



Effects of Municipal Waste Disposal Methods on Community Health in Ibadan - Nigeria

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Received: 5 May 2018 / Accepted: 5 September 2018 / Published online: 16 October 2018
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Abstract

The generation of waste, and its disposal, collection, transport and processing are important for healthy ecosystems and the health of people. The negative health effects of waste management is the subject of a large literature. Two main health outcomes have been found to be statistically associated with waste exposure: cancer and congenital malformations. This research study was designed to examine the relationship of environmental characteristics with population health, and impacts of waste disposal methods on public health of Agbowo and Bodija community residents. Primary data were collected through a semi- structured questionnaire that was used to gather information on environmental characteristics, municipal waste disposal methods and its effects on population health of Agbowo and Bodija communities' residents. 421 households in Agbowo (210) and Bodija (211) were randomly selected for this study. Data generated from our field survey were analyzed using t-test and Pearson Product Moment Correlation, (PPMC), at 0.05 alpha level. Results shows that there is a significant difference between the two study areas in terms of environmental characteristics. A significant difference was also observed between waste disposal methods of Agbowo and Bodija communities. Using PPMC, our results demonstrates a relationship between healthy ecosystems and health of communities residents in Agbowo and Bodija. In Agbowo 158 (75.24%), 163 (77.62%), 168 (80%), 109 (51.9%), 94 (44.76%), 129 (61.43%) respondents reported to suffer of watery stools, typhoid, skin infections, vomiting, sore throat, abdominal pains in the past one year. But when compared to Bodija the number of respondents who suffered of watery stools, typhoid, skin infections, vomiting, sore throat, abdominal pains in the past one year stood at 132 (62.56%), 124 (58.77%), 54 (25.59%), 73 (34.6%), 69 (32.7%), 97 (45.97%), respectively. Having established that improper waste generation and management can have adverse health effects on human health, the study concludes by recommending that government at all levels should adopt an integrated waste management system with appropriate policy agenda, public programmes and strategic action plans that will enhance environmental governance and end to indiscriminate waste disposal.

Keywords Municipal waste · Population health · Environment · Community participation

1 Introduction

Abul (2010) classified solid waste into different types, depending on their source; household waste is generally

classified as municipal waste, industrial waste as hazardous waste, and biomedical waste or hospital waste as infectious waste. The term “solid waste” means any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations (Salam Abul 2010; US Law-Solid Waste Act 2 1999). This waste are disposed at the very outskirts of the cities. Waste generated from households, shops, supermarkets, and open market places are therefore termed as Municipal waste. This waste are either properly disposed in landfills, incinerators or open dumpsites.

Salam (2010) further add that solid waste disposal sites are found on the outskirts of the urban areas, turning into the child

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sources of contamination due to the incubation and proliferation of flies, mosquitoes, and rodents; that, in turn, are disease transmitters that affect population's health, which has its organic defenses in a formative and creative state. The said situation produces gastrointestinal, dermatological, respiratory, genetic, and several other kind of infectious diseases. Consequently, dumping sites have a very high economic and social cost in the public health services, and have not yet been estimated by governments, industries, and families (Salam, 2010).

However, increasing population levels, booming economy, rapid urbanization and the rise in community living standards have greatly accelerated the municipal solid waste generation rate in developing countries (Debnath et al. 2015; Minghua et al. 2009) and urban cities such as Ibadan and Lagos. Rapid industrialization and population explosion in Lagos has led to the large scale migration of people from villages, less developed towns and urban areas across Nigeria.

Population growth and presence of series of commercial activities in Ibadan has eventually led to thousands of people influx into the city. This is evident in high population density and overcrowd of houses in Agbowo and Bodija community areas in Ibadan. The growth of population in Ibadan rose from the estimated 100,000 in 1851 to 175,000 in 1911. Between 1911 and 1921 it increased at about 3.1% per annum to 238,075. The rate of increase between 1921 and 1931 was 0.5% per annum while it was only 0.8% per annum for the period between 1931 and 1952 when the population rose from 387,133 to 459,196. In 1952, the less city was counted and it was 286,252 (Tomori 2006). From then on, the population of Ibadan metropolitan area increased at a growth rate of 3.95% per annum from 1952 and 1963 when the population rose to 1,258,625. The population rose to 1,829,300 in 1999 at a growth rate of 1.65% from 1963 and increased to 1,338,659 in 2006 at a growth rate of 2.35%. However, the population growth is gradually shifting to the less city with a growth rate of 4.7% per annum between 1991 and 2006 according to the provisional census figure released by the National Population Commission (2006) (Tomori 2006).

