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Environmental Health Determinants of School WASH Programs: Epidemiological Indicators Among Learners in Rural and Urban Informal Settlements in Kenya

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Abstract

Substandard Water, Sanitation, and Hygiene (WASH) infrastructure in learning institutions remains a environmental health challenge in developing nations. In Kenya, schools situated within resource challenged rural areas and urban informal settlements present built environments that alter biological exposure pathways, yet comparative evaluations of their specific health and educational tolls remain fragmented. This paper review systematically examined how physical infrastructure quality serves as a determinant for epidemiological indicators among learners in rural and urban informal settlements in Kenya. The study was anchored within the macro-level Eco-Epidemiological Model and F-Diagram of Pathogen Transmission. Following the PRISMA 2020 statement, a review protocol was executed across major electronic databases (including PubMed, CINAHL Plus, Embase, Web of Science, Scopus, Global Health, and Environment Complete) and grey literature repositories. The findings were anlysed using descriptive numerical summary and a narrative thematic analysis. The initial search identified 1,156 database publications and 31 grey literature articles. Following secondary title/abstract screening (n=187), full-text (n=52), and bibliography snowballing (n=4), a final yield of 56 studies spanning 19 Kenyan counties was synthesized. Rural schools confront severe geographic water scarcity and high microbiological contamination while urban informal settlements face extreme structural stress, with student-to-toilet ratios exceeding 100:1 and drainage overflows that increase ambient fecal contamination around schools. In both, rainy seasons and flooding trigger waste system failures and spike acute watery diarrhea outbreaks. Nationwide, poor water quality and broken hand hygiene drive gastrointestinal morbidity, while Soil-Transmitted Helminthiases (STH) show a prevalence of up to 44.05% in high-burden regions like Kakamega. Although deworming and footwear have controlled the foot-to-soil hookworm pathway, the fecal-oral pathway remains dominant, marked by high *Ascaris lumbricoides* intensity.

In water-scarce zones, restricted water volumes prevent routine washing, leading to highly prevalent dermatological and ocular infections like scabies and trachoma. This biological toll maps directly onto educational registers, as helminthic and diarrheal infections heavily correlate with absenteeism (r=0.7523). These attendance deficits intersect with nutrition, where inconsistent school feeding programs exacerbate drops in student retention. The infrastructure deficits drive severe gender-specific impacts: adolescent girls lose up to 60 school days annually due to menstruation because roughly half of the schools lack menstrual waste disposal or water inside cubicles, and student-to-toilet ratios in ASAL areas reach up to 97:1. This violates privacy, causes stigma, and accelerates permanent dropout pathways through teenage pregnancies. The review demonstrates that school WASH facilities function as key environmental health determinants rather than mere educational amenities. To break the cycle of morbidity and absenteeism, interventions must shift from generic provisioning toward climate-resilient environmental engineering and robust local maintenance systems. It is recommended that the Kenyan Government and partners implement context-specific strategies such as water backpacks and sand dams in rural regions, and container-based sanitation with private maintenance contracts in informal settlements while coupling hardware installations with ring-fenced financing, disability-inclusive designs, and dedicated Menstrual Hygiene Management (MHM) curricula.

Keywords: Environmental health determinants, school wash, epidemiological indicators, learner, absenteeism, informal settlements, rural Kenya

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Introduction

Access to safe Water, Sanitation, and Hygiene (WASH) in institutional settings is globally recognized as key for sustainable development, directly intersecting with United Nations Sustainable Development Goals (SDGs) 6 (Clean Water and Sanitation) and 4 (Quality Education) (Okesanya et al., 2024;

John & Ajibade, 2024. Beyond functioning as mere educational amenities or passive physical infrastructure, contemporary environmental health paradigms define school WASH programs as engineered barriers designed to interrupt pathogenic exposure pathways within pediatric populations (Anderson et al., 2022). These programs include the comprehensive provisioning of chemically and microbiologically safe drinking water, structurally sound sanitation facilities, functional handwashing infrastructure, and regular hygiene education (Alhassan, 2025; McMichael, 2019; Souza, Santos & Lisboa, 2025). When properly implemented, these interventions serve as primary structural mitigations against infectious disease transmission, creating a conducive environment that promotes the overall biological well-being and academic performance of learners (McMichael, 2019).

In low- and middle-income countries, the school environment functions as a high-density micro-ecosystem where children spend a significant portion of their formative years. When this built environment is compromised by deficient WASH infrastructure, it transitions from a protective sanctuary of literacy into an active reservoir for environmental hazards and microbial exposure (McMichael, 2019). Historically, macro-level evaluations of school health have overlooked the unique, setting-specific environmental and structural drivers that dictate how these exposures occur. Within Sub-Saharan Africa, and uniquely within Kenya, the physical topography of learning institutions is heavily stratified by geographic, socioeconomic, and structural topography. Despite extensive policy frameworks initiated by the Kenyan Ministry of Education and Ministry of Health such as the National School Health Policy substantial gaps in structural integrity, climate resilience, and operational functionality persist. These infrastructural deficits are most acutely felt within two marginalized and contrasting landscapes: rural communities and urban informal settlements (slums).

The environmental health determinants shaping school WASH effectiveness differ fundamentally between these two settlement contexts. In rural Kenyan communities, geographic isolation, highly vulnerable or unreliable water sources, long collection distances, and seasonal climatic shocks frequently culminate in absolute water scarcity. Schools in these arid and semi-arid lands (ASAL) or high-density agricultural zones often rely heavily on unprotected shallow wells, seasonal rivers, or roof catchments (REACH & UNICEF, 2024). This absolute scarcity forces schools to ration water, leaving handwashing stations dry and latrines uncleaned (REACH & UNICEF, 2024). Conversely, schools situated within urban informal settlements contend with intense spatial constraints, rapid population influxes, and an absolute lack of formal municipal planning. This results in extreme over-utilization of facilities that vastly violates standard student-to-latrine ratios (National Gender and Equality Commission [NGEC] Education Report, 2025; Wangari et al., 2021). Furthermore, poor localized drainage systems, unstable community waste infrastructure, and widespread ambient contamination mean that school water and sanitation facilities are routinely exposed to flooding, latrine overflows, and structural cross-contamination from adjacent open drainage channels filled with raw municipal waste (Lebu et al., 2024; Makau, 2024).

These distinct environmental flaws trigger specific biological exposure pathways that can be measured through clear epidemiological indicators. Determinants such as poor water quality, unlined sanitation infrastructure, deficient waste management, overcrowding, and lack of handwashing supplies directly accelerate the transmission of enteric, parasitic, and respiratory pathogens (Makau, 2024; Wangari et al., 2021). Epidemiological metrics such as prevalence of diarrhea, provide objective, biological evidence of the health burdens borne by school-age children due to inadequate WASH barriers. High contamination of school environments and adjacent water sources with fecal indicator bacteria serves as a primary driver of gastrointestinal morbidity, yet the WHO and UNICEF Joint Monitoring Programme (2023) confirmed that only a minority of Kenyan schools meet safely managed sanitation standards. Concurrently, vector and soil dynamics such as unpaved classrooms, earthen schoolyards, and fly-breeding in traditional unlined pit latrines perpetuate the lifecycle of parasites like *Ascaris lumbricoides* and protozoan pathogens like *Giardia lamblia* or *Entamoeba histolytica* (Mbae et al., 2024; Mwaniki et al., 2017; Njenga et al., 2014; REACH & UNICEF, 2024). Frequent exposure to these environmental hazards induces a cyclical disease burden that disrupts early childhood development and compromises the immune systems of these vulnerable student cohorts.

Hence, this biological toll maps directly onto learner attendance patterns, transforming a physical environmental crisis into an educational deficit. School absenteeism often serves as a proxy indicator for underlying environmental health challenges. In the Kenyan context, frequent illness-induced absences disrupt learning continuity, lower academic achievement, and elevate long-term school dropout rates (King et al., 2020; Mwenji et al., 2025)., empirical evidence demonstrates that the qualitative indicators of sanitation infrastructure specifically cleanliness, safety, and usability exhibit a far stronger statistical association with regular school attendance than the mere numerical presence of facilities (Nyamai, 2022; Wangari et al., 2021). Furthermore, this biological toll intersects with nutrition and structural support insecurity, where instability or structural shortfalls in school feeding programs and water access significantly compound illness-related absenteeism and drops in student retention (Omari et al. 2024; Nyamai, 2022; Office of the Auditor-General Kenya, 2023).

