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Factors influencing Sanitation Practices among Primary School Pupils in Port Harcourt Metropolis, Rivers State, Nigeria: Implications for Sustainable Development Goals

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Mercy Sor-Aniabari Joshua[1], Best Ordinioha[1], Michael Ige Ediabai Edaba[2]

[1]Department of Public Health, Faculty of Public Health, University of Port Harcourt, Choba, Nigeria
[2]Department of Agricultural Economics, University of Africa, Toru-Orua, Nigeria, Nigeria,

MIEE 0000000238475891

Correspondence: Michael Ige Ediabai Edaba, michael.edaba@uat.edu.ng

Abstract

School sanitation Access to adequate sanitation and hygiene facilities in schools remains a major public health challenge in many developing countries, with significant implications for child health, educational attainment, and sustainable development. This study assessed sanitation facilities and examined factors influencing hygienic practices among primary school pupils in Port Harcourt Metropolis, Rivers State, Nigeria. A comparative cross-sectional design was adopted involving 220 pupils selected from public and private primary schools. Data were collected using structured questionnaires and observational checklists. Descriptive statistics, Pearson's Chi-square analysis, Cramer's V, the Sanitation Infrastructure Index (SII), and log-linear models were employed for data analysis. The findings revealed substantial disparities in sanitation infrastructure between school types. Private schools recorded a Sanitation Infrastructure Index of 79.2%, classified as good, whereas public schools recorded 45.8%, indicating only fair sanitation conditions. Knowledge ($\chi^2 = 17.561, p = 0.002, V = 0.210$) and attitude ($\chi^2 = 17.246, p = 0.002, V = 0.208$) emerged as significant determinants of hygienic practices, while age and gender demonstrated negligible associations. Log-linear analysis further confirmed the significant influence of knowledge and attitude on pupils' hygiene behaviour. The study concludes that effective school sanitation requires both adequate infrastructure and behavioural interventions. Strengthening school WASH facilities, promoting hygiene education, and adopting inclusive sanitation policies are essential for improving child health outcomes and accelerating progress toward Sustainable Development Goals 3, 4, and 6.

Keywords: Practices, Sanitation, Hygiene, Pupils, Knowledge Sdgs

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Introduction

School sanitation and hygiene constitute fundamental components of child health, educational achievement, and sustainable development. Access to safe drinking water, adequate sanitation facilities, and appropriate hygiene practices within school environments contributes significantly to disease prevention, improved school attendance, enhanced learning outcomes, and overall well-being among school-aged children. Schools are not only centres of academic learning but also important environments where lifelong health behaviours are developed and reinforced. Consequently, the provision of safe and inclusive Water, Sanitation and Hygiene (WASH) services has become a global public health priority and a key indicator of educational quality and social development (World Health Organization [WHO] & United Nations Children's Fund [UNICEF], 2024).

Despite considerable progress in expanding WASH services globally, substantial inequalities remain. Recent estimates indicate that approximately 447 million children worldwide still attend schools without basic drinking water services, 427 million lack access to basic sanitation facilities, and 646 million do not have basic hygiene services in their schools (United Nations, 2025; WHO & UNICEF, 2024). These deficiencies are particularly prevalent in low- and middle-income countries where inadequate infrastructure, limited financial resources, weak maintenance systems, and rapid population growth continue to hinder progress toward universal WASH access. Consequently, millions of children remain exposed to preventable health risks, including diarrhoeal diseases, intestinal parasitic infections, respiratory illnesses, and other sanitation-related conditions that adversely affect educational attainment and quality of life.

Sub-Saharan Africa bears a disproportionate share of the global burden of inadequate school sanitation. In many countries within the region, insufficient sanitation facilities, overcrowded classrooms, unreliable water supply, and poor hygiene conditions remain common features of school environments. These challenges are often more pronounced in public schools due to resource constraints and inadequate institutional support. Beyond their health implications, inadequate sanitation facilities contribute to absenteeism, poor concentration, reduced academic performance, and social exclusion, particularly among girls and children with disabilities. As a result, inequalities in school WASH services have been identified as major obstacles to achieving Sustainable Development Goal 6 (Clean Water and Sanitation) and other interconnected development goals (Wada et al., 2022).

In Nigeria, disparities in sanitation infrastructure between public and private schools continue to pose significant public health concerns. Studies conducted across different regions of the country have consistently reported inadequate sanitation facilities, poor access to water, insufficient handwashing infrastructure, and weak compliance with recommended pupil-to-toilet ratios. Wami et al. (2022) reported that many schools in Rivers State lacked adequate hygiene services and reliable access to water and soap for handwashing, while Nnaji (2023) documented substantial deficiencies in WASH facilities among schools in Enugu State. Similarly, Ijeoma et al. (2020) observed poor hygiene practices among primary school pupils in Delta State, whereas Ibrahim and Tanimu (2021) identified hygiene knowledge and access to sanitation facilities as significant determinants of hygiene behaviour among pupils in Kano State. Ezeani and Ogbonna (2020) further reported that inadequate sanitation infrastructure and poor hygiene awareness negatively influenced hygiene practices among school children in Enugu State. Collectively, these findings indicate that sanitation challenges remain widespread across Nigerian schools despite ongoing efforts to improve WASH services.

Beyond the availability of sanitation infrastructure, hygienic practices among pupils are influenced by a complex interaction of demographic, cognitive, behavioural, and environmental factors. Previous studies

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have demonstrated that age, hygiene knowledge, attitudes, social norms, and behavioural motivations significantly influence sanitation-related behaviours among school children (Curtis et al., 2009; Dreibelbis et al., 2016). While adequate sanitation facilities create an enabling environment for healthy behaviours, pupils must also possess sufficient knowledge and positive attitudes to translate available opportunities into consistent hygienic practices. Recent evidence from Nigerian schools revealed substantial gaps between hygiene knowledge and actual handwashing practices, emphasizing the need for interventions that simultaneously address behavioural and infrastructural determinants of sanitation outcomes (Aremu et al., 2022; Melaku & Addis, 2023).

