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ENHANCING WATER SANITATION AND HYGIENE STANDARDS IN SECONDARY SCHOOLS OF DEVELOPING COUNTRIES: A REVIEW AND CONCEPTUAL FRAMEWORK

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ABSTRACT

This systematic review analyzed 50 peer-reviewed studies (2020–2025) to evaluate Water, Sanitation, and Hygiene (WASH) conditions in public secondary schools across developing countries. Guided by PRISMA standards, the review examined infrastructure adequacy, behavioral practices, gender inclusiveness, and health impacts. Findings reveal persistent infrastructural deficits, poor maintenance, limited hygiene education, and inadequate menstrual and disability-inclusive facilities, all contributing to illness, absenteeism, and gender inequity. Behavioral gaps remain widespread, reflecting weak institutional oversight and unsustained hygiene promotion. A conceptual framework was developed to integrate infrastructure provision, behavior change, inclusiveness, and policy enforcement, emphasizing multi-sectoral collaboration and long-term sustainability. The framework provides a strategic model for strengthening WASH interventions in resource-constrained educational environments. Overall, the review reinforces WASH's essential role in health, equity, and learning, directly supporting Sustainable Development Goals (SDGs) 3, 4, 5, and 6.

Keywords: WASH, School Health, Gender Inclusiveness, Behavior Change, Developing Countries

INTRODUCTION

Water, Sanitation, and Hygiene (WASH) in schools are foundational components of a healthy and inclusive learning environment, particularly in low- and middle-income countries where infrastructural gaps and public health risks are pronounced (Berhanu *et al*., 2022; Lawal *et al*., 2024). Access to safe drinking water, adequate sanitation facilities, and effective hygiene practices has a direct impact on students' health, school attendance, learning outcomes, and overall well-being. Despite global commitments such as the Sustainable Development Goals (SDG 6) and joint monitoring initiatives by WHO and UNICEF (2020a), WASH services in many secondary schools remain inadequate, especially for vulnerable populations such as girls and children with disabilities (Azupogo *et al.*, 2023; Dassah & Bisung, 2023).

A growing body of literature has highlighted the implications of poor WASH conditions on health and education. For instance, studies have reported elevated microbial contamination risks in school drinking water supplies, correlating with increased susceptibility to waterborne diseases among students (Ahmed *et al*., 2020). Hand hygiene, another critical component, is inconsistently practised, as shown in a systematic review across sub-Saharan Africa, revealing low compliance rates and a need for context-specific interventions (Bishoge *et al*., 2023; Berhanu *et al*., 2022). These challenges are often exacerbated during health emergencies, such as the COVID-19 pandemic, which exposed systemic deficiencies in school preparedness and resilience (Poague *et al*., 2023). Furthermore, disparities in access to inclusive WASH facilities have been consistently documented. Students with disabilities often face additional barriers due to the lack of disability-friendly infrastructure and policies in schools (Azupogo *et al*., 2023; Dassah & Bisung, 2023). At the same time, the availability of WASH facilities alone does not guarantee proper utilisation or impact. School-based interventions that incorporate health education, student engagement, and community participation have demonstrated promise in improving knowledge and hygiene practices (Mushota *et al.* 2021).

Given the multidimensional nature of WASH challenges in secondary schools, there is a need for an integrated and evidence-based conceptual framework to guide policy, infrastructure planning, and behavioural change strategies. This article presents a systematic review of recent empirical studies on Water, Sanitation, and Hygiene (WASH) in secondary schools and proposes a conceptual framework designed to improve WASH outcomes. The framework synthesises findings from diverse contexts, including Nigeria (Olatunji & Taiwo, 2021; Wami *et al*., 2022), Ghana, Ethiopia, and Brazil, and emphasises inclusivity, risk assessment, behavioural reinforcement, and pandemic resilience as core pillars for action.

MATERIALS AND METHODS

This study adopted a systematic literature review (SLR) approach to identify, evaluate, and synthesise empirical and theoretical evidence on Water, Sanitation, and Hygiene (WASH) in public secondary schools of developing countries. The review specifically focused on the availability, accessibility, adequacy, and inclusiveness of WASH facilities, as well as their relationship with health and educational outcomes. The methodology was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) framework to ensure transparency and replicability.

Search Strategy

A comprehensive electronic search was conducted across multiple databases, including PubMed, Scopus, Google Scholar, and African Journals Online (AJOL), supplemented by grey literature from the institutional repositories of UNICEF, WHO, and UNESCO. The search covered publications between January 2020 and May 2025 to capture recent evidence reflecting post-COVID-19WASHdynamics. Search terms combined Boolean operators and controlled vocabulary, using key phrases such as: *("WASH" OR "water*

sanitation and hygiene") AND ("schools" OR "secondary education") AND ("developing countries" OR "low- and middle-income countries").

