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The Status of Water and Sanitation Facilities in Public Primary Schools in Oyo State, Nigeria: Progress toward Achieving the SDG 6

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Abstract

Water and sanitation facilities in schools are directly linked to the attainment of Sustainable Development Goal (SDG) 6; however, these facilities are often grossly inadequate in both quality and quantity in public primary schools (PPS) in developing countries. This study examined the existing water and sanitation facilities in PPS in Oyo State, Nigeria, to identify disparities. Using ANOVA, variables extracted from the 2020 Oyo State Annual School Census report were analyzed and mapped to reveal spatial distribution at the local government level. Five water sources and 4 types of sanitation facilities were identified. Significant variations were observed across local government types (urban, semi-urban & rural, and rural) with respect to enrollment ($P = .000$), total number of toilets ($P = .033$), PPS with wells ($P = .002$), PPS with no water source ($P = .001$), PPS with flush toilets ($P = .001$), and PPS with other toilet types ($P = .011$). With sanitation facility availability below 20%, open defecation is likely to be prevalent in these schools. For the well-being of the pupils and the entire population of the state, the government needs to prioritize the provision of potable drinking water and improved sanitation facilities in PPS, while considering the need for facilities to be gender sensitive.

Keywords

water and sanitation facilities, SDG 6, public primary schools, mapping, Oyo State

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Introduction

The Sustainable Development Goals (SDGs), articulated through 17 goals, signify a global commitment to tackling critical challenges such as poverty, inequality, and climate change.[1] However, progress has been mixed; while some countries have made significant strides in areas like education and health, others lag behind due to conflicts, economic disparities, and the impacts of climate change.[2] Despite advancements in poverty reduction, many people still live in extreme poverty worldwide as global temperatures continue to rise, and economic disparities widen both within and between countries.[3] The 2024 Africa Sustainable Development Report highlights that only 6% of measurable SDG targets are currently on track to be achieved by 2030, with progress being uneven across different regions and sectors.[4,5] Nigeria's performance regarding the SDGs reflects broader regional challenges, facing significant hurdles such as high poverty rates, food insecurity, and inadequate infrastructure. Nevertheless, the Nigerian government has initiated various policies aimed at aligning national development plans with the SDGs.[6,7]

The SDG 6 aims to ensure the availability and sustainable management of water and sanitation for all by 2030.[8] Despite some advancements in improving access to clean water and sanitation, significant challenges persist, with many people globally lacking access to safe drinking water and basic hand-washing facilities.[2,9] In sub-Saharan Africa, over half of the population still lacks access to safe drinking water and improved sanitation facilities,[10] highlighting a strong connection between access to clean water, sanitation, and public health outcomes.[11]

Even though Water, Sanitation, and Hygiene (WaSH) in schools is a critical component for ensuring a safe and conducive learning environment for children, WaSH facilities in schools globally remain inadequate, with significant disparities in access. In Africa, water supply and sanitation facilities in public primary schools (PPS) are often grossly insufficient in both quality and quantity.[12-15] Many schools lack access to

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basic drinking water services, with over a quarter of rural PPS having no drinking water sources.[15] Sanitation services are also severely lacking, with more than half of rural PPS lacking any sanitation facilities.[15] The availability of handwashing facilities with soap and water is particularly poor, with only 3% to 13% of PPS providing basic hygiene services.[14,15] The situation is similar in Nigeria [12]; many schools do not provide these essential services, with the level of availability falling far below global targets. This deficiency contributes to the high incidence of diseases such as malaria, typhoid, and diarrhea among schoolchildren.[16]

Water and sanitation infrastructure in schools is directly linked to the attainment of SDG 6, which aims to ensure access to water and sanitation for all. However, achieving SDG 6 by 2030 will be challenging if the current state of water and sanitation facilities (WSF) in schools is not improved. Enhancing WSF in schools is also crucial for achieving other SDGs, such as SDG 3 on health and SDG 4 on quality education. Improved facilities help reduce disease transmission, enhance student health, and create a conducive learning environment.[17,18] Additionally, inadequate water supply and sanitation facilities ultimately impact educational attainment across different age groups.[19]

Inadequate WSF facilities in PPS pose a significant risk for the transmission of waterborne infectious diseases among students. Studies have documented higher rates of diarrheal diseases and gastrointestinal infections in schools that lack access to improved drinking water and sanitation facilities.[20] The deteriorating public drinking water distribution system, the increasing number of unregulated private water systems, and limited disease surveillance in many countries contribute to the health vulnerabilities of public schools.[21] As of 2020, approximately 818 million children globally lacked basic handwashing services at school, including 355 million whose schools had water but no soap, and 462 million without any handwashing facilities. Additionally, 33.3% of schools worldwide had either limited drinking water service or no drinking water service at all, while about 700 million children lacked basic sanitation services at their schools.[22,23]

Although the literature is replete with studies focused on water infrastructure challenges and vulnerabilities at a broader population level and in educational institutions,[24-26] there are few studies that consider water and sanitation infrastructure in PPPs.

Pieters et al.[27] investigated WaSH in 12 primary schools in Anápolis, Brazil, revealing significant deficiencies in sanitation infrastructure, including inadequate toilets and handwashing facilities. Microbiological tests indicated contamination, particularly E. coli, in drinking water sources, which poses serious health risks. The study also pointed out the lack of structured hygiene education programs, especially for menstrual hygiene management, crucial for girls' health and school attendance. Likewise, Pieters et al[27] assessed WaSH services in 6 primary schools in Quetzaltenango, Guatemala. They categorized services into 3 levels: basic (improved drinking water and functional sanitation), limited (significant deficiencies), and none (complete lack of facilities). Water quality tests showed varying levels of total coliforms and E. coli, highlighting health risks. Despite the availability of water in many schools, the absence of soap impeded effective hand hygiene. Sharma and Adhikari[28] found a significant link between unimproved school WaSH facilities and higher illness rates among students in Nepal, with 64.1% of those in unimproved settings reporting sickness compared to 40.9% in improved facilities. The study also noted that gender and caste affected health outcomes. It concludes that enhancing school WaSH services can significantly improve students' health, indicating that targeted interventions could lead to better health for children in Nepal.