Although several studies have investigated sanitation conditions and hygiene practices in Nigerian schools, empirical evidence simultaneously examining sanitation infrastructure and behavioural determinants among pupils remains limited, particularly in rapidly urbanizing environments such as Port Harcourt Metropolis. Existing studies have largely focused on either infrastructural conditions or hygiene behaviour without adequately exploring the interaction between these dimensions. Furthermore, comparative evidence assessing differences between private and public primary schools' remains scarce despite growing concerns regarding inequalities in access to school WASH services. Addressing this knowledge gap is essential for developing evidence-based interventions capable of improving child health outcomes, educational achievement, and sustainable development.

Therefore, this study assessed sanitation facilities and examined the factors influencing hygienic practices among primary school pupils in Port Harcourt Metropolis, Rivers State, Nigeria. Specifically, the study sought to: assess and compare the availability and quality of sanitation facilities in selected private and public primary schools; examine the socio-demographic and behavioural factors associated with hygienic practices among pupils; determine the strength of association between selected explanatory variables and hygienic practices using Pearson's Chi-square test and Cramer's V; evaluate sanitation conditions through the development of a Sanitation Infrastructure Index (SII); and investigate the effects of age, gender, knowledge, and attitude on hygienic practices using log-linear modelling. The findings are expected to provide evidence for improving school sanitation policies and contribute to the achievement of Sustainable Development Goals 3 (Good Health and Well-being), 4 (Quality Education), and 6 (Clean Water and Sanitation).

Conceptual Framework

The conceptual framework for this study posits that pupils' hygienic practices are influenced by both individual-level factors and school-level environmental conditions. Individual factors include age, gender, hygiene knowledge, and attitude toward sanitation, which collectively shape pupils' awareness, perceptions, and willingness to adopt appropriate hygiene behaviours. Drawing from the Knowledge–Attitude–Practice (KAP) framework and Rogers' Diffusion of Innovations Theory, the framework assumes that pupils with greater knowledge of hygiene and more positive attitudes toward sanitation are more likely to engage in proper handwashing, toilet use, and personal cleanliness practices.

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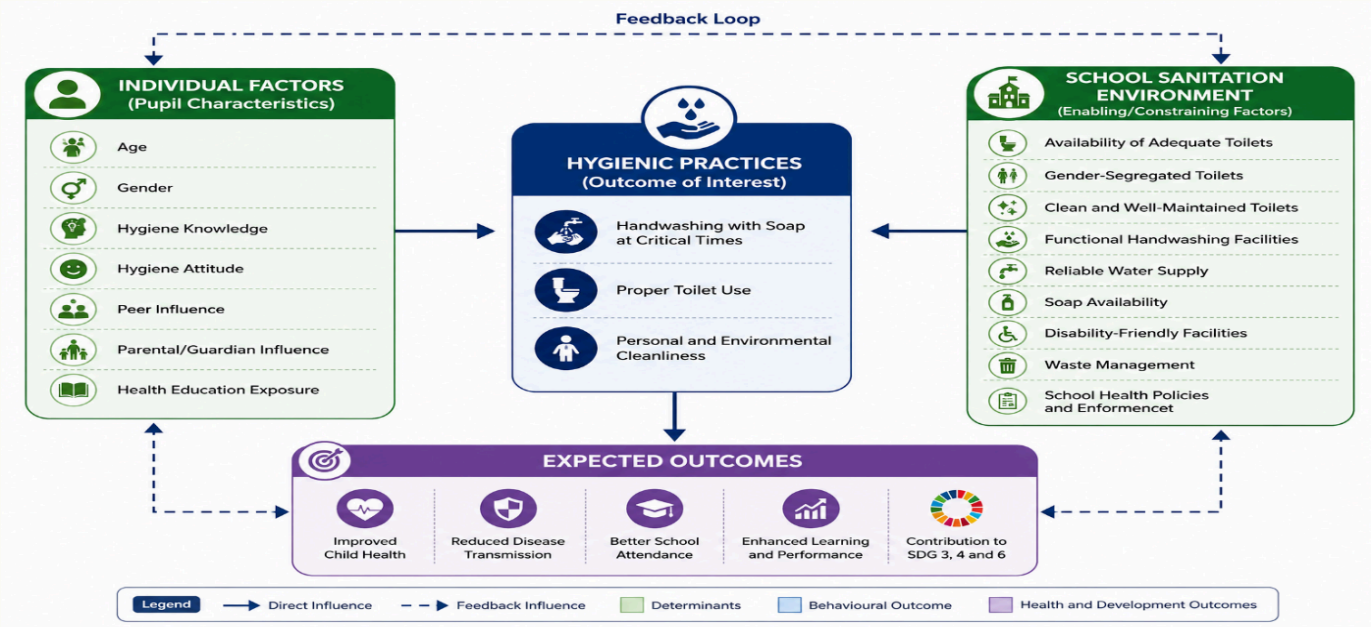

Figure 1: conceptual framework of the study

At the institutional level, sanitation infrastructure serves as an enabling factor that facilitates or constrains hygiene behaviour. The availability of adequate toilets, gender-segregated sanitation facilities, functional handwashing stations, reliable water supply, clean toilet environments, and disability-friendly facilities collectively constitute the school sanitation environment. These infrastructural conditions directly influence pupils' ability to translate hygiene knowledge into actual practice. Consequently, the framework assumes that hygienic practices are the outcome of interactions between individual characteristics and school sanitation conditions. Improved hygienic practices are expected to contribute to better health outcomes, reduced disease transmission, enhanced school attendance, and progress toward Sustainable Development Goals 3 (Good Health and Well-being), 4 (Quality Education), and 6 (Clean Water and Sanitation)

Theoretical Framework

This study was anchored on Rogers' Diffusion of Innovations Theory (Rogers, 2003), which explains how new ideas, behaviours, and practices spread through social systems over time. The theory posits that adoption of innovations is influenced by perceived benefits, compatibility with existing values, communication channels, and social interactions. In the context of school sanitation, behaviours such as handwashing with soap, proper toilet use, and environmental cleanliness can be regarded as innovations that diffuse among pupils through interactions with teachers, peers, and school authorities. The theory therefore provides a useful framework for understanding variations in hygiene behaviour and identifying pathways for promoting sustainable sanitation practices among primary school pupils.

