# COMPARISON OF SEWAGE AND SOLID WASTE DISPOSAL METHODS AMONG HOUSEHOLDS IN URBAN AND RURAL LOCAL GOVERNMENT AREAS OF ANAMBRA STATE.

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## ABSTRACT

Improper sewage and solid waste disposal lead to environmental pollution and increased risk of communicable diseases. This study compared the sanitation and solid waste disposal facilities utilized in selected rural and urban local government areas of Anambra State, Nigeria. This cross-sectional study was conducted among 1310 households and data was collected from household heads or a designated adult representative using of quantitative (questionnaire) and qualitative (KII) data collection methods. The independent variables in this study are the sociodemographic variables and the geographical location of the respondents while the dependent variables are the toilet facilities and solid waste disposal methods. Data from the questionnaire was analyzed using the SPSS version 23 and the hypotheses were tested with the inferential statistics of Chi square at 0.05 level of significance. Most respondents lie between the age group of 31-50 years. Most of the respondents in both the urban (84.4%) and rural(65.0%) areas had secondary education and above but a higher proportion in the urban compared to rural have tertiary education(41.9% versus 22.1%). The difference in educational status was statistically significant (p = 0.0001). There were more business men (46.6%) and civil servants (38.8%) in the urban area than the rural area. Most rural respondents were farmers(41.5%). Many urban household use toilet with sewer connection 152(11.7%) while pit latrine with slab is the most commonly used toilet facility 242 (18.6%). Burning was more commonly used by the rural households (n = 266, 20.5%). Open dumping of refuse and disposal into gullies and water ways were commonly done by the urban households. The gaps that exist between rural and urban areas of Anambra state may present serious health risk and environmental degradation .This issues can be addressed through health education, building more sanitary infrastructure to include the rural areas and enforcing sanitation laws.

**KEYWORDS:** sewage disposal, solid waste disposal, household toilet facility, rural, urban

## INTRODUCTION

Sanitation, the provision of facilities and services for the safe disposal of human urine and faeces, the maintenance of hygienic conditions through services such as garbage collection and wastewater disposal (World Health Organization [WHO], 2021), is fundamental to improving living standards for people (Hulton and Chase, 2017).

Toilet and sewage disposal facilities refer to mechanisms and systems employed to collect and dispose of waste water containing solid and liquid excreta derived from kitchen, bath, laundry, run off rain water and industrial waste water (Kimbi, 2013). Improper disposal of human excreta is of major public health importance as it contains a variety of pathogenic organisms and is attractive to flies and other disease vectors (Lucas and Gilles, 2011).

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Toilet and sewage disposal facilities have been classified by the Joint Monitoring Program (JMP) for water and sanitation into a sanitation service ladder of five categories ranging from the lowest, open defecation, whereby human faeces is disposed of in fields, forests, bushes, open bodies of water, beaches or other open spaces, or with solid waste; to the highest level termed 'safely managed". Safely managed sanitation facilities meet three criteria based on the use of improved facilities that are not shared with other households and excreta are (1) safely disposed of in situ or (2) stored temporarily and transported and treated offsite or (3) transported through a sewer and treated offsite. Improved sanitation facilities are those that hygienically separate excreta from human contact and is used by only members of one household, such as flush/pour flush toilets connected to piped sewer systems, ventilated pit latrines among others (United Nations Children's Fund and World Health Organization/ Joint Monitoring Program [UNICEF and WHO/JMP], 2015).In 2017, 673 million people practiced open defecation. Only 45% of the global population were using safely managed sanitation services which is however a marked improvement from the 2000 estimate of 28%. In spite of this, there is still a gap in coverage between rural and urban areas whereby seven out of every ten people living in rural areas lacked basic services (UNICEF & WHO, 2019). People in rural areas (29%) are three times more likely to practice open defecation than those in urban (10%) areas (FMWR, NBS and UNICEF, 2019). A 100 million Nigerians lack basic sanitation and some 12% of the urban population in also practice open defecation contrary to reports that open defecation has been eradicated in urban areas (Mansor, Islam, and Akhtaruzzaman, 2017). Disparities exist even within rural communities related to household wealth/income (Ohwo, 2019; Ordinioha 2008), level of education (Abubakar, 2017).

Solid waste (garbage) disposal has been described as the usual way solid waste or garbage is collected and disposed of by residents of a housing unit (United Nations Statistics Division (UNSD), 2018). Nigerian cities have solid waste disposal problems, typified by overflowing dumpsters, mountains of open refuse dumps and makeshift landfills on the edge of larger suburbs and towns. Properly operated landfills are few and far between and available ones are rodent-infested with surface and ground water pollution concerns (Adekola et al., 2021). Abila and Kantola (2019), purported that the solid waste disposal techniques prominent in Nigeria are open dumping, land fill and open burning, while incineration is rarely practiced. Moreover, recycling, an environmentally friendly option, is not fully embraced. Instead solid waste is recycled informally by scavengers who acquire un-used items from people and search legal and illegal dumpsites for materials that can be reused or recycled. A typology of solid waste disposal systems by housing units recommended by United Nations can be used to identify areas where collection and garbage disposal is none existent and to differentiate areas where residents rely on waste picking and informal disposal methods (US Census Bureau, 2021 ) (Refer to Figure 1).