The studies conducted by Ismaila et al[29] and Bah et al[16] reveal significant deficiencies in WaSH facilities in schools across Ghana and Guinea, respectively. In Ghana's Wa Municipality, while some WaSH facilities exist, they do not meet necessary standards for functionality and maintenance, impacting accessibility and service quality. In Guinea, inadequate hygiene practices correlate with increased disease incidence among children, including malaria and diarrhea, largely due to poor WaSH infrastructure. Kouamé's[13] research in Côte d'Ivoire highlights the pollution of drinking water in primary schools, where only 25% of students use available toilets, leading to widespread open defecation. Similarly, a survey in Northern Ethiopia[15] indicates better WaSH conditions in urban schools compared to rural ones, emphasizing the urban/rural divide in access to essential services.[14,15]

Akoteyon and Otusanya[30] evaluated WaSH facilities in primary schools in riverine areas of Lagos, Nigeria, and found that most schools had adequate water and handwashing facilities, with a favorable toilet ratio for boys and girls that surpassed UNICEF's standards. Furthermore, a significant correlation was found between the quality of WaSH facilities and students' academic performance, suggesting that improved conditions could positively impact educational outcomes. In contrast, an assessment in Calabar South[12] revealed that water supply and sanitation facilities in primary schools were severely lacking, highlighting a stark disparity in WaSH conditions across different regions of Nigeria.

Geography plays a crucial role in the assessment and intervention of WSF because it helps tailor interventions that are effective and sustainable, addressing the specific needs and challenges of different communities.[31,32] Nonetheless, among the studies that considered WSF in PPS, most adopted descriptive and inferential statistics for analysis, with none incorporating spatial methods. Additionally, with the exception of one study,[15] the researches did not explore variations in WSF based on location, despite the established urban/rural dichotomy in the availability of water and sanitation infrastructure.[24,26]

Hence, given that the use of spatial method has not been well exploited in the study of WaSH in PPS in Oyo State, this study adopts mapping and ANOVA test in investigating the variation in the distribution of WSF in PPS in Oyo State, Nigeria, using data from 2449 PPS based on information from the 2020 Annual School Census Report.[33]

Methods

Study Location

Oyo State is a landlocked state in southwestern Nigeria with a rich history dating back to the Oyo Empire, which ruled the region from around 1300 to 1896. The state was formed in 1976 from the former Western State and is predominantly inhabited by the Yoruba people. Oyo State consists of 33 Local Government Areas (LGAs), and its economy remains largely agrarian. Despite its rich history and cultural heritage, the state faces challenges such as infrastructural deficiencies and multidimensional poverty, which stands at 38.1%. However, it boasts high levels of employment (82.6%), literacy (79.2%), and educational attainment (88.6%).[34-36]

Study Population

This is a cross-sectional study involving children aged 6 to 11 years, enrolled in public primary schools across Oyo State, Nigeria, during the 2020 Oyo State Annual School Census.

Data Collection

The data for this study was extracted from the 2020 Oyo State Annual School Census Report from July 10 to July 11, 2024. To form the database, variables extracted at the LGA level included: the number of PPS, the number of pupils in PPS, the types of water sources, and the types of sanitation facilities. The total number of toilets and the ratio of pupils to toilets were also derived. The 33 LGAs of the state were categorized into rural and urban based on the 2018 Nigeria Demographic and Health Survey (NDHS) classification [35]; the semi-urban classification was created out of the rural classification, and was based on the author's knowledge of socio-economic factors in the LGAs.

The Annual School Census (ASC) is a statutory annual data collection from both private and public schools, regardless of their registration status, in accordance with the Nigeria Educational Management Information System (NEMIS). This initiative began in 1987 with support from the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the United Nations Development Programme (UNDP). The most recent census in the state occurred from May 6, 2019, to May 20, 2020, in collaboration with the United Nations Children's Fund (UNICEF), utilizing a questionnaire designed by the United Nations Institute of Statistics for data collection.[34] However, it is regrettable that, despite the absence of a new ASC in the state, there has not been a significant change in the water and sanitation situation.[37]

Data Analysis

At a 5% statistical significance level, ANOVA was used to explore variation in the water and sanitation data, utilizing SPSS 16.0, R version 4.1.0, and tmap,[38] along with the hypotheses:

$$H_0 : \mu_1 = \mu_2 = \mu_3$$

H_1: At least one μ_i is different,

where μ_1, μ_2, μ_3 represent the means of the different LGA types being compared.

A post-hoc analysis was conducted using Tukey's Honest Significant Difference (HSD) test to identify the specific group means that were significantly different from each other. The data were then mapped to explore spatial variation.

Analysis of Variance

Analysis of Variance (ANOVA) determines whether there are significant differences between the means of 3 or more independent groups. It is employed to test the hypothesis that different groups have the same mean, with the primary goal of partitioning the total variance observed in the data into components attributable to different sources. This allows for the detection of whether observed differences are due to actual group differences or random chance.[39]

While One-Way ANOVA tests the impact of a single independent variable on a dependent variable, Two-Way ANOVA examines the effects of 2 independent variables simultaneously, including their interaction effects. This approach helps to understand complex relationships between variables.[40,41]

The underlying assumptions of ANOVA are that the data in each group follow a normal distribution, that the variances among groups are approximately equal, and that the observations are independent of one another.[40,42] Although these assumptions can be tested using methods such as the Shapiro-Wilk test[43] and Levene's test,[44] it is not compulsory to do so in practice.

