

Analysis of the Effects of Open Defecation on its Immediate Environment in Omelenge, Owo Local Government Area, Nigeria

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Abstract: The health risks associated with open defecation are alarming, especially in rural communities. Hence, this study analysed the effects of open defecation on its immediate environment in Omelenge, Owo local government area, Nigeria. Soil and water samples were collected from some of the dunghills where the residents in Omelenge usually defecate. It also collected some soil and water samples from some parts of the project site where the residents do not use to defecate. The samples were taken to the laboratory for test and the results were clearly analysed. Hypothesis was formulated and tested using bavairate analysis. The results showed that, there is a concentration of heavy metals in the surface water samples, but that which was collected from the dunghills where the residents usually defecate was higher. The higher values might be due to the leachate from the surrounding dunghills and soil into the flowing stream. The tested hypothesis revealed that, open defecation significantly influences water quality in Omelenge.

Keywords: Omelenge, Defecation, Soil, Water, and Dunghills.

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I. INTRODUCTION

➤ Background to the Study

Open defecation refers to the practice of defecating in fields, forests, bushes, bodies of water or other open spaces (World Health Organization/United Nation International Children's Emergency Fund, (WHO/UNICEF) Joint Monitoring Programme (JMP), 2018). Open defecation is a common practice in Ondo State. Many families have a demigod on their dunghills which is usually at the back of their residential buildings. The belief is that, the more people defecate on the dunghills the more active the demigod who they believe resides on the dunghills. So, most households ensure their dunghills are always patronized by the residents. Adults in the house usually defecate on the dunghills at the early hours of the day, or when it is dark in the night, while the young ones use it anytime. Three of such dunghills dotted the landscape of Omelenge at the back of the community. In facts, each of them covers about an acre of land. And the only stream which the community depends on for domestic uses bounded these dunghills at the northern part of the village.

Consequently, it is imperative to know that, Urban and Regional Planning is a profession that deals with the

allocation of land for different uses in order to create aesthetically pleasing environment and compatibility in terms of land-uses. Odogiyon (2015, p.5) stated that, a clean environment is paramount to a healthy living condition for man. He stated further that, we cannot continue to wait for the outbreak of epidemic diseases in our cities before we take vigorous steps as urban and regional planners. He further informed that, no city in Nigeria is ranked among the cleanest cities in Africa.

Furthermore, the World Bank Statistics suggest that regions with high rates of open defecation experiences tremendous problem in terms of sanitation and proper waste management. They informed further that, the result of open defecation near water ways is that it is carried into the water system minus treatment. As a consequence, the contaminated water ends up in the main water source. When people in these regions use the water as it for drinking and cooking (since the water is not boiled most of the time because of poverty and lack of education) it results in water borne diseases such as cholera, typhoid, and trachoma. It is noteworthy that, the environment also suffers as a result of open defecation because it introduces toxins and bacteria into the ecosystem in amounts that it cannot handle or break down at a time. This

leads to build up of filth. Also, the load of microbes can become so great that in the end, they end up in aquatic systems thereby causing harm to aquatic life. At the same time, it can contribute to eutrophication or the formation of algal blooms that form disgusting scum on the surface of the water ways which disturb aquatic life underneath the water by preventing oxygen and light diffusion into the water. Based on the fore-going, the analysis of the effects of open defecation on its immediate environment in Omelenge is inevitable at this time.

II. RESEARCH SITE

Omelenge is a small village in Owo Local government Area of Ondo State, Nigeria. It is located between latitude $7^{\circ}18'$ and $5^{\circ}28'$ North of the equator and longitude $5^{\circ}28'$ East of the Greenwich meridian, and on a plain with elevation of 1095 feet and high altitude of 5025 feet. It is bounded at the North by Ujan camp, at the South East by Okitiofa village, at the South by Ijgunma village, at the South West by Aratokun camp, at the North West by Igbe community and Ipele junction. It has an estimated population of 3,767 people (NPC, 1991, p. 34 and Authors' input, 2026). The inhabitants are mainly of Yoruba, and Ebira descent. The major occupation of the people are farming and trading. Omelenge is the host of the largest regional market in Owo local government area of Ondo State, Nigeria. The major source of water supply is a seasonal stream called Omi-fun.