Figure 1: Solid waste disposal system classification: The recommended solid waste disposal system by housing unit is:
• Solid waste collected on a regular basis by authorized collectors.
• Solid waste collected on an irregular basis by authorized collectors.
• Solid waste collected by self-appointed collectors.
• Occupants dispose of solid waste in a local dump supervised by authorities.
• Occupants dispose of solid waste in a local dump not supervised by authorities.
• Occupants burn solid waste.
• Occupants bury solid waste.
• Occupants dispose solid waste into river, sea, creek, or pond.
• Occupants compost solid waste.
• Other arrangement.(Source: US Census Bureau, 2021).

**STATEMENT OF THE PROBLEM:** Access to basic sanitation is sacrosanct to all traditions and culture of the world. Lack of access to safe, clean drinking-water and basic sanitation, as well as poor hygiene cause nearly 90% of all deaths from diarrhea, mainly in children (WHO, 2011). According to US Centre for Disease Control and Prevention (CDC) report (2021) , improved sanitation has the potential to prevent at least 9% of the global disease burden and 6% of global deaths and it has contributed to a 15% decrease in diarrheal deaths in Southeast Asia, East Asia, and Oceania, and more than a 10% decrease in diarrheal deaths globally .

There is lack of access to adequate sanitation in Nigeria (Shehu and Nazim, 2022).She still faces challenges despite substantial progress made in developing policies and strategies for sanitation service delivery. Approximately 122 million people still lacked access to "at least basic" sanitation (WHO and UNICEF,2017). Open dumping and defecation are still practiced in Nigeria rural communities. According to source, over 110 million lack access to improved sanitation in 2013 while open defecation rates continue to pose grave public health risks. A report by the World Health Organization revealed that access to safe water and sanitation is a major challenge in Nigeria. Sanitation coverage rates in the country are amongst the lowest in the world (WHO, 2011). Poor sanitation practices and inadequate sanitary facilities can pose different problems but in general, expose people to increase risk of infectious disease.

**SIGNIFICANCE OF THE STUDY:** In 2019, the Government of Anambra state, Nigeria, through its Ministry of Environment, declared a state of emergency on waste management in the state in order to tackle the challenges  militating against sanitation in both rural and urban areas in Anambra (Ugokwe and Nwauba, 2019). The 6th sustainable development goal aims to ensure availability and sustainable management of water and sanitation for all. It directly addresses sanitation, aiming to achieve access to adequate and equitable sanitation and hygiene, and end open defecation by 2030 (United Nations, 2023). These aspirational targets need to be achieved in Anambra and the rest of Nigeria. Re-directing the country's limited resources towards equitable provision of improved sanitation facilities in rural areas would require evidence that takes into consideration the inequalities that exist between rural and urban areas. It is to this end that this study compared the toilet, sewage and solid waste disposal facilities and practices among rural and urban households in selected local government areas (LGA) in Anambra state with a view to providing evidence for advocacy to stakeholders on measures to improve sanitation and reduce rural-urban inequalities.

**OBJECTIVE OF THE STUDY:** The objective of this is to assess the sewage and solid waste disposal facilities compared in an urban and rural Local Government in  Anambra State.

**LITERATURE REVIEW:** Safe sewage and solid waste disposal systems such as latrines and toilets, excreta collection and disposal, garbage disposal are essential to preventing disease and death from diarrheal and other communicable diseases. Death rates from these diseases declined in Europe and North America when people began filtering and chlorinating their water and safely disposing human and animal excreta (Clasen, cited in Detels, 2015). That notwithstanding, basic sanitation still remains a problem to some low and middle income countries. In 2015, only 30% of sub-Saharan Africans had access to improved sanitation facilities (Centres for Disease Control and Prevention, 2021).

**HOUSEHOLD TOIET FACILITIES IN URBAN AND RURAL AREAS:**

 The proportion of people depending on shared toilets is higher in the least developed countries and highest in sub-Saharan Africa (Rheinlander, Konradsen, Karaita, Apoya and Gyapong, 2015). Though,the global population using safely managed sanitation services increased from 28 per cent in 2000 to 43 per cent in 2015 and to 45 per cent in 2017, with the greatest increases occurring in Latin America and the Caribbean, sub-Saharan Africa and East and South-East Asia, yet 701 million people still practiced open defecation in 2017 (UN Sustainable development goal knowledge platform [UN-SDG knowledge platform], 2019). In east and southern Africa, cultural acceptance and misuse of the

