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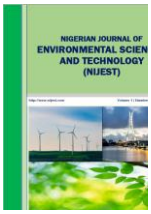

Assessment of Household Waste Management Practices and Influencing Factors in Makurdi, Gboko, and Otukpo, Benue State, Nigeria

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ABSTRACT

This study investigated residential waste disposal practices in three major towns of Benue State: Makurdi, Gboko, and Otukpo. Using a multistage sampling procedure, four locations were purposively selected from each town with sample size of 431. Google Forms was used to administer questionnaire. Findings revealed that waste was predominantly generated daily (50.6%), with organic waste accounting for the largest proportion (97.2%). While 37.1% of respondents were aware of existing waste management programs, only 26.7% had actively participated. The lack of adequate waste management infrastructure (57.5%) was identified as the primary challenge. Residents perceived several factors to influence waste disposal practices, including urbanization (89.1%), economic conditions (84.5%), education (63.8%), and cultural practices (56.6%). Urbanization exhibited strong positive correlations with economic factors ($r = 0.520$, $p < 0.01$) and moderate associations with education ($r = 0.403$, $p < 0.01$) and cultural practices ($r = 0.332$, $p < 0.01$). Economic factors were strongly correlated with education ($r = 0.482$, $p < 0.01$) and cultural practices ($r = 0.378$, $p < 0.01$), with education and cultural practices also moderately correlated ($r = 0.448$, $p < 0.01$). Regression analysis showed a moderate relationship ($R = 0.417$) between predictors and household management, explaining 17.4% of the variance ($p < 0.001$). Correlational analysis also identified significant positive relationships among environmental variables, such as strong correlations between air pollution and greenhouse gas emissions ($r = 0.660$, $p < 0.01$) and between habitat destruction and health risks ($r = 0.486$, $p < 0.01$). A significant majority (87.9%) recognized household waste as a potential health risk. Recommendations from residents emphasized the need for enhanced public education (65.9%), increased community awareness (52%), and, from the government, the development of robust waste management policies (62.4%), investment in collection infrastructure (51%), and provision of door-to-door waste collection services (59.2%). The study highlights the urgent need to enhance residential waste management in Benue State through improved infrastructure, sustained public education, and increased community participation.

Keywords: Waste management, Waste disposal practices, Urbanization, Household waste, Solid waste

1.0. Introduction

Globally, the management of solid waste has emerged as one of the most pressing environmental challenges of the 21st century. The world currently generates an estimated 2.24 billion tons of solid waste annually, with projections suggesting this figure will rise to 3.88 billion tons by 2050 if current trends persist (World Bank, 2022). Rapid urbanization, population growth, and changing consumption patterns are primary drivers of the increasing waste burden (Iqbal et al., 2020). Although developed nations have adopted advanced and sustainable solid waste management systems such as recycling, composting, and waste-to-energy technologies, many developing countries still struggle with inadequate waste collection, treatment, and disposal (Abubakar et al., 2022).

Solid waste management in Africa poses significant environmental and public health concerns. Sub-Saharan Africa alone generates approximately 180 million tons of municipal solid waste annually, with an average collection efficiency of less than 55% (UNEP, 2023). Poor waste management practices such as open dumping, open burning, and indiscriminate disposal into drainage channels and water bodies contribute to flooding, air pollution, and the spread of infectious diseases (Teshome, Ayele, & Abib, 2022). Studies in Ethiopia, Kenya, and Ghana have shown that the absence of effective waste management infrastructure, weak institutional frameworks, and low public awareness are key barriers to sustainable waste management (Dahlawi & El Sharkawy, 2021).

The problem of solid waste management in Nigeria, is particularly alarming. The country generates about 32 million tonnes of waste annually, with only 20–30% collected properly (Noiki et al., 2021). The rapid urbanization rate of 4.3% per annum, coupled with poor enforcement of environmental regulations and inadequate funding, has exacerbated the crisis. Major cities such as Lagos, Abuja, Port Harcourt, and Benin face recurring waste disposal challenges, characterized by overflowing dumpsites and blocked drainage systems (Adogu et al., 2015; Achi et al., 2012). Even with several national environmental policies and sanitation initiatives, implementation remains weak due to limited institutional capacity and poor public participation (Agboola et al., 2024).

Benue State, located in north-central Nigeria, mirrors this national challenge. With an estimated population of over 5.7 million people (National Population Commission, 2022), urban centers such as Makurdi, Gboko, and Otukpo generate increasing volumes of solid waste daily without corresponding waste management infrastructure. Ibrahim (2022) noted that rapid land-use change and unplanned urban expansion in Makurdi have intensified environmental degradation. Similarly, Akaagerger et al. (2023) found that dumpsites in Gboko and Otukpo contain high levels of radionuclides, posing health and ecological risks. Studies by Onyilokwu et al. (2024) and Shaibu et al. (2025) also revealed that poor waste segregation, irregular collection, and inadequate waste disposal facilities contribute to unsanitary living conditions in many urban neighborhoods.

Despite various government and community-based interventions, waste management practices in Benue State remain largely inefficient. The problem of solid waste disposal in Makurdi, Gboko, and Otukpo therefore lies in the persistent gap between waste generation and effective management. The absence of sustainable systems for collection, treatment, and disposal continues to degrade the urban environment, block drainage systems, and expose residents to vector-borne diseases. This problem creates the urgent need to assess existing waste management practices within the three major towns of Benue State such as Makurdi, Gboko, and Otukpo. The main objective of the study was to investigate residential waste disposal practices in the three major towns (Makurdi, Gboko, and Otukpo) of Benue State with the aim of understanding the types, frequency, awareness, challenges, and factors influencing household waste management. Also, the study further sought to understand residents' perceptions and recommendations for improving waste management systems in Benus State.

2.0. Methodology

2.1. Study Area

The study was carried out in the three major towns (Gboko, Otukpo, and Makurdi) in Benue state, Nigeria as shown in Figure 1. Makurdi is the capital city of Benue State, situated in the central part of Nigeria along the south bank of the Benue River. Makurdi town is located at Latitudes 7° 471 and 10° 001 North and Longitudes 6° 251 and 8° 81 East of the equator (Shabu and Tyonum, 2013). It is positioned in the Middle Belt region, which is known for its diverse ethnic groups and agricultural activities. The city serves as a major transportation hub, being located on the main highway network and having an airport, making it accessible from various parts of Nigeria.

