





Multilevel Analysis of Socioeconomic and Contextual Determinants of Unsafe Household Waste Disposal in Nasarawa, Nigeria

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Abstract	Article History
<p>The problem of municipal solid waste management has been worsened by the fast pace of urbanization in low and middle income countries due to lack of proper infrastructure development. Unsafe methods for the disposal of waste at home, such as open dumping or burning, have been identified to occur commonly in many households. They are known to pose major health and environmental risks. This study aimed at investigating the social and environmental determinants of unsafe household waste disposal in urban communities in North-Central Nigeria using a multilevel logistic regression analysis. A cross-sectional study was carried out involving 612 households from 18 communities. Data were obtained from the participants through the administration of structured questionnaires that sought their socio-demographic characteristics and availability of community waste services. Open dumping or burning was the outcome. Its prevalence rate was 44.3%. There existed considerable heterogeneity across communities (ICC=16.3%). In the full model, tertiary education (AOR=0.48, 95% CI: 0.31–0.74), high income (AOR=0.54, 95% CI: 0.36–0.81), awareness of sanitation regulations (AOR=0.63, 95% CI: 0.45–0.89), and household size (AOR=1.08, 95% CI: 1.02–1.14) were significant predictors. In the community level, provision of municipal waste collection service facilities was a protective factor against engaging in unsafe behaviors (adjusted odds ratio [AOR] = 0.39; 95% confidence interval [CI]: 0.25–0.60), while being farther away from disposal facilities increased the risks (AOR = 1.72; 95% CI: 1.18–2.50). Unsafe disposal behaviors are thus determined not only by individual socioeconomic factors but also by community-level structural factors.</p> <p>Keywords: Household waste management, Unsafe waste disposal, Multilevel analysis, Socioeconomic determinants, Municipal waste services, Urban environmental health</p>	<p>Received: 14 Apr 2026 Accepted: 18 May 2026 Published: 25 May 2026</p> <div style="text-align: center;">  Scan QR Code to view </div> <p>License: CC BY 4.0</p> <div style="text-align: center;">  Open Access article. </div>
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Introduction

Urbanization has emerged as one of the prominent demographic trends in the contemporary era, especially among developing countries with fast-growing cities. While urbanization may offer development prospects, it has also resulted in an increased strain on the natural resources through higher levels of waste creation. Currently, more than two billion metric tons of municipal solid waste is created worldwide, and this number is expected to rise significantly without any changes in consumption behaviors (Kaza et al., 2018). The situation becomes even more worrying in Sub-Saharan Africa where increasing amounts of waste production are accompanied by a limited capacity within institutions to manage and properly dispose of the waste. Consequently, individuals have no other option left except to resort to the informal process of dumping and burning their waste (Kaza et al., 2018; UN-Habitat, 2020). Dumping and burning of wastes are environmentally hazardous and pose risks to human health. Indeed, the dumping of waste is one of the leading sources of soil and water contamination and attracts disease-causing organisms, whereas the

burning of waste leads to an unhealthy atmosphere due to particulate matter emissions (World Health Organization [WHO], 2018).

In many urban areas where there is inadequate formal waste management infrastructure, these practices cannot be attributed to sheer neglect but rather as an adaptation strategy in light of such environmental challenges. This calls for an integrative analysis framework that takes into consideration not only the individualistic aspect but also the environmental dimension of such behavior. The issue of improper solid waste disposal in Nigeria is exacerbated by the increasing rate of urbanization in the country. While formal waste collection infrastructure exists in many cities, its efficacy is compromised by infrastructural inadequacy, economic challenges, and regulatory weaknesses (Ogundele et al., 2018). Consequently, many people have resorted to disposing of waste in inappropriate places such as dumping grounds, drainage channels, or burning within the household environment. The practice of such improper waste disposal behavior has been found to persist in various urban settings in Nigeria, with previous researchers at-

tributing the phenomenon to socioeconomic factors like income level, educational attainment, and household composition (Ogwueleka, 2009; Adejumo et al., 2014). Nevertheless, empirical evidence on this topic has mainly focused on descriptive analyses with few attempts at applying analytical models.