In the face of this increasing population levels and rapid urbanization, the major urban environmental concerns- municipal waste management, sanitation and associated adverse health impacts- the increased urbanization with large population density can further intensify these concerns, unless we take urgent effective steps to improve sanitation and solid waste management. In the words of Debnath et al. (2015) and Taylor (2003), landfilling is the simplest and normally cheapest method for disposing of waste. However, this claim may not be true for waste management methods in developed countries. For instance landfilling is a very expensive method of managing waste in industrialised countries like China, Netherlands and Germany (Lam and Chaudry 2005). Improper management of municipal waste has become one

of the problems facing developing urban cities across the world. Little attention is given to waste management practices as it is common to see heaps of waste in the major cities littering the streets, dumped indiscriminately in drainages, vacant plots and open space especially in the developing cities and our study areas in particular. This has contributed not only to the spread of communicable diseases in the affected areas; it has effect on flooding and other environmental problems (Abd'Razack et al. 2013; Babalola et al. 2010; Wilson et al. 2009). A typical solid waste management system in developing countries displays an array of problems among which include low collection coverage and irregular collection services (Abd'Razack et al. 2013; Nwaka 2005; Omran et al. 2007).

Current global MSW generation levels are approximately 1.3 billion tonnes per year, and are expected to increase to approximately 2.2 billion tonnes per year by 2025. According to Debnath et al. (2015) this increase represents a significant increase in per capita waste generation rates, from 1.2 to 1.42 kg per person per day for a decade to come. However, global averages are broad estimates only as rates vary considerably by region, country, city, and even within cities (Debnath et al. 2015; Hoomweg 2005). Nigeria, with population exceeding 170 million, is one of the largest producers of solid waste in Africa. Despite a host of policies and regulations, solid waste management in the country is assuming alarming proportions with each passing day. Nigeria generates more than 32 million tons of solid waste annually, out of which only 20–30% is collected. Reckless disposal of MSW has led to blockage of sewers and drainage networks, and choking of water bodies. Most of the wastes is generated by households and in some cases, by local industries, artisans and traders which litters the immediate surroundings. Improper collection and disposal of municipal wastes is leading to an environmental catastrophe as the country currently lack adequate budgetary provisions for the implementation of integrated waste management programmes across the states (Bakare 2016).

Sada (1984) has observed that in 1980, on the average, a balance of 100 metric tons of solid waste are piled up daily in Benin City. This is because while about 350 metric tons of solid wastes are generated daily, the maximum rate of evacuation achievable was only 250 metric tons daily. Uchegbu (1988) remarked that big cities like Port Harcourt, Lagos, Kano, etc. in Nigeria produced on the average 46 kg of solid waste per person, per day. Amuda et al. 2014 states that; as at 2010 estimated MSW generated in Lagos, Port Harcourt, Ibadan and Warri are 1.23×10^5 ; 762,143; 996,102 and 174,372 t/ year respectively. On the contrary, Bakare 2016 states that Lagos with a population estimate of 21 million has a per capita waste generation of 0.5 kg per day, the city generates more than 10,000 tons of urban waste every day. Ibadan with a projected population of 3,154,487, the quantity of waste generated in Ibadan Metropolis in 2012 is estimated at

634,998.43 t/year and 0.55 kg per capita per day which included provision for street sweeping (Olowe 2018).

The practice of indiscriminate and improper dumping of Municipal Solid Waste (MSW) is on the increase in Agbowo and Bodija communities areas in particular and Nigeria in general and it is compounded by a cycle of poverty, population explosion, decreasing standard of living, poor governance and low level of environmental awareness, and the end product of it all is the dumping of these waste in any available open space (Rachel et al. 2009). Abd'Razack et al. 2013 stated that it has been observed that because of poor or improper land use planning in some part of many organically developed cities has results into the creation of informal settlement with narrow streets, which makes it difficult for waste collection trucks to access such areas (Nabegu 2010; Swapan 2008). Waste are dumped into the drainages that block the free flow of runoff water and this practice gives rise to flooding and the communities are adversely affected, some people dumped their waste to the road side, thereby reducing the width of the road and esthetics of the cities especially in Nigeria. This is evident as one walk across the nook and the crannies of Nigeria; you find heaps of refuse littering the entire landscape, road sides, parks, gardens, commercial centres and other land use (Danbuzu 2011; Imam et al. 2007).