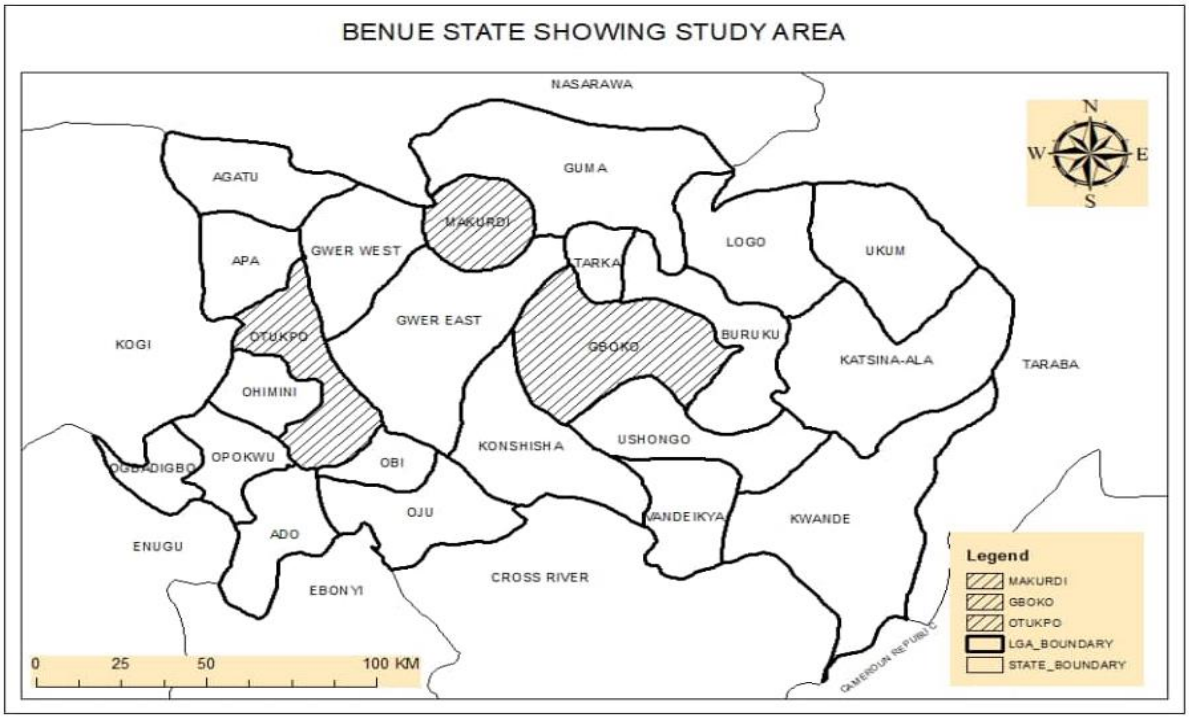

Figure 1: Map of Benue State showing the Study areas

Gboko is situated in the northern part of Benue State and serves as the headquarters of the Gboko LGA. It is known for its hilly terrain, particularly Mkar Hill, and is part of the savanna region of Nigeria. The town is the seat of the Tor Tiv, the supreme traditional leader of the Tiv people, which underscores its cultural significance. Gboko is predominantly inhabited by farmers, making agricultural trade a cornerstone of its economy. Additionally, the town hosts industrial establishments, including the Dangote Cement Company and local rice mills, which contribute to its economic growth. The fertile lands surrounding Gboko support the cultivation of significant quantities of crops, while mineral reserves like limestone and granite further enhance its economic potential, solidifying Gboko's role as a commercial hub for the region. Otukpo is in in zone C in Benue State and serves as the headquarters of the Otukpo Local Government Area. It is a key town within Idoma land, which is primarily populated by the Idoma people. Otukpo LGA lies between longitude 70 45' and 80 17' East of the Greenwich Meridian and latitude 70 00' and 70 40' North of the equator (Enefu, 2016). The Idoma language is widely spoken, although various local dialects exist. The town has a significant Christian population, with Catholicism being the first introduced religion, followed by Methodism and various Pentecostal denominations. Traditional beliefs also persist, particularly the worship of ancestral deities. Otukpo is known for its vibrant market activities and agricultural production, including rice, yams, and cassava. It also boasts a rich cultural heritage, being home to the Ochi-Idoma, the paramount ruler of the Idoma people.

2.2 Population of Study

The population of the study comprised all residential houses in the three major local Government in Benue State. This implies the population of people living in Gboko, Otukpo, Makurdi, LGAs of Benue State. The population of people in such areas is as stated: Gboko-521,700; Makurdi-433,700 and Otukpo-266,411.

2.3 Sample and Sampling Techniques

Multistage sampling was adopted for this study to select towns and locations for data collection. Makurdi, Gboko, and Otupko towns were purposively from the 3 geopolitical zones A, B and C respectively of Benue State. In each town 4 locations each were purposively chosen as following: Makurdi (North Bank, Wurukum, Wadata and High Level); Gboko (Gboko Central, Gboko East, Gboko South and Gboko North) and Otupko (Otukpo Town, Otukpo Central, Otukpo East and Otukpo West). The sample size for this study was determined from 2006 National population census as projected and presented in (Table 1).

2.4 Determination of sample size

Population projection formula by George, (2014)

$Pn = Po(1 + r)t$ …….. (1)

Where:

P_n = Projected Population

P_o = Last population to be projected

R = population Growth rate (0.028% = 0.028)

t = number of years of projection

Population projection: $P_{2024} = P_{2006}(1+r)^t$

2.5 Determination of sample size

Sample size was determined by the formula of Neyman (1934) cited by Magnussen (2021) as stated below:

$n_h = (n \times N_h)/N$

Where:

nh = the sample size for a particular stratum or group,

Nh = the population size of that stratum (projected population),

N = the total population,

n = the total sample size for the whole population.

