

Original Research

Environmental and economic drivers of persistent open defecation in the rural state of Osun, Nigeria

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Abstract

Introduction: Open defecation remains a major environmental health challenge in Sub-Saharan Africa, with Nigeria bearing one of the highest global burdens despite increasing access to improved water sources and widespread awareness of sanitation-

related health risks in rural areas. Community-led total sanitation (CLTS) emphasizes behavioural change, prompting families to build their own latrines using local materials. CLTS drives community mobilization to stop open defecation collectively; the widespread

prevalence of the practice in rural areas reveals a significant gap between sanitation knowledge and actual practice. Furthermore, very few empirical studies integrate the roles of environmental constraints, household financial choices, and sanitation behaviour gaps in under-resourced settings. This study addresses this gap by investigating the environmental and socioeconomic determinants of open defecation persistence through a baseline assessment conducted during CLTS in the rural state of Osun, Nigeria.

Methods: A cross-sectional survey was conducted among 200 respondents across four rural villages in Osun between March and May 2023. Data on sanitation infrastructure, defecation practices, water access, hygiene behaviours, and household economic priorities were collected using semi-structured questionnaires. Associations were examined using χ^2 tests, ANOVA, and multiple regression analyses.

Results: A total of 91.5% of households practised open defecation, with only 5.5% owning improved toilet facilities, despite 89.5% having access to improved water sources. A pronounced knowledge–practice gap was observed: 51.5% of households practising handwashing before meals were still disposing of faeces in open spaces ($\chi^2=36.4$, $p<0.01$). Household income significantly

influenced prioritization of mobile phone purchases over latrine construction ($\chi^2=19.34$, $p=0.04$), while education level correlated with toilet quality perceptions ($\chi^2=41.36$, $p<0.01$). Soil type significantly influenced flooding risk and latrine siting feasibility ($\chi^2=8.51$, $p=0.004$). Regression analysis revealed that household size, gender, and perceived importance of handwashing significantly predicted water storage expenditure ($F=7.44$, $p<0.001$, $R^2=0.188$).

Conclusion: This study shows that awareness campaigns alone cannot stop open defecation in rural Nigeria, as knowledge and water access cannot overcome the structural barriers of extreme poverty and environmental constraints. Therefore, securing a nationwide open defecation-free status by 2030 requires a paradigm shift beyond behavioural interventions. In rural settings, sustainable progress depends on integrating subsidized financing mechanisms, conducting environmental feasibility assessments, and embedding sanitation initiatives within national poverty reduction frameworks. This comprehensive approach is necessary because current non-subsidized CLTS approaches are insufficient for rural communities facing extreme resource constraints.

Keywords

community-led total sanitation (CLTS), environmental health, knowledge–practice gap, open defecation, rural Nigeria, sanitation infrastructure, socioeconomic determinants.

Introduction

Open defecation is the practice of defecating outside in the open (eg in fields, bushes, canals, rather than into a toilet). This practice is common in areas where sanitation infrastructure remains a critical public health challenge in Sub-Saharan Africa, with Nigeria accounting for 48 million people who practice open defecation, the second-highest global burden^{1,2}. Despite national commitments to achieve open defecation-free status by 2030, progress remains slow, particularly in rural areas where sanitation coverage lags significantly behind water access improvements². Community-led total sanitation (CLTS), a participatory behavioural change approach, has demonstrated success in several countries^{3,4}. However, implementation challenges persist in contexts characterized by extreme poverty, difficult environmental conditions, and complex socioeconomic barriers^{5,6}.

The environmental health implications of open defecation extend beyond effects on individuals practising open defecation. Human faecal matter contains high concentrations of pathogens, including bacteria, viruses, and parasitic worms⁷. Faecal contamination creates transmission pathways for diarrheal diseases, helminthic infections, and environmental enteropathy, contributing to approximately 432,000 annual deaths globally⁸. In tropical environments, deposited faecal matter contaminates soil, water sources, and agricultural produce^{9,10}. Geochemical analysis of groundwater near defecation sites shows elevated faecal indicator bacteria, alongside chemical signatures including dissolved oxygen and chloride, creating complex exposure pathways that affect entire communities¹¹. Children under 5 years bear a disproportionate disease burden, with inadequate sanitation perpetuating cycles of malnutrition, stunting, and impaired cognitive development¹².