Tukey's Honest Significant Difference Test

Tukey's Honest Significant Difference (HSD) test is a widely used post-hoc analysis technique that follows an ANOVA.[45] It is designed to identify which specific group means are significantly different from each other after establishing that at least one group mean differs significantly in an ANOVA test. This method addresses the issue of multiple comparisons and controls the experiment-wise error rate, which is particularly important because multiple comparisons can inflate the likelihood of falsely rejecting the null hypothesis. The test is conducted by comparing specific pairs of means based on the ANOVA results and calculating the HSD. The calculated HSD value is then compared to the critical value obtained from Tukey's q table. If the absolute difference between any 2 means exceeds this critical value, those means are considered significantly different.

$$\text{HSD} = q.\sqrt{\frac{MSE}{n}}$$

where q is the critical value from the Studentized range distribution, MSE is the mean square error from ANOVA, and n is the sample size for each group.

Mapping

Using the names of the LGA as a unique identifier, the data in Table 1 was linked to the LGA map of Oyo State in the R environment. To minimize within-group variance while maximizing between-group variance, the Jenks classification method was adopted to produce the map, utilizing tmap.[38]

Table 1. Identified waters sources and toilet types in Public Primary Schools in Oyo State, Nigeria.

LGA	Type	n_PPS	n_pupils	Ave pupils	p_pipe	p_borehole	p_well	p_other	p_none	n_pit	n_bucket	n_flush	n_other	no_ toilets	Pupil:Toilets
Afijio	Rural	69	48259	699	0	1	22	0	77	32	5	24	38	111	435
Akinyele	Semi-U & R	123	62155	505	0	0	1	0	99	41	1	34	23	203	306
Atiba	Semi-U & R	79	54513	690	0	0	3	0	97	20	3	22	54	90	606
Atisbo	Rural	57	52906	928	0	0	0	2	98	57	6	10	26	68	778
Egbeda	Semi-U & R	78	59431	762	1	7	18	0	74	20	4	53	22	129	461
Ibadan North	Urban	77	73501	955	1	3	37	3	56	75	3	21	1	151	487
Ibadan North-East	Urban	74	69196	935	0	6	15	0	75	42	0	55	4	108	641
Ibadan North-West	Urban	41	65684	1602	0	8	38	0	55	61	0	23	16	69	952
Ibadan South-East	Urban	61	70012	1148	5	8	39	0	48	31	7	61	1	134	522
Ibadan South-West	Urban	88	72325	822	1	3	38	1	56	54	0	41	5	184	393
Ibarapa Central	Rural	63	45412	721	0	11	10	3	76	59	0	4	37	105	432
Ibarapa East	Rural	61	46509	762	0	3	3	0	94	24	1	33	41	111	419
Ibarapa North	Rural	73	51190	701	0	3	0	0	97	27	1	5	67	85	602
Ido	Semi-U & R	77	66116	859	0	0	0	0	100	32	8	41	19	112	590
Irepo	Rural	71	48110	678	0	21	1	3	75	41	3	6	50	96	501
Iseyin	Rural	137	62903	459	0	1	0	4	96	34	3	11	52	101	623
Itesiwaju	Rural	72	42985	597	1	4	6	0	89	32	3	25	40	130	331
Iwajowa	Rural	61	47755	783	0	5	20	0	75	40	4	22	33	90	531
Kajola	Rural	71	52007	732	0	5	22	0	73	54	0	19	27	85	612
Lagelu	Semi-U & R	83	63048	760	0	4	12	0	84	46	0	11	43	116	544
Ogbomosho North	Semi-U & R	28	50082	1789	0	7	21	0	71	65	4	23	8	52	963
Ogbomosho South	Rural	28	47968	1713	0	0	48	0	52	75	0	20	6	51	941
Ogo-Oluwa	Rural	60	50649	844	0	0	0	0	100	23	0	49	28	96	528
Olorunsogo	Rural	47	42088	895	0	8	4	2	86	72	0	12	17	60	701
Oluyole	Semi-U & R	113	78207	692	0	0	3	1	96	40	10	42	8	106	738
Ona Ara	Semi-U & R	103	71620	695	0	4	30	1	65	35	4	22	38	144	497
Orelope	Rural	66	44652	677	0	6	6	0	88	29	0	21	49	95	470
Ori-Ire	Rural	131	58110	444	0	4	4	0	92	67	14	0	19	78	745
Oyo East	Rural	27	44531	1649	0	0	19	0	81	67	0	17	15	52	856
Oyo West	Rural	41	49825	1215	3	11	18	3	66	80	19	0	2	59	844
Saki East	Rural	71	48314	680	0	1	14	3	82	40	0	11	48	99	488
Saki West	Rural	108	56688	525	1	2	19	0	78	89	2	5	3	132	429
Surulere	Rural	110	56033	509	0	4	9	0	87	31	2	22	45	121	463

Abbreviations: Semi-U & R, semi urban & rural; n_PPS, number of PPS; n_pupils, number of pupils; Ave pupils, average number of pupils; p_pipe, percentage of PPS with pipe borne water; p_borehole, percentage of PPS with borehole; p_well, percentage of PPS with well; p_other, percentage of PPS with other water sources; p_none, percentage of PPS with no water source; n_pit, number of PPS with pit toilets; n_bucket, number of PPS with bucket toilets; n_flush, number of PPS with flush toilets; n_other, number of PPS with other toilet type; no_toilets, number of PPS with no toilets; Pupil:Toilet, pupil-to-toilet ratio.

