

ASSESSMENT OF WATER AND SANITATION FACILITIES AND HYGIENE PRACTICES IN PANKSHIN DISTRICT, PANKSHIN LOCAL GOVERNMENT AREA, PLATEAU STATE, NIGERIA.



¹UKACHUKWU M. I., ¹EZE C. E., ²MBAH A., ¹OKPARA P. O., ³PATIENCE B.,
³DOMINIC T. Y., ¹IBRAHIM M. U., ¹MUSA G. S.,

¹Federal College of Animal Health and Production Technology, Vom, Plateau state.

²Nutrition and Dietetics department, Federal College of Veterinary and Medical laboratory Technology, Vom, Plateau state.

³Federal College of land Resources Technology Kuru, Jos.

*Corresponding author: ukachukwumary@gmail.com 08061517145

ABSTRACT

This study assessed water and sanitation facilities and hygiene practices among residents of Pankshin District in Pankshin Local Government Area, Plateau State, Nigeria. The study aimed to examine residents' access to water sources, sanitation facilities, and hygiene practices, as well as to evaluate their level of awareness regarding sanitation and health. A descriptive survey design was adopted, and structured questionnaires were administered to 200 randomly selected respondents across communities within the district. Data were analyzed using descriptive, Chi-square, and one-way Analysis of Variance (ANOVA). Findings revealed that although a majority of residents had access to some form of water supply, many relied on unimproved sources such as wells and streams, increasing their vulnerability to waterborne diseases. Sanitation infrastructure was inadequate, with pit latrines being the most common facility, while open defecation remained prevalent due to limited toilet availability and long distances to existing facilities. Inferential analysis showed a significant relationship between access to water facilities and sanitation practices ($\chi^2 = 31.688$, $p < 0.001$), while sanitation practices also differed significantly according to educational level ($F = 113.949$, $p < 0.001$). The study concluded that despite relatively high awareness of sanitation-related health risks, inadequate water and sanitation infrastructure, poverty, and weak institutional support continue to undermine effective hygiene practices. It recommends increased investment in sustainable water supply systems, improved sanitation infrastructure, and strengthened community-based hygiene education programs to enhance sustainable WASH (Water, Sanitation, and Hygiene) outcomes in Pankshin District.

Keywords: Water access, Sanitation Facilities, Hygiene Practices, WASH, Pankshin District

INTRODUCTION

Access to safe drinking water, adequate sanitation, and proper hygiene remains fundamental to public health and sustainable development globally. Despite international progress in expanding water, sanitation, and hygiene (WASH) services, significant disparities persist, particularly in low- and middle-income countries. Recent global assessments indicate that billions of people still lack safely managed drinking water and sanitation services, with sub-Saharan Africa bearing a disproportionate burden (Bain et al., 2018; JMP, 2023). Inadequate WASH services continue to contribute substantially to diarrhoeal diseases and other preventable health conditions, especially among vulnerable populations (Prüss-Ustün et al., 2019).

Across sub-Saharan Africa, access to improved sanitation and the elimination of open defecation remain critical challenges. Structural inequalities, rural–urban disparities, and limited infrastructure coverage influence household access to safe water and sanitation services (Yaya et al., 2018; JMP, 2023). Evidence further suggests that sanitation improvements produce stronger public health outcomes when community-wide coverage is achieved, thereby generating protective effects beyond individual households (Fuller et al., 2018). However, sustained reductions in waterborne diseases depend not only on infrastructure availability but also on consistent hygiene practices, particularly handwashing with soap and safe water handling behaviors (Pickering et al., 2019).

In Nigeria, these regional patterns are reflected in persistent gaps in access to safely

AIM AND OBJECTIVES

The main aim of this study is to assess water and sanitation facilities and hygiene

managed water sources and improved sanitation facilities. Many communities continue to rely on unimproved or partially improved water sources, increasing exposure to contamination risks (Bain et al., 2018). Open defecation and shared sanitation facilities remain prevalent in underserved and rural settings, contributing to environmental contamination and disease transmission (Yaya et al., 2018). Furthermore, evidence indicates that awareness of hygiene practices alone does not guarantee consistent behavioral adoption without reliable access to enabling facilities and sustained community engagement (Wolf et al., 2022).