III. METHODOLOGY

➤ Sampling Strategies

This study focused mainly on the analysis of the effects of open defecation on its immediate environment in Omelenge. It embraced both primary and secondary sources of information. Soil and water samples were collected from the dunghills where the residents usually defecate. It also

collected some soil and water samples from some parts of Omelenge where the residents do not use to defecate. These samples were taken to the laboratory for test and the results were clearly analysed. Hypothesis was formulated and tested.

IV. RESULTS AND DISCUSSIONS

Investigation revealed that, there were three big dunghills at Omelenge where almost the whole residents usually defecate. Each of these dunghills covered about an acre of land. Example of one of them is shown on PLATE 1.



Fig 1 One of the Dung Hills where People Usually Defecate at Omelenge.

Source; Authors' Field Survey, 2026.

Table 1 Physicochemical Characteristics of the Soil Samples from the two Dunghills and the Control at Omelenge.

	Dung-Hill Location	1		2		
Parameters	Sample Code	S1	S2	S3	S4	Control
pH		5.46+0.02 ^b	4.88+0.02 ^d	3.46+0.02 ^e	5.51+0.02 ^a	4.99+0.01 ^c
OM (%)		22.53+0.11 ^c	31.41+0.02 ^b	42.13+0.05 ^a	21.46+0.05 ^d	2.93+0.05 ^e
TOC (%)		12.55+0.05 ^a	5.28+0.02 ^d	8.48+0.02 ^c	12.03+0.05 ^b	1.55+0.05 ^e
Total N (%)		0.65+0.05 ^c	0.91+0.02 ^b	0.63+0.02 ^c	1.09+0.01 ^a	0.33+0.02 ^d
Total P (mg/kg)		0.75+0.05 ^d	1.30+0.00 ^b	0.48+0.02 ^e	0.91+0.02 ^c	1.48+0.02 ^a
Na ⁺ (cmol/kg)		0.53+0.02 ^c	0.16+0.02 ^e	0.26+0.02 ^d	0.81+0.02 ^b	1.69+0.01 ^a
K ⁺ (cmol/kg)		1.26+0.02 ^a	0.46+0.02 ^d	0.91+0.02 ^b	0.73+0.05 ^c	0.68+0.01 ^c
Ca ²⁺ (cmol/kg)		1.76+0.02 ^c	1.80+0.00 ^c	1.91+0.02 ^b	1.51+0.02 ^d	2.56+0.05 ^a
Mg ²⁺ (cmol/kg)		1.31+0.02 ^c	1.83+0.02 ^b	1.16+0.02 ^d	1.21+0.02 ^d	2.53+0.05 ^a

Values with different superscripts in each row are significantly different ($P < 0.05$)

TOC – Total Organic carbon, OM – Organic matter, P – Phosphorus, N – Nitrogen.

Source; Authors' Field Survey and Laboratory Input (2026).

The physicochemical characteristics of the soil samples obtained from the two dunghills are presented in Table 1. Two soil samples were taken from each dunghill along with a cross-sample serving the two sampling locations. This table shows the pH, % organic matter (OM), % total organic carbon (TOC), total phosphorus (mg/kg), Total N (%), Na⁺

(cmol/kg), K⁺ (cmol/kg), Ca²⁺ (cmol/kg), and Mg²⁺ (cmol/kg). The pH value across the two sampling locations is in the range of 5.51+0.02 - 3.46+0.02. The pH varies from one sampling location to the other. There is a significant difference in the pH values across all the sampling locations and the control sample. The pH is the degree of alkalinity or

acidity of a sample. PH is known to influence other soil physicochemical parameters of soil (Hartemink and Barrow 2023; Onwuamaoike et al., 2021; Akinnusotu and Arawande, 2016). The % organic matter (OM) ranges between 42.13 ± 0.05 - 21.46 ± 0.05 across the two dunghills including the control sample. The % OM of the control sample differs significantly from the values from other sampling locations across the two dung hills. Organic matter, organic material, or natural organic matter refers to the large source of carbon-based compounds found within natural, engineered, terrestrial, and aquatic environments. This matter composed of organic compounds that have come from the faeces and remains of organisms such as plants and animals (Murindangabo et al., 2023).