facilities have been cited as challenges to their use (Nakagiri, Niwagaba, Nyenje, Kulabako, Tumhairwe and Kasiime, 2015). Reports by UNICEF revealed that Nigeria is making progress in improving sanitation due to great number of people upgrading their toilets to improved private toilets in their homes and open defecating decreasing slightly from 47 million in 2018 to 46 million in 2019 (Drakopoulos, 2020). Overall, 56% of Nigerian households use improved toilet facilities, 74% in urban areas and 39% in rural areas. Likewise, other studies have reported  more residents in the urban areas using toilet facilities more than residents in the rural areas (Abubakar, 2017; Budhathoki, 2017; Tumwire et al, 2010). Open defecation is still widespread in Nigeria, with 25% of households (33% of rural households and 15% of urban households) engaging in this practice. Overall, 53% of the Nigerian population has access to an improved sanitation facility, while 24% has access to an unimproved facility. Twenty-three percent of the population engages in open defecation(NPC and ICF, 2019). The 2019 WARSH NORM report showed that access to safely managed and basic sanitation in Nigeria increased by 2% between 2018 and 2019 but the practice of open defecation only reduced by 1%. Up to 23% of the population still defecate in the open. People in rural areas (29%) are three times more likely to practice open defecation than those in urban (10%) areas (FMWR, NBS and UNICEF, 2019). The percentage of households with access to an improved sanitation facility is highest in the South West zone and lowest in the North Central and North West zones. At the state level, Abia has the highest percentage of households with an improved sanitation facility (93%), Anambra has 82.5%. Only 9% of households in Kebbi and 10% in Ebonyi have basic sanitation service, the lowest percentages among the states (NPC and ICF, 2019).

**Solid waste disposal patterns:** In Nigeria the common methods of municipal waste disposal still remain: open dumping, open burning, incineration, unregulated land- fills, composting, and dumping into drain channels, streams and rivers (Ikpeze, 2014).Indiscriminate dumping on farmland and burying methods are common in rural area (Obionu, 2007). These methods have their disadvantages like causing fly nuisance and odour, air pollution, leaching of harmful chemicals into the soil and groundwater (Bill, Chidi, Onyemeziri and Ewizie, 2015; Omole, Isiorho and Ndambuki, 2016).While provinces like USA, UK, China,India, Brazil and Qatar use sanitary landfill as their waste management option (DEFRA, 2019; Mihai and Taherzadeh, 2017; Zhou, Sun and Yi, 2017).Actually, vulnerability to illegal dumping is high in both urban and rural areas in some countries (Milhai,2012). Though outdated in  waste management practice, they occur more in peri- urban and rural areas (Mihai and Taherzadeh, 2017).  Milhai and Grozavu(2019) recorded high (58%)

waste amounts disposed in rural dumps of North East region of Romania attributing the cause to lack of waste collection services by rural municipalities which has contributed to indiscriminate disposal of waste resulting in a horrible site that threatens the local environment. ,Similarly, Adogu, Uwakwe, Egenti, Okwuoha and Nkwocha ( 2015) on assessment of waste management practices among residents of Owerri showed that the most popular methods of waste disposal known to the respondents were open dumping 279 (98.94%) followed by burning 267 (94.68).In Lagos 16.2% , 10.5% and 22.2% of the residents in the high, medium and low densities respectively dispose solid waste in Lagos State Waste Management(LAWMA) refuse bins (Ojewale, 2014). Shamaki and Shehu (2017), in another study to assess solid waste management in Sokoto metropolis identified that using waste bin is a common practice among the respondents (81.7%).It was further recommended that acquiring waste storage facility and government house to house evacuation of solid waste can reduce the rate of indiscriminate dumping sites(Babayara and Bogoro, 2011). Omele (2016) describe indiscriminate dumping as ineffective and harmful to public health and environment.

## METHODOLOGY

The study was conducted in Onitsha south, an urban LGA and Anaocha, a rural LGA, both in Anambra state. Onitsha south LGA consists of six towns, and has a population of 137,191; Anaocha LGA has eight communities and a population size of 284,215 (Mfonobong, 2023;Federal Republic of Nigeria Official gazette,2009).

The study used a cross-sectional design. The study population consisted of household heads or a designated adult representative, who had lived in the study area for up to one year prior to the survey. Staff of Anambra State Waste Management Authority (ASWAMA), Awka who gave consent for the Key Informant Interview (KII) were included.

A sample size of 1310 households was calculated using the formula for calculating sample size in a comparative study (Aroye, 2008), $n = 2 Z^2 Pq / d^2$ (Aroye, 2008) ,where

n = The desired sample size

z = The normal standard deviate at 95% confidence interval = 1.96.

P=The proportion in the target population estimated to have a particular characteristic. Using the 25.9% respondents reported by Oluwale (2014) that uses accredited private sector participation as a method of sanitation in high density area of Lagos metropolis. So P = 0.259,

q = the complimentary probability of P. q= (1-p) = (1-0.259) = 0.741

d = Degree of accuracy desired, set at 5% for comparative study.