Critical gaps remain in understanding the disconnect between sanitation awareness and actual behaviour change. While many communities demonstrate knowledge of sanitation-related health risks, this knowledge often fails to translate into latrine adoption or consistent use^{13,14}. Additionally, CLTS programs have historically neglected child faeces management¹⁵. Economic constraints in non-subsidized CLTS contexts further complicate adoption, as households facing extreme poverty must prioritize immediate survival needs over sanitation investment despite evidence that children's faeces contribute substantially to environmental pathogens^{16,17}.

This cross-sectional study explicitly examines the knowledge–practice gap in hygiene and defecation behaviours, household economic decision-making regarding sanitation investments, child faeces management practices, and environmental factors affecting latrine feasibility.

Methods

Study design and setting

Osun is a state in South-West Nigeria with a projected population of 5.8 million in 2026 (up from 3.4 million in the 2006 national census)^{3,18}. This cross-sectional study was conducted in four highly vegetated rural villages across two local government areas (LGAs) between March and May 2023 (Fig1). Villages were selected based on high open defecation prevalence (>70% preliminary assessment), presence of improved water sources, no recent sanitation interventions, accessible community leadership willing to participate, and varied soil and topographic conditions to assess environmental feasibility factors. The villages (represented by the codes AY, BA, BE, IT) comprised 861 total households with populations ranging from 164 to 278 households per village.