In terms of households, the social economic status is highly influential on how the disposal behavior is carried out within each home. For example, higher education has been associated with higher levels of environmental consciousness and adoption of waste management techniques (Adejumo et al., 2014). Additionally, higher income increases one's capability to pay for formal services or transport wastes in areas where there are not such services. Moreover, larger household sizes increase the amount of wastes disposed of by a household, increasing the use of non-conventional means for waste disposal. This idea supports the social determinants of health, in that social economic status determines one's exposure to environmental hazards (Solar & Irwin, 2010).

In addition to individual attributes like socio-economic background, community-level characteristics can be considered to have a significant impact on waste disposal behavior of the household members. According to the ecological model of health behavior, environment and structure exert a strong influence on the individual's behavior within a community context (McLeroy et al., 1988). With regard to waste disposal behavior, some environmental factors, such as municipal waste collection facilities, waste disposal facilities, and community attitudes, can be very influential. Communities having adequate waste management facilities are expected to observe higher rates of safe waste disposal, while communities lacking necessary infrastructure tend to perpetuate unsafe waste disposal patterns (UN-Habitat, 2020).

It is important to note that families residing in the same community are exposed to similar environmental factors and face similar constraints in infrastructure, making them mutually dependent. Traditional regression models based on a one-level approach presume independence of observations and thus tend to ignore contextual influences or yield biased results when dealing with clustered data. Multilevel modeling represents an appropriate methodological tool for analyzing hierarchical data sets, taking into consideration the simultaneous effects of the individual- and community-level variables and clustering (Snijders & Bosker, 2012).

Although the significance of contextual variables affecting environmental health behaviors is increasingly acknowledged, there have been few studies that use multilevel approaches to explore household waste disposal behaviors in urban areas in Nigeria. The majority of previous studies considered individual households as the unit of observation, failing to recognize the effect of heterogeneity at the community level. This is a major omission, especially in developing urban areas where differences in infrastructure and service provision are evident.

In light of this, the current paper explores the impact of socioeconomic and contextual variables on unsafe household waste disposal behaviors in an urban area in North-Central Nigeria through multilevel logistic regression modeling. The primary

objectives include assessing the degree of between-community heterogeneity for unsafe household waste disposal behaviors, examining the effect of socioeconomic attributes of households, and analyzing the effect of contextual factors such as municipal waste services.

Methodology

This study utilized a community-based cross-sectional study design to investigate the socio-economic and contextual factors influencing unsafe waste disposal practices among households in Keffi, which is an urban setting in Nasarawa State, North-Central part of Nigeria. The target population involved all households living in the identified administrative communities (wards) of the study area.

Study Design and Sampling Procedure

Multistage sampling method was used. Communities were initially selected using probability-proportional-to-size sampling method. Households within the selected communities were then systematically sampled using the random sampling method. Eligible participants were adults, either household head or their representative, aged 18 years and above, who had lived in the community for more than six months before data collection.

Data Collection

Data were collected using a structured interview questionnaire that captured socio-demographic information about households, waste management practices, knowledge about environmental sanitation laws, and contextual information about municipal solid waste collection and disposal services. The research instrument underwent pre-testing in a nearby community with similar socio-demographic characteristics.

Variables and Measurements

The key outcome variable was unsafe waste disposal, which was dichotomously coded. Households that practiced open dumping in unofficial dumping sites or burning of household waste within the household premises were coded as unsafe waste disposal behavior (code = 1), whereas households utilizing the official waste disposal channels were coded as safe waste disposal (code = 0).

Variables at both the individual and aggregate levels were used in the analysis:

- **Household-level variables (Level 1):** Age of household head (continuous), gender (male/female), highest level of education attained (no education, primary, secondary, tertiary), income per month (quartile), number of household members (continuous), and knowledge of environmental sanitation laws (yes/no).
- **Community-level variables (Level 2):** Availability of municipal waste collection service (yes/no), mean distance to approved waste disposal site (kilometers), and availability of community-level enforcement mechanism for environmental sanitation law (yes/no).

