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Statistical Analysis of Open Defecation Practices and their Socioeconomic Determinants in Osun State, Nigeria

Oyegoke, O.A., Ogunwole, B.O. and Folorunso, I.A.
Department of Statistics, Osun State Polytechnic, Iree

Correspondence e-mail address: odunayo4mine@gmail.com

Abstract— Open defecation, the act of relieving oneself in open spaces instead of using a toilet, poses significant public health challenges. It contributes to the spread of diseases like diarrhea, typhoid, and cholera, especially in areas where toilets or latrines are underutilized. This study provides an in-depth analysis of the factors influencing open defecation practices among households in Osun State, Nigeria. Adopting a cross-sectional design, data were collected using a well-structured questionnaire and analyzed using SPSS version 25.0. Chi-square analysis revealed significant associations between open defecation and education level ($\chi^2 = 67.280$, $p < 0.001$, Cramer's V = 0.259), occupation ($\chi^2 = 368.189$, $p < 0.001$, Cramer's V = 0.607), and household size ($\chi^2 = 182.066$, $p < 0.001$, Cramer's V = 0.427). Ordinal regression analysis indicated that individuals with no formal education were significantly more likely to practice open defecation compared to those with postgraduate education (B = 2.701, $p < 0.001$). Despite 66.3% of households having toilet facilities, 73.7% reported practicing open defecation, primarily due to water unavailability (31.1%) and lack of functioning facilities (29.4%).

Keywords: Open defecation; OD practice; Ordinal regression; socio-economic factors; Chi-square test; Osun-State

Introduction

Open defecation is when individuals or groups defecate in open spaces, such as fields or bodies of water, instead of using toilets. This unsanitary practice poses serious public health risks, causing diseases like cholera and diarrhea (Center for Legislative Research and Advocacy, 2013; Coffey, 2015; Saleem et al., 2019; Onyemaechi et al., 2022; Mukhtar et al., 2023). Addressing open defecation is vital for global sanitation and achieving Sustainable Development Goal 6. Even with toilet access, behavioral change through education is needed to promote their use.

In 2021, WHO and UNICEF estimated that 494 million people, mostly in rural sub-Saharan Africa, practiced open defecation (WHO, 2021; Belay et al., 2022). Between 2015 and 2020, open defecation in Central and Southern Asia decreased by nearly 50% (from 23% to 12%), while sub-Saharan Africa saw a slight drop from 22% to 18%. In Nigeria, 6% to 25% of people still defecate openly, varying by region. Diarrheal disease is the second leading cause of death for children under five, resulting in 1.7 million illnesses and 760,000 deaths annually, especially in Africa. Poor sanitation causes health issues like diarrhea and

trachoma, with open defecation increasing disease spread, particularly among children. Diarrhea rates are four times higher in communities with open defecation. This practice also exposes women and girls to risks during menstruation, especially in rural areas. Factors like finances and region influence open defecation rates. Effective sanitation can reduce diarrheal diseases by limiting fecal contamination. However, open defecation remains prevalent in sub-Saharan Africa, especially Nigeria, contributing to child deaths and posing risks to adult health, including physical attacks and snake bites. Inadequate sanitation limits national progress by reducing productivity, life expectancy, savings, investments, and children's education (UNICEF, 2014). Open defecation contaminates vegetables (Antwi-Agyei et al., 2015). The work is similar to that of Belay et al., (2022). However, research on open defecation in Osun state is scarce. This study aims to evaluate contributing factors and determine their prevalence in the State.

Materials And Methods

Population of Study

This study was conducted among people of the three Senatorial districts which comprises of 30 local governments of Osun State, South-West Nigeria. From these local governments, 6 local governments cut across 3 Senatorial districts where higher Institutions being sited were considered (Osogbo, Ede, Ilesha, Ila, Boripe, and Iwo LGAs). Data on households were collected through the use of the questionnaire. All households in this enumeration area(E/A) found across these 6 local governments will be our study population.

Study Design Instrument

A cross-sectional descriptive study design involved the administration of a well-structured questionnaire by the trained, interviewers.