Table 1: Determination of sample size from 2006 population census projected to 2024

LGA	Population (2006 Census)	Projected Population	Sample Size
Gboko	361,325	379969.37	156
Makurdi	300,377	315876.45	129
Otukpo	266,411	280157.81	115
Total	**928,113**	**976003.63**	**400**

2.4 Instrument for Data Collection

While gathering information for this research work, the researchers used a structured questionnaire. The questionnaire was tagged 'Waste Disposal Practices (WDP) Questionnaire'. It sought information on Waste Disposal Practices in residential buildings in the three major local Government Areas in Benue State. The questionnaire sought information directly related to Waste Disposal Practices in residential buildings in the three major local Government of Benue State. The questionnaire was structured on the bases of Strongly Agreed (SA), Agreed (A), Neutral (N), Disagree (D) and Strongly Disagree (SD) responses.

2.5 Method of Data Collection

The method of data collection is the Questionnaire and interview methods. It also includes site visits to observe existing infrastructure for waste collection and disposal. The researcher administered the questionnaire in the 400 selected homes in person by visiting the selected homes and interacting with the respondents face to face. In most homes visited, the researcher intimated the various residents of the sampled homes of her intentions for visiting and sought permission appropriately.

Although the calculated sample sizes for the study were 156 for Gboko, 129 for Makurdi, and 115 for Otukpo, totaling 400, the actual number of respondents during data collection slightly exceeded these figures, as shown in Table 2. This discrepancy occurred because the questionnaire was administered online, making it difficult to immediately control or ascertain the exact number of respondents.

Table 2: Households, public and industrial Locations

S/No.	Town	Location	Frequency	Percentage (%)	Mean
1.	Gboko	Gboko Central	40	9.3	159(36.9)
		Gboko East	40	9.3	
		Gboko South	40	9.3	
		Gboko North	39	9.0	
	Total	**4**	**159**	**36.9**	
2.	Makurdi	North Bank	34	7.9	136(31.6)
		Wurukum	34	7.9	
		High Level	34	7.9	
		Wadata	34	7.9	
	Total	**4**	**136**	**31.6**	
3.	Otukpo	Otukpo Town	34	7.9	136(31.6)
		Otukpo Central	34	7.9	
		Otukpo East	34	7.9	
		Otukpo West	34	7.9	
	Total	**4**	**136**	**31.6**	
Ground Total		**12**	**431**	**100**	**431(100)**

2.6. Questionnaire Validation and Reliability Assessment

For this study, the questionnaire was validated through expert review and a pilot test to ensure clarity, relevance, and comprehensiveness of the questions. Reliability was assessed using Cronbach's alpha a statistical measure that evaluates the internal consistency of the questionnaire according to Nunnally (1978). A Cronbach's Alpha (α) value of 0.7 or higher was aimed for, indicating acceptable reliability and that the questionnaire items consistently measured the intended constructs. This process ensured the instrument was both valid and reliable for collecting data on residential waste disposal practices in the study area.

2.7 Ethical Approval and Informed Consent

Ethical approval for this study was obtained from the Benue State Ministry of Water Resources and Environment and the Benue State Environmental Sanitation Authority (BENSESA). Permissions were sought to ensure compliance with State regulations on environmental health and sanitation. Informed consent was also obtained from all participants prior to data collection, with assurances given regarding confidentiality, voluntary participation, and the right to withdraw at any point without consequence.

2.8 Data Analysis Technique

The study utilized a 5-point Likert scale ranging from Strongly Agree to Strongly Disagree, which was transformed into numerical codes from 5 to 1 for quantitative analysis. Descriptive statistics summarized the data distributions for the locations Gboko, Makurdi, and Otukpo. ANOVA was employed to detect significant differences in perceived household management factors and environmental impacts across these locations, with Duncan's Multiple Range Test used to identify specific location pairs differing significantly. Pearson's correlation analysis examined the strength and significance of associations among socio-economic and environmental variables at a 0.01 significance level. Multiple regression models assessed the predictive influence of key factors on household waste management and waste disposal effects. All statistical procedures were conducted using IMB SPSS statistics version 27.

3.0 Results and Discussion

3.1 Demographic Characteristics of Respondents

The findings in Table 3 indicate that most respondents were male (59.4%), with an average age of 36.2 years, suggesting that household waste management activities are largely influenced by adult males within

productive age groups. This result aligns with the observation by Onyilokwu et al. (2024), who reported a predominance of male respondents (57.8%) in their study on waste management practices in higher institutions within Makurdi Metropolis. Similarly, Agboola et al. (2024) found that males were more involved in household waste management in Benue South, attributing it to cultural norms where men often take responsibility for outdoor domestic activities. The data also show that a large proportion of respondents were Christians (89.3%) and married (66.4%). This religious and marital distribution reflects the demographic structure of Benue State, as noted by Akaagerger et al. (2023), who reported that Christianity is the dominant religion in Gboko, Makurdi, and Otukpo, while most households consist of married adults with children. The educational status of respondents reveals that most had attained at least secondary (41.8%) or undergraduate (42.5%) education, suggesting a literate population capable of understanding waste management principles. This corresponds with Shaibu et al. (2025), who noted that literacy levels among urban residents in Benue State contribute significantly to awareness and adoption of environmental management practices. Furthermore, most respondents (49.7%) were engaged in business as their primary occupation, with 60.6% indicating business as their secondary occupation. This economic profile supports Ibrahim (2022)'s assertion that the growth of small-scale commercial activities in Benue urban centers contributes to increased household waste generation. The household size distribution (majority having 4 - 6 members) also reflects national averages for family structures in Nigeria, consistent with Achi et al. (2012) who noted that medium-sized households tend to produce moderate to high quantities of waste.