Within Plateau State, similar infrastructural and behavioral challenges are evident, particularly in semi-urban and rural districts where public water supply systems are inconsistent and sanitation facilities are often basic. In Pankshin District of Pankshin Local Government Area, reliance on alternative water sources, shared sanitation facilities, and variable hygiene practices may heighten vulnerability to WASH-related health risks. Given the established link between inadequate WASH services and adverse health outcomes (Prüss-Ustün et al.), localized assessments are essential to identify context-specific service gaps and behavioral patterns.

Therefore, this study assesses water and sanitation facilities and hygiene practices in Pankshin District, Pankshin LGA, Plateau State. By generating community-level evidence, the study contributes to broader efforts aimed at improving WASH access, strengthening community-wide sanitation coverage, and reducing preventable water-related diseases in line with global WASH improvement strategies.

practices in Pankshin District, Pankshin Local Government Area, Plateau State, Nigeria. The specific objectives are to:

1. determine the socio-demographic characteristics of the respondents in the study area.
2. determine the level of access to water sources and patterns of water use among respondents in the study area
3. assess the availability and condition of sanitation and hygiene facilities among households in the study area.
4. evaluate hygiene awareness and practices among respondents in the study area.

HYPOTHESES

The following null hypotheses were formulated and tested for the study:

1. There is no significant relationship between access to water facilities and sanitation practices among residents of Pankshin District.
2. There is no significant difference in sanitation practices based on the educational level of residents.

Significance of the Study

The findings of this study will provide empirical evidence beneficial to key stakeholders concerned with water, sanitation, and hygiene (WASH) improvement in Pankshin District and similar settings. For policymakers and government agencies, the study offers data-driven insights to support evidence-based policy formulation, resource allocation, and the development of effective WASH interventions. Public health practitioners and health institutions will benefit from the identification of potential health risks associated with unsafe water sources and inadequate sanitation, thereby strengthening disease prevention and control strategies. Development agencies and non-governmental organizations (NGOs) can utilize the findings to design targeted

community-based programs and sustainable WASH initiatives tailored to local needs. Additionally, community leaders and residents will gain increased awareness of safe hygiene practices and the importance of protecting water sources, fostering behavioral change and community participation, by addressing critical gaps in water and sanitation services, the study contributes to the advancement of Sustainable Development Goal 6 (Clean Water and Sanitation) and supports long-term public health and socio-economic development.

Theoretical Framework

This study is anchored on the Health Belief Model (HBM), a widely used psychological theory for explaining and predicting health-related behaviors. The HBM posits that individuals' engagement in preventive health behaviors is influenced by their perceptions of susceptibility to a health problem, the severity of its consequences, the benefits of taking action, and the barriers to adopting the behavior (Rosenstock, 1974; Glanz et al., 2008). Additional constructs, such as cues to action and self-efficacy, further explain the motivation and confidence required for behavior change. In the context of water and sanitation, the HBM suggests that residents' decisions to use safe water sources, maintain hygiene, and adopt proper sanitation practices are shaped by their perceived risk of waterborne diseases (perceived susceptibility), the seriousness of potential illness (perceived severity), the benefits of safe water and hygiene practices (perceived benefits), and the challenges they face in accessing safe facilities (perceived barriers). Cues to action, such as community health campaigns or health education programs, and self-efficacy, the confidence in practicing proper hygiene, are critical in motivating and sustaining these behaviors.

Applying the HBM to this study provides a framework for understanding not only the availability and accessibility of water and sanitation facilities but also the behavioral and cognitive factors that influence residents' hygiene and sanitation practices. This aligns directly with the study objectives: assessing demographic characteristics, determining access and usage of water, evaluating sanitation facilities, and examining hygiene awareness and practices among residents of Pankshin District. By integrating infrastructural and behavioral perspectives, the HBM allows for a holistic analysis of the factors affecting water and sanitation outcomes in the community.