Inclusion and Exclusion Criteria

Studies were included if they: Were peer-reviewed or high-quality institutional reports; Focused primarily on school-based WASH interventions, assessments, or outcomes; Presented quantitative, qualitative, or mixed-method evidence on infrastructure, hygiene behaviour, gender inclusiveness, or policy implementation; Were published in English between 2020 and 2025; and reported measurable or interpretable health, behavioural, or educational indicators.

Studies conducted outside educational settings (e.g., households or health facilities); Publications lacking empirical data or methodological clarity (e.g., opinion papers, editorials);

Duplicate entries retrieved across multiple databases, and Articles not meeting minimum quality standards during appraisal.

Screening and Duplicate Handling

All retrieved records were exported into Mendeley Reference Manager, where duplicates were identified and removed automatically using DOI, title, and author matching. A manual verification was followed to ensure no relevant study was excluded. The remaining records underwent a two-stage screening:

(1) Title and abstract review, and

(2) Full-text assessment by two independent reviewers.

Quality Appraisal and Bias Assessment

Methodological quality of the included studies was appraised using a modified Joanna Briggs Institute (JBI) Critical Appraisal Checklist for observational and qualitative studies. Each study was rated on sampling adequacy, clarity of objectives, validity of measurement tools, and robustness of data analysis. Studies scoring below 60% were excluded from synthesis. Potential publication bias was minimised through the inclusion of grey literature and cross-referencing of institutional databases. The risk of selection bias was reduced by adhering to predefined inclusion criteria and independent screening. While quantitative meta-analysis was not feasible due to heterogeneity of study designs, thematic frequency counts were used to indicate the relative prevalence of recurring WASH issues across regions.

Data Extraction and Analysis

A standardized data extraction form was developed to capture key information, including:

Author(s), publication year, and country of study; Study design and sample characteristics;

WASH components (water, sanitation, hygiene, inclusiveness, and policy); and Reported outcomes related to student health, attendance, and behaviour. Extracted data were synthesised using thematic analysis, grouping findings into major categories: (i) infrastructure adequacy, (ii) hygiene behaviour, (iii) gender inclusiveness, (iv) health outcomes, and (v) policy and governance. Quantitative trends were tabulated using frequency counts and regional distribution summaries to strengthen the statistical interpretation of evidence.

Conceptual Framework Development

The conceptual framework was derived through the synthesis of reviewed literature and theoretical models, including the F-diagram, Health Belief Model (HBM), UNICEF Three-Star Approach, and systems thinking framework. These models were integrated to illustrate the interaction between WASH inputs (infrastructure, funding, and policy), mediating behavioural processes, and educational and health outcomes among students in developing countries.

Ethical Considerations

Since this review exclusively utilised secondary data from published sources, ethical approval was not required. However, all studies were appropriately cited and acknowledged to maintain academic integrity.

RESULTS AND DISCUSSION

WASH Infrastructure in Secondary Schools

The findings from the reviewed studies in Table 1 collectively show that deficits in Water, Sanitation, and Hygiene (WASH) infrastructure are systemic rather than isolated, spanning regions, income levels, and governance structures. Despite this widespread pattern, there are variations in both the nature of infrastructural gaps and the ways they are understood and addressed.

For instance, Brazil's WASH discourse, as discussed by Pereira *et al*. (2024), adopts a rights-based approach that frames access to clean water and sanitation within the broader context of legal and moral obligations. This perspective positions WASH services as fundamental human rights, underscoring their role in preserving student dignity and promoting educational inclusion. In contrast, studies from Nepal and Nigeria (Phoju *et al.*, 2021; Olatunji & Taiwo, 2021) emphasize more operational and infrastructural concerns, such as non-functional toilets, irregular water supply, and poor maintenance. These differences may reflect varying levels of policy maturity, institutional enforcement, and national prioritization of WASH within education systems. In Sub-Saharan Africa, including countries such as Nigeria, Cameroon, and Ghana, infrastructural challenges are primarily attributed to limited funding, poor supervision, and weak institutional frameworks (Annan, 2022; Ashu et al., 2021; Olatunji & Taiwo, 2021) (Table 1). Conversely, in South Asian contexts such as India and Nepal, WASH inadequacies are frequently compounded by high population densities, design inefficiencies, and limited monitoring of microbial risks associated with sanitation facilities (Adhikari et al., 2023; Aniruddh & J.P., 2021). These variations highlight how socio-economic pressures, population dynamics, and governance systems interact to shape the state of school WASH infrastructure across regions.