Loredana and Maria (2010) states that several studies have reported the effects of waste exposure on health. A wide range of toxic substances can be released into the environment from waste disposal sites, for example; methane, carbon dioxide, benzene and cadmium. Many of these pollutants have been shown to be toxic for human health. In addition, if the waste disposals are illegal they are likely to contain highly hazardous compounds resulting from industrial activities (e.g. nuclear discharges, Asbestos, Lead). Two main health outcomes have been found to be statistically associated with waste exposure: cancer and congenital malformations. Hazardous waste has been shown to influence the likelihood of developing lung, brain cancer, bladder and lung cancer (Loredana and Maria 2010). A United Nations Report (August 2004) noted with regret that while developing countries are improving access to clean drinking water they are falling behind on sanitation goals.

At one of its summit in 2000 (Uwaegbulam 2004) revealed that The World Health Organization- (WHO 2004) and United Nations International Children Education Fund- (UNICEF 2004) joint report in August 2004 that: "about 2.4 billion people will likely face the risk of needless disease and death by the target of 2015 because of bad sanitation". The report also noted that bad sanitation – decaying or non-existent sewage system and toilets- fuels the spread of diseases like cholera and basic illness like diarrhea, which kills a child every 21 s. The hardest hit by bad sanitation is rural poor and residents of slum areas in fast-growing cities, mostly in Africa and Asia (Napoleon et al. 2011).

The importance of waste collection, transfer and disposal cannot be overemphasized. Apart from the issue of esthetics, uncollected wastes constitute a health risk, which can be a serious consideration in low income residential areas. Leachate from uncollected and decomposed garbage waste can contaminate groundwater and this could have enormous health implications in low-income communities where the use of well-water for drinking is common (UNCHS 1988). Environment health conditions are hampered through the pollution of ground and surface water by leachates from dump sites. Air pollution is often caused by open burning at dumps leading to foul odors and wind-blown litters. In dump sites, Methane is an important greenhouse gas, which is a by-product of the anaerobic decomposition of organic wastes (Amuda et al. 2014). Numerous research studies has shown that environmental governance is at the lower ebb in Nigeria. This definitely has consequential implications and impacts on the public health of the people. Olukanni and Akinyinka (2012), Napoleon et al. (2011), Amuda et al. (2014), Ye-Obong and Uduak (2013), Kaoje et al. (2015) all established various perspectives on the poor environmental governance, irritable environmental behaviour and the challenges confronting human health due to improper management of MSW.

In addition, Olukanni and Akinyinka 2012 join other researchers to conclude that there are potential risks to the environment and human health from improper handling of solid wastes. Direct health risks concern mainly the workers in this field, who need to be protected, as far as possible, from contact with wastes. This further reveals other epidemiological studies that shows that a high percentage of workers who handle refuse, and of individuals who live near or on disposal sites, are infected with gastrointestinal parasites, worms and related organisms. Disease transmission by houseflies is greatest where inadequate refuse storage, collection and disposal is accompanied by inadequate sanitation (Olukanni and Akinyinka, 2012). The mountainous heaps of solid wastes that deface Nigerian cities and the continuous discharges of industrial contaminants into streams and rivers without treatment motivated the federal government of Nigeria to promulgate Decree 58 for the establishment of a Federal Environmental Protection Agency (FEPA) in 1988. Nevertheless, research studies since 1988 has generally revealed the bankruptcy of the FEPA establishment and how largely Nigeria communities have suffered from poor environmental governance and the subsequent public health challenges which has constituted great threats to the population health.

This paper therefore emanates from the need to address improper disposal and management of MSW in Bodija and Agbowo communities in particular. The major thrust of this study is to investigate the effects of MSW disposal and management on the population health of Agbowo and Bodija communities' residents. Implications of the waste management methods and environmental characteristics of Agbowo and

Bodija communities on health conditions of the residents were investigated.