Therefore n = $2 \times 1.96^2 \times 0.259 \times 0.741 / 0.05^2$ =589.8 and with 10% non-response rate = 655 sample size. For the two selected areas the total sample size = 1310.

Based on the population size of each LGA, the sample size was proportionally allocated as 422 households selected from Onitsha South and 884 from Anaocha LGA. A multi-stage sampling technique was employed. At stage one, the 21 LGAs in Anambra state were designated as 7 urban and 14 rural LGAs (NPC, 2006). With each stratum of LGAs, simple random sampling by balloting was used to select Anaocha (a rural LGA) and Onitsha south ( an urban LGA). Next, Neni and Odoakpu were selected from Anaocha and Onitsha south respectively by simple random sampling method. Then at stage three, households were selected by modified cluster sampling by spinning a bottle on the ground of a central location in each study location and the starting point determined by the household facing the direction to which the neck of the bottle was facing. If a compound had more than one household, one was selected by balloting.

Survey data was collected using a mixed of quantitative(questionnaire) and qualitative(KII) data collection method. Before the actual study ,the questionnaire was pre- tested at Neni, on eight eligible volunteers from both study areas. It was done to check the clarity and suitability of the questions to the targeted respondents. The questionnaire was administered with the help of six trained research assistants who were community health extension workers. The questionnaire examined the availability of toilet facilities in the households and their solid waste disposal practices. The key informant interview(KII) guide was adapted from essential WASH assessment primer questions(UNHCR, 2020) and was administered to fifteen ASWAMA staff in Awka through face-to-face interviews. These staff are experienced and have first-hand knowledge of the sanitation and solid waste management of the LGAs in Anambra state and could contribute to this study. The research assistants aided in the note-taking since the sessions were recorded with pen and paper. Each interview session lasted about 30 minutes and was completed in two weeks. The KII provided information on the availability, quality, and sufficiency of sanitation services in the study area, current sewage disposal practices, and solid waste collection and disposal. They also gave insight into disciplinary measures utilized as deterrents against illegal waste disposal and the challenges they experienced in providing waste management services in the state.

The study variables were geographical location i.e. rural or urban, household sociodemographic characteristics, availability of toilet facilities and solid waste disposal facilities. Quantitative data were analyzed using statistical package for the social sciences version 23.0. Descriptive (frequencies, percentages,

mean ± standard deviation) and inferential (Chi-square test) statistics were calculated and statistical significance was set at alpha level of 0.05. Due to the increased risk of a type I error following Chi-square analysis that includes explanatory variables with three or more categories, a post-hoc test was done using the Bonferroni adjustment. Pairwise multiple comparisons were made and the alpha level adjusted to αadjusted = α/n where α is the original alpha level of 0.05 and n is the total number of paired comparisons. The unadjusted p-values obtained from pairwise chi-square analysis were then multiplied by the total number of comparisons to obtain the adjusted p-values. Thus, for example, for the association between type of household toilet facility (having 6 categories) and geographical location, 15 pairwise comparisons were made therefore the Bonferroni-adjusted alpha was calculated as 0.05/15

= 0.0033. The adjusted p-values less than 0.0033 were statistically significant.

The qualitative data was analyzed manually. Notes were thoroughly read, important responses were categorized by themes. Findings where further discussed and revised with research supervisors and other researchers that analyzed the same data. Content of the important findings were summarized and highlighted.

Ethical approval was obtained from the Nnamdi Azikiwe University Teaching Hospital ethics committee (reference number: NAUTH/CS/,66/VOL.14/VER 3/125/2021/081).Written informed consent was obtained from the participants.

**RESULTS :** A 1310 survey questionnaires were distributed and 1298 were returned complete and without errors giving a response rate of 99.1%.
**Sociodemographic characteristics Participants' demographic data**

### Table 1: Socio-demographic characteristics of respondents.

| Characteristics | Location | | | | |
|---|---|---|---|---|---|
| Age of the participants | Urban n(%) | Rural n(%) | Total n(%) | Chi-square | P- value |
| 18-30 years | 87(20.5) | 81(9.3) | 168(12.9) | 55.0023 | 0.0001 |
| 31-40 years | 197(46.4) | 335(38.4) | 532(41.0) | | |
| 41-50 | 109(25.6) | 347(39.7) | 456(35.1) | | |
| 50 years and above | | 32(7.5) | 110(12.6) | | 142(10.9) |
| Mean age | 38.7(SD=17.2) | 43.4(SD=13.7) | | | |
| **Education** | | | | | |
| Non-formal | 21(4.9) | 166(19.0) | 187(14.4) | 84.1510 | 0.0001 |
| Primary | 45(10.6) | 139(15.9) | 184(14.2) | | |
| Secondary | 181(42.5) | 375(42.9) | 556(42.8) | | |
| Tertiary | 178(41.9) | 193(22.1) | 371(28.6) | | |
| **Occupation** | | | | | |
| Business | 198(46.6) | 358(41.0) | 556(42.8) | 408.3895 | 0.0001 |
| Civil servant | 165(38.8) | 25(2.9) | 190(14.6) | | |
| Farming | 10(2.4) | 362(41.5) | 372(28.7) | | |
| House wife | 52(12.2) | 128(14.7) | 180(13.9) | | |
| **Location** | | | | | |
| Rural | 284(66.8) | 576(66.0) | 860(66.3) | 0.0911 | 0.7628 |
| Urban | 141(33.2) | 297(34.0) | 438(33.7) | | |