The % total organic carbon (TOC) is in the range of 12.55 ± 0.05 - 5.28 ± 0.02 across the two dunghills. The concentration of % TOC in the control soil sample is 1.55 ± 0.05 which differs significantly from all the other sampling locations. Total Organic Carbon (TOC) is a measure of the total amount of carbon in organic compounds in the soil sample (Murindangabo et al., 2023).

Total Nitrogen (%) in the soil samples is in the range of 1.09 ± 0.01 - 0.63 ± 0.02 for the soil sampling locations from the two dunghills of the selected location. Statistically, the total nitrogen concentration (%) across the sampling locations varies throughout the dunghills while the control sample differs significantly from the four sampling locations across the two dunghills. The total nitrogen (%) from the control is 0.33 ± 0.02 . Soil total nitrogen (TN) is the sum of nitrate (NO_3^-), nitrite (NO_2^-), organic nitrogen, and ammonia (all expressed as N). Analysis and quantification of TN are used to estimate nitrogen availability from the natural decay of organic materials (Hu et al., 2023).

The total phosphorus in mg/kg across the sampling locations from the two dunghills is in the range of 1.30 ± 0.00 - 0.48 ± 0.02 mg/kg. This concentration differs significantly from that concentration value from the control location (1.48 ± 0.02 mg/kg). The total phosphorus concentration from the control location is higher when compared to the concentrations from the dunghills. Phosphorus is one of the

major plant nutrients in the soil. It is a constituent of plant cells, essential for cell division and development of the growing tip of the plant. For this reason, it is vital for seedlings and young plants (Jindo et al., 2023).

The concentration of Na^+ and K^+ (cmol/kg) varies across the sampling locations from the two dunghills. The concentration of Na^+ ranges between 0.81 ± 0.02 - $0.16 \pm 0.02^+$ (cmol/kg). The highest concentration is from dunghill sampling location 2 while the least is from the second sampling location of the first dunghill. Sodium ion concentration from the control sample is 1.69 ± 0.01 , which is higher when compared to the concentration from other sampling locations across the two dunghills. Potassium ion concentration range between 1.26 ± 0.02 - 0.46 ± 0.02 (cmol/kg) coming from dunghill locations 1 and 2. The K^+ of the control samples is 0.68 ± 0.01 which shows a similar concentration to 0.73 ± 0.05 from the second sampling location of the second dunghill (S4).

The concentration of Ca^{2+} in cmol/kg is in the range between 1.80 ± 0.00 - 1.51 ± 0.02 cmol/kg. The concentration from the two sampling locations from the first dunghill shows no significant difference but differs from the other sampling locations including the control sample which is with the highest concentration (2.56 ± 0.05 cmol/kg). The Mg^{2+} (cmol/kg) concentration across the two dunghills is between the range of 1.83 ± 0.02 - 1.16 ± 0.02 (cmol/kg) (dunghill 1, sampling location 2, and dunghill 2 sampling location 1). The concentration of Mg^{2+} from the second dunghill shows no significant difference from each other but significantly differs from the other sampling locations and the control sample. The control sample has the highest concentration value of 2.53 ± 0.05 (cmol/kg) being the highest value. The concentration of Ca^{2+} and Mg^{2+} from the control sampling location was higher than the concentrations from the two dunghills. Calcium (Ca) and Magnesium (Mg) are secondary plant nutrients but are just as essential for plant growth even though those elements are required in negligible amounts compared to macronutrients. While Calcium is part of every plant cell, it keeps cell walls upright and increases fruit set and quality (Babiy et al., 2023).