Table 3: Demographic characteristics of respondents

Variables	Frequency	Percentage (%)	Mean
Sex			
Male	256	59.4	
Female	175	40.6	
Total	**431**	**100**	
Age Range			
Below 18	7	1.6	
18 – 25	86	20	
26 – 35	115	26.7	
36 – 45	105	24.4	36.2
46 – 50	75	16.7	
51 – 55	4	0.9	
56 – 60	7	1.6	
Total	**431**	**100**	
Religion			
Christianity	385	89.3	
Islam	37	8.6	
Traditional	7	1.6	
No religion	2	0.5	
Total	**431**	**100**	
Marital status			
Single	133	30.9	
Married	286	66.4	
Separated	12	2.8	
Total	**431**	**100**	
Primary Occupation			
Civil Servant	56	13	
Farming	97	22.5	
Business	214	49.7	
Student	64	14.8	
Total	**431**	**100**	
Secondary Occupation			
Farming	91	21.1	
Teaching	18	4.2	
Business	261	60.6	
Student	61	14.2	
Total	**431**	**100**	
Educational Status			
Primary	17	3.9	
Secondary	180	41.8	
Undergraduate	183	42.5	
Postgraduate	32	7.4	
Non formal	19	4.4	
Total	**431**	**100**	
Household size			
1 – 3	125	29	
4 -6	195	45.2	
7 – 10	71	16.5	
11 – 13	55	5.1	

14 – 16	10	2.3
17 – 20	6	1.4
Above 21	2	0.5
Total	**431**	**100**
Type of house		
Thatch house	22	5.1
Single room	228	52.9
Flat	148	34.3
Bungalow	33	7.7
Total	**431**	**100**

3.2 Frequency of Waste Generation in Benue State

The data in Figure 2 show that most respondents (50.6%) generate waste daily, while 25.8% and 22.3% generate waste weekly or several times a week, respectively. This high frequency of waste generation is characteristic of urbanizing communities and aligns with findings by Shaibu et al. (2025), who observed that rapid population growth and increasing urban activities in Makurdi have led to daily accumulation of municipal solid waste. Similarly, Adogu et al. (2015) reported a comparable pattern in Owerri, where over half of households produced waste daily due to increasing consumption and poor recycling culture. According to Iqbal et al. (2020), urban households in developing countries tend to produce waste daily due to lifestyle changes, food consumption habits, and inadequate waste minimization practices. The daily waste generation rate observed in Benue State, therefore, underscores the need for improved collection systems and public sensitization to ensure environmental sustainability.

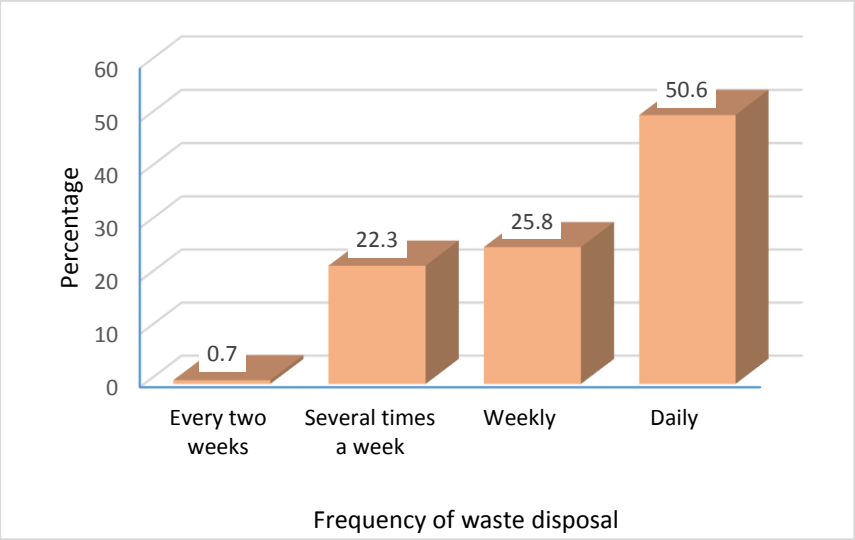

Figure 2: Frequency of waste generation in Benue State

3.3 Method of Household Waste Disposal in Benue State

The findings reveal that most respondents dispose of waste through informal means, with only a small proportion utilizing organized collection systems. This is consistent with Onyilokwu et al. (2024), who found that open dumping and irregular collection remain the dominant methods of solid waste disposal in Makurdi Metropolis. Achi et al. (2012) also reported similar practices in Abeokuta, noting that insufficient waste collection infrastructure compels residents to adopt unsafe disposal methods. Furthermore, Teshome et al. (2022) emphasized that in many Sub-Saharan African cities, household waste disposal is still largely unregulated and dependent on individual efforts rather than municipal services. The persistence of these informal disposal practices in Benue State reflects systemic inefficiencies in waste management policy implementation and weak enforcement of environmental sanitation laws.

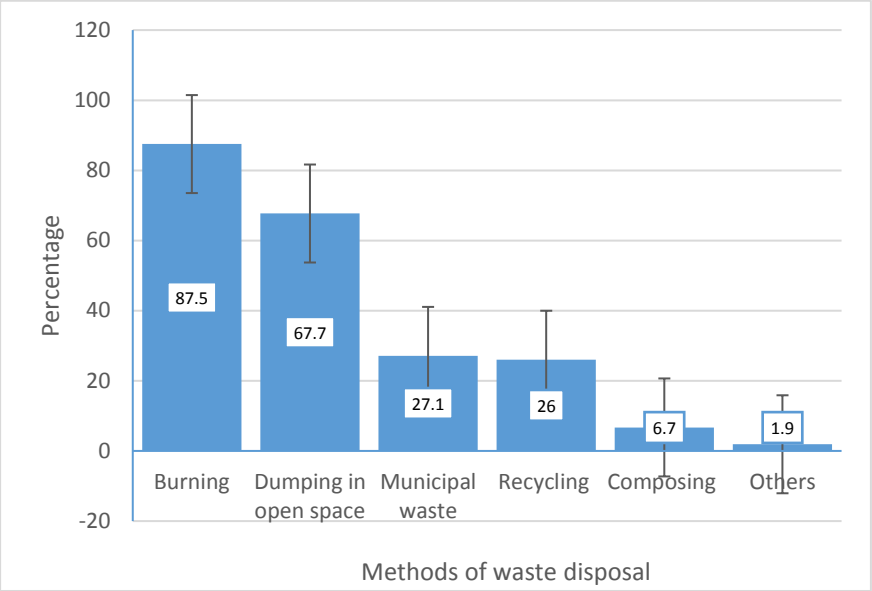

Figure 3: Method of household wastes disposal of in Benue State

3.4 Types of Waste Commonly Generated from Households in Benue State

Figure 4 reveals that organic waste constitutes the highest proportion (97.2%) of household waste in Benue State, followed by paper and cardboard (70.8%) and plastics (55.5%). This pattern is typical of waste composition in developing economies dominated by biodegradable materials.