Statistical Analysis

Considering the nature of the data, where the households are grouped into clusters (the communities), a multilevel model of binary logistic regression was used to deal with the clustering

effect, as well as to split the variance into household and community variances. Traditional simple regression models do not consider the dependence of observations, thereby leading to the generation of bias in estimation (Snijders & Bosker, 2012). The model was fitted in four steps. First, a null (or empty) model without any predictors was run to get a baseline community-level variance regarding the unsafe practices. The estimation of the variance allowed obtaining the intra-class correlation coefficient (ICC), which indicated the proportion of the total variance accounted for the differences between the communities.

$$ICC = \frac{\sigma_u^2}{\sigma_u^2 + 3.29} \tag{1}$$

Secondly, a model that included only the household-level predictors was run to evaluate the individual socioeconomic factors. Thirdly, the community-level predictors were considered only in another model to identify the contextual variables. Finally, a full model, including the household and community-level predictors was estimated to get the adjusted values of the parameters.

The general form of the two-level logistic regression model is expressed as follows:

$$\text{logit}(P_{ij}) = \beta_0 + \sum \beta_k X_{kij} + \sum \gamma_m Z_{mj} + u_j \tag{2}$$

where P_{ij} indicates the probability of household i in community j disposing waste unsafely, β_0 is the fixed intercept, X_{kij} indicates household-specific covariates, Z_{mj} represents community-specific variables, β_k and γ_m are fixed effect parameters, while u_j is the random intercept associated with community j , and it is assumed to be normally distributed with a mean of zero and variance σ_u^2 .

All fixed effects were reported in adjusted odds ratios with 95% confidence intervals. Level of significance was taken at a p value of less than 0.05. The quality of model fit was evaluated based on AIC and BIC criteria; smaller values indicated improved model fitness. All statistical analyses were carried out in R software (R Foundation for Statistical Computing, Vienna, Austria) using the lme4 package for multilevel models.

Results and Discussion

There were 612 households nested in 18 communities used in this study. The general prevalence rate for unsafe waste management practices (through open dumping/burning) was found to be 44.3% ($n = 271$), whereas the other 55.7% households used official municipal services for disposal.

Multilevel Analysis of Unsafe Waste Disposal

From the results obtained from the null model, it was observed that there existed some variation in unsafe waste management practices among communities. The calculated variance between communities (σ_u^2) was found to be 0.64, which means that the intra-class correlation coefficient (ICC) was 16.3%, suggesting that the variability between communities contributed substantially to the observed variation in practices. Therefore, multilevel modeling is recommended in such circumstances.

In order to see the effect of individual level and community level predictors on the outcome of interest, a few factors remained statistically significant, as listed in **Table 1**.

Table 1. Multilevel Logistic Regression Analysis of Determinants of Unsafe Household Waste Disposal

Variable	AOR	95% CI	p-value
Household-Level Variables			
Secondary education	0.71	0.50 – 1.01	0.056
Tertiary education	0.48	0.31 – 0.74	0.001
Highest income quartile	0.54	0.36 – 0.81	0.003
Household size (per additional member)	1.08	1.02 – 1.14	0.009
Awareness of sanitation regulations	0.63	0.45 – 0.89	0.008
Male household head	1.19	0.86 – 1.66	0.289
Community-Level Variables			
Availability of municipal collection	0.39	0.25 – 0.60	<0.001
Distance to disposal site (>2 km)	1.72	1.18 – 2.50	0.004
Active sanitation enforcement	0.58	0.37 – 0.91	0.018

Random Effects (Full Model)

Table 2. Model Fit Statistics for Multilevel Logistic Regression Models

Model	Description	AIC	BIC	Log-Likelihood
Model 0	Null Model (Random Intercept Only)	812.6	821.4	-403.3
Model 1	Household-Level Variables Only	768.4	801.2	-372.2
Model 2	Community-Level Variables Only	781.9	806.7	-383.0
Model 3	Full Model (Household + Community Variables)	742.8	789.5	-357.4

The results from the model fit statistics presented in Table 2 show progressively improving models as the hierarchical model levels proceed. Null models had the highest AIC and BIC, indicating that they had poor ability to explain the data without predictors. The introduction of household level variables in Model 1 resulted in better model fit, whereas Model 2 showed an improvement albeit modest. This improvement was because only community level variables were introduced. The model with the best fit was the complete model where household and community variables were included. The AIC, BIC, and log-likelihood scores for the full model were the lowest and highest respectively.