Table 2 Heavy Metals in the Soil samples from the Two Dunghills and the Control at Omelenge, Owo Local Government Area of Ondo State.

Parameters	Dung-Hill Location	1		2		Control
	Sample Code	S1	S2	S3	S4	
Cd (mg/kg)		4.06 ± 0.02^b	4.61 ± 0.02^a	3.21 ± 0.02^d	3.73 ± 0.02^c	0.05 ± 0.00^e
Pb (mg/kg)		1.04 ± 0.01^c	2.06 ± 0.01^a	1.04 ± 0.01^c	1.56 ± 0.02^b	0.05 ± 0.00^d
Zn (mg/kg)		1.86 ± 0.02^a	1.48 ± 0.02^d	1.76 ± 0.02^b	1.56 ± 0.02^c	1.01 ± 0.02^e
Fe (mg/kg)		656.60 ± 0.51^b	504.86 ± 4.50^d	688.46 ± 0.45^a	579.50 ± 0.50^c	256.00 ± 1.73^e
Cr (mg/kg)		1.51 ± 0.02^d	2.11 ± 0.02^c	2.21 ± 0.02^b	2.53 ± 0.02^a	0.11 ± 0.02^e
Ni (mg/kg)		0.96 ± 0.01^d	1.13 ± 0.05^c	1.95 ± 0.05^a	1.53 ± 0.02^b	0.02 ± 0.01^e
Co (mg/kg)		0.91 ± 0.02^c	1.25 ± 0.08^b	1.51 ± 0.02^a	0.85 ± 0.05^c	0.26 ± 0.02^d
As (mg/kg)		0.51 ± 0.02^b	0.36 ± 0.02^c	0.09 ± 0.01^d	1.05 ± 0.00^a	0.03 ± 0.01^e

Values with different superscripts in each row are significantly different ($P < 0.05$)

Source; Authors' Field Survey and Laboratory Input (2026).

The concentration of heavy metals (mg/kg) in the soil samples from the two dunghill locations and the control sample are presented in Table 2. The concentration of cadmium (Cd) is in the range of 4.61 ± 0.02 - 3.21 ± 0.02 (mg/kg). The highest concentration is from the second sampling location (S2) of the first dung hill while the least is from the second point (S3) of sampling from the second dunghill. There is a significant difference in Cd across the two dunghills. The concentration from the control sample (0.05 ± 0.00 mg/kg) is far less than from the sampling locations from the dunghills. The concentration of lead (Pb) ranged from 2.06 ± 0.01 - 1.04 ± 0.01 (mg/kg). The concentration of Pb from the first dunghill sampling location 1 (S1) and the second dunghill first sampling location (S3) show no significant difference. Other concentrations show significant differences from one another including the control that is 0.05 ± 0.00 (mg/kg). The concentration of zinc (Zn) and iron (Fe) show significant differences across the two dung hills and their respective control concentration values. Zinc (Zn) is in the range of 1.86 ± 0.02 - 1.48 ± 0.02 (mg/kg) and 688.46 ± 0.45 - 504.86 ± 4.50 (mg/kg) for iron (Fe). The result obtained from the control sample was greatly lesser when compared to that of the concentration from the dunghills. The highest concentration of Fe is from the first sampling location