Methodology

This study employed a descriptive cross-sectional survey design to systematically assess the status of water and sanitation facilities and hygiene practices among residents of Pankshin District. This design was appropriate because it enables the collection of quantitative data from a defined population at a single point in time, allowing for the description of prevailing conditions, behaviors, and access patterns without manipulating study variables.

The target population comprised all residents aged 18 years and above in Pankshin District, estimated at approximately 15,000. A sample size of 200 respondents was determined using Yamane's (1967) formula, which provides a statistically reliable sample for a known population at a 5% margin of error. A multistage sampling technique was adopted to enhance representativeness and minimize sampling bias. First, stratified sampling was

used to categorize the district into its major communities or wards to ensure proportional representation. Second, simple random sampling was applied to select households within each stratum. Finally, systematic sampling was used to select one eligible adult respondent per household, ensuring fairness and practicality in participant selection.

Data were collected using a structured questionnaire consisting of two sections: (i) socio-demographic characteristics and (ii) knowledge, access, and practices related to water, sanitation, and hygiene (WASH). Questionnaires were administered through face-to-face interviews by trained research assistants fluent in both English and the local language to ensure clarity and accuracy. Prior to data collection, respondents were informed about the study objectives, and informed consent was obtained. Data analysis was conducted using Statistical Package for the Social Sciences (SPSS) version 25. Descriptive statistics (frequencies, percentages, and means), Chi-square, and one-way Analysis of Variance (ANOVA) were used to summarize the data.

To ensure instrument validity, the questionnaire was reviewed by three experts in public health and environmental studies, establishing content validity. A pilot study involving 30 residents from a neighboring community yielded a Cronbach's alpha coefficient of 0.82, indicating high internal consistency and reliability. Ethical considerations were strictly adhered to. Participation was voluntary, confidentiality of responses was assured, and collected data were used solely for academic research purposes.

Results**Table 1: Socio demographic characteristics of the respondents**

Parameters	Frequency	Percentage %
Age		
18 and below	12	6
19-30	72	36
31-45	60	30
46-60	56	28
Gender		
Male	97	48.5
Female	103	51.5
Marital status		
Single	80	40
Married	92	46
Divorced	14	7
Widowed	14	7
Educational level		
No formal education	25	12.5
Primary	45	22.5
Secondary	80	40
Tertiary	50	25
House size		
1-3	30	15
4-6	95	47.5
7-9	50	25
10+	25	12.5

Source: (Field Survey, 2025)

Table 1 shows the Socio-Demographic characteristic which indicate that most respondents were young and middle-aged adults, with the largest group aged 19–30 years (36%) and 31–45 years (30%). This suggests that the majority of respondents are economically active and likely responsible for household water and sanitation management. Gender distribution was

almost balanced, with females slightly higher (51.5%) than males (48.5%), indicating a fairly representative sample of both sexes. Marital status, 92 (46%) were married, 80 (40%) single, and smaller proportions were divorced or widowed (7% each), showing that household responsibilities may vary across marital groups. Education levels were moderate, with 40%

having secondary education and 25% tertiary education, while 22.5% had primary education and 12.5% no formal schooling. This suggests that a significant portion of respondents may have the capacity to understand and adopt proper

hygiene practices. Regarding households, 95 (47.5%) revealed the largest in size and this may place a greater demand on available water and sanitation.