Table 1: Summary of Reviewed Studies on WASH Infrastructure in Public Secondary Schools (2019–2024)

Author(s) & Year	Country/Region	Key Infrastructural Findings	Related Outcomes/Implications	Remarks on Similarity/Difference
McMichael (2019)	Global (Low-income countries)	Inadequate sanitation and water supply; lack of gender-sensitive facilities.	Affects attendance, especially among girls; promotes absenteeism.	Consistent with findings from India and Nigeria showing gender disparities due to inadequate toilets.
Donde *et al.* (2021)	Multi-country (Low-income)	Weak WASH infrastructure hindered the COVID-19 response.	Limited ability to enforce hygiene protocols in schools.	Similar to Wada & Oloruntoba (2021, Nigeria), where handwashing facilities were inadequate.
Howard *et al.* (2020)	Global	Chronic deficiencies in water supply and sanitation in vulnerable communities.	Threatens public health resilience.	Confirms the global trend noted by McMichael (2019).
Pereira *et al.* (2024)	Brazil	Access to clean water and sanitation is framed as a human right.	Promotes dignity and inclusiveness in learning environments.	Differs slightly—focuses on legal and rights-based framing rather than infrastructure gaps.
Phoju *et al.* (2021)	Nepal	Non-functional toilets, unreliable water supply.	Persistent risks to student health.	Matches patterns in Nigeria and Cameroon regarding maintenance lapses.
Adhikari *et al.* (2023)	Nepal	Weak latrine design; absence of pathogen-level monitoring.	Ineffective sanitation planning and disease prevention.	Unique in emphasizing microbiological safety rather than structural adequacy.
Aniruddh & J. P. (2021)	North India	Lacked safe drinking water, functional toilets, and handwashing facilities.	Poor hygiene and increased absenteeism.	Comparable to findings in Nigeria and Ghana.
Ashu *et al.* (2021)	Cameroon	Insufficient handwashing stations; dirty toilets.	Health and dignity concerns among students.	Aligns with African regional findings on maintenance deficiencies.
Annan (2022)	Ghana	Dysfunctional facilities due to weak supervision and funding gaps.	Ineffective WASH sustainability in schools.	Similar to the Nigerian evidence on poor maintenance culture.
Olatunji & Taiwo (2021)	Nigeria	Poor maintenance and insufficient funding limit WASH infrastructure.	Impairs the health and attendance of students.	Reinforces findings from Ghana and India on financial barriers.
Mohammed, Hassan & Shuaibu (2021)	Nigeria (Minna)	Overcrowded toilets, poor sanitation, and inadequate water sources.	Environmental health and safety risks in schools.	Similar to Nepal and Cameroon, emphasizing overcrowding and inadequate sanitation.
Ohwo (2019)	Nigeria (Yenagoa)	Poorly maintained toilets and the absence of hygiene education.	Increases infection risks and absenteeism.	Confirms McMichael (2019) on the importance of hygiene education.
Wada & Oloruntoba (2021)	Nigeria	Lack of handwashing facilities during COVID-19 despite high awareness.	Reduced pandemic preparedness in schools.	Similar to Donde et al. (2021), showing global infrastructure gaps during COVID-19.

Source: Author's Work, 2023

Drivers of Similarities and Differences in WASH infrastructure in Secondary Schools

The observed similarities in WASH infrastructure deficits (Table 1) across developing countries stem largely from shared structural and institutional weaknesses. Common factors include insufficient financial commitment to school WASH programs, poor maintenance culture, weak accountability systems, and over-reliance on donor-driven interventions that lack sustainable local ownership (Howard *et al.*, 2020; Donde *et al.*, 2021). Such systemic limitations hinder the long-term functionality of facilities and contribute to cyclical patterns of infrastructural decay.

However, the variations across countries arise from several contextual factors. Governance capacity and the degree of decentralization in education management play crucial roles; for example, Ghana's weak local oversight contrasts sharply with Brazil's relatively robust institutional mechanisms (Annan, 2022; Pereira *et al.*, 2024). Cultural and demographic contexts also influence facility utilization and design priorities, as seen in South Asia, where gender-segregated sanitation facilities are more strongly emphasized due to cultural sensitivities around privacy and menstruation (Adhikari *et al.*, 2023). Furthermore, differences in monitoring and evaluation systems are evident; some countries have institutionalized WASH audits within educational inspections, while others lack consistent mechanisms for performance tracking and reporting.