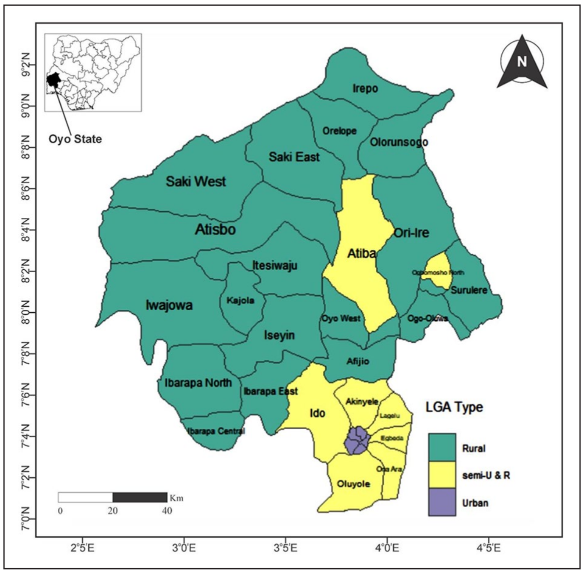

Figure 1. Local government area map of Oyo State showing Local Government type.

Table 2. Result of the ANOVA test of the variables across LGA types.

Variable		F	*P*
	Number of schools	0.86	.341
	Enrollment	28.16	.000
	Average number of pupils	1.29	.291
	Total number of toilets	3.84	.033
	Ratio of pupils to toilets	0.01	.991
Water source			
	Pipe borne	3.26	.052
	Borehole	0.71	.498
	Well	7.931	.002
	Other	1.00	.380
	None	9.45	.001
Toilet type			
	Pit	1.31	.284
	Bucket	0.41	.668
	Flush	8.40	.001
	Other	5.28	.011

Results

The 33 Local Government Areas (LGAs) of the state (Figure 1) were categorized into Rural (60.6%), Semi-urban & Rural (24.2%), and Urban (15.2%). A total of 1 852 784 pupils aged 6 to 11 years were enrolled in the PPS across the state, which comprises 2449 PPS, resulting in an average of 77 schools per LGA and an average of 756 pupils per school. While Oluyole LGA had the highest enrollment rate at 4.2%, Iseyin LGA had the highest number of schools at 5.6%, and Ogbomoso North LGA had the highest average number of pupils per school, with 1789 pupils.

The census identified 5 water sources: pipe-borne (2.0%), borehole (21.1%), well (72.4%), undefined (0.6%), and other (3.9%). Additionally, it identified 4 types of sanitation facilities: pit (44.6%), bucket (3.1%), flush (25.6%), and other (26.7%). The availability of pipe-borne water was highest in Ibadan Southeast LGA (5%), while borehole water was prevalent in Irepo LGA (21%). The highest availability of wells was recorded in Ogbomoso South LGA (48%), and the other water source was prevalent in Iseyin LGA (4%). There were no water sources in any of the PPS in Ido and Ogo-Oluwa LGAs.

Regarding sanitation facilities, the highest number of PPS with pit toilets was in Saki West LGA (89). Oyo West LGA (19), Ori-Ire (14), and Oluyole LGAs (10) had the most PPS with bucket toilets. In contrast, PPS with flush toilets were most prevalent in Ibadan Southeast LGA (61), while the highest number of PPS with the other toilet type was found in Ibarapa North LGA (67). On average, the availability rates of both water and sanitation facilities were below 20.0% across PPS in the state. Akinyele LGA had the lowest ratio of pupils to toilet facilities (306), whereas Ogbomoso North LGA had the highest ratio (963). Further details are provided in Table 1.

Based on LGA type, there was significant variation in the following areas: enrollment ($P = .000$), total number of toilets ($P = .033$), percentage of PPS with wells ($P = .002$), percentage of PPS with no water source ($P = .001$), percentage of PPS with flush toilets ($P = .001$), and percentage of PPS with the other toilet type ($P = .011$). Further details can be found in Table 2. The results of the post-hoc tests (Table 3) were statistically significant at $P < .05$, confirming the actual differences across the LGA types. However, among the 6 variables that exhibited variation, only the comparisons for the total number of toilets did not yield significant results across LGAs, with *p*-values exceeding .05 for all pairwise comparisons.

Considering spatial distribution, the semi-urban & rural LGAs of Akinyele, Iseyin, and Ori-Ire had the highest number of PPS in the state (Figure 2a), with the average number of pupils per school being highest in rural LGAs. The LGAs with the most toilets were predominantly located in the southern part of the state (Figure 2b), encompassing all 3 types of LGAs. The pupils-to-toilet ratio was highest in the mid-northern region of the state (Figure 2d), which consisted mainly of rural LGAs; however, Ibadan Northwest, an urban LGA, recorded the second-highest pupils-to-toilet ratio.

The distribution of pipe-borne water in PPS across the state showed no apparent pattern (Figure 3a). However, boreholes were concentrated in the northernmost part of the state (Figure 3b), which consisted of rural LGAs. Although Ogbomoso South, a rural LGA, had the highest percentage of wells (Figure 3c), the distribution of these wells did not exhibit any obvious pattern. Other sources of water, including streams, rivers, and ponds, were predominant in rural LGAs (Figure 3d), with Iseyin LGA having the highest concentration. The LGAs with the highest percentages of PPSs without water sources (Figure 3e) formed a belt in the central part of the state and a cluster in the south, primarily consisting of rural LGAs.

Although pit toilets were predominant in PPS in rural LGAs (Figure 4a), semi-urban & rural and urban LGAs also had considerable numbers of them, with Ibadan North, an urban LGA, ranking among those with the

Table 3. Post-Hoc test of the multiple comparisons of the mean difference by Tukey's HSD.

