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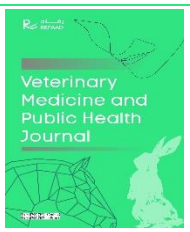

Household Solid Wastes: Collection and Disposal Methods in Abuja Municipal Area Council (AMAC), Federal Capital Territory, Nigeria

Abdulrahman M. ADEIZA[1*], Nma Bida Alhaji[1], Nuhu A. SANI[2], Enid A. GODWIN[1], Elizabeth C. OKOLO[1], Andrew M. ADAMU[1]

[1] University of Abuja, Faculty of Veterinary Medicine, Department of Veterinary Public Health and Preventive Medicine, Sultan Maccido Road, Airport Road, Abuja, Nigeria.

[2] University of Abuja, Faculty of Veterinary Medicine, Department of Veterinary Pathology, Sultan Maccido Road, Airport Road, Abuja, Nigeria.

*** Corresponding author:** Abdulrahman M. ADEIZA (ovavu64@gmail.com)

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Abstract

Objectives: This study was to assess the composition and quantity of solid wastes and their collection and disposal methods in Abuja Municipal Area Council, Federal Capital Territory of Nigeria.

Method: A total of 420 well-structured questionnaires (in English language) were administered to consenting participants to obtain information on methods of waste collection and disposal. Secondary data such as waste characteristics and types generated were collected from the Abuja Environmental Protection Board (AEPB) records from January to December 2020.

Results: Proportion of solid wastes generated in AMAC were in the order Food and other organic wastes, Papers, water sachets, plastics, metals, glass and textiles, 46.23%, 20.27%, 13.23%, 8.53%, 4.88%, 4.37% and 2.45% respectively. On waste collection, significant 55.71% proportion of the respondents choose government-approved bins, 25.23% use household items while 19.04% employed commercial waste collectors (χ^2 = 32.5454, df= 12, P= 0.00113). An insignificant 47.4% of the respondents in the study claimed to patronize only government approved dumpsites in disposing off their household wastes, 24.5% at any available open spaces while 24.3% dumped their wastes in their private backyards, 3.80% disposed the wastes in drainages (χ^2 = 18.8314, df= 18, P= 0.4022).

Conclusion: This study successfully achieved the objective for which it was set. This study successfully assessed the composition and quantity, collection and disposal methods of waste generated in AMAC, FCT, Nigeria.

Keywords: *Household Wastes; Wastes; Disposal Method; Abuja.*

1 Introduction

In the course of human and animal activities, varieties of garbage materials described by Nathanson, (2020) as solid wastes are often generated and discarded as useless and unwanted. They are mainly generated from industries, residences, and commercial areas. These materials are the ones used in the construction, sanitary, industrial, municipal, restaurants, kitchens, demolition and construction waste sites often called landfills (Rick, 2020). World Bank (2020) categorized wastes based on their essential components such as paper, glass, plastic, metal. (Rick, 2020) further classified the wastes based on their potential to inflict harms as flammable, toxic, infectious, radioactive and non-toxic. Further categorization has also been made based on the origin of the waste as domestic, institutional, commercial, industrial, construction and demolition. Systematic management of wastes must however be made irrespective of the origin, hazard-potential or content to ensure environmental best practices so that human health and environment are protected while disposing wastes (USEPA, 2023).

As an important part of environmental hygiene, management of solid wastes should be a part of environmental planning (World Bank, 2020). Management of wastes or its disposal may include such actions involved in its management from source to final disposal (Kumari and Raghubanshi, 2023). These actions include the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process and waste-related laws, technologies and economic mechanisms (World Bank, 2022).

The challenges of managing solid wastes have recently been on the increase due to climate change, urbanization, globalization, increased population and increasing rate of industrialization in many underdeveloped and developing countries (Ferronato and Torreta, 2019 and Ayodeji *et al*, 2020). This is partly because the frenzy of industrialization has distracted some developing countries from articulating comprehensive solid waste management protocols into its programs (Siddiqui, 2021). Many developing countries made ambitious budget for solid waste management but most times the execution is dismissal in terms of improvement in service delivery (Siddiqui, 2021). Increasing accumulation of Municipal Solid Waste (MSW) is therefore a result of urbanization (Zambrano-Monserrate, 2021). Fernando and Zutshi (2023) categorized Municipal Solid Waste Management (MSWM) system as comprising collecting, transferring, treating, recycling, recovering resources and disposing of solid waste. The effect of waste accumulation is very deleterious on environment, humans, animals and plants. These deleterious effects according to Alabi et al (2021) can only best be minimized by proper solid waste management.

Odoh and Nnamani, (2021) reported solid waste management to be the most challenging environmental problems confronting urban and rural areas of Nigeria. The habit of indiscriminately dumping solid wastes on and along highways and sometimes turning them into temporary dump sites is a regular sight within municipalities in Nigeria (Alabi et al., 2021).