2 Research Methodology and Materials

2.1 Study Area

The city of Ibadan, with an heterogeneous population, is located approximately on longitude $3^{\circ}5^{\prime}$ East of the Greenwich Meridian and latitude $7^{\circ}23^{\prime}$ North of the Equator at a distance some 145 km worth east of Lagos. Ibadan is directly connected to many towns in Nigeria, as its rural hinterland by a system of roads, railways and air routes. The physical setting of the city consists of ridges of hills that run approximately in north-west – southeast direction. There are 11 Local government areas across Ibadan- part of which include Ibadan North local government. The two most popular towns in Ibadan North local government include Agbowo and Bodija towns. Ibadan North Local government Area has a household population of 76,740 (Tomori 2006).

Agbowo is located at the heart of the historic city, Ibadan, while Bodija faces it in the Northward direction and Ojo to its West. It is directly facing the University of Ibadan at the South, Nigerian Institute of Social and Economic Research (NISER), to its west and connects to the Trans Amusement Park, along Mokola road to the Eastern direction. Agbowo and Bodija communities are densely populated with students of the University of Ibadan and The Polytechnic, Ibadan. Agbowo has many features of an urban slum: overcrowding, unplanned housing, and lack of basic social amenities such as piped water (Akinremi and Samuel 2014).

Municipal waste management methods was poor as we observed open drainages and sewers poorly constructed were available and totally absent in most households. Residents of Agbowo and Bodija were fond of indiscriminate disposal of both liquid and solid municipal wastes. Evidence to this was dominance of open dumpsites, mountainous heaps of solid waste and refuse packs dumped openly along the streets. Inadequate toilet facilities were observed among the households in Agbowo. This makes the residents to openly dispose solid waste, including feces, into drainages. More dominant, too, is the presence of open dumpsites at backyards or closer to houses.

2.2 Research Study Design

In this investigative study, a comparative cross-sectional design was employed which involved the use of semi-structured interviewer-questionnaire to randomly selected household respondents. Socio-demographic characteristics, environmental characteristics and waste disposal and management methods were compared between the two study areas. Community

participation in MSW management and its effects on population health were compared between the two areas.

2.3 Study Population

Our study population included household residents of Agbowo and Bodija who are matured enough to participate in waste disposal and its management. A representative in each household was randomly chosen to participate in the survey. The total sampling techniques i.e. maximized convenience sample was adopted for this study. There were 421 household respondents from Agbowo ($n = 210$) and Bodija ($n = 211$) that participated in this survey.

2.4 Survey and Sampling Method

Multi-stage sampling technique was used to collect the data involving a two - stage design procedure.

Stage1: The division of the study areas into four stratum to represent primary selection units which denote the strata from where the data were collected.

Stage 2: Simple random selection of household respondents in each of the locations in each stratum. Further details of sampling procedures are summarized in Table 1. This adopted sampling method help us to collect data that will truly represent the household population estimates at both study areas.

A semi-structured interviewer administered questionnaire was used to obtain information on environmental characteristics, waste management practice methods and environmentally related health symptoms and conditions among our

Table 1 Sampling design for administration of questionnaires

Study areas	Streets	Total Household respondents
AGBOWO	Abimbola street	50
	Ajetunmobi Street	50
	Ilupeju Street	50
	Alhaji Taiwo- Adewunmi Streets	60
		210
BODIJA	Farayola Street	61
	Adewunmi Lay out	50
	Olive- Farayola Street	50
	Orisunmibare Street	50
		211
TOTAL	8	421
		421

Source: Author's Field survey, (2017)

respondents. The questionnaire was divided into: Section A: Socio- demographic Information, Section B: Environmental Characteristics, Section C: Waste Disposal Methods, Section D: Participants' Knowledge on Waste Disposal and Section E: Health Problems and Conditions. Each questionnaire was carefully reviewed for completeness and appropriateness of responses.

2.5 Statistical Analytical Techniques

Primary data collected from our field survey were entered, managed and analyzed using IBM SPSS Statistical package version 21. Data were analyzed using descriptive statistics, One Sample T test- to find any significant difference in environmental characteristics between Agbowo and Bodija, significance difference in waste disposal methods between Agbowo and Bodija; Correlation analysis was done to find out any relationship between environmental characteristics and health conditions of our respondents in both study areas.

