total population of 141 governmental primary schools. A purposive sampling technique was used to select 16 available governmental primary schools. The selected boys' schools included Idris Youssef, the Leadership School, Imam El-Shafei, Ibrahim Shams El-Din, El-Omda Abdel-Aziz, Moaz Bin Jabal, Ali bin Abi Talib, Al-Saliheen, Qadir Al-Mahdi, and Abd al-Rahman al-Nujumi. The selected girls' schools included Al-Ribat, Mrs. Zainab, Jadiya Awad El-Karim, Umm El-Momeneen, Khawla Bint Al-Azwar, and Rabiah Al-Adawiya. A cluster random sampling technique was employed, wherein schools were grouped based on the four geographical directions of El-Obeid City. From these clusters, schools were selected using a simple random sampling method.

A checklist was utilized to assess the

Figure 1
Distribution of basic facilities and access to public services in Governmental Primary Schools, El-Obeid City



Note: a) Governmental school location from public services, b) Type of school's drinking water source, c) Availability of toilets, d) Availability of canteen or cafeteria.

physical environment of the schools. For the data collection process, the checklist was developed following a systematic and critical review of relevant studies, focusing on key variables aligned with the study objectives. The checklist underwent peer and expert review. The final version comprised 34 items categorized into four domains. The checklist included the following components: Part 1 – The school's physical environment (e.g., location, building structure, and hygiene); Part 2 – The classroom environment (e.g., board type and color, seat dimensions, building orientation, ventilation, and paint color); Part 3 – Environmental sanitation services (e.g., drinking water sources, toilet and latrine availability, handwashing facilities, and solid waste management); Part 4 – School canteen conditions (e.g., ventilation and lighting, window design, furniture and equipment, and possession of medical fitness cards).

After data collection, checklist forms were completed, cleaned, and subsequently analyzed using the Statistical Package for the Social Sciences (SPSS) version 16.0 and Microsoft Excel 2010. The study was conducted following approval from relevant authorities. It was reviewed and approved by the Research Committee of the Department of Public and Environmental Health at the University of Kordofan, as well as by the Ministry of Education and school headmasters.

RESULTS

A total of 16 governmental primary schools were surveyed to assess the physical environment and sanitation conditions in public primary schools. Figure 1 shows that 93% of the schools were located at a suitable distance from public services, pollution, and noise sources. Table 1 indicates that 62.5% of the schools had sufficient space for future expansion. All school buildings were deemed acceptable. Additionally, 56.3% of the schools had appropriate spatial positioning of the buildings, and 62.5% of the schools had buildings that provided protection from harsh environmental conditions. 56.3% of the schools were reported to maintain good hygiene.

Table 2
Assessment of the classroom environment

Variables	Frequency	Percentage
Is there a blackboard?		
Yes	16	100%
No	-	
Is the board color appropriate?		
Yes	16	100%
No	-	-
Is the seat length compatible with the pupils' leg length?		
Yes	8	50%
No	8	50%
Is the seat arched from front to back?		
Yes	4	33.30%
No	12	66.70%
Is the orientation of the school buildings compatible with the general standards?		
Yes	11	68.80%
No	5	31.20%
Are there windows behind the pupils' backs?		
Yes	-	-
No	16	100%
Is ventilation adequate?		
Yes	8	50%
No	8	50%
Is there artificial ventilation in the classrooms?		
Yes	7	43.70%
No	9	56.30%
Is the paint color appropriate in and out of the classrooms?		
Yes	10	62.50%
No	6	37.50%
Does classroom design prevent noise?		
Yes	9	56.30%
No	7	43.70%
Is there a space between the last row and the wall at least one meter?		
Yes	5	31.20%
No	11	68.80%

All schools had blackboards properly mounted on the walls, and the board colors were deemed appropriate. However, 50% of the schools provided inappropriate seating and had poor ventilation. Poor artificial ventilation was reported in 56.3% of the schools. 62.5% of the schools had appropriate paint colors inside and outside the classrooms. Moreover, 56.3% of the schools had architectural designs that helped prevent noise intrusion. Only 31.2% of the schools had adequate space between the last row of seats and the classroom wall (see Table 2).