With a population of over 214 million according to worldometers.info>nig (2022), Nigeria is rated as one of the largest producers of solid waste in Africa. In spite of the plethora of policies and regulations, solid waste management in the country is fast becoming a nightmare (Odoh and Nnamani, (2021)).

Blockage of sewers and drainage networks and choking of water bodies have been a result of the indiscriminate disposal of MSW mostly from households and sometimes local industries, artisans and traders. Odoh and Nnamani (2021) observed the absence of adequate budgetary provisions for the implementation of integrated waste management programs across the States as a predictable sign of environmental catastrophe for Nigeria in the face of improper collection and disposal of municipal wastes in the country.

This study is designed to assess the quantity of wastes, methods of collection and disposal in Federal Capital Territory using Abuja Municipal Area Council as a case study. It is hoped that data generated from this study will assist in developing policies towards tackling the scourge of environmental hazards due to unwholesome waste management in the FCT.

2 Materials and Methods

2.1 Study Area

This survey was conducted in Abuja Municipal Area Council (AMAC) of Federal Capital Territory (FCT), Nigeria. (Fig 1). FCT has a landmass of 7,315km2 and located between latitude 8°25′ and 9°20′N of the Equator and longitude 6°45′ and 7°39′E of Greenwich Meridian (Wikipedia, 2021). It

lies in the Guinean forest-savannah mosaic zone of the West African sub-region. FCT has three main annual weather conditions of warm, humid rainy and extremely hot dry season (Adeiza and Nafarnda, 2021). Abuja Municipal Area Council has a Population of 1,967,500 (National Census, 2016), 1,476 km² landmass and 310c temperature.

2.2 Study Site

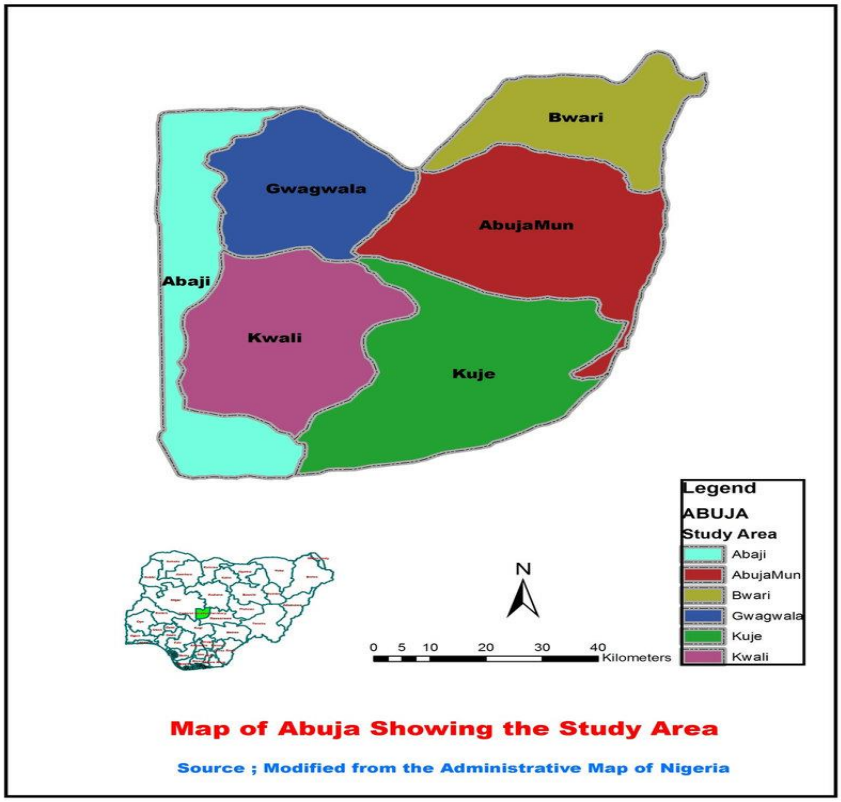

Fig. 1: Map of Abuja showing the study area (AMAC in Red).