3 Results and Discussion

3.1 Socio-Demographic Characteristics of Respondents

The socio-demographic characteristics of household respondents as collected during our field survey is presented in Table 2 below. From our data collection it was observed that 45 (17%) of respondents in Agbowo are less than 20 years old while it was 17 (8.1%) in Bodija. 54 (25.6%) are within 20–29 years old in Agbowo while it was 28 (13.3%) in Bodija. In Agbowo 24 (11.4%) of respondents are between 30 and 39 years old while we have 43 (20.4%) of respondents in Bodija. 32 (15.2%) respondents in Agbowo are between 40 and 49 years old, 66 (31.3%) in Bodija, 55 (26.1%) household respondents in Agbowo are above 50 years old while it was 57 (27%) in Bodija. 109 (51.7%) are Male respondents in Bodija, and 157 (74.4%) in Agbowo; Female respondents in Agbowo are lower, 53 (25.1%), compare to 102 (48.3%) in Bodija.

Also from Table 2: it was clear from the data that Married respondents are higher in our study population: 118 (55.9%) in Bodija and 58 (27.5%) in Agbowo. 31(14.7%) are single in Bodija while the figure rise to 45 (21.3%) in Agbowo. 9 (4.3%) of our respondents in Bodija are divorced, while the number was at 20 (9.5%) in Agbowo. 23 (10.9%) respondents have separated from their marriage in Bodija, while it was 14 (6.6%) in Agbowo. 13 (6.2%) respondents are Co-habiting in Bodija and 21 (10%) in Agbowo. 52 (24.6%) of Agbowo respondents are widowed while the number stood as 17 (8.1%) in Bodija. From our analysis, the number of respondents that have both Primary and Secondary education stood as 47 (22.3%) and 53 (25.1%) respectively at both Agbowo

and Bodija while 75 (35.5%) respondents had tertiary education in Bodija against 62 (29.4%) that had tertiary education in Agbowo. 48 (22.7%) of respondents in Agbowo had only Islamic education while it was only at 36 (17.1%) in Bodija.

Our data reveals that traders form the highest population in our respondents at both Agbowo, 57 (27%), and Bodija, 59 (28%). This was followed by Students, 40 (19%), in Agbowo and Artisan, 47 (19%), in Bodija. Students respondents in Bodija stood at 19 (19%) and Artisan in Agbowo at 29 (13.7%). The number of Civil servants that responded at both study areas remain the same at 38 (18%), while teacher respondents in Agbowo was 15 (7.1%) and 18 (8.5%) in Bodija. Professionals that responded in Agbowo were 13 (6.2%) and 18 (8.5%) in Bodija. Business owners that participated in the survey in Agbowo were 18 (8.5%) and 12 (5.7%) in Bodija. The analysis shows that the highest household size at both Agbowo (16–20 people) and Bodija (20 above) was 75 (35.5%), and 78 (37%), respectively. Household size 1–5 people was 9 (4.3%) in Agbowo and 19 (9%) in Bodija. Household size 6–10 in Agbowo was 17 (8.1%) but higher in Bodija at 27 (12.8%). Household size 11–15 stood at 45 (21.3%) in Agbowo and 38 (18%) in Bodija. Our data clearly tells that majority of respondents in both Agbowo and Bodija has a monthly income above 20, 000. The figure for the number of respondents that receive above 20,000 monthly income was 109 (51.7%) in Agbowo and 95 (45%) in Bodija. 23 (10.9%) of respondents at both study areas lives on less than 10,000 monthly. 29 (13.7%) respondents in Agbowo lives on 10,000 – 15,000 monthly and 19 (9%) in Bodija.

3.2 Environmental Characteristics and Management Practices

In our survey, data collected reveals that the most dependable source of portable water in our study areas is Sachet water. (Agbowo, 83 (39.3%) and Bodija 108 (51.2%)). This is followed by Borehole; 67 (31.8%) in Agbowo and 59 (28%) in Bodija. Very few of our respondents have access to Tap water in Bodija, 9 (4.3%). In Agbowo there was no evidence of Tap water at all. Agbowo community, in the face of its overcrowded houses and unplanned housing settlement is characterized with boreholes and well water. 48 (22.7%) of Agbowo residents said that they depend on well water for domestic activities while the figure was 27 (12.8%) in Bodija. In addition, 12 (5.7%) respondents in Agbowo responded that their major water source is Rain water while the figure stands at 8 (3.8%) in Bodija. The dominant type of toilet facility is Pit latrine which is 114 (54%) in Agbowo and 112 (53.1%) in Bodija. Respondents also said that they make use of bush to dispose their feces (Agbowo: 26 (12.3%), and Bodija: 34 (16.1%)). 39 (18.5%) of Agbowo respondents reported that they make use of Stream/ Lake to dispose waste