Figure 1 reveals that 50% of the schools had access to reliable sources of sufficient clean and safe drinking water, and also shows that 75% of the schools were equipped with toilets. Table 3 illustrates that 25% of the schools had designated rest areas for students, 75% had play areas, and 43.7% had a sufficient number of toilets. Additionally, 81.3% of the schools had toilets that were divided into groups. None of the surveyed schools had hand-washing facilities or soap available for hand hygiene. Only 31.3% of the schools employed scavengers for cleaning purposes. Waste disposal by direct burning was reported in 43.7% of the schools.

According to Figure 1, 56.3% of the schools had canteens. Regarding the condition and compliance of school canteens, Table 4 indicates that 55.6% of the canteens were in poor condition, characterized by inadequate lighting and ventilation. Furthermore, 44.4% of

Table 3
Assessment of the environmental sanitation services

Variables	Frequency	Percentage
Are there sites prepared for students to rest?		
Yes	4	25%
No	12	75%
Are there playing areas?		
Yes	12	75%
No	4	25%
Is the number of toilets sufficient?		
Yes	7	43.70%
No	9	56.30%
Are the toilets divided into groups?		
Yes	13	81.30%
No	3	19.70%
How are toilets cleaned?		
By a toilet cleaner	6	35.70%
Suction is done periodically	6	35.70%
Using detergents and disinfectants	4	25%
Are there hand washing facilities near the toilets?		
Yes	-	-
No	16	100%
Is soap available for hand washing?		
Yes	-	-
No	16	100%
Are there scavengers in the school?		
Yes	5	31.30%
No	11	68.70%
How is solid waste (garbage) disposed of?		
Direct burning	7	43.70%
Collecting and then burning	9	56.30%

the canteens had window designs that prevented the entry of flies and other insects. All canteens used plastic utensils. Canteen workers in 44.4% of the schools possessed medical fitness cards.

DISCUSSION

Infectious diseases such as diarrhea, dysentery, salmonella, food poisoning, typhoid fever, and respiratory infections among pupils are the major health problems associated with poor hygiene in schools. These include the lack of clean drinking water, lack of sanitary requirements for preparing food and drinks, poor ventilation, improper waste disposal, absence of hand-washing facilities and insufficient toilets, which together represent a threat to pupils' health and in turn lead to an increase in the morbidity rate, in addition to their impact on pupils' attendance and academic achievement.

The study showed that 93% of schools had a suitable distance from public services, pollution, and noise. This result is in line with the study conducted in Shiraz, Iran, which reported that 95.34% of schools had a suitable distance from the pollution and nuisance centers (Nezhad et al., 2016). The school should be centrally located and easily accessible to students. It should be situated at an adequate distance from the main streets to eliminate the nuisance of noise (AlQuhtani, 2023). Schools should provide an environment that minimizes health risks, with particular regard to water, air, and noise pollution (Gouge et al., 2023). The study showed that all school buildings were acceptable in terms of structural materials. This result is higher than that found in Shiraz, Iran; where 29.1% of school buildings were acceptable (Nezhad et al., 2016).

This study illustrated that 56.3% of schools had appropriate positioning of the building, and 62.5% of schools had buildings that protected students from harsh conditions. A similar study showed that 42.3% of the positions of the school building had an undesirable