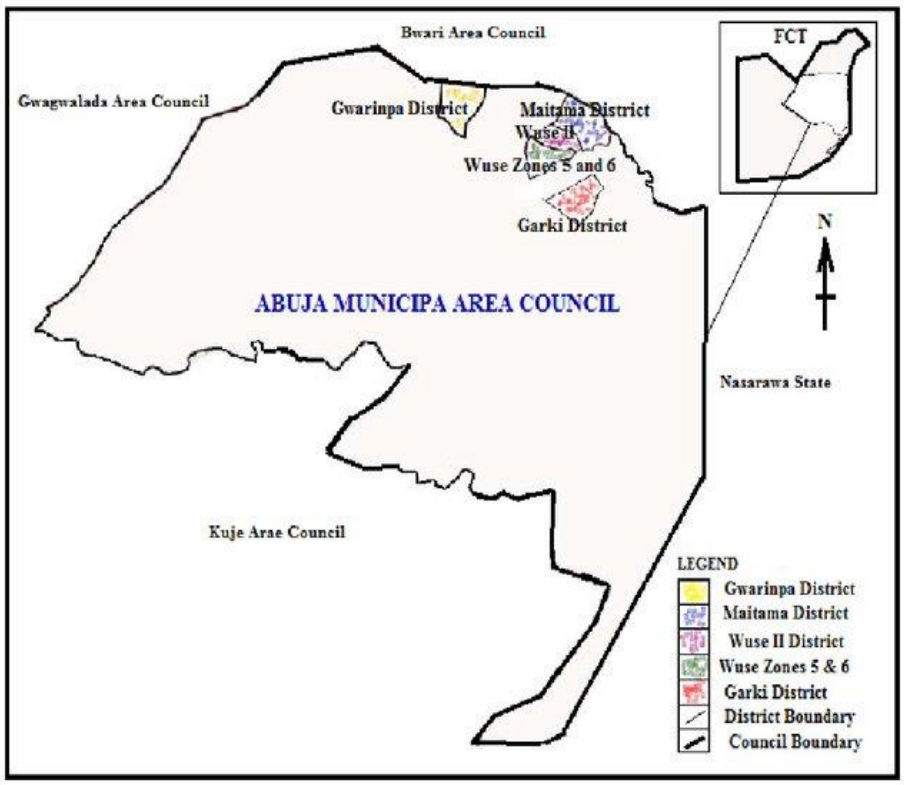

Fig. 2: Map Showing Six Districts in Abuja Municipal Area Councils of FCT Nigeria.
Source: Adapted from Abuja Geographic Information Systems (AGIS) Abuja FCT, Nigeria.

2.3 Data Collection

This is a cross sectional study that is descriptive in nature and employing quantitative method in data collection based on questionnaire. The survey combined systematic and purposive and random sampling techniques in selecting the study area and the respondents. Seven (7) districts in the area council were purposively selected for this study because of their representative characteristics of Abuja Municipal Area Council. These districts were Karu, Kabusa, Garki, Gwarimpa, Gwagwa, Gui/Airport and Nyanya (Fig. 2). The questionnaire was systematically (The fifth house in a row) distributed to the households in the districts and the questionnaire administered to the heads of the households.

Basing our Assumption on 50% (Ahmed, 2009) of the households in the study area correctly disposing their wastes, 384.16 sample size was arrived at, at a 95% confidence interval and 5% margin of error. This figure was approximated to 440 households to allow expanded participation and precision. A proportion of 5% of the population was taken for pre-text study leaving a total balance of 420 households to be enlisted in the study. All government and institutional buildings in these districts and houses without occupants were excluded from this study. A total of 420 (100%) of the population enlisted in the study responded adequately to the survey questionnaire.

Four hundred and twenty randomly selected households were evenly distributed at the rate of 60 households per district. The questionnaire collected information on the nature of wastes such as papers, textile, plastics, water sachets, metals, glass and food and other organic waste; the means of waste collection in the households which may involve the use of Government – approved bins, using household items such as baskets, disused containers and those that employ the services of commercial waste collectors who use evacuators, varieties of private truck vehicles, wheel barrows and push-carts and methods of household disposal of wastes which may involve the disposal of wastes in Govt-approved waste sites, open space, drainages and backyards.

2.4 Questionnaire

We used a closed- ended questions structured-questionnaire designed based on literature and expert advice. Based on Thrusfield (2009), the design was to get precision in responses and enhance data management.

The questionnaire was divided into three parts. For ease of communication, the questionnaire, written in English, was translated

into the three major languages spoken in the area (Hausa, Yoruba & Gwari) at least to communicate with those without formal education. In the design, part A had nine questions focused on the nature of wastes, part two had nine questions focused on methods of collection of wastes while the third part had eleven questions dwelling on disposal of wastes from different households in the respective districts. The questionnaire was reviewed for their design, content, relevance, understanding and simplicity. The questionnaire was pre-tested for reliability by subjecting 5% of the population who were eventually excluded from the study in a pilot study. Twelve-man trained enumerators were recruited to administer the questionnaire to the respondents under supervision. Verbal consent of the participants in the study was sought after the objectives of the study were read to them. Data collected was based on verbal consent as the participants showed unwillingness to append their signatures after being assured of the confidentiality of their participation. The participants were enlisted without bias and joined by volunteerism. They were at liberty to withdraw at will according Helsinki Declaration guide (WMADH, 2001).