for the second dunghill (S3) while the least is from the second sampling location of the first dunghill (S2). The concentration of chromium (Cr) and nickel (Ni) from the sampling locations across the two dunghills are significantly difference from one another. The range is 2.53 ± 0.02 - 0.96 ± 0.01 (mg/kg) for Cr and 1.95 ± 0.05 - 0.96 ± 0.01 (mg/kg) for Ni, while the control sample concentrations are 0.11 ± 0.02 (mg/kg) (Cr) and 0.02 ± 0.01 (mg/kg) (Ni). The concentration of cobalt (Co) is in the range of 1.51 ± 0.02 - 0.85 ± 0.05 (mg/kg). The highest and the least concentrations are from the second dunghill sampling locations 1 (S3) and 2 (S4). There is no significant difference in the concentration of Co from that of the first dunghill sampling location 1 (S1) and the second 90; dunghill sampling location 2 (S4). The concentration of the control sample differs significantly from all the sampling locations across the two dunghills. The concentration of arsenic (As) is in the range of 1.05 ± 0.00 - 0.09 ± 0.01 (mg/kg), the highest concentration and the least are from the second dunghill, while the concentration of the control sample is 0.03 ± 0.01 (mg/kg). The metal characteristics and concentration at dumpsites including dunghills are subject to the type of waste materials that are common in the environment which invariably influence the soil physicochemical characteristics such as pH, Om, TOC, etc.

Table 3 Physicochemical Characteristics of the Surface and Well Water Samples at the Study Area.

PARAMETER	WS 1	WS 2
Ph	5.51 ± 0.02^b	6.65 ± 0.05^a
Dissolved Oxygen (ppm)	4.81 ± 0.02^b	10.53 ± 0.05^a
B.O.D. ₅ (ppm)	10.61 ± 0.02^a	5.60 ± 0.17^b
COD (mg/l)	60.16 ± 0.28^a	15.30 ± 0.17^b
E. CONDUCTIVITY (μ mhos)	255.96 ± 0.50^a	112.30 ± 0.26^b
TURBIDITY (NTU)	10.25 ± 0.05^a	3.55 ± 0.05^b
SUSPENDED SOLIDS (mg/l)	0.72 ± 0.57^a	0.09 ± 0.00^b
TOTAL DISSOLVED SOLIDS (mg/l)	145.50 ± 0.00^a	68.24 ± 0.01^b
TOTAL SOLIDS (mg/l)	146.05 ± 0.00^a	68.34 ± 0.00^b
NITRATES (mg/l)	104.95 ± 0.12^a	25.26 ± 0.07^b
TOTAL HARDNESS (mg/l)	129.48 ± 0.48^a	36.40 ± 0.10^b
TOTAL ALKALINITY (mg/l)	92.16 ± 0.28^a	44.43 ± 0.05^b
CHLORIDES (mg/l)	105.98 ± 0.01^a	50.53 ± 0.05^b
PHOSPHATES (ppm)	59.68 ± 0.59^a	22.51 ± 0.02^b
SULPHATES (ppm)	85.29 ± 0.06^a	18.85 ± 0.05^b

WS 1 – Flowing surface water sample (close to the dung hills)

WS 2 – Well water at the back of the Primary school

Source; Authors' field survey and laboratory input (2026)

The physicochemical characteristics of the two water samples are presented in Table 3. WS1 is the surface water flowing close to the two dunghills assessed and WS2 is well water available at the back of the community primary school. The pH of the surface water is 5.51 ± 0.02 while the well water is 6.65 ± 0.05 . The pH of the well water is acidic while that of the well water is close to neutral (good), this falls within the WHO standard for drinking water. The acidity of the surface water might be due to the pollution coming from the dunghills and other discharges such as cassava effluents from the cassava processing centres in the community. One major source of pollution of water is the discharge of effluent into it without treatment (Akinnusotu and Arawande, 2016). The pH of a solution is the degree of acidity or alkalinity. It plays an

important role in several metabolism processes (Zaib et al., 2023; Akinnusotu et al., 2015). The dissolved oxygen (DO) in the surface water (WS1) 4.81 ± 0.02 is lower than the well water (WS2) 10.53 ± 0.05 . Dissolved oxygen (DO) is a measure of how much oxygen is dissolved in the water - the amount of oxygen available to living aquatic organisms (Chidiac et al., 2023). The biochemical oxygen demand (BOD₅) is 10.61 ± 0.02 for the surface water and 5.60 ± 0.17 for the well water.