Materials and Method

Study Area

The study was conducted in Port Harcourt Metropolis, the capital of Rivers State, located in the South-South geopolitical zone of Nigeria. Port Harcourt Metropolis comprises the Port Harcourt City and Obio/Akpor Local Government Areas and serves as one of the country's most important economic and industrial centres. The metropolis is characterized by rapid urbanization, high population density, and considerable socioeconomic diversity, with an estimated population exceeding three million inhabitants (National Population Commission [NPC], 2023). Its strategic role as the hub of Nigeria's petroleum

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industry has stimulated substantial infrastructural development, population growth, and urban expansion over the past two decades.



Figure 2: the map of Port Harcourt City

The metropolis hosts a large concentration of both public and private educational institutions that differ considerably in funding, management structures, and infrastructural capacities. These variations make the area particularly suitable for comparative studies on school sanitation, hygiene behaviour, and child health outcomes. Previous studies have reported significant disparities in water, sanitation, and hygiene (WASH) facilities among schools within urban centres in Nigeria, including Rivers State (Wami et al., 2022; Wada et al., 2022). Furthermore, the city's socioeconomic heterogeneity provides an appropriate context for examining how environmental and behavioural factors interact to influence sanitation practices among school children.

The study population comprised primary school pupils aged 6–14 years enrolled in selected public and private primary schools within Port Harcourt Metropolis. Pupils within this age range were considered appropriate because they are active users of school sanitation facilities and possess sufficient cognitive ability to understand and respond reliably to interviewer-administered questionnaires. In addition, this age group represents a critical stage for the development and reinforcement of lifelong hygiene behaviours, making it particularly relevant for sanitation and public health research (Babalola et al., 2020; UNICEF, 2021)

Sample Size and Sampling Technique

The sample size for this study was determined using Cochran's formula for estimating proportions in large populations, which is widely recommended for population-based cross-sectional studies (Charan & Biswas, 2013). A total of 220 pupils participated in the study, comprising 110 pupils from private primary schools and 110 pupils from public primary schools, giving a total of 220 pupils. This sample size was considered sufficient to detect meaningful differences in sanitation practices and associated factors between the two school categories. The calculated sample was subsequently allocated proportionately across the two strata (public and private schools). Within each selected school, pupils were randomly selected from upper primary classes (Primary 4–6), as pupils within this age group are generally more capable of understanding and providing reliable responses to hygiene-related questions. This approach is

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consistent with previous school-based hygiene studies conducted among primary school children in Nigeria and other developing countries (Babalola et al., 2020).

The Cochran formula, as described by Charan and Biswas (2013), is expressed as:

$$n_0 = \frac{Z^2_{1-\alpha/2}\, p(1-p)}{d^2} \quad (1)$$

Where:

n_0 = initial estimated sample size

$Z_{1-\alpha/2}$ = standard normal deviate at a 95% confidence level (1.96)

p = estimated prevalence of good hygienic practices among pupils

$1 - p$= complementary proportion

d = margin of error (precision), set at 5% (0.05)

A multistage sampling technique was adopted. In the first stage, public and private primary schools within the metropolis were stratified by ownership. In the second stage, a simple random sampling method was used to select an equal number of schools from each stratum. In the final stage, eligible pupils were selected from the chosen schools using systematic random sampling, based on class registers, until the required sample size was attained. An adapted observational checklist was used to assess the availability, quality, and functionality of sanitation facilities in the selected schools. Indicators assessed included number of toilets, gender segregation, cleanliness, water availability, presence of handwashing facilities, and disability-accessible toilets. A pre-tested, interviewer-administered structured questionnaire was used to collect data on pupils' socio-demographic characteristics, sanitation-related knowledge, attitudes, and hygiene practices. The questionnaire was designed in simple language to enhance comprehension and reliability of responses. Also, hygienic practices were assessed using composite scores derived from responses to practice-related questions. Based on established cut-off points, sanitation practices were categorized as good, average, or poor. Knowledge and attitude variables were similarly scored and categorized to allow for meaningful statistical comparison,

Data Analysis

Data were coded and analyzed using Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics, including frequencies and percentages, were used to summarize variables. Pearson's Chi-square test was employed to determine whether significant associations existed between hygienic practices and selected explanatory variables, namely age, gender, knowledge, and attitude. The test compares observed frequencies with expected frequencies under the assumption of independence between variables. A statistically significant Chi-square value indicates that the observed distribution differs from what would be expected by chance, suggesting the presence of an association between the variables. In this study, the Chi-square analysis revealed that knowledge and attitude were significantly associated with hygienic practices, whereas age and gender showed no significant relationships. While the Chi-square test is useful for detecting the existence of an association, it does not indicate the strength or practical importance of the relationship, thereby necessitating the use of an effect size measure.

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To address this limitation, Cramer's V was calculated to quantify the strength of the association between each factor and hygienic practice. Cramer's V is a standardized measure of association derived from the Chi-square statistic and is particularly appropriate for contingency tables of varying dimensions. The statistic ranges from 0 to 1, where values closer to zero indicate weak associations and values closer to one indicate stronger relationships. The measure was computed using Equation (1):

$$V = \sqrt{\frac{\chi^2}{N(k-1)}} \quad (2)$$

Where,

$V =$ Cramer's V

$\chi^2 =$ Pearson Chi-square statistic

$N =$ total sample size

$k =$ number of rows or columns in the contingency table.

By standardizing the Chi-square value, Cramer's V facilitates meaningful comparisons of association strength across different variables regardless of table size. The combined use of Pearson's Chi-square test and Cramer's V provides a more comprehensive interpretation of the results than either statistic alone. While the Chi-square test identifies whether an association exists, Cramer's V evaluates the magnitude of that association and its practical significance. In the present study, knowledge and attitude exhibited weak-to-moderate associations with hygienic practices, indicating that these behavioural factors play meaningful roles in shaping hygiene behaviour among pupils. Conversely, age and gender demonstrated negligible effect sizes, suggesting that demographic characteristics contributed little to explaining differences in hygienic practices. This dual analytical approach strengthens the robustness of the findings by enabling both statistical significance testing and effect size assessment, which are increasingly recommended in public health and educational research for informed decision-making and policy development (Cohen, 1988; Kim, 2017; McHugh, 2013).