Synthesis and Implications in WASH infrastructure in Secondary Schools

Overall, Table 1 reveals that the reviewed evidence confirms that infrastructural inadequacy remains the most critical bottleneck in achieving universal WASH access in Public secondary schools across developing regions. Persistent deficits in water supply, sanitation, and hygiene infrastructure directly undermine student attendance, particularly among girls, while exacerbating health risks linked to waterborne and hygiene-related diseases. Moreover, inadequate facilities diminish learning outcomes and compromise the inclusivity of educational environments. Addressing these systemic gaps requires sustained investment, policy coherence, and multi-sectoral coordination. Strengthening institutional accountability, promoting community participation, and integrating WASH monitoring into routine school inspections could enhance sustainability. Ultimately, improving WASH infrastructure is not only a public health necessity but also a prerequisite for achieving educational equity and advancing the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education) and SDG 6 (Clean Water and Sanitation).

Behavioural Factors in Secondary School WASH Practices

Behavioural determinants play a critical role in the effectiveness of WASH interventions within school environments. The reviewed studies reveal that even where infrastructure is available, hygiene behaviour among students is shaped by multiple socio-cultural, institutional, and environmental factors, as seen in Table 2. At the regional level, Berhanu *et al*. (2022) found that in Ethiopia, students rarely practised hand hygiene without supervision, highlighting the influence of parental education and school culture on hygiene compliance. Similarly, Mushota *et al*. (2021) in Zambia reported significant improvements in students' hygiene knowledge and practices following the introduction of structured WASH education programs. This finding aligns with Winter *et al.* (2021), who argued that students can act as "WASH ambassadors," transferring hygiene knowledge from schools to their households and communities, thereby amplifying the behavioural impact of school-based interventions.

In South Asia, Patel *et al.* (2025) demonstrated that students in private schools in Gujarat, India, consistently exhibited better WASH-related knowledge, attitudes, and practices (KAP) compared to their counterparts in public schools. The disparity was attributed to differences in institutional management, teacher motivation, and the availability of hygiene materials. Similarly, Ejelonu *et al* (2020) in West Bengal observed that schools combining hygiene education with infrastructure improvements recorded immediate behavioural and attendance gains, though they cautioned that long-term behavioural sustainability requires continued institutional and financial support. In Nigeria, behavioural gaps persist even when basic WASH infrastructure exists. Otto *et al*. (2022) attributed these gaps to the lack of soap, inconsistent water supply, and limited hygiene education. Egbinola and Amanambu (2015) also documented behavioural deficiencies in secondary schools in Ibadan, where students exhibited poor hygiene habits that negatively affected their health, attendance, and learning engagement. These findings emphasize that behavioural change must complement infrastructure provision through structured, context-specific hygiene promotion initiatives.

Table 2: Summary of Reviewed Studies on Behavioural Factors Influencing School WASH Practices

Author(s) & Year	Country/Region	Key Behavioural Findings	Determinants/Drivers	Implications for WASH Policy/Practice
Berhanu *et al.* (2022)	Ethiopia	Low hand hygiene without supervision	Parental education, school culture	Need for parental involvement and teacher supervision
Mushota *et al.* (2021)	Zambia	Improved hygiene practices after WASH education	Structured hygiene programs	Integrate hygiene education into the curriculum
Winter *et al.* (2021)	Multi-country	Students act as hygiene ambassadors	Knowledge empowerment	Promote peer-led hygiene campaigns
Patel *et al.* (2025)	India (Gujarat)	Private school students show better hygiene behaviour	Institutional type, resources	Address disparities between public and private schools
Ejelonu, Feng & McKeon (2020)	India (West Bengal)	Sustained behaviour changes with hygiene education	Combined education and infrastructure	Continuous funding is needed for behavioural sustainability
Otto *et al.* (2022)	Nigeria	Poor hygiene practices despite infrastructure	Lack of soap, poor supervision	Prioritize hygiene materials and student monitoring
Egbinola & Amanambu (2015)	Nigeria (Ibadan)	Weak hygiene attitudes and practices	Inadequate hygiene education	Integrate behaviour change communication in schools

Source: Author's Work, 2023

Comparative Analysis of Behavioural Findings of WASH in Secondary Schools

The reviewed evidence shows that an interplay of educational exposure, institutional commitment, and cultural context shapes hygiene behaviour among students in developing countries. A consistent trend across studies is that WASH education programs significantly improve hygiene knowledge and practices, as demonstrated in Zambia (Mushota *et al.,* 2021) and India (Ejelonu *et al.,* 2020). These findings corroborate Winter *et al.* (2021), who highlighted the multiplier effect of student-led hygiene diffusion. However, differences in behavioral outcomes are seen across regions. In Sub-Saharan Africa (e.g., Ethiopia, Zambia, Nigeria), behavioral issues are often tied to resource shortages, lack of supervision, and poor integration of hygiene education into the school curriculum. In contrast, in South Asia (e.g., India),

behavioral disparities tend to correspond with socio-economic status and school type, indicating that institutional inequality has a greater impact than material scarcity.