The turbidity of the surface water is 10.25 ± 0.05 while that of the well water is 3.55 ± 0.05 NTU. Turbidity is the clarity of a solution measured in NTU. The turbidity of the surface water sample is higher than that of the well water

samples. The total solids (TS) in the surface water (146.05±0.00 mg/L) is higher than the well water (68.34±0.00 mg/L). Total solids include the dissolved solids in a water sample. The total hardness of the surface water is higher than the well water. The total hardness of the surface water is 129.48±0.48 mg/L which is higher than that of the well water (36.40±0.10). The presence of calcium (Ca²⁺) and

magnesium ions (Mg²⁺) accounts for the hardness of water samples. In general, statistically, the concentration of all the analysed physicochemical parameters differs significantly from each other. The values from the well water are better than the surface water in terms of water quality assessment. The influence of the dunghill and the dumpsites is a factor to the degree of surface water pollution.

Table 4 Heavy Metal Concentrations in the Water Samples Analysed

Sample/Element	Cd (ppm)	Pb (ppm)	As (ppm)	Cr (ppm)	Ni (ppm)	Co (ppm)	Zn (ppm)
WS 1	0.64±0.00	0.05±0.02 ^a	1.01±0.01 ^a	0.25±0.00 ^a	1.25±0.01 ^a	0.25±0.00	1.91±0.05 ^a
WS 2	ND	0.001±0.00 ^b	0.03±0.01 ^b	0.002±0.00 ^b	0.003±0.00 ^b	ND	0.50±0.00 ^b

WS 1 – Flowing surface water sample (close to the dung hills)

WS 2 – Well water at the back of the Primary school (far from the dung hills)

Source; Authors' field survey and laboratory input (2026).

The concentration of the heavy metals (HMs) in the water samples from the study site is depicted in Table 4. The heavy metals analysed are Cd, Pb, As, Cr, Ni, Co, and Zn. The concentrations of Cd and Co are 0.64±0.00 ppm and 0.25±0.00 ppm in the surface water (WS1) and below the detection limit or not detected in the well water sample. The presence of Cd in water samples causes several neurological disorders in humans (Sarker et al., 2023). The concentration of Pb and arsenic are 0.05±0.02 ppm and 1.01±0.01 ppm for the surface water and 0.001±0.00 ppm and 0.03±0.01 ppm for the well water sample. Heavy metals can be harmful to various organs, including the neurological systems, liver lungs, kidneys, stomach, etc. even at low exposure levels (Muhammad et al., 2023). The concentration of chromium (Cr) is 0.25±0.00 ppm in the surface water and 0.002±0.00 ppm in the well water. Nickel (Ni) and zinc (Zn) are 1.25±0.01 ppm for the surface water sample while that of the well water sample are 0.003±0.00 ppm and 0.50±0.00 ppm. Statistically, the concentration of the heavy metals in the surface water sample is higher than that of the well water. The higher values might be due to the leachate from the surrounding dunghill and soil into the flowing river. Heavy metals can come from atmospheric precipitation arising from anthropogenic activities (Abulude et al., 2022; Abulude et al., 2020; Akinnusotu et al., 2021).

➤ Hypothesis

In order to allow for accurate and data based generalization the following hypothesis was put forward and tested;

- H₀: Open defecation has no significant effect on its immediate environment.
- H₁: Open defecation has significant effect on its immediate environment.

The word environment is omnibus and ubiquitous meaning various things to all sundry and respects; however,