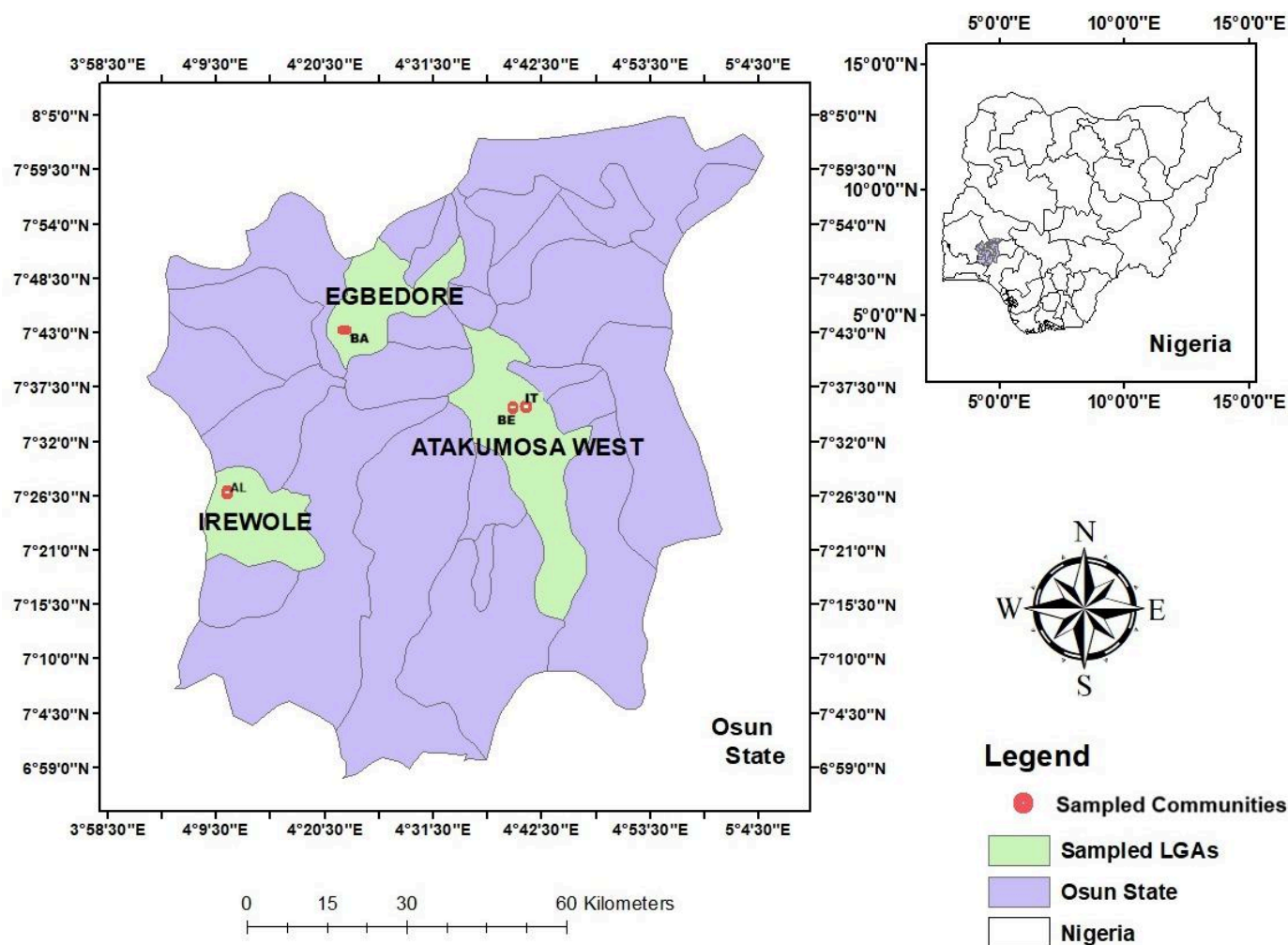


Figure 1: Map of communities accessed in Osun State, South West Nigeria. LGA, local government area.

Sample size and sampling

Target population

All households in the four selected villages were eligible for inclusion. Households were defined as groups of people who eat from the same pot and sleep under the same roof for at least 6 months of the year.

Inclusion criteria

Inclusion criteria were as follows: permanent residents of the village (≥ 6 months residence); heads of household or adult household representatives (≥ 18 years) available and willing to participate; households with or without children (to capture child faeces management practices and assess differential behaviours).

Exclusion criteria

Exclusion criteria were as follows: temporary residents, seasonal migrants, or visitors; households where no adult respondent was available after three visit attempts; households explicitly refusing participation.

Sample size calculation

For cross-sectional survey designs estimating proportions:

$$n = [Z^2 \times p(1 - p)] \div d^2$$

where:

- $Z = 1.96$ (95% confidence level)
- p (expected prevalence of open defecation) = 0.75 (based on preliminary data and Nigeria Demographic and Health Survey estimates)
- d (desired precision) = 0.05 ($\pm 5\%$)
- $n = [1.96^2 \times 0.75(0.25)] \div 0.05^2 = 288.12 \approx 290$ households.

Adjusting for non-response (10%): $290 \times 1.10 = 319$ households.

Due to logistical and resource constraints, a total of 200 households were surveyed, representing 23.2% of total village households (200/861), a coverage proportion that compares favourably with similar rural WASH baseline surveys in Nigeria and Ghana, which typically sample 10–20% of target households^{19,20}.

Power analysis

Power level of 80% was used to detect differences in proportions: 15% between groups ($\alpha=0.05$).

Precision

Achieved precision was $\pm 6.7\%$ at 95% confidence level for prevalence estimates.

Sampling strategy

A stratified random sampling approach was employed.

Stratification by village

Households were proportionally allocated to villages based on population size:

- AY: $200 \times (187 \div 861) = 43$ households
- BA: $200 \times (232 \div 861) = 54$ households
- BE: $200 \times (164 \div 861) = 38$ households
- IT: $200 \times (278 \div 861) = 65$ households

Random selection within villages

Village household lists (enumeration) were obtained from village heads. Every k th household was selected (k = total households $\div$ sample size).

If a selected household refused or was unavailable, the next household on the list was approached. A maximum of three visits were attempted before replacement.

Data collection

A semi-structured questionnaire adapted from WHO/UNICEF Joint Monitoring Programme WASH tools²¹ and Nigeria Demographic and Health Survey modules²² assessed household demographics, water access and practices, sanitation facilities and defecation behaviours, child faeces management, hygiene practices, household economic priorities, and environmental observations. The questionnaire was translated to Yoruba, pilot-tested with 20 households, and validated for content (expert review) and internal consistency (Cronbach's $\alpha=0.78$).

Six trained enumerators (three male, three female) administered the questionnaires with household heads or adult representatives (age ≥ 18 years) in local language. Data were entered directly into digital tablets using KoBoToolbox (Harvard Humanitarian Initiative [<https://www.kobotoolbox.org>]) with real-time validation. Field supervisors conducted daily debriefings and randomly verified 10% of households for quality assurance. Environmental assessments documented soil type, topography, flood risk, visible faecal contamination, and proximity to water sources through physical observation.