Synthesis and Implications of Behavioural Findings of WASH in Secondary Schools

Overall, the evidence demonstrates that infrastructure alone does not guarantee improved Sanitation and hygiene outcomes; behavioural reinforcement through education, supervision, and community engagement remains essential. Where WASH education is sustained and culturally adapted, students exhibit stronger hygiene compliance and contribute to improved public health outcomes. Conversely, in contexts with weak behavioural reinforcement mechanisms, even well-equipped schools struggle to maintain hygiene standards. Strengthening WASH behaviour, therefore, requires integrating hygiene education into national curricula, training teachers as hygiene champions, and establishing school-level monitoring mechanisms. These actions would ensure that behavioural improvements accompany infrastructural investment, thereby promoting sustainable WASH outcomes and supporting SDG 6 (Clean Water and Sanitation) and SDG 4 (Quality Education).

Gender and Inclusiveness in Secondary Schools WASH Systems

Table 3 shows that gender-sensitive and disability-inclusive WASH systems are fundamental to achieving equity in education and fulfilling the principles of the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education) and SDG 6 (Clean Water and Sanitation). Evidence from multiple countries shows that deficiencies in menstrual hygiene management (MHM) and the lack of inclusive infrastructure disproportionately affect female students and learners with disabilities, contributing to absenteeism, stigma, and educational disadvantage.

In Ghana, Akanzum and Pienaah (2023) found that inadequate access to sanitary facilities significantly undermined girls' school attendance, especially during menstruation. The study revealed that schools with gender-segregated toilets and menstrual hygiene materials recorded lower absenteeism rates, underscoring the critical role of gender-responsive WASH planning. Similarly, Jovanović *et al.* (2022) in Serbia reported that limited menstrual hygiene management (MHM) facilities led to discomfort and absenteeism among girls, reflecting the broader consequences of poor sanitation design on gender equity in education.

Beyond gender, inclusiveness for learners with disabilities remains a largely neglected component of school WASH policy. Azupogo *et al.* (2023) and Dassah and Bisung (2023) observed that most schools lack accessible infrastructure, such as ramps, handrails, and widened toilet cubicles, thus excluding students with physical disabilities from fully participating in school life. In line with these observations, Wilbur *et al.* (2024) advocated for disability-inclusive WASH approaches that integrate accessibility standards into school construction and policy planning. The study emphasized that without deliberate design for inclusiveness, WASH interventions risk perpetuating systemic inequality and violating children's rights to safe learning environments.

Table 3: Summary of Reviewed Studies on Gender and Inclusiveness Factors in School WASH

Author(s) & Year	Country/Region	Focus Area	Key Findings	Policy/Practice Implications
Akanzum & Pienaah (2023)	Ghana	Gender (MHM)	Limited access to menstrual facilities caused absenteeism among girls; schools with segregated toilets showed reduced absenteeism.	Need for gender-segregated toilets and provision of sanitary materials in schools.
Jovanović *et al.* (2022)	Serbia (rural)	Gender (MHM)	Lack of menstrual hygiene facilities led to discomfort and absenteeism	Prioritize menstrual hygiene management in rural school WASH design
Azupogo *et al.* (2023)	Ghana	Disability Inclusion	Absence of ramps, handrails, and accessible toilets limited the participation of students with disabilities	Integrate accessibility standards in school WASH policies.
Dassah & Bisung (2023)	Sub-Saharan Africa (multi-country)	Disability Inclusion	Limited institutional commitment to inclusive WASH for disabled learners	Promote inclusive WASH budgeting and disability audits
Wilbur *et al.* (2024)	Global	Gender & Disability	Advocated for disability- and gender-inclusive WASH to achieve SDG 4 and SDG 6	Mainstream inclusive WASH design and monitoring into global education policies

Source: Author's Work, 2023

Comparative Analysis of Gender and Inclusiveness in School WASH Systems

Across the reviewed studies, three interrelated themes consistently emerge regarding gender and inclusiveness in school WASH systems. First, menstrual hygiene management (MHM) remains inadequately addressed in most public schools, particularly in rural and low-income regions. Second, disability inclusion is frequently neglected, as many schools lack the necessary infrastructural adaptations, such as ramps, handrails, or accessible toilets, to accommodate students with physical impairments. Third, weak institutional oversight and policy enforcement continue to impede progress, especially in Sub-Saharan Africa and parts of Eastern Europe.