**Table 1**.The socio demographic characteristics of the respondents are presented in Table 2. The mean ages of the urban and rural respondents were 38.7 ± 17.2 years and 43.4 ± 13.7 years respectively. The 31-40 years age group constituted the highest proportion (46.4%) among the urban respondents while the 41-50 years age group had the highest proportion among the rural respondents. There was a statistically significant difference in the ages by residence (p = 0.0001). .Majority of the respondents in both the urban (84.4%) and rural (65.0%) areas had attained secondary education and above but a higher proportion in the urban compared to the rural have tertiary education (41.9% versus 22.1%). The difference in educational status was statistically significant (p = 0.0001). There are also statistically significant differences in occupation between the two groups (p = 0.0001); more rural respondents were engaged in farming (n = 362, 41.5%) compared to the urban respondents (n = 10, 2.4%) while more of the urban respondents were civil servants (n = 165, 38.8%) compared to the rural respondents (n = 25, 2.9%).

**Household toilet facilities:**

**Table 2: Distribution of available toilet facilities categorized by location in 1298 households in Anambra State, South East Nigeria (n=1298))**

| Availability of Toilet facilities | Location Rural(n%) | Urban(n%) | Total n(%) | Chi-square | P-value |
|---|---|---|---|---|---|
| Toilet with sewer connection | 148(11.4) | 152(11.7) | 300(23.1) | 93.793 | 0.0001 |
| Pour-flush latrine to sewer, septic tank or soaker pit | 200(15.4) | 129(9.9) | 329(25.3) | | |
| Pit latrine with slab | 242(18.6) | 72(5.5) | 314(24.1) | | |
| Pit latrine without slab | 78(6.0) | 23(1.8) | 101(7.8) | | |
| Pour flush latrine not to sewer, septic tank or soaker pit | 62(4.8) | 6(0.5) | 68(5.2) | | |
| Open defecation/ no facility | 143(11.0) | 43(3.3) | 186(14.3) | | |

**Table 2** shows the distribution of available toilet facilities in the study households categorized by location. Many households living in the urban use toilet with sewer connection 152(11.7%), followed by pour flush latrine to septic tank or soaker pit 129(9.9%). In the rural area pit latrine with slab is the most commonly used toilet facility 242 (18.6%), seconded by flush latrine to sewer 200(15.4%) and toilet with sewer connection 148(11.4%). The proportion using bush or open defecation is higher in the rural area 143(11.0%) than urban area 43(3.3%).The difference in distribution of toilet facility according to rural or urban location was statistically significant, chi-square = 93 79 df, p = 0.0001. None of the rural or urban households used composting pit latrine, bucket latrine or hanging toilet therefore data was not shown in the table.
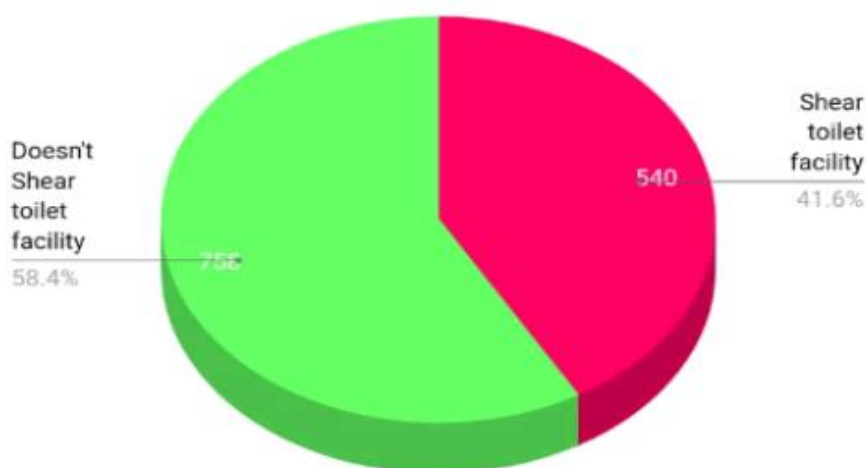


**Figure 2:** Pie Chart showing seven hundred and fifty eight (58.4%) household in the study sample (n = 758) that does not share their toilet facility with other households while 540(41.6%) households share toilet facility.