						95% Confidence interval	
Variable	(I) LGA	(J) LGA	Mean difference (I-J)	Std. error	Sig.	Lower Bound	Upper Bound
Enrollment	1	2	−1.33E4*	2.59E3	.000	−19697.24	−6906.36
		3	−2.03E4*	3.10E3	.000	−27942.91	−12654.89
	2	1	13301.80*	2.59E3	.000	6906.36	19697.24
		3	−6997.10	3.53E3	.135	−15712.61	1718.41
	3	1	20298.90*	3.10E3	.000	12654.89	27942.91
		2	6997.10	3.53E3	.135	−1718.41	15712.61
Total number of toilets	1	2	−27.75	13.69	.123	−61.49	5.99
		3	−37.95	16.36	.068	−78.28	2.38
	2	1	27.75	13.69	.123	−5.99	61.49
		3	−10.20	18.65	.849	−56.18	35.78
	3	1	37.95	16.36	.068	−2.38	78.28
		2	10.20	18.65	.849	−35.78	56.18
Well water source	1	2	0.25	4.81	.999	−11.60	12.10
		3	−22.15*	5.75	.002	−36.32	−7.98
	2	1	−.25	4.81	.999	−12.10	11.60
		3	−22.40*	6.55	.005	−38.55	−6.25
	3	1	22.15*	5.75	.002	7.98	36.32
		2	22.40*	6.55	.005	6.25	38.55
No water source	1	2	−2.65	5.16	.865	−15.37	10.07
		3	25.10*	6.17	.001	9.89	40.30
	2	1	2.65	5.16	.865	−10.07	15.37
		3	27.75*	7.03	.001	10.41	45.09
	3	1	−25.10*	6.17	.001	−40.30	−9.89
		2	−27.75*	7.03	.001	−45.09	−10.41
Flush toilet type	1	2	−15.20*	5.61	.029	−29.04	−1.36
		3	−24.40*	6.71	.003	−40.94	−7.86
	2	1	15.20*	5.61	.029	1.36	29.04
		3	−9.20	7.65	.461	−28.06	9.66
	3	1	24.40*	6.71	.003	7.86	40.94
		2	9.20	7.65	.461	−9.66	28.06
Other toilet type	1	2	5.27	6.89	.726	−11.70	22.25
		3	26.75*	8.23	.008	6.45	47.04
	2	1	−5.27	6.89	.726	−22.25	11.70
		3	21.47	9.39	.073	−1.66	44.61
	3	1	−26.75*	8.23	.008	−47.04	−6.45
		2	−21.47	9.39	.073	−44.61	1.66

*The mean difference is significant at the 0.05 level, 1 = Rural, 2 = Semi-Urban& Rural, 3 = Urban.

highest percentages. Similarly, while the use of bucket toilets displayed no clear pattern (Figure 4b), all types of LGAs utilized them to varying degrees, with the highest percentage of use found in rural LGAs. Apart from Ogo-Oluwa, a rural LGA, the distribution of flush toilets was concentrated in the southern part of the state (Figure 4c), where semi-urban & rural and urban LGAs exhibited the highest percentages. A high percentage of other toilet type was observed in the southwest and north-central parts of the state, all within rural LGAs (Figure 4d).

Discussion

This study examined the distribution of existing water and sanitation facilities (WSF) in public primary schools in Oyo State, Nigeria, aiming to identify disparities by utilizing data from the 2020 Annual School Census Report and employing statistical and spatial techniques. While the distribution of some WSF in PPS varied among LGAs, wells were the predominant water source, and pit toilets were the most common sanitation facility.

Although some of the findings of this study corroborate previous studies, others conflict with the results of earlier research.

Water and sanitation facility availability rates below 20%, which are significantly lower than the reported global rates,[46] are a source of concern. Inadequate WSF in schools have been identified as precursors to various diseases,[7,9,10] negatively impacting education. Santiago & Resende[19] discovered that inadequate WSF ultimately affects educational attainment, with access to water and sanitation services having a positive and significant effect on the number of