Data analysis

Data were analysed using R software v4.3.0 (R Foundation for Statistical Computing [<https://www.R-project.org>]). Descriptive statistics summarized demographic characteristics, sanitation infrastructure, and behavioural practices using frequencies, percentages, means, and standard deviations. Chi-squared tests were used to examine associations between categorical variables (education and toilet quality, handwashing and faecal disposal, income and economic priorities, soil type and flooding risk). One-way ANOVA compared water collection time across villages. Multiple linear regression identified predictors of household water storage expenses. Statistical significance was set at $p < 0.05$. Missing data ($< 3\%$ for all variables) were handled through listwise deletion.

Ethics approval

Written informed consent was obtained from all participants after explanation in their preferred language. Participation was voluntary with no incentives provided. Confidentiality was maintained through anonymized data collection, and village identities were protected using pseudonyms. Ethics approval was granted by the State Department of Environmental Health (ACS/417-2023).

Results

Household characteristics

Among 200 participating households, respondents were predominantly aged 41–50 years (29%), married (73%), with secondary school education (31%) or primary education (29%) as the most common attainment levels. Twenty-two percent had no formal education. Religious affiliation was balanced between Christianity (43%) and Islam (41%), with 16% practising traditional religions. Gender distribution was relatively even (54% male, 46% female) (Table 1).

Table 1: Demographic characteristics of study participants (N=200)

Variable	Values	n (%)
Age (years)	<20	23 (12)
	21–30	15 (8)
	31–40	57 (28)
	41–50	59 (29)
	≥ 51	46 (23)
Sex/gender	Male	107 (54)
	Female	93 (46)
Level of education	No formal education	43 (22)
	Higher education/university	7 (3)
	Primary education	58 (29)
	Technical/vocational	31 (15)
	Secondary school leaving certificate	61 (31)
Marital status	Single	29 (15)
	Married	147 (73)
	Divorced	4 (2)
	Widowed	20 (10)
Religion	Islam	82 (41)
	Christianity	86 (43)
	Traditional worshipper	32 (16)

Water access and sanitation infrastructure

The vast majority of respondents relied on hand-pump boreholes as their primary drinking water source (89.5%), while the remaining population utilized rainwater collection (10.0%) and public taps (0.5%).

It was observed that, despite water accessibility, sanitation coverage was critically low: 91.5% practised open defecation (bush/field/shallow burial), 5.5% had flush/pour-flush pit latrines, and only 3.0% used pit latrines with covers. Among facilities, 74.0% of respondents used public open spaces/yards/bushes for defecation, 17.5% practised burial, and 8.5% had private toilets (Table 2).

Table 2: Water sources and sanitation facilities used by respondents

Question	Response categories	n (%)
What is the main source of drinking water for members of your household?	Rainwater collection	20 (10.0)
	Hand-pump borehole	179 (89.5)
	Public tap/standpipe	1 (0.5)
What kind of toilet does your household use?	Flush/pour flush to pit	11 (5.5)
	Pit latrine with cover	6 (3.0)
	Open air/bush/field/bury	183 (91.5)
Is the toilet private (one household), shared (more than one household) or public?	Private	17 (8.5)
	Public open space/yard/bush	148 (74.0)
	Burying	35 (17.5)
What kind of maintenance is needed for the household's toilet daily?	Digging new hole (when pit is full)	11 (5.5)
	Cleaning	7 (3.5)
	Removing bushes when necessary and or burying	182(91.0)

Economic priorities and sanitation investment

Chi-squared analysis revealed a significant association between household income and preference for purchasing mobile phones over building latrines ($\chi^2=19.34$, $df=6$, $p=0.04$). Among the lowest-income group (<N50,000/A\$52.50 monthly, representing 71% of

respondents), 35.5% agreed and 35% strongly agreed they would prioritize phone purchases over latrine construction. This pattern persisted across income categories, suggesting economic constraints fundamentally shape sanitation decision-making (Table 3).