**Table 3: Post hoc analysis of the association between type of household toilet facility and place of residence (rural versus urban) using Bonferroni multiple comparisons (Adjusted alpha=0.00033)**

| Toilet facility Comparison | Unadjusted P-values | Adjusted P- values |
|---|---|---|
| TS vs PFS | 0.0039 | 0.058 |
| TS vs PLS | <0.00001 | 0.0002* |
| TS vs  PL | <0.00001 | 0.0002* |
| TS vs PF | <0.00001 | 0.0002* |
| TS vs OD | <0.00001 | 0.0002* |
| PFS vs PLS | < 0.00001 | 0.0002* |
| PFS vs PL | 0.0025 | 0.038 |
| PFS vs PF | < 0.00001 | 0.0002* |
| PFS vs OD | 0.0002 | 0.003* |
| PLS vs PL | 0.97 | 1.00 |
| PLS vs PF | 0.0089 | 0.133 |
| PLS vs OD | 0.96 | 1.00 |
| PL vs PF | 0.018 | 0.26 |
| PL vs OD | 0.95 | 1.00 |
| PF vs OD | 0.011 | 0.16 |

* means statistically significant relationship; TS : toilet with sewer, PFS : pour flush latrine to sewer, septic tank or soaker pit, PLS: pit latrine with slab, PL: pit latrine without slab, PF: pour flush latrine not to sewer, septic tank or soaker pit, OD: open defecation/no facility

**Table 3** Post hoc comparisons of types of toilet facilities by place of residence using Bonferroni multiple comparison test (Adjusted alpha=0.0033) revealed significantly in the  households using toilet with sewer system and pour flush latrine to sewer than others using other toilet facility.

**Solid waste disposal**

**Table 4: The distribution of solid waste disposal methods utilized by 1298 urban and rural households in Anambra State.**

| Methods of Solid waste disposal | Location | | Total n(%) | Chi-square | P-value |
|---|---|---|---|---|---|
| | Rural n(%) | Urban n(%) | | | |
| Public waste bin 295(22.7) | 69(5.3) 73(5.6) | 96(7.3) | 165(12.7) | 489.086 | 0.0001 Burning 368(28.4) |
| Open dumping | 88(6.8) | 62(4.8) | 150(11.5) | | |
| Composting | 213(16.4) | 10(0.8) | 223(17.2) | | |
| Disposal into gullies or water way | 208(16.0) | 40(3.1) | 248(19.1) | | |
| Door to door collection by Government  Waste  Collectors | 0(0) | 144(11.1) | 144(11.1) | | |

The distribution of solid waste disposal methods used by the study households is shown in **Table 4.** Overall, burning was the most commonly used method in the study sample (31.3%) but was more commonly used by the rural households (n = 266, 20.5%) than the urban households (n = 140, 10.8%). The rural households also utilized composting (n = 147, 11.3%) more than the urban households (n = 70, 5.4%). Open dumping of refuse and disposal into

gullies and water ways were also common methods employed by both the rural and urban households but more by the urban households. Only households in the urban area benefitted from door-to-door collection by government-appointed waste collectors (n = 144, 11.1%). The association between method of solid waste disposal and location was statistically significant (chi-square = 489.09, df = 5, p = 0.0001).

**Table 5: Post hoc analysis of association between types of solid waste disposal methods used and place of residents (rural vs urban) using Bonferroni multiple comparison test (Adjusted alpha =0.0033)**

| Disposal methods Comparisons | Unadjusted P - value | Adjusted P - value |
|---|---|---|
| PWB vs BRN | <0.00001 | 00002* |
| PWB vs OD | 0.0028 | 0.042 |
| PWB vs COMP | <0.00001 | 00002* |
| PWB vs DGW | <0.00001 | 00002* |
| PWB vs DDC | <0.00001 | 00002* |
| BRN vs OD | <0.00001 | 00002* |
| BRN vs COMP | <0.00001 | 00002* |
| BRN vs DGW | 0.24 | 1.0000 |
| BRN vs DDC | <0.00001 | 00002* |
| OD vs COMP | <0.00001 | 00002* |
| OD vs DGW | <0.00001 | 00002* |
| OD vs DDC | <0.00001 | 00002* |
| COMP vs DGW | 0.00004 | 0.0006* |
| COMP vs DDC | <0.00001 | 00002* |
| DGW vs DDC | <0.00001 | 00002* |

*mean statistically significant relationship; PWB: public waste bin, BRN: Burning, OD:Open dumping, COMP: Composting, DGW:Dumping into gullies or water ways, DDC:door to door collection by government waste collectors.

**Table 5** post-hoc comparisons using the Boferroni adjustment ($\alpha$adjusted = 0.0033) revealed that significant difference occurred in public waste bin, door to door government waste collection, open dumping, composting and burning compared to all other method of disposal.

**KII report summary of Anambra State Waste Management Authority Staff:**
The key findings include:
**On the existing toilet facilities:** Majority of the urban residents make use of toilet piped to sewer system. Pour flush latrines to sewer, and toilet piped to sewer are also present in markets, parks, and other public places. Pit latrines, and composting toilets are mostly present among rural dwellers.
**The common toilet facility in the state:** All respondents indicated that the water closet piped to the sewer is the most commonly used toilet facility in the state.