Target audience for the questionnaire were mostly residents from the districts in the study area. The secondary data was generated from Abuja Environmental Protection Board (AEPB) records to determine the waste characteristics and quantities generated for the year 2020.

2.5 Statistical Analysis

The qualitative data was analyzed descriptively, while the quantitative data was analyzed statistically using a statistical program for social sciences (IBM SPSS version 29). Pearson chi-square was used to further analyze the data obtained.

3 Results

According to this study, wastes generated in the Abuja Municipal Area Council, FCT consists mainly of plastics/rubber, paper, glass, metals, water sachets, Glass/ceramics and food and other organic wastes. Out of the 74,571.9 tons of wastes (Table 1) generated in Abuja Municipal Area Council (AMAC), 46.2% (34,481.0 tons) were food and other organic wastes. Others were papers 20.23% (15,122.0 tons), water sachets 13.2% (9,867.8 tons), plastic/rubbers 8.5% (6,367.8 tons), metals 4.89% (3642.7 tons), Glass/Ceramics 4.34% (3260.5 tons) and textiles 2.4% (1830.4 tons) (Table 1).

Table 1: Composition of the wastes generated in Abuja Municipal Area Council, FCT.

Composition of Solid waste	Quantity (Tons)	Percentage (%)
Paper	15121.85500	20.27
Textile	1830.40990	2.45
Plastics/Rubber	6367.786800	8.53
Water sachets	9867.811700	13.23
Metals	3642.704500	4.88
Glass/Ceramics	3260.477200	4.37
Food and other organic waste	34480.87300	46.23
Total	74571.9181	100

*Tons = Tones; % = percentage

In the 420 households sampled across the seven districts of AMAC for household waste collection methods, 55.71% of the respondents use government approved waste bin for waste collection, 25.23% use household items while 19.04% employed commercial waste collectors who use waste evacuators, varieties of private truck vehicles, wheel barrows and push-carts. There was a statistically significant difference in the waste collection methods used by the households in various districts within AMAC (χ^2 = 32.545, P= 0.00113). In Garki district of AMAC, 71.7% of the households use Government-approved waste bins to collect their wastes compared to 35% in Nyanya. In terms of using household items for collection of wastes, households in Gwagwa (30%) were highest compared to 18.3% in Garki households. In the category of using commercial waste collectors to collect their household wastes, Nyanya was highest (40%) compared to 1.4% each in Garki and Gwagwa (Table 2).

Table 2: District-based waste collection methods in FCT.

Districts	No of Respondents	Govt-Approved Waste bins	Household Items (%)	Commercial Collectors (%)
Karu	60	34 (26.7)	16 (26.7)	10 (16.7)
Kabusa	60	30 (50)	14 (23.3)	16 (26.7)
Garki	60	43 (71.7)	11 (18.3)	6 (10)
Gwarimpa	60	37 (61.7)	15 (25)	8 (13.3)
Gwagwa	60	36 (60)	18 (30)	6 (10)
Gui/Airpor	60	33 (55)	17 (28.3)	10 (16.7)
Nyanya	60	21 (35)	15 (25)	24 (40)
Total	420	234 (55.7%)	106(25.2%)	80 (34.2%)

*No = number; % = percentage

In terms of the method of disposal of wastes, 47.38% of the respondents in the AMAC dispose of their wastes in Government-approved locations, followed by 24.5% of the respondents who claimed to dump their wastes in an open space, 24.28% of the respondents who dispose of their wastes in their backyards and the rest were the 3.80% who dispose of their wastes into the drainages. There was no significant difference in the method of waste disposal used by respondents within AMAC (χ^2 = 18.8314, P= 0.4022). Amongst the studied districts, Nyanya had the highest number of households (65%) dumping their wastes in Government-approved sites while Gwarinpa was lowest (35%). Gwarimpa district had the highest number of households (31.7%) disposing their wastes into the open space in AMAC while the least were the households in Airport and Garki districts (21.7%). Households in Gwagwa and Garki were highest (6.7%) in vending their wastes into drainages while 1.7% of the households each in Kabusa and Nyanya dispose of their wastes in drainages. A total of 30% of the households in Gwarimpa district were highest vendors of wastes into their private backyards in AMAC while the least were the 15% of the households in Karu district (Table 3).

Table 3: District-based waste Disposal Methods in FCT.

Districts/Respondents	Govt-approved waste bin (%)	Open space	Drainages	Backyards
Karu (60)	32 (53.3)	14 (23.3)	2 (3.3)	12 (20)
Kabusa (60)	26 (43.3)	16 (26.7)	1 (1.7)	17 ()28.3
Garki (60)	28 (46.7)	13 (21.7)	4 (6.7)	15 (25)
Gwarimpa (60)	21 (35)	19 (31.7)	2 (3.3)	18 (30)
Gwagwa (60)	23 (38.3)	17 (21.7)	4 (6.7)	16 (26.7)
Gui/Airport (60)	30 (50)	13 (21.7)	2 (3.3)	15 (25)
Nyanya (60)	39 (65)	11 (18.3)	1 (1.7)	9 (15)
Total (420)	**199 (47.4)**	**103 (24.5)**	**16 (3.8)**	**102 (24.3)**

*% = percentage.