Table 3: Chi-squared analysis of household income and preference for purchasing mobile phones over building latrines[†]

Income level	Preference for purchasing mobile phones over building latrines n (%)		
	Agree	Strongly agree	Neither agree nor disagree
<N50,000 (<A\$52.50)	71 (35.5)	70 (35.0)	1 (0.5)
N51,000–100,000 (A\$52.50–105.00)	12 (6.0)	9 (4.5)	0 (0.0)
N100,000–200,000 (A\$105.00–210.00)	2 (1.0)	24 (12.0)	0 (0.0)
>N200,000 (>A\$210.00)	7 (3.5)	4 (2.0)	0 (0.0)

[†] $\chi^2(6)=19.34$ ($p=0.04$)

Education and toilet quality perceptions

A strong statistically significant relationship existed between respondents' education levels and perceptions of toilet quality ($\chi^2=41.36$, $df=4$, $p<0.01$). Respondents with secondary education

(29.5%) most frequently reported that available toilets 'looked bad most times', while those with tertiary education showed lower concern about toilet appearance, suggesting education influences both sanitation standards and quality expectations (Table 4).

Table 4: Cross-tabulation and χ^2 table of education level and quality of toilet sanitation[†]

Level of education	Toilet quality perception n (%)	
	Low perception (no concern about toilet look)	Fair perception (toilet looks bad most times)
None	0 (0.0)	43 (21.5)
Higher education/university	3 (1.5)	4 (2.0)
Primary education	0 (0.0)	58 (29.0)
Technical/vocational	1 (0.5)	30 (15.0)
Secondary school leaving certificate	2 (1.0)	59 (29.5)

[†] $\chi^2(4)=41.36$ ($p<0.01$)

Hygiene practices and faecal disposal disconnect

A critical knowledge-practice gap was observed among respondents who washed hands before eating, 51.5% still disposed of faeces outside in bushes, 3% flushed into toilets, and 3.5% threw

waste in yards. Among those washing hands after eating, none reported flushing faeces into toilets, while 3.5% disposed outside and 2.5% in yards. Chi-squared analysis confirmed a significant association between handwashing timing and faecal disposal

methods ($\chi^2=36.4$, $df=8$, $p<0.01$), indicating that hygiene knowledge does not necessarily translate to proper sanitation practices (Table 5).

Table 5: Cross-tabulation and χ^2 result for handwashing and faecal disposal[†]

Faecal disposal method	Handwashing practice <i>n</i> (%)		
	Before eating	After eating	Before and after eating
Dropped into toilet	0 (0.0)	0 (0.0)	6 (3)
Disposed outside premises/bush	40 (20)	7 (3.5)	103 (51.5)
Disposed in the yard	0 (0.0)	5 (2.5)	19 (9.5)
Buried	3 (1.5)	0 (0.0)	0 (0.0)
Nothing done / left there	0 (0.0)	0 (0.0)	17 (8.5)

[†] $\chi^2(8)=36.4$ ($p<0.01$)

Water discharge methods and toilet facilities

A cross-tabulation of the used water disposal patterns varied significantly by toilet facility type ($\chi^2=94.35$, $df=12$, $p<0.01$). Among the households, 40% discharged used water outside

premises/bushes, 29.5% into yards/gardens, 0.5% through open channels, and only 3.0% used sanitation facilities. This demonstrates that even respondents and their households with water access lack integrated wastewater management systems, potentially creating additional contamination pathways (Table 6).

Table 6: Cross-tabulation and χ^2 result for discharge of used water and type of toilet[†]

Discharge of used water	Toilet type <i>n</i> (%)			
	Sanitation facility	Open channel	Space outside premises/bush	Premises yard or garden
Used sanitation facility	6 (3.0)	0 (0.0)	0 (0.0)	0 (0.0)
Used potty inside house	0 (0.0)	0 (0.0)	3 (1.5)	4 (2.0)
Went into yard	1 (0.5)	0 (0.0)	27 (13.5)	0 (0.0)
Went outside premises	10 (5.0)	1 (0.5)	80 (40.0)	59 (29.5)
Not applicable	0 (0.0)	0 (0.0)	2 (1.0)	7 (3.5)

[†] $\chi^2(12)=94.35$ ($p<0.01$)

Environmental factors: soil type and flooding risk

Soil characteristics significantly influenced flooding vulnerability ($\chi^2=8.51$, $df=1$, $p=0.004$). Communities with loamy soil (52.5%) and sandy soil (36.5%) reported no flooding experience, while 10% in

loamy soil areas and 1% in sandy/rocky areas reported moderate flooding risk. Loamy soils, predominant in non-flooded areas, offer advantages for latrine siting and construction, while rocky or flood-prone areas present structural challenges for pit latrine feasibility (Table 7).