Table 4
Assessment of the school canteen conditions

Variables	Frequency	Percentage
Are the ventilation and lighting in the canteen good? (n= 9)		
Yes	4	44.40%
No	5	55.60%
Are the windows of the canteen designed to prevent the entry of flies? (n= 9)		
Yes	3	33.30%
No	6	66.70%
Are the canteen equipment and furniture clean? (n= 9)		
Yes	3	33.30%
No	6	66.70%
Are plastic utensils used? (n= 9)		
Yes	9	100%
No	0	-
Do the canteen workers have a medical fitness card? (n= 9)		
Yes	4	44.40%
No	5	55.60%

situation which led to noise pollution and disruptive events (Khaniki et al., 2014). The schools should be responsible for minimizing the risk of physical injury and disease transmission by ensuring that adequate protective measures are put in place (Tanzania Ministry of Health and Community Development, 2018). This result is also comparable to a study conducted in primary schools; only 57.7% of the schools had favorable building orientation (Khaniki et al., 2014). The present study found that all schools had a blackboard and appropriate board color. This result is higher than that found in Shiraz, Iran, where 93.02% of schools' blackboards were suitable (Nezhad et al., 2016).

The current study revealed that 50% of schools provided inappropriate seating. The height of the seat should be such that the feet of the children do not remain suspended in the air (Abulhassan & Davis, 2021). The provision of comfortable seating arrangements and adequately spacious classrooms contributes to creating a conducive environment for schoolchildren (UNESCO & Open Society Foundations, 2020).

This study showed that half of the schools had poor ventilation. This finding is consistent with a study conducted in Southern Thailand, which showed that 50% of schools had poor ventilation (Decharat & Pan-in, 2019). This finding is comparable to the study conducted in Shiraz, Iran, where lacking windows were in the poorest condition and only in 27.9% of schools had windows (Nezhad et al., 2016). Classrooms should be separated and adequately ventilated (Ding et al., 2021).

This study showed that half of the schools have access to reliable sources of sufficient clean and safe water. This result is lower than previous studies conducted in different parts of the world. In Shiraz, Iran, the water supply in all schools (100%) was suitable and hygienic (Nezhad et al., 2016). In a study conducted in Southern Thailand, all schools had a water supply (Decharat & Pan-in, 2019). In Pakistan, 61% government primary schools lack drinking water. An adequate supply of potable drinking water should be available for consumption through a sufficient number of well-maintained and accessible sources (Mashabela et al., 2022). The Ministry of Education and the local government are obligated to implement the school environment standards/specifications issued by the Ministry, which are: (a) Providing potable water, (b) Providing toilets and bathrooms, ensuring basic health conditions are observed, (c) Disposal of waste in accordance with the Ministry's standards (Khartoum State School Health Law, 2010).

This study illustrated that 50% of

schools obtained clean and safe water from the public tap. This finding was in line with a study conducted in Southern Thailand, which showed that 59.09% of schools got their water from the tap followed by filtration before drinking (Decharat & Pan-in, 2019). Also, Hu et al. (2021) reported that there should be a continuous supply of safe and potable water through taps. It is better to drink water directly from the tap than from storage tanks. The provision of safe, clean drinking water contributes to creating a conducive environment for the children in the school (UNESCO & Open Society Foundations, 2020).

The current study showed that 75% of schools had large playgrounds. Policy guidelines reported that schools should provide accessible and safe physical environments to all people, including those with special needs (Tanzania Ministry of Health and Community Development, 2018). Every school must allocate an appropriate space for sports activities approved by the administration (Khartoum State School Health Law, 2010).

This study showed that 75% of schools had toilets, 43.7% had a sufficient number of toilets, and 81.3% were divided into groups. Zemer et al. (2023) mentioned that pit latrines and urinals should be provided in schools. A similar study conducted in Southern Thailand showed that all schools provided separate toilets for boys and girls (Decharat and Pan-in, 2019). In Pakistan, 56% of government primary schools do not have latrine facilities (UNESCO & Open Society Foundations, 2020).

All schools did not have hand-washing facilities and did not have soap for hand washing. Smith et al. (2021) mentioned that there should be hand-washing for students after using toilets. Our finding is in disagreement with those studies conducted in different countries; in Shiraz, Iran, all schools (100%) had suitable liquid soap (Nezhad et al., 2016). In Southern Thailand, although all schools had hand-washing facilities, 86.37% did not provide soap or detergents for cleaning (Decharat & Pan-in, 2019). The premises of each school should include an appropriate number of hand-washing facilities, toilets, and drinking fountains for all students (Poague et al., 2025).