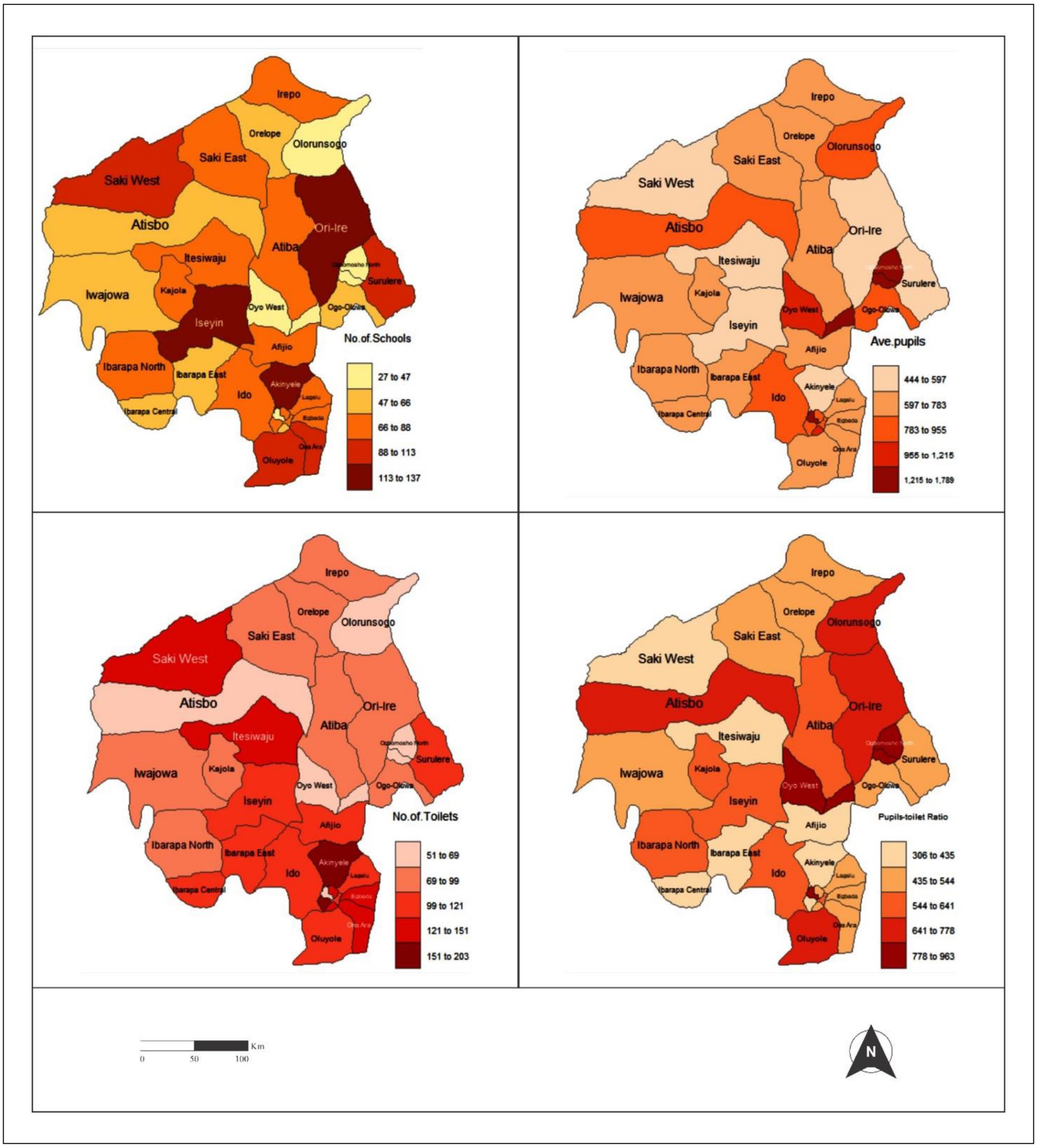

Figure 2. LGA map of Oyo State showing: (A) number of schools, (B) average number of pupils, (C) number of toilets, and (D) pupil-toilet ratio.

completed school years for children across different age ranges. Similarly, Akoteyon and Otusanya[30] suggested that improved access to water and sanitation facilities can lead to better educational outcomes. Therefore, to ensure that the education of schoolchildren in Oyo State does not lag, there must be a concerted effort to significantly improve the availability rates of improved WSF in PPS.

The significant variations observed in this study regarding enrollment, well water sources, the absence of drinking water sources, flush toilets, and other type of toilets substantiate the findings of previous studies. As indicated by the results of the post-hoc test (Table 3), the observed variation primarily exists between rural LGAs and other LGA types.

In an evaluation of WaSH facilities in Brazilian schools, Poague et al.[26] reported that urban schools generally exhibit better facilities compared to rural schools, with only 19% of public schools in a rural region having access to water supplies, compared to a national average of 68%. Similarly, the study by Ngcongo and Tekere[18] found that in rural settings, schools frequently depend on local sources such as rivers or wells, while urban schools typically have better access to treated water supplies. Additionally, the assessment by Inah et al.[12] highlights the rural-urban dichotomy

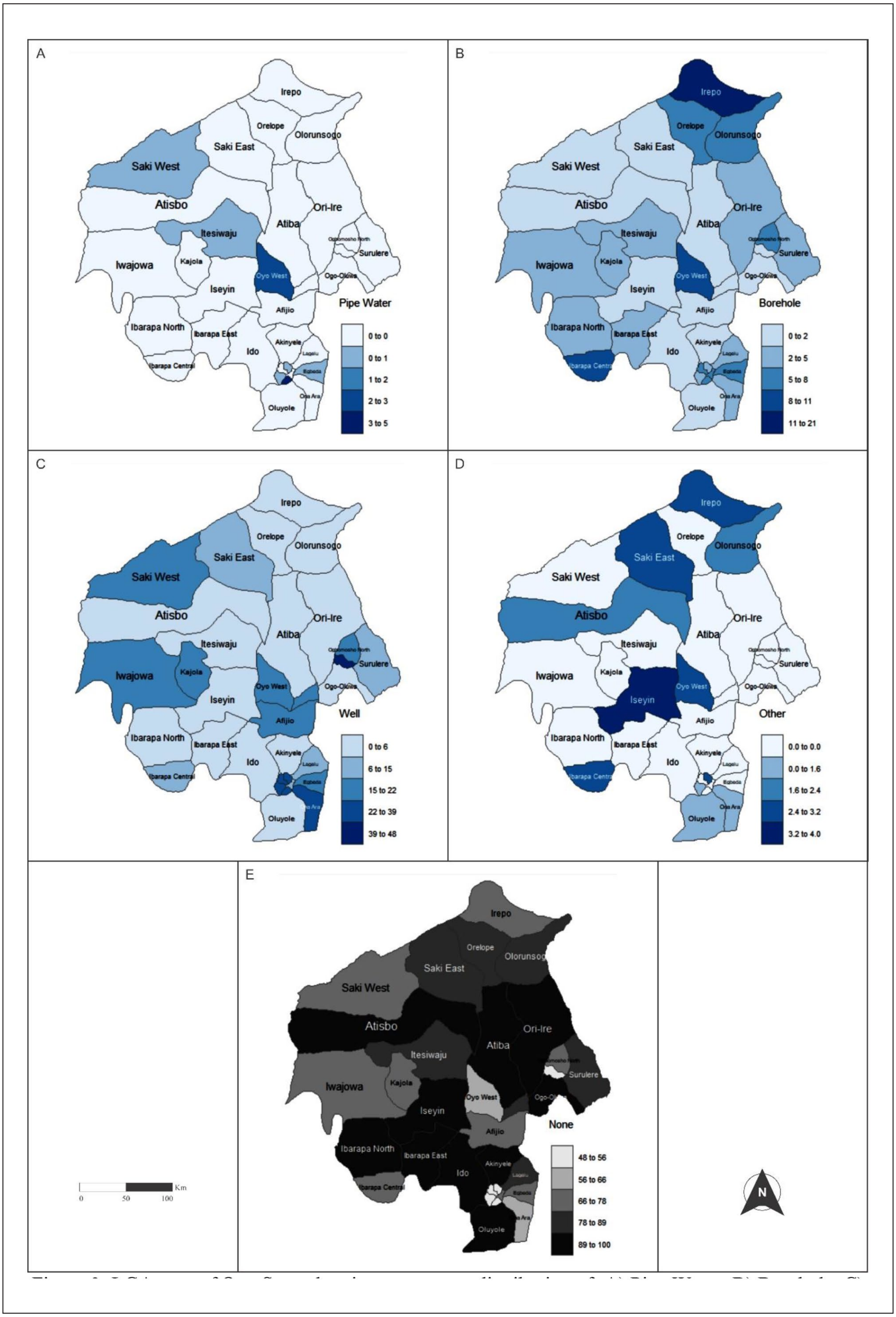

Figure 3. LGA map of Oyo State showing percentage distribution of: (A) pipe water, (B) borehole, (C) wells, (D) other water sources, and (E) none availability of water sources.