Despite these commonalities, regional variations exist. In Ghana and Serbia, menstrual hygiene challenges dominate the discourse on gender inclusiveness, reflecting stronger advocacy and policy attention to girls' needs (Akanzum & Pienaah, 2023; Jovanović *et al.*, 2022). Conversely, in broader Sub-Saharan contexts, discussions have expanded to include disability inclusiveness as a core concern in achieving equitable education (Dassah & Bisung, 2023; Wilbur *et al.*, 2024). These variations are shaped by differences in policy maturity, socio-cultural norms, and the extent of advocacy by governmental and non-governmental actors. The similarities observed, particularly high absenteeism among girls during menstruation and persistent exclusion of learners with

disabilities, indicate systemic neglect of inclusiveness in WASH planning. Differences, however, reflect the uneven integration of gender-sensitive and disability-inclusive standards within national education frameworks, as well as varying levels of enforcement and cultural openness toward menstrual and disability-related issues.

The synthesis of findings demonstrates that gender and inclusiveness remain underdeveloped dimensions of school WASH programs. Persistent inadequacies in menstrual hygiene management facilities continue to hinder female students' participation and academic performance, while inaccessible infrastructure systematically marginalizes learners with disabilities. These patterns affirm that equitable WASH implementation must integrate both gender and disability considerations into planning, monitoring, and policy frameworks. Without such integration, the goal of inclusive education and equitable access, as envisioned in the Sustainable Development Goals, will remain unattainable.

Health Impacts of WASH Deficiencies in Schools

Empirical evidence across global studies consistently demonstrates that inadequate WASH infrastructure poses significant health risks to school-aged children. Adhikari *et al.* (2023) highlighted that poorly designed and inadequately maintained latrines expose students to microbial contamination, particularly in schools lacking regular cleaning and safe waste disposal systems (Table 4). In Brazil, Poague *et al*. (2022, 2023, 2024) examined the influence of WASH facilities during the COVID-19 pandemic, revealing that schools with improved hygiene infrastructure experienced lower transmission rates. Nonetheless, their longitudinal study also revealed persistent inequalities in WASH access, disproportionately affecting marginalized communities and limiting the broader public health benefits of these interventions. Ahmed *et al*. (2020) conducted a quantitative microbial risk assessment in Pakistan, identifying a strong correlation between unsafe drinking water and the prevalence of waterborne diseases among schoolchildren. Similarly, Sang *et al.* (2023) found that improved access to safe water in Kenyan schools significantly reduced absenteeism by lowering illness incidence, thereby strengthening the link between health and academic outcomes. In Mozambique and Uganda, Morgan *et al.* (2021) demonstrated that contamination of stored drinking water was primarily due to poor storage practices, inadequate sanitation infrastructure, and unhygienic behaviors, which reintroduced microbial risks even when the initial water source was safe.

Furthermore, Mela Danjin *et al.* (2021) established a direct relationship between poor WASH conditions and child malnutrition in Gombe State, Nigeria (Table 4). Their findings revealed that limited access to clean water and sanitation not only contributes to frequent illness but also exacerbates nutritional deficiencies and learning challenges. Collectively, these studies illustrate that insufficient WASH in schools undermines child health, learning, and overall well-being, reinforcing the argument that health-promoting environments are integral to educational success.

Table 4: Summary of Health Impacts of Inadequate WASH Facilities in Schools

Author(s) and Year	Country/Region	Health Issue Identified	Key Findings	Implications
Adhikari *et al.* (2023)	Nepal (Global context)	Microbial exposure from latrines	Poor sanitation design and maintenance increase infection risks	Highlights the need for sanitation standards and regular maintenance
Poague *et al.* (2022–2024)	Brazil	Disease transmission (COVID-19)	Improved WASH reduces transmission, but disparities persist	Equity-focused WASH investments improve pandemic resilience
Ahmed *et al.* (2020)	Pakistan	Waterborne diseases	Unsafe water quality is strongly correlated with illness	Safe water monitoring and treatment are essential
Sang *et al.* (2023)	Kenya	Student absenteeism and illness	Safe water access lowers absenteeism	WASH improves academic performance and attendance
Morgan *et al.* (2021)	Mozambique & Uganda	Microbial contamination in stored water	Poor storage and hygiene reintroduce risks	Behavioral and infrastructural interventions are needed
Mela Danjin *et al*. (2021)	Nigeria (Gombe State)	Child malnutrition and illness	Poor WASH contributes to disease and undernutrition	Integrating WASH with school health programs is essential

Source: Author's Work, 2023

Comparative Analysis of Health Impacts of WASH Deficiencies in Schools

Across the reviewed studies, consistent evidence indicates that inadequate WASH facilities in schools lead to increased disease burden, absenteeism, and nutritional deficits among students. The similarity in outcomes across diverse contexts ranging from Africa to South Asia and Latin America reflects the universal nature of WASH-related health risks and the shared challenges of poor infrastructure, limited funding, and weak maintenance systems.