Table 2: Water access and usage in Panskin District

Parameters	Frequency	Percentage %
Main source of drinking water		
Borehole	42	21
Stream	35	17.5
Rain	15	7.5
Well	78	39
Sachet	30	15
Distance to the source		
Less than 500m	95	47.5
500m-1km	65	32.5
Above 1km	40	20
Frequency of fetching water		
Daily	140	70
Weekly	45	22.5
Monthly	15	7.5
Main person fetching water		
Women	115	57.5
Men	30	15
Children	55	27.5
Liters of water used per day		
Less than 50 liters	45	22.5
51-100 liters	55	27.5
100 and above	100	50
Source function		
Yes	135	67.5
No	65	32.5
Treat drinking water		
Yes	110	55
No	90	45
Treatment method used		
Boiling	50	45.5
Filtering	35	31.8
Chlorination	25	22.7
Satisfied with water quality		
Yes	130	65
No	70	35

Source: (Field Survey, 2025)

Table 2 titled access to water and usage in Panskin, shows that wells constitute the primary source of drinking water (39%), and followed by boreholes (21%), streams (17.5%), sachet water (15%), and rainwater (7.5%). This distribution reveals continued reliance on potentially unsafe water sources, particularly wells and streams. In terms of distance to water sources, (47.5%) respondent's accessed water from sources located within 500 meters, while 32.5% traveled between 500 meters and 1 kilometer, and 20% traveled over 1 kilometer. A majority had relatively close access, a substantial proportion still faced long distances, which can negatively affect water quantity, hygiene practices, and overall well-being. Water collection is predominantly a daily activity (70%), with women (57.5%) and children (27.5%) bearing the primary responsibility, indicating a gendered burden in water provision. Regarding water usage, half of the

respondents (50%) reported using 100 liters or more per day, (22.5%) used less than 50 liters, showing disparities in household water consumption. Although (67.5%) of respondents indicated that their water sources were functional, (32.5%) reported non-functional sources, revealing infrastructural limitation.

Treatment of water, (55%) of household treated their drinking water, with boiling (45.5%) being the most common method, followed by filtering (31.8%) and chlorination (22.7%). (45%) of respondents did not treat their water which may increase vulnerability to contamination risk. Despite these practices, only (65%) of respondents expressed satisfaction with their water quality, while (35%) were dissatisfied.

Table 3: Availability of Sanitation and Hygiene facilities in Pankshin District

Parameters	Frequency	Percentage %
Toilet used		
Pit	85	42.5
Flush	60	30
Others	55	27.5
Toilet shared with others		
Yes	110	55
No	90	45
Distances to toilet		
Less than 10m	90	45
10-50m	80	40
Above 50m	30	15
Clean and functional		
Yes	125	62.5
No	75	37.5
House has bathroom		
Yes	145	72.5
No	55	27.5
Waste water disposal methods		
Soak away	85	42.5
Open drainage	55	27.5
Bush	35	17.5
Others	25	12.5
Waste collection frequency		
Weekly	55	27.5
Monthly	45	22.5
Rarely	100	50
Open defecation practice		
Yes	140	70
No	60	30
Reasons for open defecation		
No toilet	80	57.9
Cultural practice	29	20.7
Long distances	30	21.4

Source: (Field Survey, 2025)

Table 3 shows that Pit latrines were the most commonly used toilet facilities (42.5%), followed by flush toilets (30%) and other types (27.5%). More than half of the respondents (55%) shared toilet facilities, increasing potential exposure to

sanitation-related health risks. Distance to toilet, 45% of households had toilets located within 10 meters of their residence, 15% traveled more than 50 meters to access facilities. Only (62.5%) of respondents reported having clean and functional

toilets, while (37.5%) indicated poor maintenance conditions. While 72.5% of households had bathrooms, wastewater disposal practices varied considerably. Soak-away systems were the most common method (42.5%), yet unsafe disposal methods such as open drainage (27.5%) and bush disposal (17.5%) were

still prevalent. Waste collection practices were irregular, with half of the respondents (50%) reporting rare disposal. Open defecation remains widespread, practiced by 70% of respondents, primarily due to lack of toilet facilities (57.9%), long distances to available toilets (21.4%), and cultural practices (20.79