This impact is also heavily gendered; adolescent girls are disproportionately affected when school latrines fail to provide privacy, internal locks, running water, and proper waste disposal mechanisms (Mokaya, 2023; Mutegi et al., 2023; Onyango et al., 2024). Inadequate Menstrual Hygiene Management (MHM) resources and substandard infrastructure cause acute hygiene stress, peer ridicule, and stigma, forcing girls to miss multiple school days per menstrual cycle (Sanyanda et al., 2026; Ombogo, 2023)). Cumulatively, these deficits drive wider gender disparities in enrollment and retention, particularly in regions where structural barriers are exacerbated by severe pupil-to-toilet overloads, high rates of teenage pregnancy, and heightened safety concerns during environmental disasters like flooding (Lebu et al., 2024; NGEC Education Report, 2025).

Despite substantial investments from the Government of Kenya, development partners, and non-governmental organizations, significant gaps remain in our systemic understanding of how these environmental health determinants drive epidemiological and educational outcomes across different settlement types. Existing literature remains fragmented, frequently tracking health metrics, parasitic infection intensities, or pedagogical variables in isolation while offering minimal comparative analysis between rural and urban informal school environments. Without a comprehensive synthesis of these dual realities, the precise linkages within the environment-health-attendance pathway remain obscured. This paper review addresses this gap by synthesizing current empirical evidence to establish how distinct school WASH environments influence disease occurrence and learner attendance across diverse Kenyan settings, providing public health engineers and policymakers with the data necessary to design targeted, setting-specific structural interventions.

Theoretical Framework

The Eco-Epidemiological Model serves as the macro-level structural framework for this review by conceptualizing the school environment as a multi-layered ecosystem where physical infrastructure, geographic realities, and human biology interact. Originally developed by Susser and Susser (1996) to transcend purely individualistic biomedical models, this framework provides the capacity to analyze how complex, nested macro-environmental determinants shape pathogen eco-epidemiological dynamics and population-level health trends (Occhibove et al., 2022). In the context of this study, the model is applied to treat the school not merely as an educational facility, but as a specific micro-ecosystem where spatial and geographic conditions directly dictate exposure risks. In rural Kenyan settings, the dominant eco-epidemiological drivers stem from absolute water scarcity and unprotected source ecology, whereas in urban informal settlements, the drivers shift to severe spatial overload and a lack of municipal infrastructure. Hence applying this model, the review systematically maps how these distinct physical settings alter the structural quality of school WASH programs, thereby generating setting-specific epidemiological indicators and subsequent absenteeism patterns across marginalized landscapes.

The F-Diagram of Pathogen Transmission provides the micro-level mechanistic framework for this study, mapping the precise environmental routes through which infectious agents move from environmental reservoirs to student hosts. Historically formalized by Wagner and Lanoix (1958) to illustrate fecal-oral transmission pathways, this classical public health engineering diagram focuses on five primary vectors: Fingers, Flies, Fields, Fluids, and Food (Stein & Chirilă, 2017). This model is applied to isolate exactly how specific failures in school WASH infrastructure break down critical environmental health barriers designed to protect public health (Phillips, 2025). For example, dry handwashing stations in rural schools unlock the "Fingers" and "Food" pathways during school meals, while cracked or submerged water pipes in urban slums allow sewage from external drainage to infiltrate drinking "Fluids" (Jensen et al., 2023). By utilizing the F-diagram, this review mechanically demonstrates how deficient physical infrastructure functions as a broken environmental barrier, failing to interrupt pathogen flows and directly transforming structural neglect into measurable clinical outcomes, such as acute watery diarrhea and soil-transmitted helminthiases (Duflo et al., 2015).

Methodology

This systematic review was conducted in accordance with the PRISMA 2020 statement. A review protocol was developed *a priori*, utilizing an iterative three-phase search strategy designed in collaboration with a health sciences research librarian. Following an initial pilot search in PubMed and CINAHL, comprehensive searches were systematically executed across PubMed, CINAHL Plus, Embase, Web of Science, Scopus, Global Health, and Environment Complete. The search strings combined controlled vocabulary (such as MeSH terms) and free-text terms covering "school WASH," "environmental health," "epidemiological indicators," "learner attendance," and "Kenya." Supplementary searches included citation tracking and screening grey literature from UNICEF Kenya, the World Health Organization (WHO), the World Bank, the African Journals Online (AJOL) repository, and the Kenyan Ministries of Health and Education. The search was restricted to studies published in English or with available English translations.

Study eligibility was governed by the Population, Concept, and Context (PCC) framework. The population comprised primary and secondary school learners in Kenya. The core concept included school-based WASH programs and environmental health determinants including water quality, sanitation infrastructure, and hygiene behavior alongside their subsequent effects on epidemiological health indicators and classroom attendance. The context was restricted strictly to rural areas and urban informal settlements within Kenya. Eligible study designs included primary empirical data from observational (cross-sectional, cohort, case-control), quasi-experimental, and mixed-methods designs. Editorials, purely qualitative studies, or studies focusing on non-school community settings were excluded.

Title, abstract, and full-text screening were conducted independently by two reviewers with a third reviewer arbitrating any disagreements. A 50-record pilot screening was performed initially to calibrate reviewer agreement. Data were then extracted into a piloted Microsoft Excel charting form to capture study characteristics, participant demographics, environmental health determinants. Data was synthesized using narrative thematic analysis.

Results and Discussion

Yielded Studies

The initial search terms identified 1,156 publications across several databases. An additional 31 articles were identified from grey literature. The secondary screening based on title and abstract identified 187 articles. Following full-text screening against the Population-Concept-Context eligibility criteria, 52 articles met the inclusion criteria and were retained for data extraction and synthesis.

The geographic distribution of included studies spanned 19 Kenyan counties, with concentrated representation from Nairobi (Kibera, Mathare, Korogocho, Viwandani, Mukuru), Kakamega, Kilifi, Kisumu, Baringo, Turkana, Garissa, Isiolo, Uasin Gishu, Kiambu, Tharaka Nithi, Kitui, Laikipia, Kirinyaga, Narok, and Bomet. Bibliographies of these references identified 4 additional articles that had been missed in the initial database search, bringing the final yield to 56 studies included in the review.

Characterization of School WASH Environments: Rural vs. Urban Informal Settlements

Rural School Environments and Environmental Drivers

In rural areas in Kenya, the primary environmental challenge identified is geographic water scarcity and source vulnerability. The REACH and UNICEF (2024) assessment of 732 schools in Garissa and Turkana Counties documented that communities faced diverse priority WASH needs requiring tailored responses, with prolonged drought from 2021 to 2023 and floods from October 2023 to May 2024 significantly impacting WASH infrastructure. Schools in these ASAL regions relied heavily on unprotected shallow wells, seasonal rivers, or roof catchments, and water scarcity forced trade-offs where available water was allocated for drinking, leaving handwashing stations dry. This finding aligned with the Kenya WASH in Schools Strategy 2024–2029, which documented that approximately 85% of rural schools lacked handwashing services and 50% had limited sanitation, while an estimated 25% of rural primary schools lacked adequate water facilities entirely (Ministry of Health, Kenya, 2024).

The microbiological quality of these water sources posed severe environmental health risks. Wambua et al. (2022) evaluated 60 surface and groundwater samples from four administrative units in Isiolo County and found that all sources were highly contaminated, exceeding Kenyan and WHO standards. The highest mean *Clostridium perfringens* counts reached 1,452 Cfu/ml in groundwater and 3,421 Cfu/ml in surface water, while *Escherichia coli* and coliforms contamination accounted for 29.88% and 88.2% of samples respectively. Shallow wells showed the highest mean coliform counts at 5,185 Cfu/ml, and springs recorded *C. perfringens* at 8,177 Cfu/ml. Rainwater which might be presumed safe had the highest *E. coli* count at 160 Cfu/ml. Total coliforms had a significant negative relationship with residual chlorine ($r = -0.76$), indicating that inadequate disinfection was a primary driver of contamination. These findings established that rural school water sources functioned as environmental reservoirs for enteric pathogens, with seasonal fluctuations exacerbating exposure risks.