However, notable regional differences exist. In Brazil, the health focus is largely shaped by pandemic preparedness and response (Poague *et al.,* 2022–2024), while in African contexts such as Kenya and Nigeria, attention centers on infectious diseases and malnutrition (Sang *et al.,* 2023; Mela Danjin *et al.,* 2021). South Asian studies, particularly from Pakistan and Nepal, emphasize microbial contamination due to infrastructural deficits and inadequate monitoring (Adhikari *et al.,* 2023; Ahmed *et al.,* 2020). These variations can be attributed to differing climatic conditions, policy enforcement levels, and health system capacities across regions.

Evidence reveals that WASH deficiencies in schools constitute a major public health concern, directly influencing student health, attendance, and educational outcomes. Although regional emphases differ, the underlying determinants of poor sanitation design, unsafe water storage, and weak institutional oversight remain consistent. Strengthening WASH infrastructure, integrating health education, and implementing rigorous monitoring

frameworks are therefore essential for reducing disease risks and achieving Sustainable Development Goals (SDG 3 and SDG 6) related to health and clean water access.

Policy and Institutional Support

Despite global advocacy, institutional commitment to school WASH remains uneven. WHO/UNICEF (2020a, 2020b) set global benchmarks for WASH in schools, especially during the COVID-19 pandemic, but many countries lack mechanisms to monitor compliance. Chirgwin *et al*. (2021) noted gaps in implementation research and stressed the need for context-specific WASH strategies. Okello (2023), in his Ugandan case study, observed that even when WASH infrastructure is installed, functionality is often compromised due to weak maintenance and oversight structures. Pereira *et al*. (2024) echoed this concern, advocating for rights-based, sustainable, and participatory WASH governance in schools. Eshun (2023) provided a human-centred perspective by documenting the psychological and physical effects of water insecurity on female students in Ghana, reinforcing the need for responsive policy mechanisms that go beyond infrastructure to address lived experiences. The study by Godana, Esho, and Karama (2020) evaluates the implementation of Kenya's national COVID-19 hygiene and sanitation guidelines in primary schools within Marsabit County. The findings reveal significant gaps in the availability and functionality of essential WASH facilities, including inadequate access to clean water, soap, and gender-segregated toilets. Despite national directives, many schools lacked the resources and infrastructure to meet basic hygiene standards, compromising efforts to prevent disease transmission during the pandemic. The study highlights the critical need for targeted investments, capacity building, and monitoring mechanisms to ensure compliance and sustainability of school hygiene and sanitation practices, particularly in underserved regions.WASH Conceptual Framework for Secondary Schools in Developing Countries

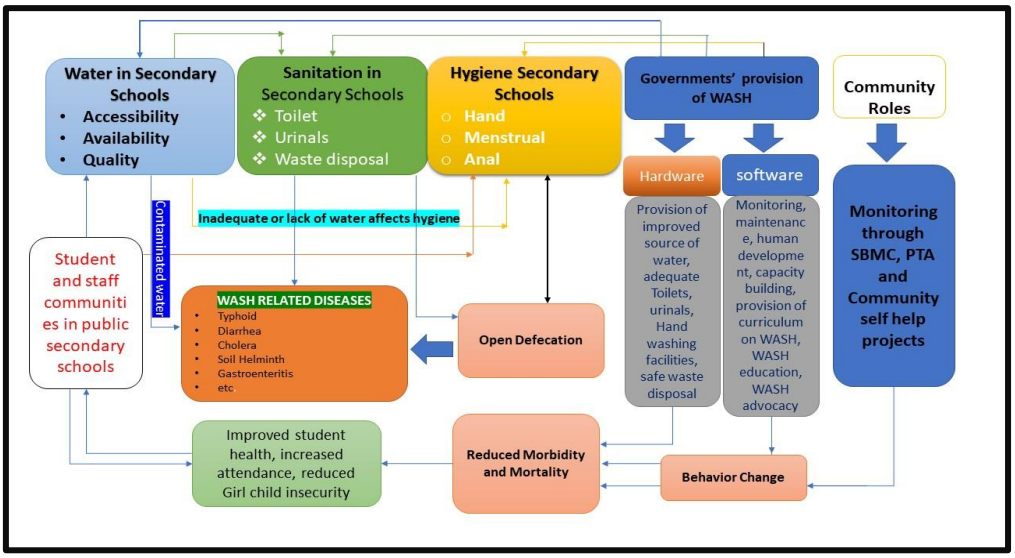

Figure 1: Conceptual Framework for WINS
Source: Author's Work (2023)

The conceptual framework in Figure 1 provides a comprehensive visual synthesis of the interrelated factors influencing Water, Sanitation, and Hygiene (WASH) systems in public secondary schools. Drawing on insights from the literature review, it reflects how infrastructure, institutional responsibilities, behavioural practices, community involvement, and health outcomes interact to shape the effectiveness of WASH services in school environments.