4 Discussion

Wastes from households (residential) and similar types from commercial and industrial premises, institutions such as schools, care homes, prisons and public places such as streets, markets, slaughter houses, public toilets, bus stop, parks and gardens including most commercial, business, construction and demolition wastes except wastes of industrial process and other hazardous are described by Ezeudu et al. (2021) as Municipal Solid Wastes. Differentials in the standard of living of societies, level of urbanization and industrialization, and depth of agricultural activities is responsible for the differences in waste level, types, treatment and disposal problems faced by
countries, and between rural and urban areas.

A total of 74,571.92 tons of wastes was generated in AMAC according to this study. This is part of the annual 644, 000 tons of wastes generated in Abuja, 32 million tons of waste generated in Nigeria and 2.24 billion tons in the world (World Bank, 2022). Factors of culture, economic development, energy sources, climate and urbanization generally influence the composition of wastes (Siddiqui, 2021). The wastes that were generated in the pre-industrial era which consisted largely of leaves, paper and wood products, with little plastic or hazardous chemicals was generally less voluminous and less complex than contemporary industrial times of today coupled with the rising population (Ogunwumi and Salami, 2023). The attendant growth in waste accumulation has posed a significant challenge to its management. In Nigeria, random dumping of Municipal Solid Waste (MSW) is on the increase and further

exacerbated by worsening poverty, low living standard, lack of environmental education and spate of rising population and all these have resulted in reckless dumping in open space (Ezeudu et al., 2021). The challenges of waste management have been further exacerbated in the country by widening sanitary and public utility infrastructures have been overstretched by population explosion, heightening volume of municipal wastes especially in the cities, the type of wastes generated and the burgeoning cost of maintenance of complex system needed for management of wastes (Singh et al., 2023). High activity area to which our current area belongs, had earlier been described by Lazo et al. (2023) as lacking organized waste management services, areas with abandoned wastes, where wastes are burnt or buried without consideration for its attendant consequences. The environmentally unfriendly act of burning solid waste has been described by Mebratu and Mbandi (2022) and Powrie et al (2021) as a consequence of economic wellbeing and affordability status of households, but nonetheless hazardous to the ecosystem. While such burning is often intended as an act to lower hygiene problems, it invariably emits variety of cancerous toxic substances such as dioxins, furans and other ozone depleting and greenhouse gases (Ramadan et al., 2022 and Pathak et al., 2023).

Various illnesses relating to bad sanitation due to poor health management has been reported to be responsible for the top ten diseases of public health concerns such as cholera, intestinal worms and typhoid (Velleman et al 2023 and Prüss-Ustün et al. 2019). This represents how Municipal waste management is a critical challenge to environmental health managers in developing world (Sharma and Sharma (2020). Since wrong disposal of wastes by a resident in a community may affect others, countries have enacted policies that task institutions, individuals and establishments to contribute to keeping their communities and environment clean (Jerumeh et al., 2022 and Jallo et al., 2021).

In this study area, various forms of solid wastes generally referred to as Municipal Solid Wastes (MSW) are Generated in the study area. Food/organic wastes is the highest and contributes 46.23% to the total Components of solid wastes such as metals, papers, textiles, plastic/rubber, water sachets and glass ceramics generated in the AMAC. This result corroborates World Bank reports on solid waste composition in developing countries where organic wastes were reported to constitute the bulk of wastes from households (World Bank, 2020). This is because most fresh and unprocessed food items brought home from the market for use lack good refrigeration and storage due to inadequate power supply making them to become wastes. The long exposure of these items in the markets also make many of them to deteriorate and decay before they are brought home. Many fresh, unprocessed foods and other organic items often constitute wastes that are disposed into various outlets. The deficiencies in infrastructures in AMAC to cope with the collection and clearing of these wastes generated, make accumulated or uncleared refuse to most often block the main roads (Okpalaoka, 2021).

The high component (46.23%) of the food and organic wastes amongst other forms of waste in AMAC in this study agrees with the high value of 66.7% in Ibadan and to a larger extent the 52% obtained in Nigeria by Okpalaoka, (2021) and Siddiqui, (2021) respectively. The high figure in this study further agrees with the 40% to 85% range attributed to food waste/ organic of the total wastes in developing world in the World Bank, (2020) reports affirming a high percentage of organic matter that is combustible in the urban waste stream in poor countries. Consumption of semi and unprocessed foods in undeveloped countries as against processed ones in the developed countries have been reported to be responsible for the high percentage of putrescibles (food waste/ organic) in solid wastes from developing countries (Adams et al., 2020).