Table 7: Cross-tabulation and χ^2 result of risk of village flooding and soil condition[†]

Village flooding risk	Sandy/hard rocky soil	Loamy soil
Not subject to flooding	73 (36.5)	105 (52.5)
Somewhat at risk of flooding	2 (1.0)	20 (10.0)

[†] $\chi^2(1)=8.51$ ($p=0.004$)

Time interval used for accessing water across villages

One-way ANOVA revealed significant differences in water collection time across villages (F =significant, $p=0.01$). Communities BA and IT, as well as BE and AY, demonstrated similar water access

times (<10 minutes round trip), indicating relatively equitable water infrastructure distribution across study sites. The European Union-funded boreholes provided accessible water within walking distance for most households in all villages (Table 8).

Table 8: Analysis of variance: how long does it take to get water and return?

Analysis	Degrees of freedom	Sum of squares	Mean square	<i>F</i> statistic	<i>p</i> -value
Between-group	3	393.756	131.252	15.147	<0.01
Within-group	196	1698.399	8.665		

Predictors of water storage expenses

Multiple regression analysis identified significant predictors of household expenses for drinking water storage containers ($F(6,193)=7.44$, $p<0.001$, $R^2=0.188$). The model explained 18.8% of variance in storage expenses. Significant predictors included gender ($\beta=340.89$, $p=0.015$), number of adults ($\beta=-139.73$,

$p=0.008$), number of infants ($\beta=297.40$, $p=0.007$), preference for phone over latrine ($\beta=570.70$, $p<0.001$), perceived importance of handwashing for children ($\beta=77.80$, $p=0.001$), and child defecation location ($\beta=-191.31$, $p=0.005$). These findings suggest that household members, hygiene perceptions, and economic priorities collectively influence sanitation-related investments (Appendix I).

Discussion

This baseline assessment reveals a stark paradox in the rural state of Osun: near-universal water access (89.5%) coexists with near-universal open defecation (91.5%), highlighting that infrastructure provision alone is insufficient to achieve sanitation goals. The findings illuminate three critical barriers to sanitation adoption that have profound implications for Nigeria's 2030 open defecation-free target and broader CLTS implementation in resource-constrained settings.

The knowledge–practice gap in sanitation behaviour

The study revealed a disconnect between hygiene knowledge and actual sanitation practice, challenging fundamental CLTS assumptions that awareness automatically translates to behaviour change. Over half of respondents (51.5%) who practised handwashing before meals – indicating sanitation awareness – still disposed of faeces in open spaces. This paradox suggests that cognitive recognition of health risks is necessary but insufficient for behavioural transformation.

Previous studies in Ghana²⁰ and India¹⁵ similarly documented high sanitation awareness alongside persistent open defecation, attributing this gap to structural barriers including poverty, land scarcity, and social norms. The present study extends available literature by quantifying the specific magnitude of this disconnect and demonstrating its persistence even among educated respondents. Notably, no respondents who washed hands after eating reported proper faeces disposal (toilet flushing), suggesting that even sequential hygiene behaviours remain disconnected from sanitation infrastructure use.

The child faeces management gap further illustrates this paradox. Despite widespread awareness of diarrheal disease risks to children, caregivers routinely disposed of child faeces inappropriately, consistent with findings from Bangladesh²³ and Odisha, India¹⁵. The perception that child faeces are 'less dangerous' than adult faeces – though microbiologically inaccurate – persists across cultures and undermines comprehensive CLTS effectiveness.

Economic constraints and household decision-making

The data demonstrate an entrenched mindset regarding economic prioritization, showing that there is a choice across all income levels – and most acutely within the lowest-earning group (71% of the sampled population) – to allocate limited financial resources to non-sanitation expenses, significantly prioritized mobile phone purchases over latrine construction ($p=0.04$). This pattern, rather than reflecting 'irrationality', reveals the invisible nature of sanitation benefits compared to the immediate, tangible advantages of mobile phones (communication, economic opportunities, emergency access, social capital).