Household-Level Determinants

Educational achievement turned out to be another important protective factor, since households with people educated up to tertiary level had considerably less risk of participating in hazardous methods compared to uneducated ones (AOR = 0.48; 95% CI: 0.31–0.74). This is in line with earlier research which shows that education increases awareness regarding environmental protection (Adejumo et al., 2014; Ogwueleka, 2009).

Also, families from high-income categories had lower probabilities of unsafe disposal of their solid wastes (AOR = 0.54; 95% CI: 0.36–0.81), which is explained by their possibility to access professional waste collection. The number of people in the household was also shown to positively correlate with the chances of unsafe solid waste disposal (OR = 1.08; 95% CI: 1.02–1.14), which means that the more people there are in the family, the higher the amount of generated waste. Moreover, knowledge of the environmental regulations also decreased the risk of using unsafe disposal methods (AOR = 0.63; 95% CI: 0.45–0.89).

Community-Level Determinants

In terms of community-level variables, having access to municipal waste collection was identified as a key protective factor. Those who came from households in communities where there is access to municipal waste collection services were less likely to dispose of their waste unsafely (AOR = 0.39; 95% CI: 0.25–0.60).

On the other hand, increased distance from authorized waste disposal areas increased the chances of unsafe disposal of wastes (AOR = 1.72; 95% CI: 1.18–2.50). Having systems for the active enforcement of sanitation was also shown to be a protective variable against unsafe waste disposal (AOR = 0.58; 95% CI: 0.37–0.91).

Graphical Representation of Model Estimates

Moreover, the magnitude and nature of the relationships between predictors and unsafe waste disposal are shown more clearly in **Figure 1**. The figure reveals how increased education, higher levels of income, and presence of municipal waste services act as significant protective factors while larger household size and greater distances to waste disposal areas increase the risk of unsafe disposal of waste materials. The graph is a visual depiction of what has been statistically revealed in **Table 1**.

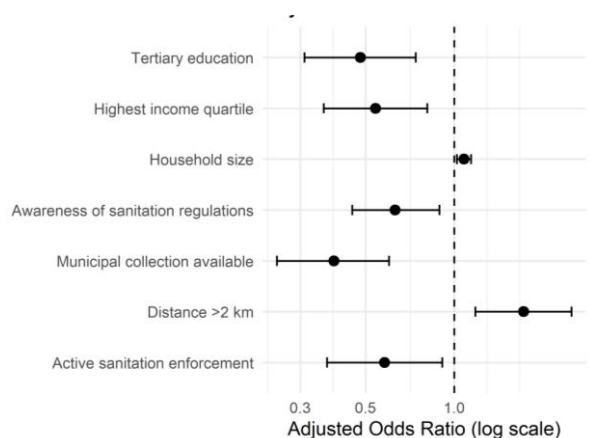


Figure 1: Adjusted Odds Ratios from Final Multilevel Model

Random Effects and Model Explanation

For the adjusted model, it should be noted that the community level variance became 0.29, compared to 0.64 in the null model. This means that the variables used in the analysis explain about 55% of the variance among communities.

The intra-class correlation coefficient (ICC) for the adjusted model became 8.1%, implying that while most of the variance among communities was explained by the selected variables, some remained. Thus, other contextual variables not included in the model, such as social factors and differing levels of law enforcement, may have an influence on people's behavior towards waste management.

Interpretation and Implications

In conclusion, it is evident that unsafe practices associated with the disposal of household waste are determined by a combination of factors. Although individual socioeconomic and structural elements like education level, income, and household size can determine individual choices regarding waste disposal, other community-based elements, particularly access

to waste management facilities, have been found to play a crucial role.