In addition, to provide a more comprehensive assessment of school sanitation conditions, this study developed a Sanitation Infrastructure Index (SII), which aggregates multiple sanitation indicators into a single composite measure. Composite indices are widely used in public health and sustainable development research because they summarize multidimensional phenomena into an interpretable metric that facilitates comparison across institutions and settings. The SII was constructed using six key WASH indicators: adequacy of toilet facilities, availability of gender-segregated toilets, toilet cleanliness, functionality of handwashing stations, reliability of water supply, and accessibility for pupils with disabilities. These indicators are consistent with international school WASH standards advocated by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), which emphasize safe, inclusive, and gender-responsive sanitation facilities as essential components of healthy learning environments.

The SII enables objective comparison of sanitation performance between public and private schools by converting multiple infrastructure characteristics into a standardized score ranging from 0 to 100, where higher values indicate better sanitation conditions. Unlike individual indicators, the index provides a holistic representation of school sanitation environments and allows for the identification of infrastructural gaps that may influence pupils' hygiene behaviours and health outcomes. Furthermore, the index offers a

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practical and replicable framework for monitoring progress toward Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), and SDG 6 (Clean Water and Sanitation), thereby supporting evidence-based policy interventions and resource allocation in the education sector.

The index is specified as:

$$SII = \frac{\sum_{i=1}^{n} X_i}{n} \quad (3)$$

where:

SII= Sanitation Infrastructure Index

X_i= Percentage score of the i^{th}sanitation indicator

n= Total number of sanitation indicators assessed

$i = 1, 2, 3, \ldots, n$

For this study, $n = 6$

representing the following sanitation indicators:

Adequate number of toilets available

Separate toilets for boys and girls

Clean and litter-free toilets

Functional handwashing stations

Continuous water supply

Toilets accessible to pupils with disabilities

The index ranges from:

$0 \leq SII \leq 100$

where:

0 indicates complete absence of sanitation infrastructure;

100 indicates full compliance with all assessed sanitation indicators.

Interpretation: 0-39.9 = poor, 440 - 59.9 = fair, 60 – 79.9 = good, 80 – 100 = excellent

Also, a log-linear model was employed to examine the relationships between hygienic practices and selected categorical factors among pupils in private and public primary schools. Log-linear analysis is a multivariate statistical technique used to analyze associations among categorical variables by modeling the natural logarithm of expected cell frequencies in a contingency table as a linear combination of main and interaction effects. Unlike traditional regression models that require a clearly defined dependent variable, log-linear models treat all variables symmetrically and are particularly suitable for multidimensional categorical data. In this study, hygienic practice (good, average, and poor) was analyzed in relation to age,

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gender, knowledge, attitude, and school type. The general form of the model, as used by Yıldız, (2023) is expressed as:

$$\ln ln\left(\mu_{ijklm}\right) = \lambda + \lambda_i^H + \lambda_j^A + \lambda_k^G + \lambda_l^K + \lambda_m^T + \lambda_{ij}^{HA} + \lambda_{ik}^{HG} + \lambda_{il}^{HK} + \lambda_{im}^{HT} + \lambda_{ij}^{ST} + \varepsilon \quad (4)$$

where,

μ_{ijklm} = expected frequency in each cell of the contingency table;

$\lambda$is = overall mean effect; λ_i^H, λ_j^A, λ_k^G, λ_l^K,

λ_m^T = main effects of hygienic practice, age, gender, knowledge, and attitude, respectively;

λ_{ij}^{HA}, λ_{ik}^{HG}, λ_{il}^{HK}, λ_{im}^{HT}, λ_{ij}^{ST} = the interaction effects between hygienic practice and explanatory variables;

ε = random error term.

Statistical significance was assessed at the 5% level ($p < 0.05$), with significant interaction terms indicating the existence of an association between hygienic practice and the corresponding explanatory variable. This approach enabled the identification of factors that significantly influenced pupils' hygienic practices while accounting for the multidimensional nature of the categorical data.

Results and Discussions

Table 1: The sanitation facilities in private and public primary schools.

Sanitation Facilities	Private Schools Number/Total (%)	Public Schools Number/Total (%)
Adequate number of toilets available	3/4 (75%)	2/4 (50%)
Separate toilets for boys and girls	4/4 (100%)	2/4 (50%)
Toilets are clean and free of litter	3/4 (75%)	1/4 (25%)
Functional handwashing stations	4/4 (100%)	3/4 (75%)
Continuous water supply	3/4 (75%)	2/4 (50%)
Toilets accessible to students with disabilities	2/4 (50%)	1/4 (25%)

Source: field survey, 2024.

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The findings presented in Table 1 shows the availability and condition of sanitation facilities in private and public primary schools, revealing notable disparities in sanitation infrastructure between the two school categories. Private schools consistently recorded higher levels of sanitation facility provision than public schools across most indicators. Adequate numbers of toilets were available in 75% of private schools compared with 50% of public schools, while all private schools (100%) provided separate toilets for boys and girls compared with only 50% of public schools. The provision of gender-segregated sanitation facilities is particularly important in promoting privacy, dignity, and regular school attendance, especially among female pupils. These findings suggest that private schools generally maintain better sanitation standards, which may contribute to a healthier and more conducive learning environment for pupils. Similar disparities between private and public schools have been reported in developing countries, where private institutions often have greater financial capacity to provide and maintain sanitation infrastructure (Adams et al., 2009).

The condition and functionality of sanitation facilities also differed substantially between the two school types. While 75% of private schools reported clean and litter-free toilets, only 25% of public schools met this standard. Likewise, all private schools (100%) had functional handwashing stations, compared with 75% of public schools. Clean sanitation facilities and access to handwashing stations are critical components of school hygiene because they reduce the transmission of infectious diseases and encourage positive hygiene behaviours among pupils. The availability of functional handwashing facilities is particularly important for preventing diarrhoeal diseases and respiratory infections, which remain major public health concerns among school-aged children. According to the Joint Monitoring Programme of the World Health Organization and UNICEF, schools that provide adequate sanitation and handwashing facilities are more likely to achieve improved health outcomes and reduced absenteeism among pupils.