Kirira et al. (2023) also conducted qualitative multisectoral research in Laikipia County and documented that schools in semi-arid areas had no piped water; pupils fetched water from nearby wells or springs using water backpacks. During drought, schools purchased water to meet sustenance needs. The study found an association of diarrhea outbreaks with unsafe hygiene practices compounded by water scarcity, and evidence indicated the applicability of water backpacks in strengthening handwashing, storage, and transport of water. Quantitative data from the program indicated that 91% of pupils took water from the backpack daily, and up to a 45% drop in absenteeism was reported, demonstrating that even modest water access interventions could yield significant attendance benefits in water-scarce rural settings.

Similarly, Njeru, Juma et al. (2023) assessed 219 public primary schools in Tharaka Nithi County and found that 78.1% were day schools, 47.5% had less than five toilets for boys, and 41.1% had between five and ten toilets for girls. Only 51.1% had water available for handwashing outside latrines, and 62.1% had drains but 53.6% of these were open. Stagnant water was observed in 45.7% of school compounds, 51.6% lacked composite pits, and only 58% of latrines were clean. The study concluded that schools lacked sanitary facilities, water, soap, and protective clothing, leading to poor sanitation levels and risk of disease outbreaks like cholera. Regression analysis showed that functional, regularly maintained water systems significantly predicted water availability for handwashing outside toilets ($p<0.05$), highlighting the critical role of maintenance in sustaining WASH services.

Vector and soil dynamics further compounded the environmental health burden in rural schools. The REACH and UNICEF (2024) assessment documented that unpaved classrooms and earthen schoolyards, coupled with traditional unlined pit latrines lacking proper structural concrete slabs, created ideal environmental reservoirs for soil-transmitted pathogens. The Ministry of Health, Kenya (2024) reported that water facilities in Kenyan schools had a 35% non-functionality rate within three years of commissioning, indicating that infrastructure deterioration was rapid and required sustained operational maintenance rather than one-time capital investment. The latrine ratio in rural areas stood at one toilet to 29 girls and one to 34 boys, approaching but still failing to meet national standards of 1:25 for girls and 1:30 for boys. The Three-Star Approach established in the national strategy ranging from Zero Star (no functional services) to Three Star (comprehensive services including menstrual hygiene management products, disability-friendly facilities, and 2.5 litres of treated water per child per day) provided a framework for incremental improvement, yet rural schools predominantly clustered at the lower tiers.

Seroney et al. (2025) assessed 51 primary schools in Uasin Gishu County and found that 61% had piped water, 49% relied on protected wells, and 24% collected rainwater. However, 73% lacked disability-friendly infrastructure, 67% reported water for handwashing yet 59% lacked soap, and 74% of toilets were not clean with feces, urine, and odors commonly present. Private schools outperformed public schools in operation and maintenance, and rural schools had significantly smaller enrollments (mean 369 pupils) compared with urban schools (mean 852 pupils), suggesting that resource constraints were distributed unevenly across the rural-urban continuum. The WHO/UNICEF Joint Monitoring Programme (2023) confirmed that many Kenyan schools had achieved basic water services, but large gaps remained in handwashing services with soap and safely managed sanitation, with rural schools consistently lagging behind urban schools.

Seroney (2026) subsequently convened 20 experts who reached strong consensus (means 4.5–4.8 on a 5-point scale, 95–100% endorsement) that multi-sectoral governance, ring-fenced financing, reliable water supply, upgraded inclusive sanitation, and robust menstrual health management systems were priority components for strengthening school WASH implementation. All experts agreed (100%) that newly established schools should have ramps and disability-appropriate sanitation facilities, and 95% agreed on employing staff specifically for sanitation facility cleanliness. The Kenya Institute of Curriculum Development (2023) similarly identified inadequate water supply, overcrowded sanitation facilities, and poor maintenance as barriers to healthy learning environments in public schools implementing the Competency-Based Curriculum.

Urban Informal Settlement School Environments and Structural Stress

In contrast to the geographic challenges of rural settings, schools within urban informal settlements face severe spatial constraints and structural overloads that generate distinct environmental health risks. The student-to-toilet ratios in these settlements frequently exceed 100:1, vastly violating the Ministry of Education standards of 1:30 for boys and 1:25 for girls. In Mathare Sub-County, an examination of 68 Early Childhood Development Education centers by Mwangi and Ndani (2022) revealed that while all schools possessed functional handwashing facilities, most Alternative Providers of Basic Education and Training (APBET) schools had only a single station that lacked soap most of the time. Furthermore, while public schools provided handwashing and anal cleansing materials, these assets served teachers and staff alone; consequently, more than 50% of the schools maintained toilets in pathetic conditions, with only nine centers meeting quality standards due to overcrowding and poor maintenance. This structural overcrowding directly amplifies fecal-oral transmission pathways. An assessment of 342 pupils across 20 primary schools in Mathare by Wangari et al. (2021) determined that a pupil-to-toilet ratio above 1:25 was the single strongest predictor of student morbidity (Exp B=3715.8, p=0.000), followed by pupils not washing hands with soap (Exp B=810.9, p=0.003) and water unavailability in school (Exp B=47.9, p=0.008). These findings indicated that structural overcrowding of sanitation facilities created conditions where personal hygiene was practically impossible to maintain, amplifying fecal-oral transmission pathways.

Congestion and shared infrastructure system constraints are widespread across these built environments. Spatial inequality assessments in Kibera and Mathare by Kim et al. (2022) revealed that 77.4% of the Kibera population and 60.6% of the Mathare population experienced highly limited WASH access. This institutional restriction manifests as high reliance on unsafe shared water points and open drainage systems, where negative pressure within the piping networks routinely draws external pathogens directly into drinking water supplies. Fecal-oral cross-contamination is further exacerbated because municipal water lines are frequently routed directly through open drainage trenches containing graywater and raw sewage, as documented by Mutua et al. (2024). Microbiological evaluations in Kibera by Omondi et al. (2025) confirmed this vulnerability; while 72.2% of local water sources were linked to the public supply and 65.3% utilized chlorination, 30.6% of samples remained completely untreated, nearly one-third tested positive for *Escherichia coli*, and sewage pollution actively exposed 50% of all sampled sources. Spatial mapping of WASH accessibility and opportunity by Githaiga et al. (2021) further highlights that only 22.6% of the Kibera population and 39.4% of the Mathare population have adequate access, dropping to a stark 3% in Kambi Muru, 2% in Lindi, and 0% in Soweto East. Large standard deviations across these data points indicate major within-settlement disparities, proving that aggregate statistics obscure extreme localized deprivation.

The physical resilience of sanitation infrastructure under environmental duress introduces an additional layer of structural stress. An infrastructure appraisal of 200 toilets in Kibera by Lebu et al. (2024) documented that 43% were unimproved latrines, 35% were flush toilets connected to septic systems, 35% were flush toilets connected to sewers, 6% were ventilated improved pit (VIP) latrines, and 6% were hanging toilets. Overall, 49% failed to meet improved sanitation criteria, causing catastrophic facility collapses, structural failures, and widespread fecal overflow during flooding events. Fluorescent dye tracking confirmed that microbial contamination spreads unchecked through the community during inundations, severely impacting schools located in active flood zones. These vulnerabilities were heavily exposed during the devastating 2024 floods in Kenya, which claimed approximately 300 lives, displaced an estimated 50,000 families, and entirely overwhelmed informal settlement sanitation systems.

To counter these structural failures, alternative sanitation delivery modalities have been deployed, though not without institutional hurdles. An exploration of container-based sanitation (CBS) implemented by Chumo et al. (2025) in Mukuru Kwa Reuben identified three distinct deployment models by Sanergy commercial (pay-per-use), school (for pupils and teachers), and residential. While Sanergy had successfully leased more than 7,600 toilets across Kenya by February 2024 (primarily within Mukuru), the user fee of five Kenyan shillings (US$0.04) per use for public facilities proved cost-prohibitive for the poorest residents. Furthermore, localized governance barriers persist as landlords routinely prioritize lucrative rental rooms over sanitation space, leaving non-state actors, cartels, and manual pit emptiers to operate within a fragmented sanitation regime characterized by minimal local government oversight.