Table 2 Socio- demographic Characteristics of household respondents in Agbowo and Bodija

Particulars	AGBOWO				BODIJA		
	Variable	Freq	%	MODE	Freq	%	Mode
Age(in years)	Less than 20	45	21.3		17	8.1	
	20–29	54	25.6		28	13.3	
	30–39	24	11.4		43	20.4	
	40–49	32	15.2		66	31.3	40–49 years
	50 - above	55	26.1	50- above	57	27	
	TOTAL	210	100		211	100	
Gender	Male	157	74.4	Male	109	51.7	Male
	Female	53	25.6		102	48.3	
	TOTAL	210	100		211	100	
Marital Status	Single	45	21.3		31	14.7	
	Married	58	27.5	Married	118	55.9	Married
	Divorced	20	9.5		9	4.3	
	Separated	14	6.6		23	10.9	
	Co- habiting	21	10		13	6.2	
	Widowed	52	24.6		17	8.1	
	TOTAL	210	100		211	100	
Education	Primary	47	22.3		47	22.3	
	Secondary	53	25.1		53	25.1	
	Tertiary	62	29.4	Tertiary	75	35.5	Tertiary
	Islamic	48	22.7		36	17.1	
	TOTAL	210	100		211	100	
Household size	1–5	9	4.3		19	9	
	6–10	17	8.1		27	12.8	
	11–15	45	21.3		38	18	
	16–20	75	35.5	16–20	49	23.2	
	20 - above	64	30.3		78	37	20 above
	TOTAL	210	100		211	100	
Occupation	Artisan	29	13.7		47	22.3	
	Teaching	15	7.1		18	8.5	
	Civil servant	38	18		38	18	
	Professional	13	6.2		18	8.5	
	Trader	57	27	Trader	59	28	Trader
	Student	40	19		19	9	
	Business owner	18	8.5		12	5.7	
	TOTAL	210	100		211	100	
Monthly income	Less than ₦10,000	23	10.9		23	10.9	
	₦ 10,000 – ₦ 15,000	29	13.7		19	9	
	₦ 15, 000 – ₦ 20,000	49	23.2		74	35.1	
	₦ 20, 000 above	109	51.7	₦ 20,000 above	95	45	₦ 20,000 above
	TOTAL	210	100		211	100	

Source: Field survey (2017)

materials, the number is 17 (8.1%) in Bodija. At our two study areas, different MSW disposal and management practices is very common from one household to the other, especially at Agbowo where MSW and environmental management is not

been regulated. 57 (27%) households in Agbowo practice open burning of waste and 59 (28%) respondents in Bodija dispose waste via open burning. In Bodija the most common means of waste management is open dumping. The number of

households that practice open dumping is 87 (41.2%) in Bodija and 47 (22.3%) in Agbowo. Only 2 (0.9%) household in Agbowo managed their waste through waste scavengers. In Agbowo just 14 (6.6%) respondents employed contracted waste collectors in waste management, the number of household that employ contracted waste collectors stood at 10 (4.7%) in Bodija. 53 (25.1%) respondents in Agbowo makes use of Open dumpsite and 24 (11.4%) in Bodija. 37 (17.5%) household respondents in Agbowo dump their refuse and manage waste by dumping in streams and lake while the figure stood at 31 (14.7%) in Bodija.

From our survey at both study areas- Agbowo and Bodija communities, our result clearly reveals the major environmental characteristics of both communities and the level of environmental sanitation. It was clearly shown in our data collected that 83 (39%) households in Bodija responded that they experience Flies most, those that responded they experience Mosquitoes most in their household was 54 (25.6%), Cockroaches: 24 (11.4%) households, Rats: 31 (14.7%) households, Bedbugs 19 (9%) while in Agbowo 110 (52.1%) households reported they experience Flies most, 28 (13.3%) household responded they experience Mosquitoes most, Cockroaches: 17 (8.1%), Rats: 34 (16.1%) and Bedbugs: 21 (10%). However, when asked how frequently waste collectors patrol the community to collect waste; 61 (28.9%) households in Agbowo responded they come once weekly and 47 (22.3%) in Bodija, 27 (12.8%) households in Agbowo reported more than once weekly and 38 (18%) in