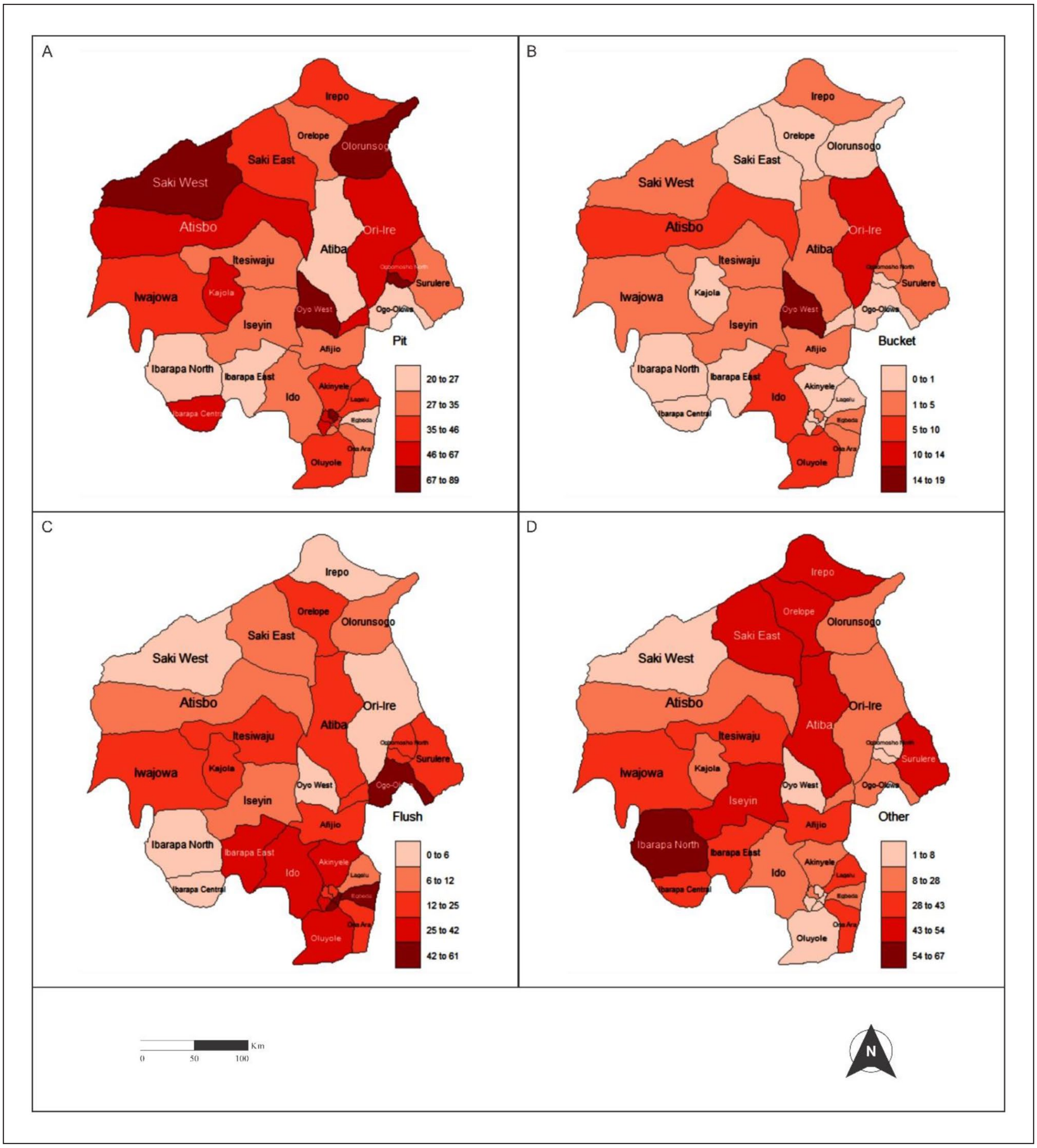

Figure 4. LGA map of Oyo State showing percentage distribution of: (A) pit toilets, (B) bucket toilets, (C) flush toilets, and (D) other sanitation facility types.

in WSF in PPS, emphasizing the need for improved infrastructure in rural areas to meet the standards typically found in urban schools. Urban PPS generally have better WSF compared to their rural counterparts.

Interestingly, although the ANOVA result indicated a significant variation in the total number of toilets, the post-hoc test revealed that none of the comparisons were significant. While this does not negate the ANOVA result, the discrepancy may stem from several factors: insufficient power in post-hoc tests due to having too few observations per group; a high number of comparisons, which increases the chance of Type I errors (false positives); the ANOVA result being only marginally significant (ie, a P-value close to .05); and some post-hoc tests requiring stronger evidence to declare significance.[47] In this study, while the Semi-Urban & Rural and Urban LGA groups had few observations, the total number of toilets showed marginal significance ($P = .033$). Hence, the post-hoc result might have been influenced by one or both of these.