Solid waste management deficits further compound these environmental health hazards. Investigations of NGO-supported sanitation initiatives in Mathare by Makau (2024) revealed that poor waste disposal systems actively undermine structural investments, as overflowing waste and weak drainage create conditions where ambient environmental contamination around schools is persistent rather than episodic. The 2024 floods and subsequent demolitions severely worsened these dynamics by shifting or destroying waste-related community-based organization structures, wiping out local waste-related livelihoods, and causing a rapid mushrooming of informal dumpsites adjacent to learning institutions. These institutional deficits begin at the earliest stages of the educational pipeline; a survey of 77 childcare centers in Korogocho and Viwandani by Mwangi et al. (2024)—where close to 70% of centers enrolled between 10 and 25 children—found severe WASH service deficits. Because the vast majority of these centers are home-based or informal rather than center-based or attached to formal primary schools, they lack proper social accountability mechanisms, creating a weak quality assurance baseline for children entering the primary school system.

This combination of poverty-linked WASH stressors and structural overcrowding maps directly onto educational outcomes. In Kibera and Mathare, an examination of school-support mechanisms by Nyamai (2022) demonstrated that the structural withdrawal of school-feeding programs caused an immediate enrollment drop of 116 learners, confirming that sanitation deficiencies intersect with acute nutrition insecurity to compound educational disadvantage. To interrupt these pathways, environmental health interventions must combine physical infrastructure with rigorous behavioral and regulatory determinants. In Kiambu County, an evaluation of student hygiene practices by Ndungu et al. (2025) showed that structured hygiene observation, demonstration, and routine inspection were powerfully associated with improved handwashing compliance, yielding adjusted odds ratios ranging from 5.4 to 8.8. Recognizing these dual requirements, the Kenya WASH in Schools Strategy 2024–2029 mandates alternative sanitation delivery modalities like container-based sanitation and private sector service delivery for informal settlements, under the condition that contracts incorporate mandatory maintenance and waste removal services (Ministry of Health, Kenya, 2024).

Large-scale program evaluations demonstrate the profound benefits of combining structural upgrades with targeted hygiene promotion. Between 2023 and 2025, the School Toilet Enhancement Programme (STEP) documented by UNICEF Kenya (2025) benefited over 14,000 students across multiple institutions. At St. Marks Makutano Comprehensive School, the installation of improved sanitation facilities caused student enrollment to jump from 376 to 488 in a single term, alongside a significant drop in student reports of diarrhea and stomach aches. Following these findings, the framework was integrated into a broader national WASH in Schools Programme, successfully scaling safe sanitation access to an additional 113 schools across six counties, reaching 24,382 children. This complements the broader Operation Come-to-School (2015–2023*)* initiative reported by UNICEF Kenya (2024), which enrolled 605,628 out-of-school children with an 89% retention rate, and delivered targeted school WASH services to 196,805 children across 547 schools in 2024 alone. Similarly, the WE REACH WASH Project (2023) in Kakamega County documented marked reductions in student illness and absenteeism across 15 primary schools by implementing a combined framework of improved handwashing facilities, structured hygiene promotion, and robust menstrual health management awareness among learners and teachers. Hence, intervention data from Kamau et al. (2023) in Kibera confirms that combining safe water delivery pipelines with structured behavior change communication effectively reduces diarrheal disease prevalence and breaks the environmental exposure pathways that perpetuate soil-transmitted helminth and protozoan infections among urban school-aged children.

Epidemiological Indicators and Biological Exposure Pathways

The structural failures in school WASH environments documented in the preceding section translated into distinct exposure pathways that drove measurable epidemiological outcomes among learners in Kenya. The evidence base comprised quasi-experimental trials, cross-sectional microbial assessments, longitudinal surveillance data, systematic reviews, and regional comparative studies that collectively established the causal chain from environmental contamination to disease morbidity.

Waterborne and Gastrointestinal Morbidity

1. Fecal Coliform Contamination in School Water Sources

Systematic testing of school drinking water sources in both rural and urban informal settlement settings revealed high contamination levels with fecal indicator bacteria, establishing waterborne transmission as a primary exposure pathway. Wambua et al. (2022) evaluated 60 surface and groundwater samples from four administrative units in Isiolo County and found that all sources were highly contaminated, exceeding Kenyan and WHO standards. The highest mean *Clostridium perfringens* counts reached 1,452 Cfu/ml in groundwater and 3,421 Cfu/ml in surface water, while *Escherichia coli* and coliforms contamination accounted for 29.88% and 88.2% of samples respectively. Shallow wells showed the highest mean coliform counts at 5,185 Cfu/ml, springs recorded *C. perfringens* at 8,177 Cfu/ml, and even rainwater which might be presumed safe had the highest *E. coli* count at 160 Cfu/ml. Total coliforms had a significant negative relationship with residual chlorine (r = -0.76), indicating that inadequate disinfection was a primary driver of contamination. These findings established that rural school water sources functioned as environmental reservoirs for enteric pathogens, with the lack of decentralized treatment such as localized chlorination or solar disinfection ensuring that water points acted as super-spreading environments.

In urban informal settlements, the contamination dynamics were equally severe but structurally distinct. Omondi et al. (2025) assessed *E. coli* contamination in informal water sources in Kibera and found that while 72.2% of sources were public supply and 65.3% used chlorination, 30.6% of samples were completely untreated and nearly one-third tested positive for *E. coli*. Sewage pollution exposure affected 50% of sources, and while the median *E. coli* count was zero (indicating >50% met standards), very high contamination in some samples indicated intermittent but serious breaches. Nyaga et al. (2023) similarly assessed microbial contamination in informal water sources supplying Kibera and found high prevalence of *E. coli* contamination across sampled sources, with the majority of water sources classified as unsafe. This indicated strong fecal-oral exposure pathways into schools relying on informal supply. Kim et al. (2022) documented that high reliance on shared water systems and informal distribution points increased contamination risk pathways into institutions including schools, with 77.4% of the Kibera population and 60.6% of the Mathare population experiencing limited WASH access.

The regional comparison provided by Ng'ombe et al. (2026) in Lusaka, Zambia a comparable East African peri-urban context found that 92.3% of unprotected water sources contained ≥100 CFU/100 mL of fecal coliforms and *E. coli*, while protected sources showed 18.3% exceeding the same threshold. Treated water sources performed substantially better (88.5% free of detectable fecal coliforms), underscoring the critical importance of centralized or point-of-use treatment in preventing waterborne disease. This comparative evidence suggested that the lack of systematic chlorination in Kenyan schools, as documented by Kirira, Oyatsi, Waudo, and Mbugua (2023), represented a modifiable risk factor of high public health significance.

2.Acute Watery Diarrhea and Seasonal Dynamics

Outbreaks of acute watery diarrhea were highly cyclical in urban informal settlements, tracking tightly with seasonal flooding, while in rural settings gastrointestinal morbidity spiked at the onset of the rainy season when surface runoff flushed agricultural and human waste into open water sources used by schools. Lebu et al. (2024) evaluated 200 toilets in Kibera and found that flooding caused latrine collapse, sewage overflow, and direct environmental contamination. Fluorescent dye tracking revealed contamination spreading through the community during floods, and school sanitation systems in flood zones showed high failure rates during heavy rainfall. The 2024 floods in Kenya were particularly devastating, with around 300 lives lost and an estimated 50,000 families displaced, many from informal settlements where sanitation infrastructure was overwhelmed.

Onyango et al. (2024) also examined waterborne disease trends among school-age children in flood-prone counties in western Kenya and found that acute watery diarrhea increased significantly during rainy seasons due to runoff contamination of shallow wells and surface water used in schools. Seasonal spikes were observed in diarrheal morbidity patterns, confirming that rainfall acted as an environmental trigger for waterborne disease outbreaks. Segut et al. (2025) assessed seasonal variations in microbial water quality from shallow wells and found that *E. coli* contamination increased from 26 ± 16 CFU/100 mL in the dry season to 55 ± 20 CFU/100 mL in the wet season, with 100% of wells exceeding the WHO zero threshold during rains. In the dry season, 75% already fell within the high-risk category (11–100 CFU/100 mL). Temperature and pH were positively correlated with *E. coli* counts, indicating that warming climates may exacerbate microbial proliferation in stored water.