Economic theory explains this through temporal discounting and opportunity costs. Latrine construction requires substantial upfront capital (₦50,000–100,000 (A\$52.50–105.00) for basic facilities) with benefits that are preventive and diffuse (reduced illness frequency, dignity, environmental protection). In contrast, mobile phones provide immediate returns. For respondents earning less than

₦50,000 (<A\$52.50) monthly, allocating 2 or 3 months' income to sanitation while facing daily food insecurity represents an economically untenable choice.

This finding challenges CLTS's core 'no subsidy' principle, which assumes communities can mobilize resources through cost reduction (local materials, communal labour) and collective action. While this approach succeeds in middle-income contexts, the present study data reveal it may be inappropriate for extreme poverty settings. Similar critiques have emerged from evaluations in Ethiopia²⁴ and Kenya²⁵, where non-subsidized CLTS achieved limited sustained coverage among the poorest households.

Environmental constraints to latrine feasibility

The significant association between soil type and flooding risk ($p=0.004$) highlights often-overlooked environmental determinants of sanitation success. While 52.5% of respondents occupied areas with favourable loamy soils, communities in flood-prone or rocky terrain face structural barriers to conventional pit latrine construction. During rainy seasons (April–October in southern Nigeria), pit latrines in clayey or low-lying areas rapidly fill with water, collapse, or overflow, creating health hazards and financial losses that discourage reconstruction.

The loamy soils prevalent in the study areas (52.5%), while structurally favourable for pit latrine construction, may facilitate bacterial transport to depths of 1 metre within weeks of faecal deposition, through preferential flow pathways²⁶. Furthermore, under tropical conditions, high nitrification rates can result in elevated nitrate relative to ammonium, depending on soil properties, thereby creating groundwater contamination pathways that undermine improved water infrastructure²⁷. Consequently, appropriate siting and design standards become critical in such environments. To mitigate groundwater pollution risks, the base of pit latrines should be positioned at least 2–15 m above the groundwater table and maintain a minimum horizontal distance of 30 m from any water source to limit microbial exposure^{9,28}.

Climate change intensifies these challenges. Increasingly erratic rainfall patterns in West Africa²⁹ produce both extended droughts (affecting water availability for flush latrines) and intense flooding events (destroying pit latrines). CLTS programs rarely incorporate climate adaptation strategies or alternative sanitation technologies (raised latrines, composting toilets, biodigesters) suitable for difficult environments.

Gender and sociocultural determinants of sanitation behaviour

The study highlights a critical need to investigate gender dimensions within local sanitation efforts. Women and girls (46% in this study) bear the brunt of open defecation risks, facing unique menstrual hygiene, safety, and water collection challenges.

Previous studies reveal how inadequate sanitation facilities force women to defecate during darkness for privacy, increasing exposure to violence and snakebites^{30,31}. The present data also indicated that younger household members bear 83% of water collection and cleaning responsibilities, highlighting a critical vulnerability: exposure of children and adolescents to acute occupational health risks through direct faecal contact in the absence of protective equipment in the environment.

The observed high prevalence of open defecation (91.5%) and poor handwashing–sanitation integration (51.5% practising handwashing yet disposing faeces openly) cannot be attributed solely to gender dynamics or infrastructure deficits. The study reveals underlying attitudinal and sociocultural factors that fundamentally shape sanitation behaviours; specifically, when the majority of a community engages in open defecation, the practice becomes culturally normalized and ceases to be viewed as deviant or shameful.

This explains why knowledge alone (handwashing awareness) fails to translate to behaviour change – social norms override individual cognition²⁵. Also, a perceived convenience and free open spaces (remarks observed during discussion sessions) revealed that some community members explicitly preferred open defecation, citing the freedom of open spaces, natural privacy of bushes, and avoidance of confined, potentially malodorous latrine structures. This preference, particularly among older adults socialized into these practices from childhood, represents an attitudinal barrier distinct from resource constraints. The perception that ‘our ancestors lived this way and were healthy’ reflects resistance rooted in tradition rather than ignorance²⁶.