The study further revealed deficiencies in water supply and accessibility for students with disabilities, particularly in public schools. Continuous water supply was available in 75% of private schools but only 50% of public schools, while disability-accessible toilets were available in 50% and 25% of private and public schools, respectively. These findings indicate that both school categories, especially public schools, still face challenges in achieving inclusive and sustainable sanitation services. Access to water is essential for the effective use and maintenance of sanitation facilities, while disability-friendly infrastructure ensures that all pupils can enjoy equal opportunities for safe sanitation. The low provision of accessible toilets observed in the study highlights a need for greater attention to inclusive school infrastructure development. Consistent with findings from UNESCO (2022), inadequate and inaccessible sanitation facilities can negatively affect pupils' well-being, participation, and educational outcomes. Therefore, increased investment in school WASH facilities, particularly in public schools, is necessary to improve hygiene conditions and promote equitable access to quality education.

Table 2: Chi-square and Cramer's V Analysis of Factors Associated with Hygienic Practices among Pupils

Factor	χ^2	df	p-value	Cramer's V	Strength of Association
Age × Hygienic Practice	3.356	4	0.002**	0.092	Negligible
Gender × Hygienic Practice	0.052	2	0.974	0.016	Negligible

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Knowledge ×Hygienic Practice	17.561	4	0.002**	0.210	Weak–Moderate
Attitude × Hygienic Practice	17.246	4	0.002**	0.208	Weak–Moderate

Source: field survey, 2024

The results presented in Table X indicate that knowledge and attitude were the most important factors associated with hygienic practices among pupils, while age and gender showed negligible relationships. Knowledge demonstrated a statistically significant association with hygienic practice ($\chi^2 = 17.561$, $p = 0.002$, $V = 0.210$), suggesting that pupils with better hygiene knowledge were more likely to engage in appropriate hygienic behaviours. Although the effect size was categorized as weak-to-moderate, it was the strongest among the variables examined. This finding supports the Knowledge–Attitude–Practice (KAP) model, which emphasizes that adequate knowledge is a prerequisite for the adoption of healthy behaviours. Previous studies have similarly reported that increased hygiene awareness significantly improves handwashing, sanitation behaviour, and disease prevention practices among school children. Recent evidence from Nigeria and other developing countries has shown that hygiene education interventions contribute substantially to improved hygiene behaviour when pupils understand the health consequences of poor sanitation and inadequate handwashing practices.

Attitude also exhibited a statistically significant association with hygienic practice ($\chi^2 = 17.246$, $p = 0.002$, $V = 0.208$), with a Cramer's V value nearly identical to that of knowledge. This finding suggests that positive attitudes toward hygiene play a critical role in translating knowledge into actual behaviour. Pupils who perceive hygiene as important for disease prevention and personal well-being are more likely to consistently practice handwashing, proper sanitation, and personal cleanliness. The result aligns with behavioural theories such as the Health Belief Model and the Theory of Planned Behaviour, which identify attitudes, perceived benefits, and behavioural intentions as important predictors of health-related actions. Recent studies examining handwashing behaviour among school children have reported that positive attitudes, social norms, and behavioural motivation are often stronger predictors of hygiene practices than demographic characteristics alone. Consequently, effective school hygiene programmes should combine knowledge dissemination with behavioural change strategies aimed at fostering positive hygiene attitudes and sustained compliance with recommended practices.

Conversely, age ($\chi^2 = 3.356$, $p = 0.500$, $V = 0.002$) a positive significant association while gender ($\chi^2 = 0.052$, $p = 0.974$, $V = 0.016$) demonstrated association with hygienic practice. The very low Cramer's V values indicate that these demographic characteristics contributed little to explaining differences in hygiene behaviour among the pupils. The absence of significant gender differences suggests that boys and girls may have experienced similar exposure to hygiene information and school sanitation programmes. Likewise, the weak association observed for age implies that hygienic behaviour may depend more on behavioural, educational, and environmental factors than on developmental characteristics alone. This finding is consistent with evidence indicating that access to functional water, sanitation, and hygiene (WASH) facilities, school support systems, and hygiene promotion programmes exert stronger influences on hygiene practices than demographic variables.

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Sanitation Infrastructure Index

Private Primary Schools

$$SII_{Private} = \frac{75+100+75+100+75+50}{6}$$

$$SII_{Private} \approx 79.2$$

Public Primary Schools

$$SII_{Public} = \frac{50+50+25+75+50+25}{6}$$

$$SII_{Public} \approx 45.8$$

Table 3: Sanitation infrastructure index

School type	SII Score	Status
Private schools	79,2	Good
Public schools	45.8	Fair
Difference	33.4	Substantia gap

Source: field survey,2024

Table 3 presents the Hygiene Infrastructure Index (HII) for private and public primary schools, revealing marked disparities in the availability and quality of hygiene-supporting facilities. Private schools attained an index score of **79.2**, which falls within the *good* category, indicating that the majority of these schools possess adequate hygiene infrastructure such as functional handwashing stations, reliable water supply, sanitation facilities, and waste management systems. The availability of such facilities is fundamental to promoting positive hygiene behaviours among pupils and reducing the incidence of hygiene-related diseases. Research has consistently shown that schools with adequate water, sanitation, and hygiene (WASH) infrastructure provide healthier learning environments and encourage better compliance with hygiene practices among children (Freeman et al., 2014; Adams et al., 2009). The high score recorded by private schools may reflect better funding mechanisms, stronger maintenance practices, and greater institutional commitment to providing conducive learning environments.