**Public toilets available:** Public toilets are also found in public places like motor parks, markets like Onitsha main markets and in some major streets. However not in "all nooks and cranny" of the cities. Adding that some homes in the villages still lack good toilets.

**Existence of open defecation**: Open defecation was labelled as an eyesore and every effort is already in place to eradicate it. Majority of the respondents believe that the rate of open defecation is decreasing in urban area due to available public toilets and a lot of efforts are ongoing in the rural area to achieve " open defecation-free villages".

**How waste is currently managed**: waste is managed by ASWAMA. There are designated sites called litter points where public receptacles are strategically placed in the streets and roads. Waste is evacuated every week to the dump site by compactors or chain-up vehicles. On how the waste Is finally disposed, waste generated is taken from waste collection points and transported for disposal at the landfill site in mixed form. On whether there are location with uncontrolled dumping of waste, it is reported there are but they are unauthorized.

**Disciplinary measures for illegal waste disposal**: the perpetrators are arrested and charged to sanitary court where they are penalized for illegal dumping.

**Challenges encountered in carry out duties:** includes inappropriate disposal of waste by the residents; some residents dump waste on the floor of the designated sites while the bin is empty, lack of work equipment, poor funding and delay of staff welfare packages, lack of man power and stigmatizing waste management staff.

## DISCUSSION

The findings of this study shows that toilet with sewer connection 300 (23.1%) , pour flush latrine to sewer or septic tank 329 (25.3%) and pit latrine with slab 314(24.1%) are commonly used by respondents in both study areas. The use of improved facilities for sewage disposal in these areas is encouraging and tallies with the report of KII which reported that water closet is the commonly used facility in Anambra State and the 2018 NDHS list of improved toilet facilities (NPC and ICF, 2019). This implies that many households uses improved sanitation facility than unimproved facility and it agrees with the study by United Nations which reported an increasing rate in the global population using improved sanitation with greatest increase in Sub Sahara Africa(UN -SDG knowledge platform). The moderate proportion of households (14.3%) that defecate in the bush is commendable and the fact that composting pit latrine, bucket latrine or hanging toilet is not found in use in our study area validate the fact that there is improvement in the use of sanitation facility in recent times (Drakopoulos, 2020;UNICEF, 2018). Furthermore, 78% of households in this study using improved sanitation facility (which include toilet with

sewer connection, pour-flush latrine to septic tank or soaker pit and pit latrine with slab) is substantial and similar to the report by Nigeria DHS where Anambra State has 82.5% improved sanitation facility (NPC and ICF, 2019).Additionally, 758(58.4%) uses private facility which is more than 540%(41.6%) using shared facility. This is a positive result which shows more household using facility meant for only members of households and this correspond to the JMP definition of improved sanitation[UNICEF and WHO/JMP], 2015). Toilet with sewer connection 152(11.7%) , and pour flush latrine to sewer or septic tank 129 (9.9%) are more common in the urban area than pit latrine with slab, pit latrine without slab and pour flush latrine not to sewer. This is similar to studies that reported more urban households using improved sanitation facilities (Abubakar, 2017; Budhathoki, 2017;Tumwire et al, 2010). Conversely, pit latrine with slab 242 (18.6%) and pour flush to sewer 200 (15.4%) are mostly use in the rural area. Pit latrine is simple and affordable that may be why it is common in rural area. Fortunately, It upgrade the rural area up to the category of basic sanitation in the UNICEF, JMP sanitation ladder (UNICEF and WHO/JMP, 2015)  and the NDHS classification of improved sanitation (NPC and ICF, 2019)  and also saves the community from diseases arising from poor sanitation. Generally, the finding of this study discloses that many households that uses unimproved facility (pit latrine without slab, pour flush not to sewer and open/no facility) reside in the rural area. This is similar to a study by Abubakar (2017) where the majority of the households using unimproved sanitation lives in rural areas. Open defecation is still practiced by 143(11.0%) rural households, a result bigger than urban area where 43(3.3%) households practice open defecation. This is in tandem with the findings of some studies which affirms that open defecation occur more in rural than urban area (Abubakar, 2017; FMWR, NBS and UNICEF, 2019; Rheinlander et al., 2015). There was a statistically significant difference between respondents location (urban and rural area) and the available toilet facilities. A follow up post hoc analysis using Bonferroni after Chi Square test revealed that the significant difference occur more in the households using toilet with sewer system and pour flush latrine to sewer than others using other toilet facility. Therefore significantly greater population of the household uses toilet with sewer  and pour flush latrine to sewer system.