The observed lack of variation in improved water sources (pipe-borne and borehole) contradicts earlier studies. In the studies by Melaku et al.[14] and Amsalu et al,[15] better water sources were reported in PPS in urban areas. However, the lack of variation observed in this study may be linked to the deficiencies in infrastructure acknowledged by the Oyo State government.[34] The deficiency in infrastructure is further supported by the lack of variation in the use of pit and bucket toilets, while other studies report better sanitation facilities in urban areas.[13,14] Amsalu et al.[15] reported that over a quarter of rural PPS had no drinking water sources in the South Gondar Zone of northern Ethiopia, and over half lacked access to any sanitation facilities. Nevertheless, in this study, with observed levels of lack exceeding 80%, there was no difference between urban and rural PPS regarding the use of unimproved sanitation facilities.

That there were no water sources in any of the PPS in Ido and Ogo-Oluwa LGAs, yet there were toilets in the PPS, corroborates the assertion that availability does not translate to utilization.[48] With a combined total of 137 PPS and 116 765 pupils, these LGAs are likely to be susceptible to diarrheal diseases and gastrointestinal infections,[16,18] which could jeopardize the pupils' academic performance. This situation necessitates a focused intervention from relevant authorities to ensure the availability of safe water in the PPS within these LGAs.

Ogbomoso South LGA had the highest percentages of both wells (48%) and pit toilets (75%). Although the ASC did not gather data on water quality, considering the known interaction of these systems with underground water,[49] the drinking water in the PPS within the LGA is likely to be contaminated. Kouamé et al.[13] reported the prevalence of latrines and the reliance on traditional wells for drinking water in the south-central part of Côte d'Ivoire corresponds with findings that water samples tested from schools were often contaminated. Thus, to mitigate potential pollution of drinking water in PPS across the state, it would be beneficial for the ASC to include data collection on water quality, as contamination of drinking water in PPS is a common issue in the Global South.[27,50]

The potential impact of the observed high use of pit toilets in PPS across the study area on schoolchildren is a matter of grave concern. On average, these toilets account for 46.5% of the available sanitation facilities. Pit toilets are known to facilitate the transmission of helminths,[51] which has significant health implications. Additionally, beyond the privacy concerns reported in earlier studies,[12,18] pit toilets can pose serious health risks to girls, particularly regarding urinary and reproductive tract infections.[52] These health issues can negatively affect the education of girls.[53]

From the study by Ngcongo and Tekere,[18] access to WaSH facilities is particularly crucial for girls, especially post-menarcheal students. Adequate sanitation facilities can help alleviate barriers to school attendance related to menstruation, thereby promoting gender equality in education. Therefore, reducing the use of pit toilets to a minimum, if not eradicating them entirely, would have positive implications for the health of all pupils, particularly for girls and their academic performance and participation.[52]

The ratio of pupils to toilets in this study was notably high, with the lowest being 306:1. In Melaku et al[14] reported that the student-to-toilet ratio was 68:1 for female students and 49:1 for male students. Furthermore, Akoteyon and Otusanya[30] indicated that the ratio of toilet facilities to pupils in riverine areas of Lagos, Nigeria, exceeded UNICEF's recommended standards; however, no specific figures were provided, and gender disparities in the ratio could not be established in their study. Thus, it is evident that toilet provision in PPS in Oyo State is grossly inadequate, mirroring the findings of Inah et al.[12] Coupled with the observed low level of WSF availability, this situation appears to foster open defecation. This is supported by findings that where toilet use is at 25%, over 50% of pupils not using them engage in open defecation,[13] along with its associated consequences. With toilet availability below 20%, it can be inferred that open defecation will be rampant in PPS in Oyo State. Consequently, for the campaign[54] against open defecation to be successful in the state, improving the availability of WSF in PPS is a crucial step forward.

Strength and Limitation

The data utilized in this analysis was sourced from the 2020 Oyo State Annual School Census, which is considered reliable. However, it is important to note that the census data collection spanned an entire year, which may have influenced key variables such as student enrollment figures. Additionally, while this census represents the most recent comprehensive data available, it is now 4 years old.

Despite the age of the census, it is reasonable to assert that the information regarding aspects other than enrollment is likely still relevant and reflective of current conditions. This assumption is supported by the observation that the state's budgetary allocations for public primary schools (PPS) have not significantly improved in recent years.

Conclusion

The situation of WSF in PPS in Oyo State requires significant improvement. For the state to achieve SDG 6, and by extension SDGs 3 and 4, it is crucial to enhance the availability of WSF in these schools. Substantial investments are necessary to eliminate bucket toilets and minimize the use of pit toilets through the construction of improved sanitation facilities.

While the government can secure donor funding for the construction and maintenance of these facilities from international organizations and NGOs, host communities should be encouraged to provide consumables such as soap and tissue paper. A pertinent strategy is Community-Led Total Sanitation (CLTS), a behavior change approach that enables rural communities to recognize and address the adverse impacts of inadequate sanitation. By fostering collective action, CLTS empowers communities to develop and implement their own solutions to improve their sanitation conditions.

It is essential to prioritize the unique needs of girls in the provision of WSF. Emphasizing gender-sensitive facilities, regardless of school location, is vital, as the lack of separate toilets for girls and insufficient hygiene supplies are significant barriers to school attendance.

Given the high prevalence of wells in PPS across the state, it may be more economical to enhance them by installing concrete rings and covers. Communities should be motivated to take ownership of these improved water sources through protection and regular inspections. Nigeria operates a 3-tier government system, with Local Government being closest to the people. This tier can be entrusted with overseeing the maintenance of WSF in PPS in their areas. They can also provide periodic itinerant decontamination of water sources and evacuation of sanitation facilities in PPS.

Additionally, implementing comprehensive health education programs in PPS in Oyo State is crucial for promoting better hygiene practices among students and the wider community. Training for teachers and staff on hygiene practices will ensure effective dissemination of knowledge, particularly regarding proper menstrual hygiene management.

Author Contributions

OA was responsible for conceptualisation, data sourcing, data analysis, and the drafting of the manuscript.

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Data Availability

The data is in the public domain and available from the Oyo State Ministry of Education, Science & Technology.

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