4. Hygiene Awareness and Practices among respondents n Panskin District

Parameters	Frequency	Percentage (%)
Hand washing after toilet use		
Always	50	25
Sometimes	140	70
Rarely	10	5
Use of soap during hand washing		
Yes	145	72.5
No	55	27.5
Children taught hygiene at home		
Yes	80	40
No	120	60
Boiling purifies water		
Yes	160	80
No	40	20
Hand washing station		
Yes	95	47.5
No	105	52.5
Attend health talk		
Occasionally	90	45
Always	70	40
Rarely	30	15
Clean toilet frequently		
Always	60	30
Sometimes	130	65
Never	10	5
Heard of cholera		
Yes	175	87.5
No	25	12.5
Aware poor sanitation affect health		
Yes	180	90
No	20	10
water challenge		
Poor quality	75	37.5
Distances	65	32.5
Irregular supply	60	30
Improvement needed		
More boreholes	80	40
Water purifications	50	25
Public toilet	35	17.5
Waste disposal unit	35	17.5

Source: (Field Survey, 2025)

Table 4 shows only (25%) of respondents always wash their hands after toilet use, while (70%), and (5%) reported doing so rarely. This indicated inadequate adherence to recommended hygiene practices. (72.5%) were using soap during hand washing, indicating some level of awareness and access to hygiene materials. However, only (47.5%) of households reported having a hand-washing station, while 52.5% did not, highlighting infrastructural barriers to consistent hygiene behavior. With respect to hygiene education, (40%) of respondents reported that children were taught hygiene practices at home, whereas 60% did not, suggesting limited household-level hygiene promotion. Nonetheless, 80% correctly recognized that boiling purifies water, reflecting good knowledge of basic water treatment methods. Exposure to public health information, 40% attended health talks, 45% attended occasionally, and 15% attended rarely, indicating variable engagement

with health education programs. In terms of sanitation maintenance, 30% of respondents always cleaning their toilets, while 65% did so sometimes, and 5% never cleaned their toilets. This pattern suggests inadequate routine sanitation maintenance in many households. Awareness of waterborne diseases and sanitation-related health risks was generally high, (87.5%), heard of cholera and 90% were aware that poor sanitation affects health, demonstrating strong general knowledge of sanitation–health linkages. water-related challenges, (37.5%), had poor water quality, (32.5%) had long distances to water sources, and irregular water supply (30%), reflecting both access and quality constraints. key suggested improvements included construction of more boreholes (40%), improved water purification practices (25%), provision of public toilets (17.5%), and establishment of waste disposal units (17.5%).

Results of Hypotheses Testing

Hypothesis	Statistical Test	Test statistics	P- value	Decision
H ₀₁ : There is no significant relationship between access to water facilities and sanitation practices among residents of Pankshin District.	Chi-square	X ² =31.688	< 0.001	Rejected
H ₀₂ : There is no significant difference in sanitation practices based on the educational level of residents	ANOVA	F =113.94 9	< 0.001	Rejected

From the above table, the first hypothesis examined the relationship between access to water facilities and sanitation practices among residents of Pankshin District. The Chi-square analysis revealed a statistically significant relationship between access to water facilities and sanitation practices ($\chi^2 = 31.688$, $p < 0.001$). Consequently, the null hypothesis was rejected.

This finding indicates that access to water facilities significantly influences sanitation practices among residents of the study area.

The second hypothesis assessed whether sanitation practices varied according to the educational level of residents. The one-way Analysis of Variance (ANOVA) showed a

statistically significant difference in sanitation practices across educational groups ($F = 113.949$, $p < 0.001$). Therefore, the null hypothesis was rejected. The result suggests that educational attainment significantly affects sanitation practices among residents of Pankshin District

Discussion of Findings

The findings of this study align with global evidence documenting persistent disparities in access to safely managed water and sanitation services in low- and middle-income countries, particularly in sub-Saharan Africa (Bain et al., 2018; Wolf et al., 2022). The predominance of respondents within the economically active age group suggests that household water and sanitation decisions are largely managed by working-age adults. Educational attainment observed among respondents may enhance hygiene awareness, as education has been associated with improved sanitation utilization and health behavior adoption (Yaya et al., 2018). However, large household sizes may exert pressure on limited infrastructure, thereby compromising sanitation maintenance and hygiene standards.