Sampling method

A multi-stage probability sampling method was employed to select samples from an existing frame, differentiating between rural and urban areas. Enumeration areas (EAs) were proportionally chosen within each stratum, followed by systematic sampling of households.

Data collection took place from June to July 2023 through face-to-face interviews with six trained assistants, who received two days of training. To reduce selection bias, households were randomly chosen within each EA; if there were no responses after three visits, the next household was selected.

Study Variables

The outcome variables (dependent variables) of the study were open defecation which contains households with a lack of sanitation facilities and defecating on bush or field. The independent variables considered for this study were characterized as: individual-level variables, such as age, sex, marital status, and educational attainment of household head, household family size and household wealth index.

Data Analysis and Results

The data analysis for this study examined open defecation practices and their socioeconomic determinants in Osun State, Nigeria. We employed both descriptive and inferential statistical methods to analyze data collected from households across three Senatorial districts. Chi-square tests assessed relationships between demographic factors and open defecation practices, while ordinal regression analysis evaluated the strength and direction of these associations. The analysis focused on key variables including household demographics, sanitation facilities, economic factors, and health awareness. Statistical significance was set at $p<0.05$, and analyses were performed using SPSS version 25.0.

Table 1: Household Demographic Information

	Frequency(N)	Percentage (%)
Sex of Household Head		
Male	755	75.5%
Female	245	24.5%
Age of Household Head		
18-30 years	39	3.9%
31-40 years	130	13.0%
41-50 years	133	13.3%
51-60 years	345	34.5%
Above 60 years	353	35.3%
Educational Level of Household Head		
No formal education	320	32.0%
Primary education	305	30.5%
Secondary education	52	5.2%
Tertiary education	91	9.1%
Postgraduate education	232	23.2%

Occupation of Household Head		
Farming	79	7.9%
Trading	131	13.1%
Civil Service	208	20.8%
Private Sector Employee	324	32.4%
Artisan/Craftsperson	112	11.2%
Self-employed	107	10.7%
Retired	39	3.9%
Monthly Household Income		
Below ₦30,000	81	8.1%
₦30,000 - ₦50,000	283	28.3%
₦51,000 - ₦100,000	175	17.5%
₦101,000 - ₦150,000	253	25.3%
Above ₦150,000	208	20.8%
Number of People in Household		
1-3 people	146	14.6%
4-6 people	407	40.7%
7-9 people	434	43.4%
10 or more	13	1.3%
Housing Type		
Single room	161	16.1%
Room and parlor	223	22.3%
Flat	141	14.1%
Duplex	213	21.3%
Traditional compound house	262	26.2%

Demographic data from Osun State shows key trends: 75.5% of household heads are male, and 24.5% female. Most are older, with 69.8% over 50 years (34.5% aged 51-60, 35.3% over 60), and only 3.9% under 30. Educationally, 32% lack formal education, 30.5% have primary education, and 23.2% have postgraduate degrees. Employment is mainly in the private sector (32.4%) and civil service (20.8%), with farming at 7.9%. Households are generally middle income; 28.3% earn ₦30,000-₦50,000, and 25.3% earn ₦101,000-₦150,000. Families are often large, with 43.4% having 7-9 members and 40.7% with 4-6 members. The most common housing type is traditional compound houses (26.2%).

Table 2: Household Sanitation Facilities and Open Defecation Practices

Characteristics	Frequency(N)	Percentage (%)
Does your household have a toilet facility		
	N	%
Yes	663	66.3%
No	337	33.7%
If yes, what type of toilet facility?		
Water closet	142	21.4%
Pit latrine with slab	232	35.0%
Pit latrine without slab	120	18.1%
VIP latrine	140	21.1%
Others	29	4.4%
If no toilet facility, what are the reasons? (Select all that apply)		
Cannot afford	555	55.5%
Lack of space	263	26.3%
Landlord's responsibility	65	6.5%
Not a priority	78	7.8%