Result of solid waste disposal methods  shows that 368(28.4%) burn their waste, 223(17.2%) practice composting, 165(12.7%) use the public waste bin, 144(11.4%) wait on government waste collectors who goes house to house, 248(19.1%) dispose waste into gullies or water ways .This findings on the common methods of solid waste disposal in rural and urban areas is expected and it tallies with the different methods of disposal of municipal waste in

Nigeria reported by Ikpeze (2014). Burning of refuse is common as 368(28.4%) respondents does it and this is consistent with the findings by other authors (Adogu et al, 2015; Bakare , 2020).One hundred and forty four (11.1%) respondents rely on Government waste collectors and this support the study in Lagos where residents often dispose their refuse in government facility (Ojewale, 2014) .Composting was practiced by 223(17.2%) respondents and it is different from sanitary landfill described as common option of waste management in USA ,Qatar, China and the UK (DEFRA, 2019; Mihai and Taherzadeh, 2017; Zhou, Sun and Yi, 2017) The practice of composting is expected because this study took place in a developing country were modern methods of waste disposal is scarcely available unlike the developed countries where the access to suitable technology that ensures effective waste management is obtainable. In the rural area studied, many respondents practiced burning 295(22.7%), composting 213(16.4%), open dumping 88(6.8%) and throwing into gullies and water ways 213(16.4%) than in the urban area. This result is expected in the rural area due to inadequate waste disposal facility presenting more in the rural area and it concurs with the study which attributed the cause to lack of waste collection services across rural municipalities (Milhai and Grozavu, 2019). In the urban area, 96 (7.3%) uses public waste bin and 114 (11.1%) waits on government waste collectors. This result is not in keeping with the findings of Shamaki and Shehu (2017) who identified 83.3% respondents using waste bin in a Study to assess waste management in Sokoto. Similarly, open dumping noted to be no longer obtainable in waste management practice (Mihai and Taherzadeh, 2017), still occur in this study. Crude or uncontrolled dumping accounted for 88(6.8%) and 62(4.8%) in rural and urban areas respectively. This agrees to the author who asserts that there is vulnerability of illegal dumping in both rural and urban areas.There is no response regarding to government house to house waste collection practice in the rural area. The dearth of government embarking on waste evacuation in the rural area is consistent with the cases found in rural areas of Bauchi and Taraba where unwholesome waste disposal practices was attributed to the inadequacy of government sanitation facilities and lack of house to house waste collection by the local government (Babanyara and Bogoro, 2011;DEFRA, 2019). The lack of waste collection services across rural municipalities, as observed in this present study, has contributed to the disposal of rural household waste in open dumps. This method can cause fly nuisance and odour, air pollution, leaching of harmful chemicals into the soil and groundwater (Bill, Chidi, Onyemeziri and Ewizie, 2015; Omole, Isiorho and Ndambuki, 2016). Open or uncontrolled dumping is practice more by rural households 88(6.8%) than urban households 62(4.8%) and it was

reported by a study (Obionu, 2007).In urban area, government waste collectors who goes to households to pick up waste with their vans and public waste bins are few 96 (7.3%) while in rural area, burning and composting is a common practice ,with fewer public waste bin(5.3%). Further, KII study revealed that residents dispose of waste at local dump sites approved by authorities, which is in keeping with the typology of solid waste disposal system(US Census Bureau,2021), yet not done properly as some residents dump waste on the floor of the designated site. The reason could be due to the few dust bins discovered by this study and the insufficient sanitation equipment and poor funding asserted by the KII as part of the challenges of waste management in the state. The association between the method of solid waste disposal and location was statistically significant (chi-square = 489.09, df = 5, p = 0.0001). Additional Bonferroni multiple comparisons revealed that statistically significant changes in waste disposal methods among rural and urban households occurred in public waste bins, door-to-door government waste collection, open dumping, composting, and burning compared to all other methods of disposal. Their increase or reduction determines the waste management of the study area. Disposal into gullies and waterways was not statistically significant among households in urban and rural areas.

## CONCLUSION
This result shows that a significant number of households use improved sewage and solid waste disposal facilities but not adequately. The fact that gaps still exist between rural and urban areas of Anambra state concerning these services may present serious health risks and environmental degradation. Although toilets piped to sewer are the commonest used sanitation facility, unimproved sanitary facilities are still being used by several households in the study population and more among rural households. Further, open defecation is still a challenge putting the population at risk of communicable diseases, environmental pollution, and other public health challenges. Door-to-door waste collection by government agents is absent in the rural areas of the state and although some households in the urban area benefitted from this service, indiscriminate burning and open dumping of waste is still practiced by both rural and urban households.

In view of the study findings, it is necessary that residents in Anambra state are educated on proper sanitation and solid waste management as well as the need for behavior change towards open defecation. Building laws should be enforced to ensure that no building, whether residential or commercial is approved and erected without adequate provision made for improved toilet facilities. Properly maintained communal toilets should be

provided in the community, in a strategic location where they will be accessible to users. Furthermore, the government should fund, educate, and train more staff. Provide more waste bins and extend house-to-house waste collection to the rural area. Look for opportunities to recycle items that can be reused and by so doing cost can be curtailed and waste minimized.

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