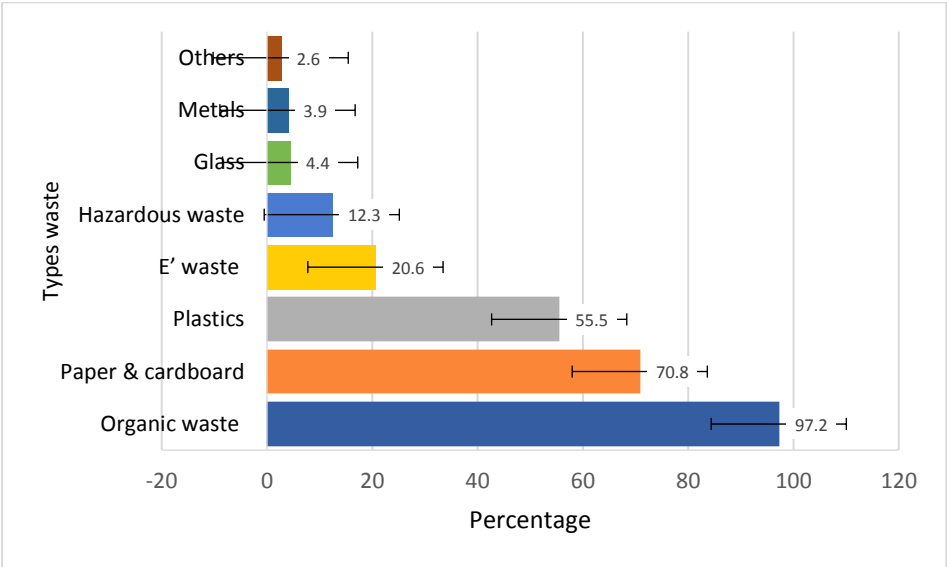

Figure 4: Types of waste commonly generated from households in Benue State

According to Ishi and Madu (2020), organic waste forms the largest fraction of municipal solid waste in Makurdi, driven by food waste from households and local markets. Similarly, Abubakar et al. (2022) reported that in the global South, organic waste accounts for over 60% of municipal waste, followed by plastics and paper. The relatively high presence of plastic waste (55.5%) corroborates the findings of Noiki et al. (2021), who attributed this to the growing use of single-use plastics and poor recycling systems in Nigerian cities. The low proportion of hazardous and metallic waste (12.3% and 3.9%, respectively) may indicate limited industrial activity among the surveyed households, consistent with Akaagerger et al. (2023) who noted that waste from residential sources in Benue tends to be non-industrial and largely biodegradable.

3.5 Respondents' Awareness, Concerns, Participation, and Satisfaction in Household Waste Management

Table 4 indicates that only 37.1% of respondents were aware of waste management initiatives in their communities, while a majority (62.9%) had no knowledge of such programs. This limited awareness is consistent with Agboola et al. (2024), who found low levels of public awareness and participation in waste management schemes across Benue South. Dahlawi and El Sharkawy (2021) also observed that lack of awareness and institutional communication undermines participation in sustainable waste management even in university campuses. Despite low awareness, most respondents (81.9%) expressed concern about the environmental impacts of poor waste disposal, suggesting a gap between environmental concern and active participation. Similar findings were reported by Adogu et al. (2015), where residents of Owerri showed environmental concern but lacked practical involvement in waste management due to weak community mobilization and insufficient municipal support. Only 26.7% of respondents had participated in waste management initiatives, reflecting a pattern identified by Achi et al. (2012), who linked poor participation to inadequate incentives and limited engagement by local authorities. Regarding satisfaction, only 20% of respondents expressed satisfaction with waste disposal services, while 67.7% were dissatisfied. This dissatisfaction mirrors the conclusions of Shaibu et al. (2025) and Onyilokwu et al. (2024), who highlighted inadequate waste collection frequency, poor coverage, and unregulated dumpsites as major challenges in Benue's waste management system.

Table 4: Respondents' awareness, concerns, participation and satisfaction of household waste generation and management in Benue State

Variable	Yes		No		Neutral	
	F	%	F	%	F	%
Awareness of any waste management programs or initiatives in the residential area	160	37.1	271	62.9	-	-
Concerns about the environmental impact of your waste disposal practices?	353	81.9	78	18.1	-	-
Actively participated in any waste management programs or initiatives in the past years	115	26.7	316	73.3	-	-
Satisfied with the waste disposal services in household	86	20	292	67.7	53	12.3

3.6 Waste Management Challenges Associated with Household Waste Collection and Disposal in Benue State

The findings (Figure 5) reveal that the major challenges affecting household waste management in Benue State include lack of proper infrastructure (57.5%), open dumping and littering (53.6%), burning of waste (50.6%), improper segregation (48.5%), and lack of awareness (46.2%). These findings indicate a weak waste management framework and limit institutional capacity in the state. This aligns with Aguoru and Alu (2015) and Adogu et al. (2015), who reported that inadequate waste infrastructure and poor collection systems remain dominant issues in many Nigerian cities, often resulting in open dumping and burning. Similarly, Bassey et al. (2024) observed that poor waste management in Uyo, Akwa Ibom State, was largely due to lack of proper disposal facilities and poor enforcement mechanisms. The high rate of improper segregation and limited awareness corroborates Debrah et al. (2021) and Abalo et al. (2018), who emphasized that inadequate environmental education limits household participation in waste sorting and recycling. Economic constraints and limited access to recycling services (34.8%) further support Adebayo et al. (2024), who found affordability and accessibility as key barriers to waste management adoption in Nigeria.