Others	39	3.9%
Source of Water Supply		
Piped water	326	32.6%
Borehole	193	19.3%
Well	107	10.7%
Stream/River	170	17.0%
Water vendor	126	12.6%
Others	78	7.8%
Does any member of your household practice open defecation		
Yes	737	73.7%
No	263	26.3%
If yes, how often		
Daily	137	18.6%
Several times a week	130	17.6%
Occasionally	337	45.7%
Only during emergencies	133	18.0%
What are the main reasons for practicing open defecation		
No toilet facility	294	29.4%
Toilet facility not functioning	39	3.9%
Water not available	311	31.1%
Preference/Habit	139	13.9%
Others	217	21.7%
Where do household members typically defecate		
Bush	170	17.0%
Uncompleted buildings	352	35.2%
Waterways/streams	233	23.3%
Open fields	193	19.3%
Others	52	5.2%

Osun State is struggling with a significant sanitation crisis. While 66.3% of households have toilets, 73.7% still practice open defecation, highlighting that access alone is insufficient. The predominant toilet type is Pit latrines with slabs (35%), followed by water closets (21.4%) and VIP latrines (21.1%). Economic challenges impede toilet ownership, with 55.5% citing cost as a barrier, and 26.3% facing space issues. Additionally, 6.5% believe landlords should provide toilets, reflecting tenancy concerns. Water access is also problematic; only 32.6% have piped water, and 17% rely on streams, while 12.6% depend on vendors, adding financial strain. Open defecation is serious, with 45.7% doing it occasionally and 18.6% daily, attributed to water scarcity (31.1%) and inadequate toilets (29.4%). Common open defecation sites include abandoned buildings (35.2%) and waterways (23.3%). This data suggests addressing open defecation needs a holistic strategy focusing on infrastructure, water access, and economic support, as many still defecate openly despite having toilets.

Table 3: Economic Factors and Community Factors of

	Frequency(N)	Percentage (%)
How much would you be willing to spend on toilet construction		
Less than ₦50,000	78	7.8%
₦50,000 - ₦100,000	272	27.2%
₦101,000 - ₦200,000	315	31.5%
Above ₦200,000	87	8.7%
Cannot afford any amount	248	24.8%
Would you be interested in a payment plan for toilet construction		
Yes	196	19.6%

No	328	32.8%
Maybe	476	47.6%
Monthly spending on water		
Below ₦2,000	131	13.1%
₦2,000 - ₦5,000	357	35.7%
₦5,001 - ₦10,000	277	27.7%
Above ₦10,000	235	23.5%
Are you aware of the health risks associated with open defecation?		
Yes	439	43.9%
No	561	56.1%
Has any household member experienced these in the past 6 months		
Diarrhea	235	23.5%
Typhoid	276	27.6%
Cholera	175	17.5%
Intestinal worms	170	17.0%
None of the above	144	14.4%
How much does your household spend monthly on treating water-related illnesses?		
Nothing	391	39.1%
Below ₦5,000	170	17.0%
₦5,000 - ₦10,000	183	18.3%
Above ₦10,000	256	25.6%
Is there a public toilet in your community		
Yes	802	80.2%
No	198	19.8%
If yes, do you use it?		
Yes	613	76.4%
No	189	23.6%
If no, why?		
Too expensive	78	39.4%
Too far	26	13.1%
Not clean	33	16.7%
Not safe	45	22.7%
Others	16	8.1%
Are you aware of any community sanctions against open defecation		
Yes	828	82.8%
No	172	17.2%

Table 4: Chi Square Analysis

Demography factors		Does any member of your household practice open defecation		Chi-square	P-value	Cramer's V
		Yes	No			
Sex of Household Head	Male	555	200	.057[a]	0.811	0.008
	Female	182	63			
	18-30 years	26	13	77.531[a]	0.000	0.278