Access to improved water sources remains inconsistent. Although boreholes and sachet water represent relatively safer options, the reliance on wells and streams suggests exposure to microbiological contamination risks. Similar patterns have been reported in global baseline assessments of drinking water services (Bain et al., 2018). The burden of water collection falling predominantly on women and children reflects gendered inequalities commonly documented in water-insecure settings (JMP, 2023). While over half of respondents reported treating drinking water, incomplete adoption increases the likelihood of enteric infections and diarrhoeal diseases, which are strongly linked to unsafe water exposure (Prüss-Ustün et al., 2019; Wolf et al., 2022).

The hypothesis testing further demonstrated a statistically significant relationship between access to water facilities and sanitation practices among residents of Pankshin District. This suggests that improved access to reliable water sources may positively influence sanitation and hygiene behaviors. The finding supports previous studies which established that inadequate access to safe water constrains effective sanitation and hygiene practices in many developing settings (Wolf et al., 2022; Bain et al., 2018).

Sanitation results reveal critical gaps, particularly the 70% open defecation rate, which represents a major public health concern. This finding reflects both infrastructural deficiencies—such as limited access to affordable and private latrines—and behavioral or socio-cultural factors, including entrenched practices and perceived convenience. This finding aligns with Yaya et al. (2018), who opined that open defecation was compounded by population growth, pressure on existing infrastructure, cultural acceptance of the practice, and insufficient government investment in sanitation projects. Thus, the finding likely reflects an interaction between structural deficits and socio-behavioral influences rather than a single cause. The coexistence of shared sanitation facilities and environmental disposal practices further increases exposure to fecal contamination and disease transmission pathways (Prüss-Ustün et al., 2019).

Despite approximately 90% of residents being aware of sanitation-related health risks, consistent hygiene practices, especially handwashing, remained limited. This demonstrates a clear knowledge–practice gap. Guided by the Health Belief Model (HBM), this gap may be explained by perceived barriers such as inadequate water availability, absence of handwashing facilities, cost of soap, limited cues to action,

and reduced self-efficacy. Thus, although perceived susceptibility and severity may be high, structural and behavioral constraints hinder the translation of knowledge into sustained preventive action (Rosenstock, 1974; Glanz et al., 2008).

The analysis also revealed a significant difference in sanitation practices based on residents' educational level, indicating that education plays an important role in shaping sanitation behavior. This finding is consistent with earlier studies showing that higher educational attainment improves awareness, understanding, and adoption of safe hygiene and sanitation practices (Yaya et al., 2018). Education may therefore enhance individuals' capacity to make informed health decisions and adopt preventive sanitation measures.

Water-related challenges reported by respondents—poor quality, long distances, and irregular supply—reflect structural service delivery limitations consistent with global monitoring data (Bain et al., 2018; JMP, 2023). However, the strong willingness among residents to contribute toward improving services suggests readiness for participatory and community-led interventions. Research indicates that community-wide engagement enhances sustainability and maximizes the health impact of sanitation coverage (Fuller et al., 2018).

However, the findings confirm that while sanitation awareness in Pankshin District is relatively high, infrastructural deficiencies, inconsistent water supply, and behavioral gaps continue to undermine safe water and sanitation outcomes. Achieving sustainable improvements requires integrated strategies that combine infrastructure investment, community-wide sanitation coverage, and sustained hygiene behavior interventions, consistent with contemporary global

evidence on WASH effectiveness (Bain et al., 2018; Wolf et al., 2022).