Ante-Testard et al. (2024) evaluated WASH interventions and child diarrhea at the interface of household and environmental conditions and found that during monsoon seasons, diarrhea prevalence among children in control groups reached 8.3% (95% CI 6.6%, 10.0%). WASH interventions showed differential effects depending on seasonal and environmental conditions, and the relationship between rainfall and diarrheal disease was complex and context-specific. This finding suggested that the effectiveness of WASH interventions was attenuated during heavy rainfall periods, when environmental contamination overwhelmed protective barriers.

The Global Task Force on Cholera Control (2025) analyzed cholera epidemiology in Kenya from 2018 to 2023 and documented three epidemic periods: 2018, 2019–2020 (with no complete interruption), and 2021 (lower intensity). Since the fourth quarter of 2022, a long epidemic continued with two peaks that decreased following oral cholera vaccine campaigns in February and August 2023, but cases resurged at the end of 2023 during seasonal flooding. As of February 25, 2024, 12,521 cases with 206 deaths were reported in 28 counties, with a median incidence of 4.04 cases per 100,000 person-years. The cyclical nature of cholera outbreaks and their association with flooding events underscored the environmental determinism of extreme waterborne disease in Kenya.

3. Intervention Effects on Diarrheal Disease

Kamau et al. (2023) conducted a quasi-experimental study in Kibera with 1,876 participants and demonstrated that combined safe water delivery with WASH behavior change communication reduced diarrheal disease prevalence by 31% (OR 0.69, 95% CI 0.55–0.86). Diarrheal disease prevalence declined in intervention villages from 33.3% at baseline to 23.5% at endline, while comparison villages saw an increase from 15.7% to 17.5%. The effect was strongest in children under two years (39% reduction, OR 0.61, 95% CI 0.43–0.86), suggesting that the youngest and most vulnerable populations benefited most from improved water access and hygiene promotion. The intervention installed 21 new water kiosks and subsidized water costs to approximately $0.02 per 20-liter jerrycan, demonstrating that affordability and proximity were key mediators of health outcomes.

Wandera et al. (2022) assessed the impact of integrated WASH interventions on diarrhoeal disease and microbial water quality in schools and surrounding communities in Kenya and found that intervention schools showed reduced diarrhea incidence linked to improved water quality and hygiene behavior. Unsafe baseline water microbial loads were associated with high infection risk, confirming that water quality improvement was a primary mechanism of diarrheal disease reduction. Freeman et al. (2012) examined the impact of school WASH interventions on diarrhea-related outcomes among younger siblings of school-going children in 185 Kenyan schools and found that in water-scarce schools, comprehensive WASH improvements were associated with decreased odds of diarrhea (OR=0.44; 95% CI=0.27, 0.73) and visiting a clinic (OR=0.36; 95% CI=0.19, 0.68). Borehole intervention reduced diarrhea odds by 46% (OR=0.54) and rainwater harvesting by 65% (OR=0.35), establishing water quantity as the binding constraint in high-burden settings.

4. Hand Hygiene and Fecal-Oral Transmission Pathways

Pickering et al. (2025) documented fecal contamination in rural Kenyan households and found that in control groups, 94% of stored drinking water samples were contaminated with *E. coli* (mean: 1.48 log10 CFU/100 mL), 90% of child hands were contaminated (mean: 1.74 log10 CFU/100 mL), and 73% of toys were contaminated (mean: 0.58 log10 CFU/toy). Flies were present at 62% of food preparation areas and 67% of latrines, providing additional mechanical vectors for pathogen transmission. The ubiquity of hand contamination indicated that even when water sources were improved, recontamination during collection, storage, and consumption perpetuated the fecal-oral cycle.

Wangari et al. (2021) in Mathare found that pupils not washing hands with soap had an exponential increase in WASH-related morbidity risk (Exp B=810.9, p=0.003), while lack of handwashing facilities in school also significantly elevated risk (Exp B=22.5, p=0.04). The pupil-to-toilet ratio above 1:25 was the strongest predictor (Exp B=3715.8, p=0.000), indicating that sanitation congestion created conditions where hand hygiene was practically impossible to maintain. Njeru, Juma, Mugo, and Odongo (2023) in Tharaka Nithi County found that high student-to-latrine ratios and lack of handwashing stations increased risk of gastrointestinal infections among learners, with only 51.1% of schools having water available for handwashing outside latrines.

5. Protozoan and Parasitic Pathogens

Mbae et al. (2024) examined the prevalence and risk factors of waterborne and foodborne protozoan pathogens in Kenya from a One Health perspective and found that *Entamoeba histolytica* was isolated from food handlers with valid health certificates, schoolchildren, inpatients and outpatients, De Brazza monkeys, and pigs. *Cryptosporidium* was identified in children, baboons, rivers, and during outbreaks in military camps, with *C. hominis* most prevalent in human infections and *C. parvum* more common in environmental and animal samples. *Giardia lamblia* was detected in children and food handlers, with unhygienic conditions, improper sewage disposal, and low socioeconomic status identified as significant risk factors. Similarly, Njambi et al (2020) determined the prevalence of intestinal parasitic infections among school children in Mwea Irrigation Scheme, Kirinyaga County, and documented intestinal polyparasitism with WASH risk factors significantly associated with parasitic infections. Poor sanitation and hygiene practices were identified as key determinants of protozoan infections in the irrigation scheme setting.

Makau (2024) also investigated waste management in Mathare informal settlement and found that poor waste disposal and drainage overflow increased fecal contamination around institutional environments, heightening exposure risk for learners. The 2024 floods and demolitions shifted or destroyed waste community-based organization structures, caused loss of waste-related income, and led to mushrooming of dumpsites, creating conditions where ambient environmental contamination was persistent rather than episodic. Nyamai (2022) examined school structural stress and attendance in Kibera and Mathare and found that poor sanitation and unstable school support systems including feeding and water access increased absenteeism linked to illness episodes and poor hygiene conditions.

The WHO and UNICEF Joint Monitoring Programme (2023) confirmed that only a minority of Kenyan schools met safely managed sanitation standards, and limited handwashing with soap increased exposure risk to fecal-oral disease transmission nationally. The evidence collectively established that the ingestion of contaminated water and the breakdown of hand hygiene were the primary drivers of diarrheal diseases among school-age children in Kenya, with seasonal environmental stressors, inadequate treatment, and structural WASH deficits operating as interconnected determinants of gastrointestinal morbidity in both rural and urban informal settlement contexts.

Soil-Transmitted Helminthiases (STH) and Neglected Tropical Diseases

The biological burden of helminth infections was heavily concentrated in rural school environments in Kenya, though urban informal settlements also presented significant transmission risks through distinct exposure pathways.

1. Hookworm and Barefoot Exposure

Njenga et al. (2014) assessed associations between school- and household-level WASH conditions and soil-transmitted helminth infection among 4,931 students from 70 schools across four regions in Kenya and found that 1,614 (32.7%) children were infected with at least one STH species. Pupils observed wearing shoes at the time of the survey had significantly lower odds of any STH infection, confirming the protective effect of footwear against hookworm larvae penetration. However, hookworm prevalence was remarkably low in most Kenyan school settings, suggesting that the National School-Based Deworming Programme had effectively reduced hookworm refugia. The REACH and UNICEF (2024) assessment in Garissa and Turkana documented that unpaved classrooms and earthen schoolyards coupled with unlined pit latrines created ideal environmental reservoirs for soil-transmitted pathogens, yet the actual hookworm burden remained low due to periodic mass drug administration.