Conversely, public schools recorded a Hygiene Infrastructure Index score of 45.8, classified as *fair*, suggesting that many public schools still face challenges in providing adequate hygiene facilities. The substantial gap of 33.4 points between private and public schools highlights significant inequalities in access to hygiene infrastructure. Such disparities may limit pupils' ability to practice recommended hygiene behaviours, even when they possess adequate knowledge and positive attitudes toward hygiene. According to the Joint Monitoring Programme of the World Health Organization and UNICEF, inadequate school hygiene facilities remain a major challenge in many developing countries and contribute to increased risks of communicable diseases, absenteeism, and poor educational outcomes. The findings therefore underscore the need for targeted government investment, infrastructure rehabilitation, and

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strengthened WASH programmes in public schools to bridge the observed gap and ensure equitable access to healthy learning environments for all pupils (WHO & UNICEF, 2023; UNESCO, 2022).

Table 4: log-linear effect of factors influencing hygiene practices among pupils

Variable	P-value	Log-linear effect	Decision
Age	0.002	Significant ($\lambda_{HA} \neq 0$)	Associated with hygienic practice
Gender	0.632	Not significant ($\lambda_{HG} = 0$)	Not associated
Knowledge	0.001	Significant ($\lambda_{HK} \neq 0$)	Associated with hygienic practice
Attitude	0.001	Significant ($\lambda_{HT} \neq 0$)	Associated with hygienic practice

Source: field survey, 2024

The log-linear analysis presented in Table 4 revealed a statistically significant association between age and hygienic practice among pupils ($p = 0.002$). Pupils aged 9–11 years demonstrated the highest proportion of good hygienic practices in both private and public schools, suggesting that hygiene-related behaviours may improve with cognitive maturity and increased exposure to health education. Children within this age bracket are generally more capable of understanding and applying hygiene instructions than younger pupils, while older pupils may experience behavioural influences that reduce adherence to hygiene guidelines. This finding aligns with studies showing that age is an important determinant of health behaviour among school-aged children because developmental stages influence knowledge acquisition, risk perception, and personal responsibility for hygiene practices. Research by Vivas et al. (2010) and Freeman et al. (2014) similarly reported that older primary school pupils were more likely to adopt appropriate hygiene behaviours than younger children.

Gender was not significantly associated with hygienic practice ($p = 0.632$), indicating that male and female pupils exhibited comparable levels of hygiene behaviour across both school types. The absence of significant gender differences suggests that hygiene education and sanitation interventions within the study area may have been equally accessible to boys and girls. This finding contrasts with some studies that reported superior hygiene practices among female pupils due to greater socialization toward cleanliness and self-care. However, it agrees with findings by Azuogu et al. (2016), who observed that gender was not a significant predictor of handwashing and personal hygiene practices among primary school children when access to sanitation facilities and health information was relatively uniform. The result implies that interventions aimed at improving hygiene practices should target all pupils rather than focusing on one gender.

Knowledge of hygiene emerged as a highly significant factor influencing hygienic practice ($p = 0.001$). Pupils with good knowledge consistently exhibited better hygiene practices than those with average or poor knowledge levels. This finding supports the Knowledge–Attitude–Practice (KAP) framework, which posits that adequate knowledge serves as the foundation for positive health behaviours. The results indicate that pupils who understand the causes and consequences of poor hygiene are more likely to engage in handwashing, proper sanitation, and other preventive health practices. Similar findings have been reported by Rabie and Curtis, who demonstrated that increased hygiene knowledge significantly improves preventive behaviours and reduces susceptibility to communicable diseases among school children.

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Consequently, strengthening school-based hygiene education programmes could substantially improve hygiene outcomes among pupils.

Attitude was also significantly associated with hygienic practice ($p = 0.001$), with pupils exhibiting positive attitudes demonstrating the highest levels of good hygiene behaviour. The log-linear interaction between attitude and hygienic practice suggests that knowledge alone may not guarantee behavioural change unless accompanied by favourable perceptions and motivation toward hygiene. Pupils who viewed hygiene as important for health protection were more likely to practice recommended hygiene behaviours consistently. This finding is consistent with the Health Belief Model, which emphasizes that positive beliefs and perceptions encourage individuals to adopt preventive health actions. Similar observations were reported by Biran et al. (2012) and Dreibelbis et al. (2013), who found that positive attitudes toward hygiene significantly increased compliance with handwashing and sanitation practices among school children. Therefore, hygiene interventions should combine knowledge dissemination with behavioural and motivational strategies to foster lasting improvements in hygienic practices.