Environmental consequence of poor waste collection, management and disposal form a great part of the MSW management in the urban areas. Soil, air, water and aesthetic pollutions are in most cases a consequence of improper disposal and MSW management and disposal of MSW contributes significantly to environmental problems. Variety of human health disorders result from the environmental pollutions due to the increased level of greenhouse gases (Manisalidis et al., 2020). In this study, the waste collection arrangement employed by residents of AMAC differ from household to household. The number of households using government-approved collection bins/bagging accounts for 55.71%. This figure is higher than the 25.2% obtained for residents who utilize variety of household items to collect their wastes. There are yet other residents constituting 19.04% of the sampled households that contract commercial waste collectors that use specialized vehicles, push-carts, wheel barrows and others in collecting their household wastes. The difference in

the methods of waste collection by residents of AMAC was significant ((P= 0.00113).

The differences in the method of collection may be due to the level of available trained manpower and funding of adequate materials for collection of wastes by the government agency called Abuja Environmental Protection Board (AEPB) responsible for waste collection and maintenance of environmental sanitation of the study area. Affordability of the services of the commercial waste collectors, the hygiene habit of the household and effectiveness of the appropriate regulatory laws of waste collection and management in the study area may influence the level of difference in the waste collection efforts. This stance is supported by Siddiqui (2021) who attributed inefficiency of waste collection in Nigeria and consequent pollution to non-privatization of waste collection and management. The poor waste collection by the government agency, AEPB which DFID (2004) attributed to serving only 56% of individuals living in the Federal Capital Territory has been attributed to inadequate manpower and funding by Dabis et al., (2023).

Garki district predominated the other districts (71.7%) in the use of government-approved bins in collecting their wastes compared to Nyanya district which had the least utilization of the same government utility but were rather highest in using household items in evacuating their wastes while households in Gwagwa district were highest in the use of commercial waste collectors in evacuating their household wastes. The differences in the means of collection according to districts may be due to the variation in availability of government facilities for waste collection in the districts, enforcement of sanitation laws, standard of living, level of hygiene and health education of the residents.

In the method of disposal of wastes, the study showed that in the overall, a little less than half of the respondents in the study (47.38%) dispose their wastes in the government designated places as against about a quarter (24.52%) that dump them in any available open space. Of the remaining households, 24.28% dispose their wastes in their private backyards while 3.80% dump their solid wastes in drainages. This low figure of dumps in the drainages in the study area contrast the findings of Ozoh et al., (2021) who reported higher dumping of wastes (58%) in drainages in Ibadan, Nigeria. Households in Nyanya district appeared to have the highest (65%) compliance to the government rule of dumping of wastes at legally designated places in the study area compared to Gwagwa district which had the highest number of households in AMAC that dump their wastes in any available open space. Garki district similarly had the highest rate of dumping wastes (refuse) in the drainages while households in Gwarimpa district had the highest rate (30%) of dumping wastes in their backyards. The nature, volume of waste involved in any district depend on the cultural practices (Festivities) of the people in the area, the efficiency of government agency responsible for environmental sanitation and the hygiene practices of the households. Odor, cleanliness and fear of disease have been cited as the main reasons why people dispose of the wastes in their houses farther away from their homes (Gupta et al., 2020). They feared that accumulation of these wastes may lead to intestinal worms, diarrhea, cholera, and typhoid malaria, which are among the top ten diseases whose outbreaks usually raise an alarm of public health concerns (Janik-Karpinska et al., 2023 and Abubakar et al., 2022). While some appropriately dump their wastes in government-approved bins which are sometimes disused vehicles, metal containers, communal sites, brick structures for incineration, many others inappropriately dump their wastes at their backyard, streets, holes, streams, bushes, gutters and uncompleted buildings which later become breeding sites for reptiles and insects.

5 Conclusion

This study revealed that wastes are randomly generated, collected and disposed of across the entire districts of Abuja Municipal Area Council in Federal Capital Territory. Food and other forms of organic wastes rank highest amongst the solid wastes generated and disposed of in AMAC. The study showed the waste collection arrangement provided by government to be more effective in Garki districts while households in Gwagwa district were highest in using the household items in collecting their wastes, those in Nyanya majorly rely on commercial waste collectors in evacuating their household wastes. We hypothesized that majority of households dispose of their wastes in open spaces such as fields, streets, dump sites. We suggest a stronger legal framework, improved infrastructures and greater funding for AEPB for effective waste collection and disposal by the district authorities. We also suggest a robust and collaborative public/private sector dialogue and initiative on waste management, sustainable public health education to compel the households in the

area for better collection and disposal of wastes in the area. This we hope, will drastically minimize the public health challenges associated with improper waste management in Abuja Municipal Area Council (AMAC).