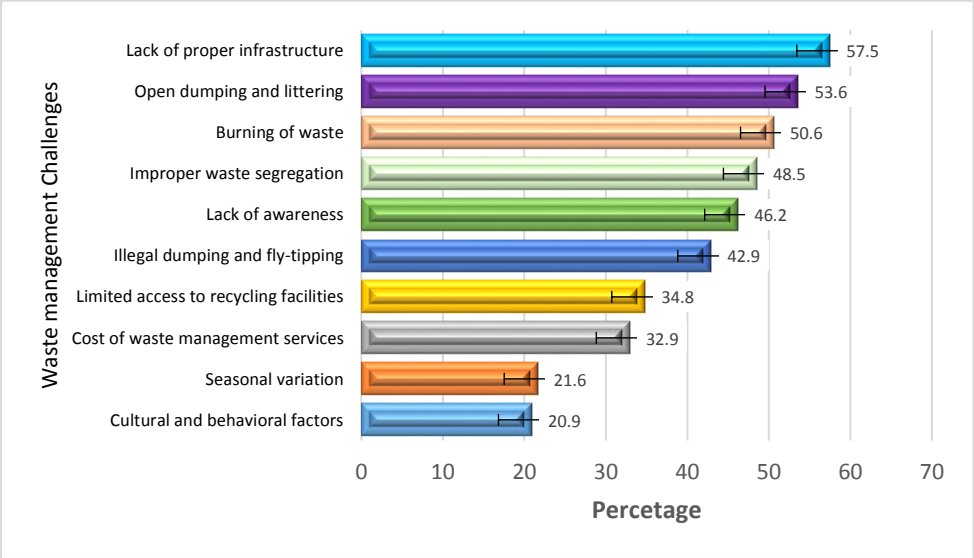

Figure 5: Waste management challenges associated with household waste collection and disposal in Benue State

3.7 Respondents' Perceived Factors Influencing Household Waste Management in Benue State

Table 5 shows that urbanization (89.1%), economic factors (84.5%), education level (63.8%), and cultural practices (56.6%) are perceived as major determinants of household waste management in Benue State. The influence of urbanization reflects the pressure that population growth places on existing infrastructure, consistent with Aguoru and Alu (2015), who linked rapid urban development to increased waste generation and disposal challenges. The strong role of economic factors agrees with Adebayo et al. (2024), who noted that household income levels and the cost of services significantly influence waste disposal choices. Similarly, Debrah et al. (2021) highlighted education as a key determinant of waste management behaviour, as higher educational attainment enhances awareness and adoption of proper disposal practices. Cultural practices also play a role, supporting Ashagidigbi et al. (2022), who argued that household waste decisions are shaped by traditional norms, gender roles, and social perceptions.

Table 5: Respondents' perceived factors influencing household management in Benue State

Factor	Strongly Agree F(%)	Agree F(%)	Neutral F(%)	Disagree F(%)	Strongly Disagree F(%)
Urbanization influences solid waste disposal among residents.	182(42.2)	202(46.9)	20(4.6)	23(5.3)	4(0.9)
Economic factors influence solid waste disposal among residents	112(26)	252(58.5)	46(10.7)	20(4.6)	-
Level of education influences solid waste disposal among residents	95(22)	180(41.8)	124(28.8)	27(6.3)	5(1.2)
Cultural practices influence solid waste disposal among residents	81(18.8)	163(37.8)	139(32.3)	36(8.4)	12(2.8)

Table 6 presents the perceived influence of urbanization, economic factors, education level, and cultural practices on household management across three locations in Benue State: Results in Gboko showed significant higher perceptions for all factors with mean scores of 4.61 for urbanization, 4.26 for economic factors, 4.04 for education, and 4.02 for cultural practices. In contrast, Makurdi showed the lowest mean values across all factors, ranging from 3.27 for cultural practices to 3.94 for urbanization. Otukpo's ratings were generally closer to Makurdi, except for economic factors which were higher at 4.09. Statistical significance was observed between Gboko and both Makurdi and Otukpo for urbanization, level of education, and cultural practices ($p < 0.05$), with economic factors differing significantly between Gboko and Makurdi only ($p < 0.05$). These findings reveal that perceptions of household management drivers vary significantly by location, likely reflecting differing socio-economic and cultural contexts. The result suggest localized strategies may be beneficial to address distinct regional needs concerning urban growth,

economic development, education, and cultural influences on household management. Research has shown that ineffective waste management practices in developing countries such as Nigeria result in substantial negative consequences for both the environment and public health (Olukanni et al., 2020). Commonly observed practices include open dumping and poor waste segregation (Abubakar et al., 2022), which significantly contribute to air and water pollution as well as environmental degradation. These detrimental effects are particularly pronounced in areas like Otukpo and Gboko, where elevated levels of air and water pollution, long-term environmental damage, and aesthetic deterioration have been documented. Public perceptions towards waste management are influenced by socio-demographic factors including income, educational attainment, and environmental awareness (Olukanni et al., 2020). The understanding and attitudes of residents play a vital role in mitigating adverse environmental outcomes, with communities exhibiting lower education and awareness levels tending to engage in unsustainable waste disposal practices, thereby exacerbating environmental challenges.

Table 6: Perceived factors affecting household management across Benue State

Location	Urbanization (Mean ±SD)	Economic factors (Mean ±SD)	Level of Education (Mean ±SD)	Cultural practices (Mean ±SD)
Gboko	4.61±0.77[a]	4.26±0.83[a]	4.04±1.00[a]	4.02±0.99[a]
Makurdi	3.94±1.02[b]	3.72±0.80[b]	3.61±0.88[b]	3.27±1.05[b]
Otukpo	3.98±0.39b	4.09±0.37[a]	3.52±0.60[b]	3.35±0.53[b]

Correlation analysis (Table 7) among key factors influencing household management in Benue State reveals statistically significant positive relationships between all variables at the 0.01 significance level. urbanization is strongly correlated with economic factors ($r = 0.520$, $p < 0.01$), and shows moderate correlations with level of education ($r = 0.403$, $p < 0.01$) and cultural practices ($r = 0.332$, $p < 0.01$). economic factors also display strong associations with education ($r = 0.482$, $p < 0.01$) and cultural practices ($r = 0.378$, $p < 0.01$). similarly, level of education and cultural practices correlate moderately ($r = 0.448$, $p < 0.01$). these findings indicate that urbanization, economic factors, education level, and cultural practices are interrelated in shaping household management perceptions and behaviours across Benue State. the strength and significance of these correlations underscore the importance of considering these variables collectively in the design and implementation of household management interventions and policies.