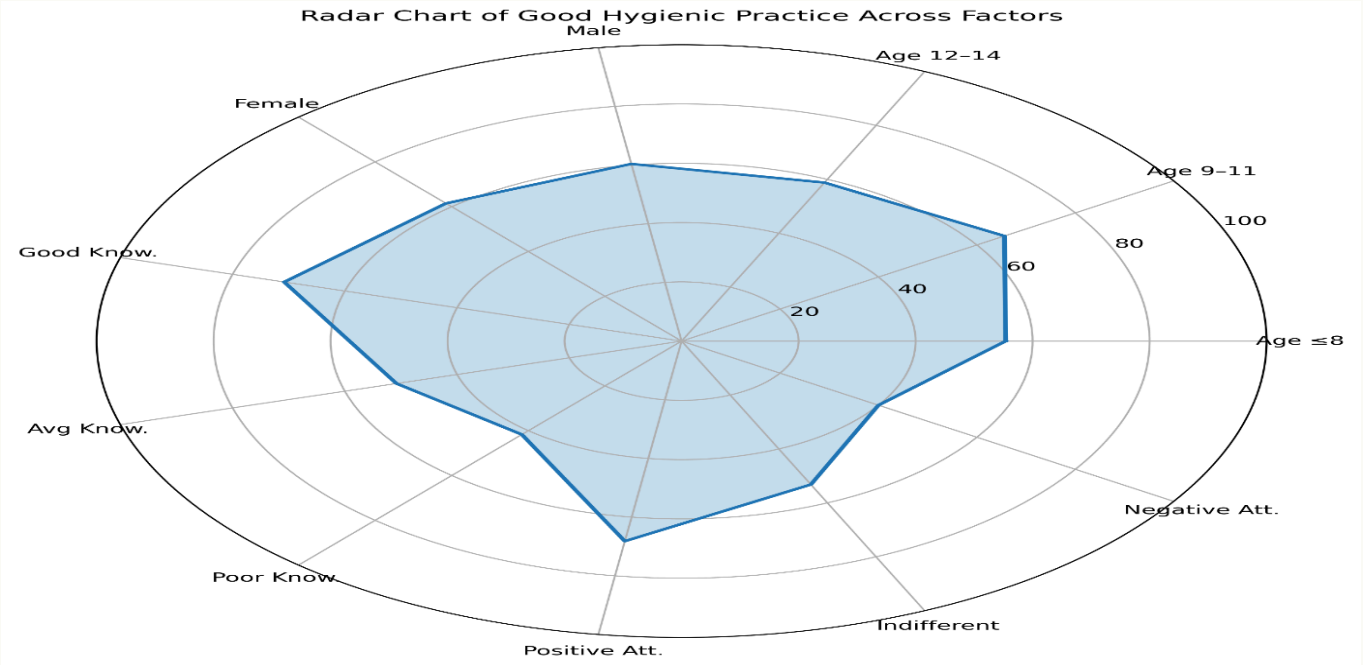

Figure 3: radar chart of good hygiene practices across factors

Source: authors' conceptualization

The radar chart provides a visual representation of the proportion of pupils exhibiting good hygienic practices across different demographic and behavioural factors. The chart reveals that the highest levels of good hygienic practice were associated with good hygiene knowledge (70.8%) and positive attitudes toward hygiene (68.2%), followed closely by pupils aged 9–11 years (65.6%). In contrast, substantially lower levels of good hygienic practice were observed among pupils with poor knowledge (41.7%) and negative attitudes (40.0%). The pronounced peaks and troughs in the radar chart highlight the strong influence of behavioural and cognitive factors on hygiene practices. These findings support the Knowledge–Attitude–Practice (KAP) framework, which posits that adequate knowledge and favourable attitudes are critical precursors to the adoption of healthy behaviours. Similar studies have demonstrated that pupils who possess greater hygiene awareness and positive perceptions of hygiene are more likely to engage in regular handwashing, personal cleanliness, and sanitation-related practices (Vivas et al., 2010; Freeman et al., 2014).

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Another notable feature of the chart is the relatively small variation between male (60.4%) and female (61.5%) pupils, suggesting that gender exerts minimal influence on hygienic behaviour. Likewise, the differences among age groups were less pronounced than those observed for knowledge and attitude, indicating that demographic characteristics alone may not adequately explain variations in hygiene practices. The radar chart therefore visually reinforces the statistical findings that knowledge and attitude are the dominant determinants of hygienic behaviour among pupils. The shrinking pattern observed from good knowledge and positive attitude toward poor knowledge and negative attitude demonstrates that improvements in hygiene behaviour are likely to be achieved through targeted health education, behavioural change communication, and supportive school environments. Recent evidence indicates that effective school-based hygiene interventions are most successful when educational programmes are combined with adequate water, sanitation, and hygiene (WASH) infrastructure, thereby enabling pupils to translate knowledge and positive attitudes into sustained hygienic practices (WHO & UNICEF, 2023; Ojo et al., 2024; Chai et al., 2024).