At the core of the framework are the three main pillars of school WASH systems - Water, Sanitation, and Hygiene. These elements are essential and must be addressed comprehensively to promote positive health and educational outcomes. Water is recognised as a vital resource, emphasising its accessibility, availability, and quality. The literature strongly supports this, with Ahmed *et al.* (2020) illustrating how inadequate or contaminated water sources increase the risk of waterborne illnesses such as typhoid and diarrhoea. Sanitation, which involves providing functional toilets, urinals, and safe waste disposal methods, is crucial for maintaining a healthy school environment. Studies by Phoju *et al*. (2021) and Adhikari *et al.* (2023) show that insufficient or poorly maintained sanitation facilities encourage open defecation and the spread of infectious diseases. Hygiene practices, including hand hygiene, menstrual hygiene, and anal cleansing, are equally important. Mushota *et al.* (2021) and Jovanović *et al*. (2022) highlight that poor hygiene habits can harm student health, especially affecting girls and students with disabilities. An important link within the framework underscores that a lack of water supply renders hygiene infrastructure unusable, as confirmed by Ashu *et al.* (2021) and Otto *et al*. (2022).

The role of government is framed through a dual lens of hardware and software provision. Hardware represents tangible infrastructure investments such as improved water sources, toilets, urinals, and handwashing stations. Software, on the other hand, involves the non-physical but equally essential components: capacity building, WASH curriculum integration, teacher training, system monitoring, and maintenance. This dual strategy aligns with WHO/UNICEF (2020a) and Chirgwin *et al*. (2021), who advocate for an integrated approach that addresses both physical infrastructure and the behavioural change needed for long-term impact.

Equally vital is the role of community stakeholders. The framework includes the involvement of School-Based Management Committees (SBMCs), Parent-Teacher Associations (PTAs), and community self-help initiatives as mechanisms to ensure local monitoring, ownership, and

accountability. The literature, particularly Wilbur *et al*. (2024) and Pereira *et al*. (2024), underscores the value of inclusive community engagement, noting that such participatory approaches lead to more sustainable and context-specific WASH outcomes.

Health outcomes are central to the framework. It illustrates how contaminated water and poor sanitation facilities contribute to a cycle of disease transmission, with consequences such as diarrhoea, cholera, typhoid, and soil-transmitted helminth infections. These health issues, in turn, result in open defecation, increased school absenteeism, and heightened vulnerability among female students findings consistent with those of Ahmed *et al*. (2020), Mela Danjin *et al*. (2021), and Akanzum and Pienaah (2023). Conversely, the presence of functional WASH systems facilitates behaviour change and leads to improved health indicators, reduced morbidity and mortality, and better school attendance, as reported by Sang *et al*. (2023) and Winter et al. (2021). At the core of the entire framework is a systems thinking approach. This view recognises that WASH challenges in schools are not separate issues but are part of a larger system of interconnected factors. Infrastructure alone cannot achieve results without the support of institutional policies, community accountability, and ongoing behavioural changes. This interconnectedness reflects the conceptual integration described in Chirgwin *et al.* (2021) and Wilbur *et al*. (2024), who emphasise the need for multi-sectoral and coordinated WASH efforts.

CONCLUSION

This review emphasizes that adequate Water, Sanitation, and Hygiene (WASH) facilities are vital for students' health, attendance, and learning. Despite growing global focus, especially after COVID-19, many schools in developing countries still face inadequate infrastructure, weak maintenance, and limited inclusiveness. Poor hygiene practices persist due to insufficient education and institutional oversight. Gender and disability gaps remain critical, with inadequate menstrual hygiene facilities and inaccessible toilets limiting participation. Health impacts, such as illness and absenteeism, further highlight the urgency for action. Achieving sustainable improvement requires integrated approaches combining infrastructure, behavior change, inclusiveness, and monitoring. Ultimately, school WASH must be recognized as essential to equity, health, and education, aligning with Sustainable Development Goals (SDGs) 3, 4, 5, and 6.

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