Contribution to knowledge and alignment with the Sustainable Development Goals

This study advances CLTS and environmental health studies by providing empirical evidence that challenges key assumptions underlying sanitation behaviour change in rural Nigeria, while directly engaging with Sustainable Development Goal (SDG) 6.2 (equitable access to sanitation) and SDG 3.9 (reduction of disease from environmental pollution). Notably, the findings demonstrate a pronounced knowledge–practice gap: over half of respondents who reported regular handwashing still practised open defecation. This quantitatively documented disconnect, rarely captured in West African CLTS literature, indicates that awareness alone is insufficient to drive sustained sanitation behaviour change and underscores the need for redesigned, context-sensitive CLTS approaches.

The study further reframes poor sanitation not as a function of ignorance but as economically rational decision-making under severe poverty. Households overwhelmingly prioritized essential communication tools over sanitation infrastructure, reflecting constrained livelihood realities rather than behavioural negligence. In addition, integrating environmental feasibility factors, such as soil conditions and flooding risk, with behavioural data revealed that a subset of communities faces structural barriers to conventional pit latrine construction. This methodological contribution strengthens CLTS diagnostics by demonstrating the necessity of aligning sanitation technologies with local ecological conditions, while the documentation of widespread child faeces mismanagement highlights a critical but under-addressed pathway of environmental contamination.

From an SDG perspective, the findings reveals that Nigeria’s ambition of achieving nationwide open defecation–free status by 2030 is unlikely under prevailing non-subsidized CLTS models. To

eliminate open defecation by 2030, rural sanitation strategies must combine direct financial subsidies for vulnerable households with diverse technological choices (a range of affordable, adaptable toilet designs) and long-term behavioural change initiatives.. By providing baseline data relevant to SDG 6.2.1, documenting environmental health risks linked to SDG 3.9, and revealing equity and environmental justice gaps, this study contributes actionable evidence for more realistic, inclusive, and sustainable sanitation planning in Nigeria and similar settings.

Conclusion

This study demonstrates a major gap between sanitation awareness, water access, and actual hygiene practices in rural Nigeria, showing that awareness campaigns alone cannot overcome financial insufficiency and environmental limitations. Achieving Nigeria’s 2030 open defecation-free target, and broader SDG 6 commitments, requires moving beyond awareness campaigns toward comprehensive interventions addressing economic barriers, environmental feasibility, and long-term sustainability.

CLTS remains a valuable participatory mobilization tool, but its non-subsidized approach appears insufficient for contexts where households earn below poverty thresholds.

The authors recommend adaptive CLTS models incorporating:

- targeted subsidies for the poorest households
- environmental pre-assessments guiding appropriate sanitation technologies
- integration with livelihood programs to address opportunity costs
- routine water quality monitoring for chemical and microbial indicators to quantify contamination and guide water source protection
- strengthened government accountability for infrastructure investment.

Without these policy reforms, rural communities will continue to face impossible choices between immediate survival needs and long-term sanitation investments – perpetuating the environmental health crisis documented in this study.

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Conflicts of interest

The authors declare that they have no competing interests.

AI disclosure statement

We used artificial intelligence (Claude.ai) to enhance understanding of our own keywords and writing in order to clarify meaning for readers. All content has been thoroughly reviewed, fact-checked, and edited by human authors to ensure accuracy and quality.

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Appendix

Appendix I: Model statistics for cost of water storage

Table A1: Analysis of variance estimate of regression model for cost of water storage

Model	Degrees of freedom	Sum of squares	Mean square	F statistic	p-value
Regression	6	36754510.625	6125751.771	7.439	<0.001
Residual	193	158932439.375	823484.142		

Table A2: Regression coefficient for fitting a predictive model for cost of water storage

Variable	Coefficient	Standard error	t statistic	p-value
Intercept	-1368.998	701.627	-1.951	0.052
Gender	340.886	139.038	2.452	0.015
Number of adults	-139.734	52.175	-2.678	0.008
Number of infants	297.403	108.241	2.748	0.007
Phone preference	570.697	135.886	4.200	0.000
Handwashing for children	77.795	22.153	3.512	0.001
Child defecation location	-191.306	67.139	-2.849	0.005

Table A3: Model summary statistics for fitting predictive model for cost of water storage

Model statistic	Estimate
R	0.433
R^2	0.188
Adjusted R^2	0.163
Standard error of the estimate	907.460

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