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Conflict of interest:

We declare that there is no conflict of interest relating to this article.

Grants:

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References

Abubakar, I. R., Maniruzzaman, K. M., Dano, U. L., AlShihri, F. S., AlShammari, M. S., Ahmed, S. M. S., Al-Gehlani, W. A. G., & Alrawaf, T. I. (2022). Environmental Sustainability Impacts of Solid Waste Management Practices in the Global South. *International journal of environmental research and public health*, *19*(19), 12717. https://doi.org/10.3390/ijerph191912717

Adams, J., Hofman, K., Moubarac, J. C. & Thow, A. M. (2020). Public health response to ultra-processed food and drinks. *BMJ*. Jun 26; 369. https://doi.org/10.1136/bmj.m2391

Adeiza M. A. & Nafarnda D. W. (2021). Associated Risk Factors of Cryptosporidium Infection in Cattle in the Federal Capital Territory, Nigeria. *International Journal of Recent Innovations in Academic Research*, 5 (5), 31-39.

Ahmed, S. (2009). *Methods in Sample Surveys, Department School of Hygiene and Public Health*. Johns Hopkins University. http://ocw.jhsph.edu/courses/statmethodsforsamplesurveys/PDFs/Lecture2.pdf

Alabi, O. A., Adeoluwa, Y. M., Huo, X., Xu, X. & Bakare, A. A. (2021). Environmental contamination and public health effects of electronic waste: an overview. *Journal of Environmental Health and Science Engineering*. 19 (1), 1209-1227. https://doi.org/10.1007/s40201-021-00654-5

Ayodeji, A., Noiki, S. A., Afolalu., Yusuf, O.O., Moses, E., Emetere, Samson, O., Ongbali., Olamilekan, R. O., Joseph, O. O., Banjo, S. O. (2022). Impact Assessment of The Current Waste Management Practices in Nigeria. *Materials Science and Engineering*, 1107-012172. https://doi.org/10.1088/1757

Dabis, N., Dibal, J., Ilenwabor, J., Maigida, G., Akinwumi, I., Maton, S. (2023). *Assessment Of Solid Waste Management Practices in Abuja Municipal Area Council (AMAC).*

Ezeudu, O. B., Agunwamba, J. C., Ugochukwu, U. C., Ezeudu, T. S. (2021). Temporal assessment of municipal solid waste management in Nigeria: prospects for circular economy adoption. *Reviews on Environmental Health*, 36 (3), 327-344. https://doi.org/10.1515/reveh-2020-0084

Fernando, S. J. & Zutshi, A. (2023). A way forward, Cleaner Waste Systems. Volume 5, 100103. https://doi.org/10.1016/j.clwas.2023.100103

Ferronato, N. & Torretta, V. (2019). Waste Mismanagement in Developing Countries: A Review of Global Issues. *International Journal of Environmental Research in Public Health*. https://doi.org/10.3390/ijerph16061060

Gupta, V., Kumar, R., Sood, U. & Singhvi, N. (2020). Reconciling Hygiene and Cleanliness: A New Perspective from Human Microbiome. *Indian J Microbiology*, 60 (1), 37-44. https://doi.org/10.1007/s12088-019-00839-5

Jallo, I. U., Kodiya, M. A. & Modu, M. A. (2021). Waste Management Practices and Environmental Implications in Hadejia Metropolis, Jigawa State, Nigeria. *Dutse Journal of Pure and Applied Sciences (DVPOPAS)*, 7(2b).

Janik-Karpinska, E., Brancaleoni, R., Niemcewicz, M., Wojtas, W., Foco, M., Podogrocki, M. & Bijak, M. (2023). Healthcare Waste-A Serious Problem for Global Health. *Healthcare (Basel)*. 11(2), 242. https://doi.org/10.3390/healthcare11020242

Jerumeh, T.R., Igbinadolor, J.I. & Akinbinu, T.O. (2022). Public health implications of solid waste management in Akure, Nigeria. *GeoJournal*, **87**, 1121–1131. https://doi.org/10.1007/s10708-020-10300-6

Kumari, T. & Raghubanshi, S. A. (2023). *Waste Management and Resource Recycling in the Developing World* In: Waste management practices in the developing nations: challenges and opportunities. Elsevier, Pages 773-797. https://doi.org/10.1016/B978-0-323-90463-6.00017-8

Lazo, L., D.P., Bojanic, D. P., Helbingen, C. & Gasparatos, A. (2023). Household waste generation, composition and determining factors in rapidly urbanizing developing cities: case study of Santa Cruz de la Sierra, Bolivia. *J Mater Cycles Waste Manag* 25, 565–581. https://doi.org/10.1007/s10163-022-01535-1

Manisalidis, I., Stavropoulou, E., Stavropoulos, A. & Bezirtzoglou, E. (2020). *Environmental and Health Impacts of Air Pollution*: A Review Front Public Health. 8:14.