describing environment *simpliciter*, it encompasses the entirety of human surroundings, including animate and inanimate entities. In the context of this study, environment connotes peculiarities around man, susceptible to the prevalence of open defecation. These features are water and soil, leading to 3 environmental outcome variables, which are water quality, incidence of water borne disease, and soil quality. It is apposite to note that these environmental outcome variables are latent in nature derived from observable variables in the questionnaire. For simplicity, indices were created for appropriate research variables in the questionnaire to generate indexes used as the parsimonious representation of the outcome (environmental) variables. For the predictor variable, open defecation index was categorised into groups of low, medium, and high to guarantee its appropriateness for the multivariate analysis of variance (MANOVA) employed to validate this hypothesis. Having said that, the data were subjected to the assumptions of MANOVA such as multivariate normality, linearity, multicollinearity, and homogeneity of variance-covariance matrices to ascertain its robustness for this test of measure. Clearly, the 3 outcome variables are continuous data measured at ratio level while the predictor has 3 independent groups of low, medium and high of open defecation. Similarly, there was independence of observations, given that it did not employ a repeated design study where a singular participant could be in more than one group. In the case of this study, there were different participants in each group with no participant occurred in more than a group. More importantly, the result for the homogeneity of variance-covariance matrices is presented in Table 5. The Box's M test was employed to assess the null hypothesis that the observed covariance matrices of the dependent variables were equal across groups of the independent variable. The findings, Box's M = 12.444, F (12, 640319.224) = 4.335, p = .140 show that p-value exceeds 0.5, and then the null hypothesis is upheld, indicating that the assumption of equal covariance matrices is valid, thereby supporting the validity and reliability of the MANOVA results.

Table 5 Box's Test of Equality of Covariance Matrices^a

Box's M	12.444
F	4.335
df1	12

df2	640319.224
Sig.	.140

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + ODCAT

Having met the cogent assumptions, the findings of the multivariate tests were presented in Table 6. The multivariate tests (Pillai's Trace, Wilks' Lambda, Hotelling's Trace, Roy's Largest Root) assess the overall effect of the predictor (open defecation) on the combined outcome variables (environment: water quality, incidence of water borne disease, and soil quality). All four tests yielded significant results ($p < .001$), indicating that the combined dependent variables were significantly affected by the level of open defecation. Succinctly expressed, open defecation has a significant effect on environmental quality.

Substantiating further, Using Pillai's Trace, there was significant effect of open defecation on environmental variables, $V = .056$, $F(6,1382) = 6.678$, $p < .001$. Wilk's statistic shows that there was significant effect of open defecation on environmental variables, $\Lambda = .944$, $F(6,1380) = 6.708$, $p < .001$. Hotelling's Trace statistics equally showed a significant effect of open defecation on the environmental variables, $T = .059$, $F(6, 1378) = 6.738$, $p < .001$. Similarly, the Roy's Largest Root result indicates a significant effect of open defecation on the environment, $\Theta = .048$, $F(3,691) = 11.112$, $p < .001$.

Table 6 Multivariate Tests^a

	Effect	Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.953	4677.241 ^b	3.000	690.000	.000
	Wilks' Lambda	.047	4677.241 ^b	3.000	690.000	.000
	Hotelling's Trace	20.336	4677.241 ^b	3.000	690.000	.000
	Roy's Largest Root	20.336	4677.241 ^b	3.000	690.000	.000
ODCAT	Pillai's Trace	.056	6.678	6.000	1382.000	.000
	Wilks' Lambda	.944	6.708 ^b	6.000	1380.000	.000
	Hotelling's Trace	.059	6.738	6.000	1378.000	.000
	Roy's Largest Root	.048	11.112 ^c	3.000	691.000	.000

a. Design: Intercept + ODCAT

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

The Levene's test in Table 7 assesses the homogeneity of variances for each dependent variable, i.e., the environmental variables. The results for water quality ($p = .118$), incidence of waterborne diseases ($p = .123$), and soil contamination ($p = .126$) indicate that the error variances are equal across the groups for all dependent variables, as none

of the p -values are less than .05 and all are non-significant, which indicate that the assumption of homogeneity of variance has been met. This further validates the assumptions required for MANOVA and confirmed that the multivariate results are robust.