Conclusion

The study reveals critical gaps in water access, sanitation, and hygiene practices in Pankshin District. While awareness of sanitation-related health risks is high, many households rely on unsafe water sources, use poorly maintained or shared toilets, and practice inconsistent handwashing and water treatment. Large household sizes and moderate education levels further influence WASH behaviors. Despite these challenges, the community shows willingness to participate in improvements, highlighting opportunities for interventions. Sustainable progress will require integrated strategies combining safe water provision, functional sanitation facilities, consistent hygiene promotion, and active community engagement to reduce waterborne diseases and achieve SDG 6 locally.

Based on the findings of the study, the following recommendations were:

1. The Plateau state Government and relevant stakeholders should prioritize investment in sustainable water supply infrastructure, including the construction of additional boreholes and the rehabilitation of existing water facilities. Emphasis should be placed on ensuring consistent functionality, particularly during dry seasons, to reduce reliance on unsafe water sources such as streams and unprotected wells.
2. Community-based awareness campaigns should be intensified to encourage the adoption of safe household water treatment methods, such as boiling, chlorination, and filtration. In addition, subsidies or affordable access to water treatment products (e.g., chlorine tablets and water filters) should be provided to

low-income households to enhance safe water consumption practices.

3. Local authorities should improve the provision, accessibility, and maintenance of public sanitation facilities. Regular monitoring, proper waste management systems, and community participation in the maintenance of toilets and waste disposal units are essential to reduce open defecation and environmental contamination.

4. Comprehensive hygiene education programs should be implemented through schools, religious institutions, health centers, and community forums. Special attention should be given to populations with lower levels of formal education to promote consistent hand washing with soap, safe water storage, proper toilet use, and other preventive hygiene practices.

References

- Bain, R., Johnston, R., Mitis, F., Chatterley, C., Slaymaker, T., & Bartram, J. (2018). Establishing sustainable development goal baselines for household drinking water, sanitation and hygiene services. *The Lancet Global Health*, 6(9), e1017–e1028.
- Fuller, J. A., Villamor, E., Cevallos, W., Trostle, J., & Eisenberg, J. N. S. (2018). I get height with a little help from my friends: Herd protection from sanitation on child growth in rural Ecuador. *International Journal of Epidemiology*, 47(2), 460–469.
- Glanz, K., Rimer, B. K., & Viswanath, K. (2008). *Health behavior and health education: Theory, research, and practice* (4th ed.). Jossey-Bass.
- JMP (WHO/UNICEF Joint Monitoring Programme). (2023). Progress on household drinking water, sanitation and hygiene 2000–2022: Special focus on inequalities. *The Lancet Global Health*, 11(8), e1229–e1240.
- Pickering, A. J., Null, C., Winch, P. J., Mangwadu, G., Arnold, B. F., Prendergast, A. J., Humphrey, J. H., & Clasen, T. (2019). The WASH Benefits and SHINE trials: Interpretation of WASH intervention effects on linear growth and diarrhoea. *The Lancet Global Health*, 7(8), e1139–e1146.
- Prüss-Ustün, A., Wolf, J., Bartram, J., Clasen, T., Cumming, O., Freeman, M. C., Gordon, B., Hunter, P. R., Medlicott, K., & Johnston, R. (2019). Burden of disease from inadequate water, sanitation and hygiene for selected adverse health outcomes. *Tropical Medicine & International Health*, 24(5), 604–611.
- Rosenstock, I. M. (1974). Historical origins of the health belief model. *Health Education Monographs*, 2(4), 328–335.
- Wolf, J., Johnston, R., Freeman, M. C., Ram, P. K., Slaymaker, T., Laurenz, E., & Bartram, J. (2022). Effect of improved water, sanitation and hygiene on diarrhoea in low- and middle-income settings: A systematic review and meta-analysis. *The Lancet*, 400(10345), 48–59.
- Yamane, T. (1967). *Statistics: An introductory analysis* (2nd ed.). Harper & Row.

Yaya, S., Ekholuenetale, M., Tudeme, G., Vaibhav, S., Bishwajit, G., & Kadio, B. (2018). Prevalence and determinants of open defecation in sub-Saharan Africa: A multilevel analysis. *BMC Public Health*, 18, 1–9.