The study findings underscore the need to realize that the unsafe disposal of domestic waste cannot be attributed entirely to individual decisions and actions. Instead, there are other underlying systemic barriers, such as lack of waste management facilities. Thus, any efforts aimed at improving the situation should include both behavioral and structural components.

The results of the present research show that the safety of household waste disposal is impacted by both individual economic characteristics of households and community-wide factors. Intra-Class Correlation Coefficient (ICC) of 16.3% found for the null model suggests that there is substantial clustering of household practices at the level of communities, implying that certain environmental and infrastructural conditions are important for the formation of such behaviors. In this context, the ecological model of health behavior developed by McLeroy *et al.* (1988) can be cited as evidence.

Approximately 55% of variance between communities associated with risky behaviors in question has been accounted for in the adjusted model, as shown by the difference in ICC values from 0.64 to 0.29. Nevertheless, the fact that residual ICC remains equal to 8.1% implies that certain unobserved contextual factors may also have an impact on behaviors in question, such as local sanitation habits, efficiency of law enforcement, and informal waste collecting.

Education and increased income levels correlated with lower instances of unsafe waste management practices, in accordance with earlier Nigerian research suggesting that education and income levels have a positive effect on improving environmental awareness and providing better opportunities for safer methods of waste disposal (Adejumo *et al.*, 2014; Ogwueleka, 2009). Furthermore, access to waste management services provided by the municipality was significantly related to safer waste practices, as supported by UN-Habitat findings highlighting lack of proper waste management infrastructure in urbanizing regions

Conclusion

The above-mentioned findings suggest that the problem of unsafe household waste disposal depends on socioeconomic and contextual factors, including educational level and household income as well as household size. In particular, the higher was education and household income level, the less chance there was to engage in such an unsafe practice. However, the higher was the number of household members, the higher was the risk of engaging in unsafe household waste disposal.

The clustering of unsafe household practices in specific communities suggests that there is a need to pay attention to structural and environmental characteristics because they may influence the decisions people make in their everyday life.

Therefore, the strategy that is expected to be most beneficial in this situation is a combined one. It is necessary to conduct both behavioral and social intervention in order to ensure efficient waste management.

Conflict of Interest

The authors declare that they have no competing interests and this research received no specific grant from any funding agency.

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References

- Adejumo, I. O., Oloruntoba, E. O. and Sridhar, M. K. C. (2014). Knowledge, attitude and practices of waste management among residents in a Nigerian urban community. *Journal of Environmental and Public Health*, 2014: 1–8. doi:10.1155/2014/653807.
- Kaza, S., Yao, L., Bhada-Tata, P. and Van Woerden, F. (2018). *What a waste 2.0: A global snapshot of solid waste management to 2050*. Washington, DC: World Bank.
- McLeroy, K. R., Bibeau, D., Steckler, A. and Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly*, 15(4): 351–377. doi:10.1177/109019818801500401.
- Ogwueleka, T. C. (2009). Municipal solid waste characteristics and management in Nigeria. *Iranian Journal of Environmental Health Science & Engineering*, 6(3): 173–180.
- Ogundele, O. M., Rapheal, O. M. and Abiodun, A. M. (2018). Effects of municipal waste disposal methods on community health in Nigeria. *Journal of Environmental and Public Health*, 2018: 1–9. doi:10.1155/2018/5896374.
- Snijders, T. A. B. and Bosker, R. J. (2012). *Multilevel analysis: An introduction to basic and advanced multilevel modeling* (2nd ed.). London: Sage Publications.
- Solar, O. and Irwin, A. (2010). *A conceptual framework for action on the social determinants of health*. Geneva: World Health Organization.
- UN-Habitat (2020). *Waste wise cities tool and SDG 11.6 monitoring guidance*. Nairobi: United Nations Human Settlements Programme.
- World Health Organization (2018). *Ambient air pollution: A global assessment of exposure and burden of disease*. Geneva: World Health Organization.