Table 7 Levene's Test of Equality of Error Variances^a

		Levene Statistic	df1	df2	Sig.
Water Quality	Based on Mean	2.636	2	692	.118
	Based on Median	2.434	2	692	.116
	Based on Median and with adjusted df	2.434	2	658.245	.116
	Based on trimmed mean	2.520	2	692	.117
Incidence of Water Borne Diseases	Based on Mean	2.098	2	692	.123
	Based on Median	1.965	2	692	.141
	Based on Median and with adjusted df	1.965	2	683.101	.141
	Based on trimmed mean	2.081	2	692	.126
Soil Contamination	Based on Mean	2.081	2	692	.126
	Based on Median	2.075	2	692	.126
	Based on Median and with adjusted df	2.075	2	667.055	.126
	Based on trimmed mean	2.081	2	692	.126

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + ODCAT

The between-subjects effects in Table 8 reveal how each dependent variable is individually affected by the level of open defecation. The results indicate that all three dependent variables show significant effects, which imply that the level of open defecation significantly influences

water quality, incidence of waterborne diseases, and soil contamination.

To sum up, the MANOVA results indicate that open defecation significantly impacts environmental quality in

Ondo State, Nigeria. Specifically, higher levels of open defecation were associated with deteriorated water quality, increased incidence of waterborne diseases, and greater soil contamination. Judging from this study, a primal rule points to the imperativeness of policy and programme changes such

as expanding public health awareness campaigns and facilitating better access to improved toilet facilities, to lessen the negative environmental effects of open defecation in the State.

Table 8 Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	Water Quality	10.161 ^a	2	5.081	4.367	.013
	Incidence of Water Borne Diseases	34.232 ^b	2	17.116	13.853	.000
	Soil Contamination	12.858 ^c	2	6.429	4.681	.010
Intercept	Water Quality	6975.716	1	6975.716	5995.850	.000
	Incidence of Water Borne Diseases	7435.036	1	7435.036	6017.848	.000
	Soil Contamination	6906.141	1	6906.141	5028.614	.000
ODCAT	Water Quality	10.161	2	5.081	4.367	.013
	Incidence of Water Borne Diseases	34.232	2	17.116	13.853	.000
	Soil Contamination	12.858	2	6.429	4.681	.010
Error	Water Quality	805.089	692	1.163		
	Incidence of Water Borne Diseases	854.964	692	1.235		
	Soil Contamination	950.371	692	1.373		
Total	Water Quality	9913.670	695			
	Incidence of Water Borne Diseases	1081 30.468	695			
	Soil Contamination	9794.992	695			
Corrected Total	Water Quality	815.250	694			
	Incidence of Water Borne Diseases	889.196	694			
	Soil Contamination	963.229	694			
a. R Squared = .012 (Adjusted R Squared = .010)						
b. R Squared = .038 (Adjusted R Squared = .036)						
c. R Squared = .013 (Adjusted R Squared = .010)						

V. CONCLUSION

This study has analysed the effects of open defecation on its immediate environment in Omelenge. Soil samples were collected from the dunghills where the people usually defecate, and another soil samples from the area where there is no dunghill. Water samples were also collected from the well that was located far from the dunghills. Another set of water samples were collected from the stream that abuts the dunghills where the majority of Omelenge residents usually defecate. In addition, hypothesis were formulated and tested in order to confirm the results of the laboratory test.

The results of the laboratory test on the soil samples indicated that, the percentage of the carbon based compounds found across the two dunghills is significantly difference from the values from other control sampling. This indicates that, the matter in the dunghills composed of organic compounds that come from the human faeces deposited on the dunghills.

In the same vein, the physicochemical characteristics of the two water samples were presented, and the results revealed that, that concentration of all the analysed physicochemical parameters differs significantly from each other. That is, the values from the well water samples are better than the values from the surface water sample in terms of water quality assessment. That is, the influence of the dunghills is a factor to the degree of surface water pollution. The result also revealed that, the concentration of heavy

metals in the surface water sample is higher than that of the well water. The higher values might be due to the leachate from the surrounding dunghills and soil into the flowing stream.

Substantiating further, the tested hypothesis revealed that, all the dependent variables showed significant effects that, the level of open defecation significantly influences water quality in Omelenge, incidence of waterborne diseases, and soil contamination. To sum it up, the overall results indicated that, open defecation significantly impacts environmental quality in Omelenge, Owo local government area, Nigeria.

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