Age of Household Head	31-40 years	117	13			
	41-50 years	120	13			
	51-60 years	265	80			
	Above 60 years	209	144			
Educational Level of Household Head	No formal education	252	68	67.280[a]	0.000	0.259
	Primary education	188	117			
	Secondary education	39	13			
	Tertiary education	52	39			
	Postgraduate education	206	26			
Occupation of Household Head	Farming	24	55	368.189[a]	0.000	0.607
	Trading	131	0			
	Civil Service	102	106			
	Private Sector Employee	274	50			
	Artisan/Craftsperson	99	13			
	Self-employed	107	0			
	Retired	0	39			
Monthly Household Income	Below ₦30,000	81	0	48.810[a]	0.000	0.221
	₦30,000 - ₦50,000	215	68			
	₦51,000 - ₦100,000	136	39			
	₦101,000 - ₦150,000	177	76			
	Above ₦150,000	128	80			
Number of People in Household:	1-3 people	120	26	182.066[a]	0.000	0.427
	4-6 people	209	198			
	7-9 people	395	39			
	10 or more	13	0			
Housing Type	Single room	120	41	12.113[a]	0.017	0.110
	Room and parlor	170	53			
	Flat	89	52			
	Duplex	153	60			
	Traditional compound house	205	57			

This dataset reveals sanitation challenges in Osun State. While 31.5% of households can allocate ₦101,000-₦200,000 for toilet construction, 24.8% can't invest anything. Most (67.2%) prefer payment plans. Monthly water bills are steep, with 86.9% spending over ₦2,000. Additionally, 56.1% are unaware of health risks from open defecation, which is linked to high disease rates—27.6% report typhoid, 23.5% diarrhea, and 17.5% cholera. Economic strain is evident, with 25.6% spending over ₦10,000 monthly on water-related health issues. Although 80.2% of communities have public toilets, usage is hindered by cost (39.4%), safety (22.7%), and cleanliness (16.7%). Many understand potential sanctions (82.8%), yet open defecation persists, signaling the need for better enforcement and infrastructure improvements.

The study reveals a complex link between open defecation and socioeconomic factors. Gender has minimal effect ($\chi^2 = 0.057$, $p = 0.811$). Age varies, with the 51-60 age group showing the highest rates (n = 265), indicating changes in sanitation practices. Education is a significant factor, with an inverse correlation ($\chi^2 = 67.280$, $p < 0.001$). Uneducated households report the highest rates (n = 252), while postgraduate households have the lowest (n = 206). Occupational status greatly affects rates ($\chi^2 = 368.189$, $p < 0.001$), predominantly among private sector workers (n = 274), and retirees show none, suggesting economic stability's influence. Income dynamics are complex ($\chi^2 = 48.810$, $p < 0.001$), as middle-income households (₦30,000-₦50,000) report the highest rates (n = 215), complicating the income-sanitation relationship.

Household size matters ($\chi^2 = 182.066$, $p < 0.001$), with larger households (7-9 members) showing the highest rates (n = 395), indicating resource constraints. Housing type also affects behaviors ($\chi^2 = 12.113$, $p = 0.017$), as traditional homes have higher rates compared to modern ones, reflecting cultural influences on sanitation.