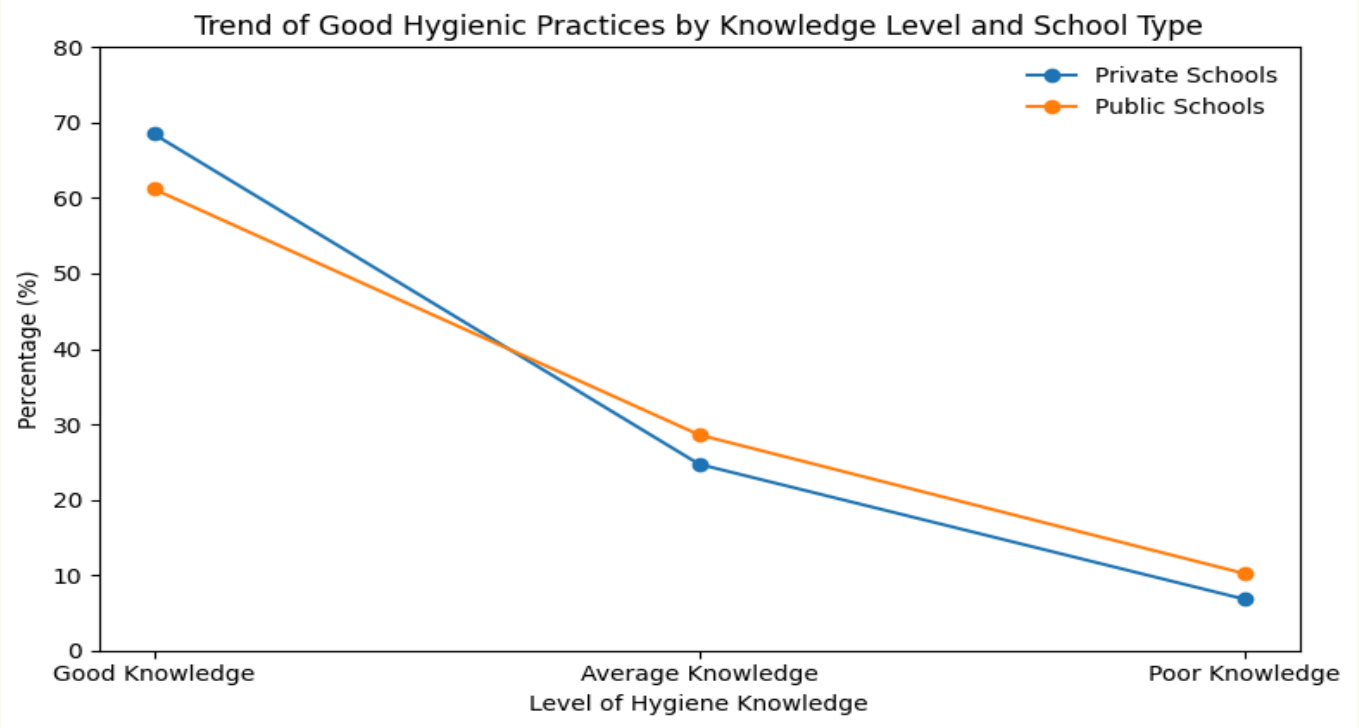

Figure 4: Trend of good hygienic practices by knowledge level and school type

The line graph in Figure 3 illustrates a clear and progressive decline in the proportion of pupils demonstrating good hygienic practices as hygiene knowledge decreases across both private and public primary schools. Pupils with good hygiene knowledge exhibited the highest levels of good hygienic practices, with those in private schools recording consistently higher proportions than their counterparts in public schools. This pattern highlights the critical role of knowledge in shaping hygiene-related behaviours among school-aged children. The pronounced decline observed between the good and average knowledge categories suggests that even modest reductions in hygiene knowledge may substantially affect the adoption of appropriate hygienic practices. This finding supports the Knowledge–Attitude–Practice (KAP) framework, which identifies knowledge as a fundamental determinant of positive health behaviours. Previous studies have similarly reported that pupils with better hygiene knowledge are more likely to engage in proper handwashing, sanitation, and personal hygiene practices (Curtis et al., 2009; Vivas et al., 2010).

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Although both school categories exhibited similar downward trends, private schools consistently maintained higher levels of good hygienic practices across all knowledge levels. This observation suggests that, beyond individual knowledge, school-level environmental factors such as adequate sanitation facilities, reliable water supply, effective hygiene supervision, and stronger institutional support may facilitate the translation of knowledge into practice. In contrast, the relatively lower proportions of good hygienic practices among pupils in public schools, particularly those with poor hygiene knowledge, indicate a dual challenge of inadequate awareness and limited access to supportive hygiene infrastructure. These findings are consistent with previous research showing that sustainable improvements in hygiene behaviour require a combination of health education and conducive water, sanitation, and hygiene (WASH) environments (Dreibelbis et al., 2013; Freeman et al., 2014). From a sustainable development perspective, the observed trend underscores the importance of integrating hygiene education programmes with investments in school sanitation infrastructure to support the achievement of Sustainable Development Goal 3 (Good Health and Well-being) and Sustainable Development Goal 6 (Clean Water and Sanitation).

Conclusion

This study provides empirical evidence that sanitation practices among primary school pupils in Port Harcourt Metropolis are significantly shaped by a combination of individual, institutional, and infrastructural factors. Marked disparities were observed between private and public primary schools in the availability and quality of sanitation facilities, with private schools consistently demonstrating better access to adequate toilets, gender-segregated facilities, functional handwashing stations, and continuous water supply. These infrastructural differences translated into observable variations in pupils' hygienic practices, reinforcing the critical role of the school environment in enabling healthy behavior. Furthermore, the findings revealed that pupils' age and level of hygiene knowledge were significantly associated with hygienic practices, highlighting the importance of developmental stage and cognitive awareness in shaping sanitation behaviour. However, the persistence of average and poor practices particularly among pupils in public schools, where basic knowledge existed, suggests that knowledge alone is insufficient to drive sustained behaviour change. This study demonstrates that hygienic practices among primary school pupils in Port Harcourt Metropolis are influenced by an interaction of behavioural and infrastructural factors. Significant disparities were observed between private and public schools in the provision of sanitation facilities, with private schools consistently outperforming public schools across key WASH indicators. The Sanitation Infrastructure Index further confirmed the existence of a substantial infrastructure gap between the two school categories, highlighting inequalities in access to safe and supportive sanitation environments.

The findings revealed that knowledge and attitude were the most important determinants of hygienic practices among pupils. Pupils who possessed adequate hygiene knowledge and positive attitudes toward sanitation were significantly more likely to engage in good hygienic practices. Conversely, age and gender demonstrated minimal influence on hygiene behaviour. These findings suggest that while awareness is important, behavioural change is most effective when supported by adequate sanitation infrastructure and institutional commitment to hygiene promotion.

From a sustainable development perspective, improving school sanitation represents a strategic pathway for achieving multiple Sustainable Development Goals, particularly SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), SDG 5 (Gender Equality), and SDG 6 (Clean Water and Sanitation). Investments in school sanitation and hygiene should therefore be viewed not merely as educational expenditures but as long-term investments in public health, social equity, and human capital development. Addressing sanitation inequalities in schools is essential for creating healthy learning environments and promoting sustainable development outcomes among future generations.

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Recommendations

i. **Strengthen WASH Infrastructure in Public Schools:** Government and education authorities should prioritize investment in sanitation infrastructure, particularly in public primary schools. This should include adequate toilets, reliable water supply systems, gender-segregated facilities, and functional handwashing stations.
ii. **Institutionalize School-Based Hygiene Education:** Hygiene education should be integrated into the school curriculum and reinforced through practical demonstrations, peer-learning programmes, and routine health promotion activities to encourage lifelong hygiene habits.
iii. **Promote Inclusive and Disability-Friendly Sanitation Facilities:** School sanitation facilities should be designed or upgraded to accommodate pupils with disabilities and ensure equitable access to sanitation services for all learners.
iv. **Establish Sustainable Maintenance and Monitoring Systems:** School management committees, Parent–Teacher Associations, and relevant government agencies should conduct regular inspections and maintenance of sanitation facilities to ensure their cleanliness, functionality, and sustainability.
v. **Encourage Multi-sectoral Collaboration:** Effective school sanitation programmes require collaboration among the education, health, water resources, and environmental sectors. Partnerships with non-governmental organizations and community groups can further strengthen sanitation interventions and behavioural change campaigns.
vi. **Adopt the Sanitation Infrastructure Index for Monitoring:** The Sanitation Infrastructure Index developed in this study should be adopted as a practical monitoring tool for evaluating sanitation performance across schools and guiding evidence-based resource allocation and policy decisions.

Ethical Considerations

Ethical approval for the study was obtained from our institutional ethics committee. Permission was also secured from relevant education authorities and school administrators. Informed consent was obtained from parents or guardians, while assent was obtained from participating pupils. Confidentiality and anonymity of participants were strictly maintained throughout the study.

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Ethical Approval: Ethical approval for this study was obtained from the appropriate institutional authority. Both written and verbal informed consent were secured from all participants prior to data collection. Additional consent was obtained from individuals whose identifiable information is included in this manuscript.

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