Table 7: Correlation of key factors influencing household management in Benue State

Variable	Urbanization	Economic factors	Level of Education	Cultural practices
Urbanization	1	0.520**	0.403**	0.332**
Economic factors	0.520**	1	0.482**	0.378**
Level of Education	0.403**	0.482**	1	0.448**
Cultural practices	0.332**	0.378**	0.448**	1

***. Correlation is significant at the 0.01 level (2-tailed)*

The regression model (Table 7) explaining factors influencing household management in Benue State showed a correlation coefficient of 0.417, indicating a moderate relationship between the predictors and household management. The model accounted for 17.4 % of the variance in household management (R Square = 0.174), with an adjusted value of 0.166, reflecting the explained variation after accounting for the number of predictors. The standard error of the estimate was 0.753, representing the average distance between observed and predicted values. The change in R Square was statistically significant ($F(4, 426) = 22.438$, $p < 0.001$), indicating that cultural practices, urbanization, level of education, and economic factors collectively have a significant impact on household waste management outcomes. These findings underscore the importance of these socio-economic and cultural variables in shaping household waste management in the Benue State and suggest targeted interventions should consider these dimensions to improve waste management outcomes.

Table 7: Regression model explaining household management factors in Benue State

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	0.417[a]	0.174	0.166	0.753	0.174	22.438	4	426	0.000

a. Predictors: (Constant), Cultural practices, Urbanization, Level of Education, Economic factors

3.8 Effects of Household Waste Disposal in Benue State

The study revealed that household waste disposal poses numerous environmental and health challenges as shown in Table 8. Majority of the respondents (52.9%) strongly agreed and 35% agreed that waste disposal poses serious health risks, including rodent infestations, odours, and mosquito breeding. Air pollution (48%), water pollution (30.6%), habitat destruction (20.4%), and greenhouse gas emissions (19.7%) were also identified as critical effects. These findings align with Adogu et al. (2015) and Aguoru and Alu (2015), who reported that improper waste handling contributes to disease spread and environmental degradation in Nigerian urban areas. Similarly, Bassey et al. (2024) confirmed that open burning and uncontrolled dumping lead to air and water contamination. The recognition of greenhouse gas emissions, though less emphasized, reflects growing public awareness of the climate impact of poor waste management, as discussed by Abalo et al. (2018).

Table 8: Effects of household waste disposal in Benue State

Variable	Strongly Agree F(%)	Agree F(%)	Neutral F(%)	Disagree F(%)	Strongly Disagree F(%)
Air Pollution	207(48)	166(38.5)	20(4.6)	32(7.4)	6(1.4)
Greenhouse Gas Emissions	85(19.7)	175(40.6)	121(28.1)	25(5.8)	25(5.8)
Habitat Destruction	88(20.4)	252(58.5)	58(13.5)	30(7)	3(0.7)
Health Risks by rodents, ants, odour, mosquitos bite	228(52.9)	151(35)	27(6.3)	23(5.3)	2(0.5)
Aesthetic Degradation	80(18.6)	197(45.7)	128(29.7)	23(5.3)	3(0.7)
Long-term Environmental Damage	125(29)	223(51.7)	66(15.3)	15(3.5)	2(0.5)
Water Pollution	132(30.6)	184(42.7)	67(15.5)	39(9)	9(2.1)
Fire hazards	71(16.5)	263(61)	65(15.1)	27(6.3)	5(1.2)

The environmental impacts of household waste disposal in three locations in Benue State showed differences across several variables (Table 9). Otukpo consistently had highest mean scores for air pollution (4.32), health risks (4.81), water pollution (4.34), and long-term environmental damage (4.22), which implies the greatest perceived environmental burden in these areas. Gboko also recorded high mean values, especially in long-term environmental damage (4.24), air pollution (4.22), and aesthetic degradation (4.09), indicating serious environmental concerns. In contrast, Makurdi showed relatively lower mean scores across most impact areas, such as habitat destruction (3.58) and water pollution (3.39), suggesting a comparatively reduced level of perceived environmental impact. The analysis indicates that habitat destruction and long-term environmental damage in Makurdi significantly differ from those observed in Gboko and Utukpo ($p < 0.05$). Conversely, health risks associated with waste in Utukpo are significantly greater than in both Gboko and Makurdi ($p < 0.005$). Aesthetic degradation in Gboko is significantly distinct from the levels reported in Makurdi and Utukpo ($p < 0.005$) while water pollution and fire hazards exhibit significant differences across all three locations ($p < 0.005$). However, no significant differences were found among locations for air pollution and greenhouse gas emissions ($p > 0.005$) (Table 4). These results highlight significant spatial variations in environmental impacts related to household waste disposal in Benue State, emphasizing the necessity for location-specific waste management strategies.

The correlational analysis (Table 10) of household waste disposal impacts in Benue State, shows significant positive relationships between air pollution, greenhouse gas emissions, habitat destruction, health risks, aesthetic degradation, long-term environmental damage, water pollution, and fire hazards. Air pollution strongly correlates with greenhouse gas emissions ($r = 0.660$, $p < 0.01$) and moderately with health risks ($r = 0.455$, $p < 0.01$) and water pollution ($r = 0.365$, $p < 0.01$). Habitat destruction exhibits strong correlation with health risks ($r = 0.486$, $p < 0.01$) and long-term environmental damage ($r = 0.442$, $p < 0.01$). Aesthetic degradation and long-term environmental damage also show a strong association (r

= 0.473, p < 0.01). Water pollution correlates significantly with fire hazards (r = 0.377, p < 0.01), indicating interconnected environmental challenges. The findings underscore the multifaceted nature of environmental degradation resulting from household waste disposal in the region. The significant interrelationships among the variables suggest that interventions addressing one factor may have cascading benefits across others. Thus, integrated waste management strategies that simultaneously address pollution, habitat loss, and health risks are critical for mitigating the overall environmental impact in Benue State.