Table 5: Ordinal regression analysis

Parameter Estimates							
Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	Df	Sig.
Female – Male	0.311	0.2949	-0.267	0.889	1.114	1	0.291
Male	Ref	Ref	Ref	Ref	Ref	Ref	Ref
18-30 years – Above 60 years	0.591	0.6851	-0.752	1.933	0.743	1	0.389
31-40 years – Above 60 years	1.382	0.3740	0.649	2.116	13.662	1	0.000
41-50 years – Above 60 years	1.787	0.3896	1.024	2.551	21.044	1	0.000
51-60 years – Above 60 years	-1.540	0.5565	-2.630	-0.449	7.657	1	0.006
Above 60 years	0[a]						
No formal education – Postgraduate education	2.701	0.5347	1.653	3.749	25.517	1	0.000
Primary education – Postgraduate education	2.262	0.7790	0.735	3.789	8.433	1	0.004
Secondary education – Postgraduate education	1.495	0.6266	0.267	2.723	5.694	1	0.017
Tertiary education – Postgraduate education	-6.510	0.4956	-7.481	-5.539	172.563	1	0.000
Postgraduate education	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Farming – Retired	-7.798	0.6875	-9.145	-6.450	128.647	1	0.000
Trading – Retired	-4.987	0.7284	-6.415	-3.559	46.878	1	0.000
Civil Service – Retired	-9.031	0.8408	-10.679	-7.383	115.356	1	0.000
Private Sector Employee – Retired	-6.356	0.5773	-7.487	-5.224	121.221	1	0.000
Artisan/Craftsperson – Retired	-6.382	0.7229	-7.798	-4.965	77.930	1	0.000
Self-employed – Retired	-7.570	0.7276	-8.996	-6.144	108.250	1	0.000
Retired	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Below ₦30,000 – Above ₦150,000	-0.333	0.5677	-1.446	0.780	0.344	1	0.557
₦30,000 - ₦50,000 – Above ₦150,000	-3.377	0.5206	-4.397	-2.357	42.082	1	0.000
₦51,000 - ₦100,000 – Above ₦150,000	-2.214	0.5497	-3.292	-1.137	16.227	1	0.000
₦101,000 - ₦150,000 – Above ₦150,000	-4.067	0.4339	-4.917	-3.217	87.868	1	0.000
Above ₦150,000	Ref	Ref	Ref	Ref	Ref	Ref	Ref
1-3 people – 10 or more	-16.371	7415.8615	-14551.193	14518.450	0.000	1	0.998
4-6 people – 10 or more	-24.437	7415.8615	-14559.259	14510.384	0.000	1	0.997
7-9 people – 10 or more	-20.606	7415.8615	-14555.428	14514.215	0.000	1	0.998
10 or more	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Single room – Traditional compound house	-0.237	0.2206	-0.669	0.195	1.155	1	0.283
Room and parlor – Traditional compound house	0.001	0.1997	-0.390	0.393	0.000	1	0.995
Flat – Traditional compound house	-0.172	0.2365	-0.636	0.291	0.531	1	0.466
Duplex – Traditional compound house	-0.039	0.2024	-0.436	0.358	0.037	1	0.848
Traditional compound house	Ref	Ref	Ref	Ref	Ref	Ref	Ref

Dependent Variable: If yes, how often
Model: (Threshold), Sex of Household Head, Age of Household Head, Educational Level of Household Head, Occupation of Household Head, Monthly Household Income, Number of People in Household, Housing Type

Ordinal regression analysis revealed key factors influencing open defecation in Osun State, Nigeria. Gender was not a significant predictor (B = 0.311, p = .291). Individuals aged 41-50 (B = 1.787, p < .001) and 31-40 (B = 1.382, p < .001) were more likely to practice open defecation, while those aged 51-60 (B = -1.540, p = .006) were less likely. Education significantly influenced behavior; individuals without formal education were more prone to open defecation compared to postgraduate holders (B = 2.701, p < .001), and tertiary education reduced this behavior (B = -6.510, p < .001). All employment groups had lower likelihoods than retirees, with civil servants showing the greatest contrast (B = -9.031, p < .001). Lower income brackets also displayed a reduced likelihood compared to those earning above ₦150,000, especially the ₦101,000-₦150,000 range (B = -4.067, p < .001). Wald values indicated correlation strength, with higher values reflecting stronger relationships. No significant findings were noted for housing type and household size (p > .05).

Discussion

This study explored the socio-demographic and economic factors affecting open defecation in households. Findings indicate complex relationships between these factors and open defecation behaviors, highlighting important implications for public health strategies and policy. Despite 66.3% of households having toilets, 73.7% still practice open defecation, revealing a gap between infrastructure and usage, consistent with Belay et al., (2022), which emphasizes that infrastructure alone does not drive behavioral change.

Education is a significant factor; households led by individuals without formal education are 2.7 times more likely to engage in open defecation than those with postgraduate education (p<0.001). This supports Abebe and Tucho's (2020) assertion that education is vital for eliminating open defecation. Our educational gradient (χ^2 = 67.280, p<0.001, Cramer's V = 0.259) underscores the need for educational initiatives in sanitation efforts.