Mwaniki et al. (2017) assessed the current status of soil-transmitted helminths among 731 children aged 4–16 years attending seven primary schools in Kakamega County, western Kenya, and found that 44.05% (95% CI: 35.80–54.20) were infected with STHs. Hookworm prevalence was only 0.27% (95% CI: 0.06–1.09), while *Ascaris lumbricoides* was most prevalent at 43.5% (95% CI: 35.21–53.74). Shitaho primary school had the highest prevalence at 62.6% (95% CI: 54.1–72.5) with mean intensity of 11,667 eggs per gram. The age group 4–5 years had the highest prevalence at 67.5%, indicating that early school entry coincided with peak exposure to environmental contamination. The near-elimination of hookworm despite high overall STH prevalence suggested that footwear promotion and deworming had successfully interrupted the foot-to-soil pathway, while the fecal-oral pathway remained dominant.

Mwinzi, et al. (2025) estimated the prevalence and intensity of STH infection in Narok and Bomet counties among at-risk groups after nearly a decade of deworming and found that few hookworm infections were detected in either county. In Bomet, STH prevalence was similar among school-aged children (16.2%, upper 95% CI: 23.1%) and preschool-aged children (15.8%, upper 95% CI: 21.7%). In Narok, STH prevalence was marginally higher among preschool-aged children (12.8%, upper 95% CI: 18.2%) compared with school-aged children (11.3%, upper 95% CI: 16.2%). Moderate-to-high intensity infection prevalence exceeded the morbidity elimination threshold of 2% in both counties for both age groups, indicating that despite low hookworm prevalence, *A. lumbricoides* and *Trichuris trichiura* continued to cause significant morbidity. This finding challenged the assumption that mass drug administration alone would achieve elimination and underscored the need for sustained WASH investments to interrupt transmission.

2. *Ascaris lumbricoides* Dominance and Fly-Mediated Transmission

A. lumbricoides emerged as the dominant STH species across all Kenyan studies, with prevalence ranging from 11.3% in Narok school-aged children (Mwinzi et al., 2025) to 43.5% in Kakamega (Mwaniki et al., 2017) and 17.9% in the broader multi-region study by Njenga et al. (2014). This dominance reflected the fecal-oral transmission pathway: *Ascaris* eggs are highly resistant to environmental degradation and can persist in soil for years. The geometric mean infection intensity for *A. lumbricoides* reached 2,754.5 epg (Njenga et al., 2014) and 11,667 epg in high-burden schools (Mwaniki et al., 2017), exceeding thresholds for significant morbidity including malnutrition, growth stunting, and cognitive impairment.

Njenga et al. (2014) found that attending a school with a ventilated improved pit latrine, more frequent access to hand-washing with soap and water, and tissue or water for anal cleansing yielded lower odds of any STH infection. However, they also documented a paradoxical finding: pupils with more frequent access to handwashing facilities equipped with soap and water were more likely to be infected with STH. This suggested that soap availability alone was insufficient without proper use technique and sustained behavior change, and that handwashing stations may have been installed in higher-burden schools as part of targeted interventions, creating a selection bias. The study also found that the presence of VIP latrines was protective, as these facilities reduced fly breeding and thus interrupted the mechanical vector pathway from pit latrines to food. Similarly, Wekesa et al. (2025) determined the prevalence of intestinal parasites among 600 school-going children in artisanal gold mining areas in Kakamega County and found an overall STH prevalence of 16.85%, with *A. lumbricoides* at 13.3% and *T. trichiura* at 0.56%. No hookworm was detected. Washing hands with water and soap was significantly associated with reduced STH and intestinal parasite infections, reinforcing that the fecal-oral hook could be interrupted through hygiene behavior change. The mass drug administration program may have reduced STH prevalence, but sanitation and hygiene practices remained critical for sustained control.

Njambi et al. (2020) determined the prevalence of intestinal parasitic infections among school children in Mwea Irrigation Scheme, Kirinyaga County, and documented intestinal polyparasitism with WASH risk factors significantly associated with parasitic infections. Poor sanitation and hygiene practices were identified as key determinants of STH and protozoan infections in the irrigation scheme setting, where the combination of waterlogged soils and inadequate sanitation created favorable conditions for parasite transmission.

Mbae et al. (2024) examined protozoan pathogens from a One Health perspective and found that *Giardia lamblia* was detected in children and food handlers, with unhygienic conditions, improper sewage disposal, and low socioeconomic status identified as significant risk factors. *Entamoeba histolytica* was isolated from food handlers with valid health certificates, schoolchildren, and animals, indicating that the fecal-oral pathway extended beyond STH to include protozoan parasites that caused persistent diarrhea and malabsorption.

3. *Program Monitoring and Deworming Sustainability*

The Ministry of Health, Kenya (2023) established a comprehensive multi-year strategic plan for neglected tropical disease control and documented that most counties (44) surveyed were endemic for STH except ASAL areas. Kenya aimed to eliminate lymphatic filariasis and trachoma by 2025, and STH and schistosomiasis as public health problems by 2027. The plan explicitly recognized that STH and schistosomiasis highest prevalence occurred in areas lacking adequate water, hygiene and sanitation, and called for improved coordination with the school health programme and WASH partners. Twelve counties were trachoma-endemic, with five still active with trachomatous follicular, and schistosomiasis was endemic in 32 counties and 158 mapped sub-counties.

The REACH and UNICEF (2024) assessment in Garissa and Turkana found that in ASAL regions, water scarcity forced trade-offs where available water was allocated for drinking, leaving handwashing stations dry. Schools relied on unprotected shallow wells, seasonal rivers, or roof catchments, and unpaved classrooms and earthen schoolyards coupled with traditional unlined pit latrines that lacked proper structural concrete slabs created ideal environmental reservoirs for soil-transmitted pathogens. Vector and soil dynamics in rural ASAL schools facilitated transmission of STH and other neglected tropical diseases, confirming that the environmental determinants of helminth infection were structurally embedded in the rural school landscape.

4. *Dermatological and Ocular Infections*

Where absolute water volume was restricted, primarily in rural areas and water-scarce informal settlements, washing-related illnesses emerged as significant epidemiological outcomes. The prevalence of scabies and bacterial conjunctivitis increased significantly when water volumes dropped below the levels required for routine face and body washing. Girma et al. (2024) conducted a systematic review and meta-analysis of scabies among African schoolchildren and found a pooled prevalence of 10.81% (95% CI: 7.10–14.51) across 19 studies including Kenya. Prevalence increased over time from 6.98% (2015–2018) to 12.90% (2019–2024), indicating a worsening trend. The strongest predictor was not bathing with soap and water (adjusted OR=8.51), directly linking water scarcity to skin disease burden. Other significant factors included infrequent cloth washing (aOR=5.30), contact with scabies cases (aOR=3.37), and family member with scabies (aOR=5.83), indicating that scabies transmission was amplified in crowded, water-poor households and schools. Being male was also a significant risk factor (aOR=1.86), possibly reflecting greater outdoor exposure and reduced hygiene practices among boys.

Wangari et al. (2021) assessed determinants of WASH-related morbidity among 342 pupils in Mathare informal settlement and found that pupils not washing their face had the strongest association with morbidity (Exp B=0.002, p=0.000), even exceeding the effect of not washing hands with soap (Exp B=810.9). Pupils not bathing with soap also significantly influenced morbidity (Exp B=47.2, p=0.017). These findings were consistent with the trachoma elimination agenda: the Ministry of Health, Kenya (2023) identified 12 trachoma-endemic counties, with five still active with trachomatous follicular. The SAFE strategy (Surgery, Antibiotics, Facial cleanliness, Environmental improvement) explicitly targeted face-washing as a core intervention, and the NTD Master Plan targeted trachoma elimination by 2025. Persistent WASH deficits in informal settlements and ASAL regions threatened this goal, as the lack of water for face-washing perpetuated the ocular infection reservoir.

Meshascience (2026) documented health impacts of water scarcity in coastal Kenya and reported that health promotion officers recorded most diseases due to unsafe water as bilharzia, diarrhea, and skin infections like ringworms, with most of the 14 dispensaries recording 3–5 cases per week. Water experts noted many schoolchildren suffering from ringworms attributed to unsafe water from water pans. Rivers near houses were polluted due to open defecation, and used diapers thrown away ended up in rivers. Women fetched this water for drinking because of water shortages, and during dry seasons contamination became more concentrated as water levels shrank. This created a cycle where water scarcity led to use of contaminated sources, which caused skin infections, which further reduced school attendance and academic performance.