The current study showed that 31.3% of schools had scavengers, 43.7% disposed of their waste by direct burning, and 56.3% collected it before burning. A study carried out in Southern Thailand found that 45.45% of schools disposed of their waste by burning, 13.63% dumped it, and 40.92% transported their waste via a local waste disposal system (Decharat & Pan-in, 2019). Finally, regarding environmental sanitation services in basic schools, studies indicated that each school should ensure access to clean and safe water, secure grounds, solid waste disposal facilities, sufficient toilets for boys and girls and learners with disabilities, as well as fire-fighting equipment and training (Tanzania Ministry of Health and Community Development, 2018). Safer water, combined with good hygiene practices, can reduce diarrheal infections by more than half (Wolf et al., 2022).

Our study showed that 56.3% of schools had a canteen or cafeteria; 55.6% of these were in poor condition (e.g., poor lighting and ventilation). Each school should provide meal services for students, as children often get hungry during school hours due to rushed or skipped meals (Mingay et al. 2022). Our finding is in disagreement with a study conducted in Shiraz, Iran, where 46 buffets existed in 41.3% of schools and healthy buffets were established with suitable conditions (Nezhad et al., 2016). Similarly, a previous study conducted in Southern Thailand showed that 63.64% of schools had inappropriate (i.e., unhygienic) food service areas (Decharat & Pan-in, 2019).

The present study showed that canteen workers in 44.4% of schools had medical fitness cards. A similar study conducted in Shiraz, Iran, showed that 78.27% of school food sellers had health cards (Nezhad et al., 2016). All canteen workers are required to have a health fitness card affirming that they are free from infectious diseases (Khartoum State School Health Law,

2010).

This study presents several notable strengths. Firstly, it offers a comprehensive assessment of school environmental health in governmental basic schools, incorporating multiple domains such as infrastructure, classroom environment, sanitation services, and canteen conditions. The use of a structured checklist developed through a critical literature review and validated by experts enhanced the reliability and relevance of the data collection tool. Furthermore, the study's focus on El-Obeid City, a historically significant educational hub in Sudan, adds contextual value and allows for meaningful comparisons with international studies.

However, the study also has some limitations. The use of purposive sampling limits the generalizability of the findings beyond the selected schools. The relatively small sample size may not fully capture the diversity of school conditions across the entire city or state. Additionally, as a cross-sectional design, the study cannot establish causal relationships between environmental conditions and student health outcomes. The reliance on observational data and the absence of direct health indicators (e.g., morbidity rates) limit the scope of the conclusions.

CONCLUSIONS

This study showed that the absence of hand-washing facilities in all schools, a lack of solid waste disposal services from local authorities, the absence of water fountains in half of the schools, and a lack of follow-up for canteen workers by school administrations are significant concerns. The study emphasized the need for continuous evaluations of school environmental health to determine the school's needs and limitations accurately, and for providing suitable techniques for improving school environmental health. Local authorities and decision-makers should provide the minimum health and environmental requirements, as well as basic standards, in schools in order to protect pupils from threats and risks that affect their health. Future research should involve larger and randomly selected samples to improve generalizability. Employing longitudinal or mixed-method designs could provide insights into the long-term effects of school environmental conditions on student health and performance. Including qualitative perspectives from school stakeholders and evaluating specific interventions would also strengthen future studies.

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AUTHORS' CONTRIBUTIONS
Eyman A. A. Koko and Jibril A. J. Alim formulated the proposal research, performed the field work. Musa A. O. Mohammed designed the study, checked and analyzed the data, wrote the manuscript and reviewed it. All authors read and approved the final manuscript.

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COMPETING INTERESTS
The authors confirm that all of the text, figures, and tables in the submitted manuscript work are original work created by the authors and that there are no competing professional, financial, or personal interests from other parties.

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