Economic factors are also complex. While 55.5% of households cited cost as a barrier to toilet access, regression analysis revealed that those earning ₦101,000-₦150,000 are less likely to practice open defecation (B=-4.067, p<0.001) compared to higher-income households. This aligns with Culley (2018), showing that economic factors intertwine with cultural and behavioral issues.

Water scarcity is a notable issue, with 31.1% of respondents indicating it as a reason for open defecation. This finding reflects Debela et al. (2018), who identified water scarcity as a major sanitation barrier in sub-Saharan Africa. The population's reliance on streams (17%) and water vendors (12.6%) suggest vulnerability in water security, exacerbating open defecation.

Health awareness is critical, as 56.1% of respondents are unaware of the health risks linked to open defecation. This knowledge gap corresponds with high disease rates, with 27.6% reporting typhoid and 23.5% diarrhea in the past six months. This aligns with Gebru et al. (2014), who found significant links between open defecation and diarrhea in Ethiopia.

Occupational status correlates strongly with open defecation (χ^2 = 368.189, p<0.001, Cramer's V = 0.607), with private sector employees showing higher prevalence. This contrasts with Mukhtar et al. (2023) in northern Nigeria, indicating regional variations in socioeconomic factors.

Age patterns show that households led by individuals aged 41-50 are more likely to practice open defecation (B=1.787, p<0.001) compared to those over 60, suggesting changing sanitation attitudes, similar to trends noted by Galan et al. (2013) in sub-Saharan Africa.

Community infrastructure and governance are also crucial. Although 80.2% of communities have public toilets, barriers like cost (39.4%) and safety (22.7%) impede usage. Despite high awareness of community sanctions (82.8%), persistent open defecation indicates ineffective enforcement, supporting the Centre for Legislative Research Advocacy (2013) on the need for community-led interventions.

The prevalence of open defecation near water sources (23.3% using waterways) poses serious public health risks, particularly regarding food contamination. This aligns with Antwi-Agyei et al. (2015), who documented similar risks in agricultural contexts, highlighting the need for integrated policies in water, sanitation, and agriculture.

Conclusion

This study reveals the ongoing challenge of open defecation in Osun State, Nigeria, showing complex links between socioeconomic factors, infrastructure, and behavior. Despite 66.3% of households having toilets, the fact that 73.7% still practice open defecation emphasizes that infrastructure alone cannot resolve this public health issue. Significant associations were found between open defecation and various socio-demographic factors, particularly education level (χ^2 = 67.280, p<0.001), occupation (χ^2 = 368.189, p<0.001), and household size (χ^2 = 182.066, p<0.001).

Economic barriers are substantial, with 55.5% citing cost as a primary constraint. The high incidence of water-related diseases, including typhoid (27.6%) and diarrhea (23.5%), underscores the health risks of current sanitation practices. Additionally, 56.1% of respondents are unaware of the health risks associated with open defecation, indicating a critical knowledge gap.

Recommendations

Based on the findings, we recommend:

1. **Infrastructure Development**
   I. Implement subsidized toilet programs for lower-income households (below ₦50,000).
   II. Develop more public toilets with enhanced maintenance and security for those who find current facilities too costly (39.4%) or unsafe (22.7%).

III. Establish community water points to address the 31.1% citing water unavailability.

2. **Economic Interventions**
   I. Create flexible payment plans for toilet construction, as 47.6% expressed interest.
   II. Foster public-private partnerships to lower toilet construction and maintenance costs.

3. **Educational and Awareness Programs**
   I. Launch health education campaigns for the 56.1% unaware of health risks.
   II. Implement school-based sanitation education.
   III. Conduct community workshops on toilet maintenance and hygiene.
   IV. Develop targeted programs for households without formal education, who are significantly more likely to practice open defecation (B=2.701, $p<0.001$).

4. **Water Access Improvement**
   I. Expand piped water infrastructure beyond the current 32.6% coverage.
   II. Implement rainwater harvesting.

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