The ChildFund Alliance (2024) reported on a water project in Mulala County and documented that before the intervention, over 60% of households relied on unreliable and unsafe water sources, and students at Mulala Girls School struggled to concentrate, faced stress, and battled skin diseases due to sharing contaminated water. After a 13-meter pipeline was constructed, students could concentrate better, health improved, and academic performance rose. This before-and-after comparison provided direct evidence that water access interventions could reduce dermatological morbidity among school-going girls.

Mwangi et al. (2024) surveyed 77 childcare centre owners in Korogocho and Viwandani informal settlements and identified significant WASH service deficits. Close to 70% of childcare centres had between 10 and 25 children enrolled, most were home-based, and very few were centre-based or attached to primary schools. The status of informal social accountability mechanisms in WASH service delivery was largely unknown, indicating that oversight and quality assurance were weak in the informal childcare sector. These WASH deficits created conditions conducive to skin and ocular infections among young children, who then carried these infections into primary school settings.

Kamau, et al. (2023) demonstrated in Kibera that combined safe water delivery with WASH behavior change communication reduced diarrheal disease prevalence, building on prior evidence that soil-transmitted helminth infection risk factors in urban school- and preschool-aged children were associated with poor WASH conditions. While their study focused on diarrheal outcomes, the intervention mechanism improved water access and hygiene behavior was equally relevant to reducing dermatological and ocular infections that depended on adequate water volume for personal hygiene.

Attendance Patterns and Socio-Educational Impacts

The biological disease burden documented in the preceding sections mapped directly onto school attendance registers, transforming an environmental health crisis into an educational deficit. The evidence base comprised quasi-experimental trials, longitudinal cohort studies, national audit reports, program evaluations, systematic reviews, and cross-sectional surveys that collectively established the causal pathways from WASH-related illness to learner absenteeism, and from gender-specific environmental neglect to educational inequity.

Illness-Induced Absenteeism

Mwenjiet al. (2025) provided direct evidence from Kibera and Korogocho slums that geohelminthic infections significantly correlated with school absenteeism (r=0.7523), with an even stronger correlation between prevalence and absenteeism pre-treatment (r=0.971; p<0.05). Children aged 11–14 years in classes 2–4 carried the highest infection intensities (16.5% light, 10.4% moderate), and females showed significantly higher infection intensities than males—suggesting that girls in informal settlements faced a compounded burden of environmental exposure and caregiving responsibilities that kept them out of school. Treatment with albendazole was more effective against *Ascaris lumbricoides* than *Trichuris trichiura*, indicating that the latter's persistence contributed to chronic absenteeism even after deworming.

Omari et al. (2024) confirmed that illness remained the primary cause of absenteeism across all groups (>70%), with diarrhea and respiratory diseases as the leading specific conditions. At baseline, absence rates were similar between intervention and control schools (22.6% vs. 26.1%; p=0.390). At endline, intervention schools improved to 20.6% absence while control schools declined to 28.7%, though the difference was not statistically significant ($\chi 2=3.823$, p=0.051). Notably, there were no significant differences in illness-related absences or specific conditions between groups, indicating that the school-led total sanitation intervention alone was insufficient to break the illness-absenteeism cycle without concurrent nutrition, healthcare, and behavior change components. School feeding programs strongly motivated attendance, and cultural practices, gender roles, and environmental factors acted as additional barriers.

The systematic review of parasitic infections and cognitive synthesized evidence across Kenya, Tanzania, Mali, Ghana, and Nigeria. King et al. (2020) in Kenya and Tanzania found that children infected with *Schistosoma mansoni* showed significant reductions in behavioral problems three weeks post-treatment, with mass drug administration benefits extending beyond detectable infection. A meta-analysis of 30 studies confirmed that *Schistosoma* infection was associated with deficits in learning, memory, school attendance, and achievement. de Clercq et al. (1998) in Mali demonstrated that infected children had significantly lower academic achievement and increased school absenteeism; higher infection intensity correlated with poorer grades (p<0.005) and elevated absenteeism (p<0.001). Absenteeism was the strongest predictor of academic decline, establishing the direct educational consequence of untreated parasitic infections. Nyamwange (2012) in Kenya found that among *S. mansoni* infected children, treatment was associated with marked cognitive improvements over six months, and post-treatment school absenteeism showed modest improvement. Elson et al. (2023) in Kenya documented that tungiasis was associated with increased absenteeism, lower academic performance, and substantial physical morbidity.

Wangari et al. (2021) assessed determinants of WASH-related morbidity among 342 pupils in Mathare informal settlement and found that water unavailability in school (Exp B=47.9, p=0.008), lack of handwashing facilities (Exp B=22.5, p=0.04), and pupil-to-toilet ratio above 1:25 (Exp B=3715.8, p=0.000) significantly influenced morbidity. Pupils not washing hands with soap had an exponential increase in morbidity risk (Exp B=810.9, p=0.003), while high knowledge level was protective (Exp B=0.012, p=0.006). These morbidity determinants translated directly into attendance deficits, as sick children were unable to attend school and those who attended were cognitively impaired by chronic infection.

School Feeding as Attendance Stabilizer

The Office of the Auditor-General Kenya (2023) documented that the National School Meals Programme achieved only 52% of intended feeding days in the in-kind modality and 20% in cash transfer over a five-year period. In Ganze Sub-County (Kilifi), one of the poorest areas in Kenya, only 56 days out of 900 possible school days were fed over five years. Critically, analysis of five sampled schools revealed that attendance improved on days when food was served and decreased when food was not served, confirming that hunger was a primary driver of absenteeism independent of illness. The meal allocation of Kshs.10 per child per day was set in 2009 and had not been reviewed despite 9.8% annual food price inflation, creating a structural underfunding that undermined the program's attendance stabilization function.

Food4Education (2024) demonstrated the inverse: where feeding was consistent, schools experienced up to 28% increase in enrollment, 67% increase in early childhood attendance, and absenteeism reductions from eight to two learners per day in Mombasa and from six to two in Murang'a. Since inception through fiscal year 2024, 55.5 million meals were served across more than 1,000 schools in seven counties. The Dishi na County initiative in Nairobi increased enrollment from 29,740 in 2023 to 30,182 in 2024, with parents citing "positive impact on children's attendance and academic performance" and "lessened food burden."

The Global Survey of School Meal Programs (2024) documented the Kenya Climate Friendly School Feeding Programme serving 1,630,000 primary school students, but noted that in 2022–2023 operations were suspended in some regions for two to five months due to drought, economic crisis, supply chain disruptions, and extreme food price inflation. Funding was inadequate to meet targets, and schools saw drops in attendance rates. Feeding frequency was only "slightly achieved," indicating that even well-designed programs faced implementation barriers that attenuated their attendance benefits.

Nation Media (2026) captured the voice of head teachers in ASAL counties: "Scrapping the programme is similar to killing the morale of the children in schools." At Mokowe Arid Zone Comprehensive School, enrollment continued to increase due to the school feeding programme, and at Lake Kenyatta Comprehensive School the head teacher emphasized that the programme was critical for learner retention. Whenever government delays food dispatch, schools collaborated with parents and stakeholders to ensure continuity, demonstrating community resilience but also systemic fragility.

Gender-Specific Absenteeism and Menstrual Hygiene Management (MHM)

1. The Infrastructure Deficit and MHM-Related Absences

Sanyanda et al. (2026) provided robust quasi-experimental evidence that menstrual product provision significantly reduced menses-related absenteeism across all intervention arms. At baseline, the median absenteeism score was 1 (IQR: 0–2); at endline, it dropped to 0 (IQR: 0–1) ($p<0.001$). Significant declines were observed in the control group ($p=0.012$), menstrual cup group ($p=0.041$), disposable pads group ($p<0.001$), and reusable cloth group ($p<0.001$). However, the study also documented that many schools lacked private, clean toilets equipped with water and soap, and girls feared ridicule from peers regarding uniform staining indicating that product provision alone could not fully eliminate MHM-related absenteeism without concurrent WASH infrastructure and stigma reduction. Only 28% of participants received menstrual education from parents, highlighting the knowledge gap that compounded infrastructure deficits.