Table 9: Impact of household waste disposal on environmental variables in Benue State

Location	Air Pollution (Mean ±SD)	Greenhouse Gas Emissions (Mean ± SD)	Habitat Destruction (Mean ± SD)	Health Risks (Mean ± SD)	Aesthetic Degradation (Mean ±SD)	Long-term Environmental Damage (Mean ± SD)	Water Pollution (Mean ± SD)	Fire hazards (Mean ± SD)
Gboko	4.22±1.12[a]	3.66±1.33[a]	4.02±0.87[a]	4.21±0.85[b]	4.09±0.88[a]	4.24±0.79[a]	3.98±1.06[c]	4.11±0.78[a]
Makurdi	4.20±0.99[a]	3.62±0.88[a]	3.58±0.93[b]	4.11±0.99[b]	3.50±0.80[b]	3.63±0.80[b]	3.39±1.03[b]	3.51±0.93[c]
Otukpo	4.32±0.49[a]	3.58±0.61[a]	4.09±0.42[a]	4.81±0.41[a]	3.52±0.62[b]	4.22±0.59[a]	4.34±0.53[a]	3.82±0.52[b]

Table 10: Correlational analysis of household waste disposal effects in Benue State Nigeria

Variable	Air Pollution	Greenhouse Gas Emissions	Habitat Destruction	Health Risks	Aesthetic Degradation	Long-term Environmental Damage	Water Pollution	Fire hazards
Air Pollution	1	0.660**	0.395**	0.455**	0.300**	0.242**	0.365**	0.129**
Greenhouse Gas Emissions	0.660**	1	0.456**	0.332**	0.346**	0.238**	0.353**	0.205**
Habitat Destruction	0.395**	0.456**	1	0.486**	0.418**	0.442**	0.267**	0.328**
Health Risks	0.455**	0.332**	0.486**	1	0.340**	0.414**	0.347**	0.259**
Aesthetic Degradation	0.300**	0.346**	0.418**	0.340**	1	0.473**	0.242**	0.306**
Long-term Environmental Damage	0.242**	0.238**	0.442**	0.414**	0.473**	1	0.353**	0.294**
Water Pollution	0.365**	0.353**	0.267**	0.347**	0.242**	0.353**	1	0.377**
Fire hazards	0.129**	0.205**	0.328**	0.259**	0.306**	0.294**	0.377**	1

***. Correlation is significant at the 0.01 level (2-tailed)*

The regression model (Table 11) yielded a moderate correlation (R = 0.532), explaining 28.3% of the variance (R^2 = 0.283) in household waste disposal effects. The adjusted R^2 of 0.270 indicates a strong explanatory power after adjusting for the number of predictors included. The standard error of estimate was 0.705, reflecting the average discrepancy between observed and predicted values. The R Square change was statistically significant (F(8, 422) = 20.870, p < 0.001), confirming that the combined environmental variables: fire hazards, air pollution, long-term environmental damage, water pollution, aesthetic degradation, health risks, habitat destruction, and greenhouse gas emissions significantly influence household waste disposal effects. These findings emphasize the importance of integrated environmental risk management and targeted interventions to mitigate the multifaceted impacts of household waste disposal in Benue State.

Table 11: Regression analysis of household waste disposal effects in Benue State Nigeria

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	0.532[a]	0.283	0.270	0.705	0.283	20.870	8	422	0.000

a. Predictors: (Constant), Fire hazards, Air Pollution, Long-term Environmental Damage, Water Pollution, Aesthetic Degradation, Health Risks, Habitat Destruction, Greenhouse Gas Emissions

3.9 Respondents' Suggestions to Individuals and Government on Better Household Waste Management Practices

Respondents suggested multiple strategies for improving waste management in Benue State. For individuals, the top recommendations include public education (65.9%), community engagement (52%), and continuous monitoring (46.2%). For the government, the leading suggestions were the establishment of comprehensive

waste management policies (62.4%), door-to-door waste collection (59.2%), and investment in infrastructure (51%).

Table 7: Respondents' Suggestions to individuals and government on better household waste management practices in Benue State

Category	Suggestion	Frequency	Percent (%)
Suggestion for individuals in household	Enhanced public education	284	65.9
	Community engagement/Public awareness	224	52
	Continuous monitoring and evaluation	199	46.2
	Enforcement of regulations	197	45.7
	Infrastructure development	192	44.5
	Support for informal waste pickers	162	37.6
	Promotion of reduce and reuse	147	34.1
	Incentivize sustainable practices	147	34.1
	Collaboration with stakeholders	141	32.7
	Integration of technology	135	31.3
	Composting	54	12.5
Suggestion to Government	Establish comprehensive waste management policies and regulations.	269	62.4
	invest in waste collection infrastructure	220	51.0
	Implement door-to-door waste collection services.	255	59.2
	Promote community-based waste management initiatives.	208	48.3
	Provide training for waste management staff	166	38.5
	Encourage public-private partnerships.	153	35.5
	Develop public awareness campaigns	172	39.9
	Offer incentives for waste reduction and recycling	163	37.8
	Implement innovative technologies	143	33.2
	Establish monitoring and evaluation mechanisms	138	32.0

These suggestions are consistent with Debrah et al. (2021) and Abalo et al. (2018), who emphasized the importance of public education and policy frameworks in achieving sustainable waste management. Similarly, Adebayo et al. (2024) and Bassey et al. (2024) recommended stronger government–community partnerships and infrastructural improvements to ensure efficiency and sustainability

4.0 Conclusions

This study outlined the demographic characteristics and waste management practices of respondents in Benue State. Most of the respondents are male, with an average age of 36.2 years, predominantly Christian and married. Most respondents are engaged in business as their primary occupation and have varied educational backgrounds, with many holding secondary or undergraduate degrees. Waste generation is frequent, with most respondents generating waste daily, and organic waste is the most common type produced. Awareness of waste management programs is low, with few respondents informed about such initiatives, while most respondents express concerns about environmental impacts. The main challenges in waste management include inadequate infrastructure, open dumping, and improper waste segregation. Factors influencing waste management practices are urbanization and economic considerations. Respondents acknowledge significant negative effects of poor waste disposal on health and the environment, with many suggesting enhanced public education and government policy improvements as key solutions. The report emphasizes the need for better infrastructure, awareness, and community engagement in waste management efforts. Recommendations focus on government-led public education on waste practices, enhanced community involvement, improved infrastructure including bins and regular collection services, mandated household segregation, and collaboration with businesses on recycling. These comprehensive measures aim to improve environmental health and waste management sustainability in Benue State.

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