Mebratu, D. & Mbandi, A. (2022). *Open Burning of Waste in Africa: Challenges and Opportunities*. https://engineeringx.raeng.org.uk/media/u4mnsto5/open-burning-final-report_1.pdf

Medical research involving human subjects. Bulletin World Health Organization. 79,

Nathanson, J. A. (2020) *Solid-waste management*. Encyclopedia Britannica, https://www.britannica.com/technology/solid-waste-management. Accessed 26 June 2021

Odoh, O. & Nnamani, E. C. (2021). *Effective Waste Management in Nigeria: An Approach for Sustainable Development*. https://www.researchgate.net/publication/351062102

Ogunwumi, O. T. & Salami, L. (2023). *Perspective Chapter: Industrial Waste Landfills*. IntechOpen.

Okpalaoka, C. (2021). Infrastructural Challenges in Nigeria and the Effect on the Nigerians Economy: A Review of Literature. *Environmental and Earth Sciences Research Journal*, 8. 159-162. https://doi.org/10.18280/eesrj.080403

Ozoh, N. A., Longe, T. B., Akpe, V. & Cock, E.I. (2021). Indiscriminate Solid Waste Disposal and Problems with Water-Polluted Urban Cities in Africa. *Coastal Zone Management Journal*, 24. 1000005.

Pathak, G., Nichter, M., Hardon, A., Moyer, E., Latkar, A., Simbaya, J., Pakasi, D., Taqueban, E. & Love, J. (2023). Plastic pollution and the open burning of plastic wastes. *Global Environmental Change*, 80 (102648), https://doi.org/10.1016/j.gloenvcha.2023.102648

Powrie, W., Velis, C., Cook, E.& Ingham, H. (2021). Open uncontrolled burning of solid waste undermines human health. Time to act. *Waste Management & Research*, 39(1), 1-2. https://doi.org/10.1177/0734242x20981800

Prüss-Ustün A., Wolf, J., Bartram, J., Clasen, T., Cumming, O., Freeman, M. C., Gordon, B., Hunter, P. R., Medlicott, K. & Johnston, R. (2019). Burden of disease from inadequate water, sanitation and hygiene for selected adverse health outcomes: An updated analysis with a focus on low- and middle-income countries. *Int J Hyg Environ Health*, 222(5), 765-777. https://doi.org/10.1016/j.ijheh.2019.05.004

Ramadan, B. S., Rachman, I., Ikhlas, N., Kurniawan, S. B., Miftahadi, M. F. & Matsumoto, T. A. (2022). Comprehensive review of domestic-open waste burning: recent trends, methodology comparison, and factors assessment. *J Mater Cycles Waste Manag*. 24(5), 1633-1647. https://doi.org/10.1007/s10163-022-01430-9

Science and Technology Series. Springer, New York, NY.

Sharma, N.K. & Sharma, S. (2020). Municipal solid waste management in developing countries: Future challenges and possible opportunities. *Journal of Green Engineering*. 10. 8788-8797.

Siddiqui, K. (2021). The Importance of Industrialization to Developing Countries. *The World Financial Review*, 899X/1107/1/012172

Singh, P., Verma, P., Singh, R., Ahamad, A. & Batalhão, A. C. S. (2023). *Waste Management and Resource Recycling in the Developing World.* Elsevier, Pages 773-797.

Thrusfield, M. (2009). *Veterinary Epidemiology*, 3rd ed. Blackwell Science Ltd, a Blackwell Publishing company, 9600 Garsingt on Road, Oxford OX4 2DQ, UK,pp. 228–238.

U.S. Environmental Protection Agency (2023). *Inventory of U.S. greenhouse gas emissions and sinks*: 1990-2021. EPA 430-R-23-002.

Velleman, Y., Blair, L., Fleming, F. & Fenwick, A. (2023). *Water, Sanitation and Hygiene-RelatedDiseases*. In: Shulman, L.M. (eds) Infectious Diseases. Encyclopedia of Sustainability Science and Technology Series. Springer, New York, NY. https://doi.org/10.1007/978- 10716-2463-0_547

WMADH, (2001). World Medical Association Declaration of Helsinki. *Ethical principles for* 24, 16(6), 1060.

World Bank, (2012). *What a waste: a global review of solid waste management, urbandevelopment series knowledge papers*.

World Bank, (2022). *Understanding poverty and urban development. Solid waste management. urban development series knowledge papers*.

Zambrano-Monserrate, M.A., Ruano, M.A. & Ormeño-Candelario, V. (2021). Determinants of municipal solid waste: a global analysis by countries' income level. *Environ Sci Pollut Res*, 28, 62421–62430. https://doi.org/10.1007/s11356-021-15167-9