Sanyanda et al. (2026) similarly assessed the impact of menstrual product provision on school absenteeism among adolescent girls in five secondary schools in Kilifi County and found that baseline absenteeism ranged from three to five school days per menstrual cycle before intervention, with reduction observed after MHM support. This quantified the direct attendance cost of inadequate MHM: girls were missing up to 60 school days annually due to menstruation alone, equivalent to approximately 12% of the school year.

Ombogo (2023) examined MHM knowledge, attitudes, and practices among 356 girls in grades 6–8 and found that MHM practices significantly influenced school attendance ($p<0.01$), explaining 43.8% of the variance. Information dissemination on MHM significantly impacted attendance ($p<0.05$), explaining 17.2% of the variance. Linear regression confirmed a positive relationship between disseminating MHM information and school attendance. Cultural taboos hindered open discussions about menstruation, and schools needed a dedicated MHM curriculum rather than relying on sporadic discussions during general health talks. This established that MHM-related absenteeism was not simply a product deficit but a knowledge-behavior-infrastructure syndrome requiring integrated intervention.

Mutegi et al. (2023) examined the influence of WASH facilities on menstrual hygiene management in secondary schools in Chuka Sub-County, Tharaka Nithi County, and found that 49.9% of schools lacked menstrual waste disposal systems and 52.9% of toilets lacked handwashing facilities. Poor MHM conditions reduced attendance and dignity among girls, confirming that the infrastructure deficit extended beyond product availability to include functional sanitation design. Mokaya (2023) assessed menstrual hygiene management practices among 442 adolescent school girls in Kibera, Nairobi, and found that 18 of 22 schools lacked water provision in toilets; the lack of privacy and inadequate facilities led to missed school days and stigma-related absenteeism.

Drop-outs and Structural Safety Concerns

The NGEC Education Report (2025) documented that menstruation-related absenteeism averaged 10.9% across 19 counties, with the worst sanitation deficits in ASAL regions:

Mandera 97:1 pupil-to-toilet ratio (boys), Wajir 86:1, Turkana 69:1. These ratios vastly exceeded the national standard of 1:25 for girls and 1:30 for boys, creating conditions where adolescent girls could not manage menstruation with dignity or privacy. Boys accounted for 52% of enrollment versus 48% girls in sampled areas, with gender disparity greater among learners with disabilities. Mandera and Wajir showed the widest gender disparities, with girls comprising less than 46% of enrollment. Teenage pregnancy was reported in 30% of schools, yet only 52.4% of schools re-admitted girls after pregnancy and only 63% offered counselling support. This created a permanent dropout pathway rather than temporary absenteeism: girls who became pregnant were unlikely to return, and those who did often lacked psychosocial support to sustain re-enrollment.

The Star (2025) reported that disparities were most severe in ASAL counties, informal settlements, and remote regions, where girls faced lower enrollment, retention, and transition rates. Structural barriers included 76% male school heads in ASAL counties versus 89% female in Nairobi informal settlements; limited female leadership in ASAL affected how schools responded to girls' challenges. Distance was a significant obstacle: in West Pokot, children walked more than one hour to school. Social challenges included menstruation-related absenteeism, teenage pregnancy, child marriage, gender-based violence, and female genital mutilation. Only 52.4% of schools re-admitted girls after pregnancy, and only 63% offered counselling.

Onyango et al. (2024) investigated gendered school absenteeism linked to health and sanitation constraints in primary schools in western Kenya and found that girls reported higher absenteeism rates than boys during menstruation, especially in schools lacking private toilets and water inside cubicles. This confirmed that the infrastructure deficit specifically the absence of locks, disposal bins, and running water was the proximal cause of MHM-related absenteeism. Kim, Hagen, Muindi, Mbonglou, and Laituri (2022) documented that 77.4% of the Kibera population and 60.6% of the Mathare population experienced limited WASH access, with shared infrastructure increasing exposure risks affecting school hygiene and girls' menstrual management conditions.

Lebu et al. (2024) assessed flood impacts on sanitation systems in informal settlements and found that flooding caused latrine overflow and contamination, increasing girls' safety risks and reducing school attendance during rainy seasons. In Kibera, 43% of toilets were unimproved latrines, 78% were shared among multiple households, and fluorescent dye tracking revealed contamination spreading through the community during floods. This structural vulnerability meant that girls faced not only hygiene challenges but also security risks when accessing shared communal latrines at the school periphery during and after flood events.

Njeru et al. (2023) in Tharaka Nithi County found that high pupil-to-toilet ratios (often exceeding 100:1) and lack of disposal bins increased menstrual hygiene challenges and absenteeism among girls. Only 58% of latrines were clean, 45.7% of schools had stagnant water in compounds, and 51.6% lacked composite pits. The WE REACH Project (2023) in Kakamega County evaluated school WASH and MHM interventions and found that improved availability of handwashing facilities and MHM awareness reduced reported absenteeism among adolescent girls and improved participation.

UNICEF Kenya (2023) assessed national WASH in schools status with a gender focus and found persistent gender disparities, with many rural and informal settlement schools lacking private toilets, water in cubicles, and disposal systems, increasing menstrual-related absenteeism. The Ministry of Health, Kenya (2024) documented that only 22% of schools had changing rooms for girls and 25% had sanitary disposal facilities, while 75% provided menstrual products but with inconsistent supply. The Three-Star Approach included comprehensive MHM services at the highest tier, but most schools remained at One Star or below.

Nyamai (2022) examined school structural factors influencing attendance in Kibera and Mathare and found that lack of WASH infrastructure and school support systems contributed to absenteeism of girls during menstruation, with absence patterns linked to hygiene stress and stigma. The withdrawal of school feeding reduced attendance by 116 learners, demonstrating that WASH and nutrition deficits intersected to compound gendered educational disadvantage.

Conclusion

School Water, Sanitation, and Hygiene (WASH) infrastructure serves as a critical, structurally embedded determinant of environmental health and educational equity across Kenyan learning institutions, rather than functioning as a mere administrative or structural amenity. The evidence demonstrates that while rural and arid regions struggle with absolute water scarcity and high soil-transmitted helminth transmission pathways, urban informal settlements experience extreme structural stress, drainage overflows, and high fecal contamination risks due to severe overutilization and broken municipal planning. Across both landscapes, these infrastructural failures translate into a heavy, seasonal biological disease burden ranging from gastrointestinal morbidity to ocular and dermatological infections—that maps directly onto school attendance registers. Crucially, the lack of private, clean, and secure sanitation facilities with consistent water supply inside cubicles inflicts a disproportionate gender-specific toll on adolescent girls, driving severe hygiene stress, stigma, and chronic menstrual-related absenteeism that culminates in permanent dropout pathways. Hence, the findings confirm that the national targets for disease elimination and educational retention cannot be sustained through temporary mass deworming or product provisioning alone, but instead necessitate integrated, climate-resilient structural interventions that simultaneously address physical infrastructure, behavioral change, and institutional support systems.

Recommendations

1. The Ministry of Education and Ministry of Health should establish a collaborative funding pool to upgrade school sanitation infrastructure. This money must immediately target high-burden arid areas and informal settlements to reduce severe pupil-to-toilet overloads. Additionally, standard school toilet designs should be updated to require durable concrete slabs, internal door locks, and full disability accessibility.
2. County Governments should shift to localized environmental engineering instead of generic hardware supply. Rural schools in arid zones need to be equipped with sand dams and water backpacks to fight absolute water scarcity. Meanwhile, schools in urban informal settlements must be integrated into municipal planning using container-based sanitation systems backed by

formal maintenance contracts to prevent flooding and sewage cross-contamination.

3. School Boards of Management and Institutional Administrators should launch ongoing hygiene behavior campaigns alongside hardware installations by ensuring handwashing stations always have water, soap, and proper usage training. Schools must also create a dedicated menstrual hygiene curriculum to fight stigma and retrofit female restrooms with changing rooms, in-cubicle water access, and disposal bins.
4. The National Treasury and Inter-Ministerial School Feeding Councils should increase the multi-year budget for the National School Meals Programme to offset severe food price inflation. Expanding and stabilizing the delivery of consistent feeding models like the Dishi na County framework is vital to protect student retention and keep daily attendance high.

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