Bodija, 83 (39.3%) households in Agbowo responded they patrol once a month while it was 23 (10.9%) in Bodija, 14 (6.6%) households in Agbowo responded that they patrol the community more than once a month while 51 (24.2%) households in Bodija. In Bodija waste collectors never visited 54 (24.6%) households in the past one year while the number stood at 25 (11.8%) households in Agbowo. However, 49 (23.2%) households in Bodija reported that they are satisfied with the level of sanitation in their community, while in Agbowo only 43 (20.4%) households consented that they are satisfied with the level of sanitation in the community, and 110 (52.1%) households reported they are unsatisfied; and in Bodija 105 (49.8%) households responded unsatisfied. In addition, 57 (27%) households in Bodija and Agbowo remain undecided about the level of environmental sanitation in their communities. Figure 1 below typically shows the rate of infestation of selected disease carrying organisms found in Agbowo and Bodija households.

From the above graph; the rate of infestation of rats is medium in Bodija and heavy in Agbowo; mosquitoes appear to heavily infest both Agbowo and Bodija communities; cockroach infestation rate seems to be relatively populated in both communities while Bedbugs infestation is medium in both areas. Flies heavily infest Bodija community compare to its rate in Agbowo.

When asked how often does environmental health officers visit each household for environmental inspection, data collected indicated that: 23 (10.9%) households in Agbowo

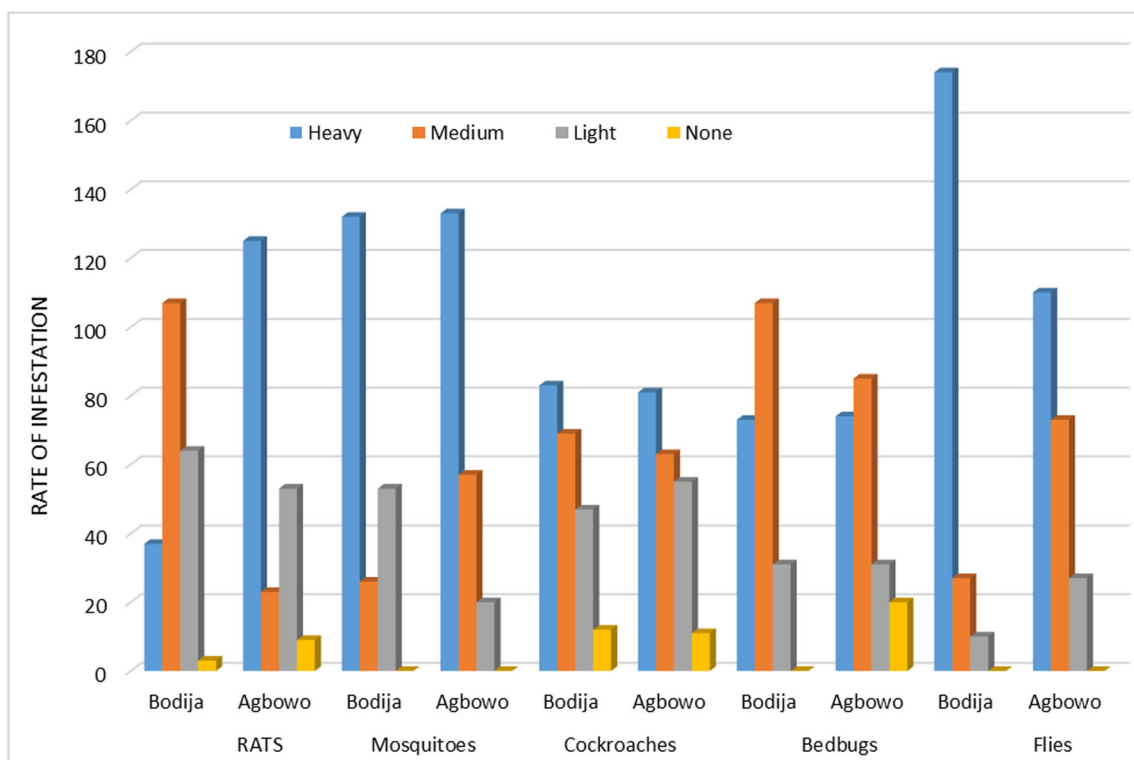


Fig. 1 Rate of infestation of disease carrying organism at our study areas. Source: Field Survey (July, 2017)

responded that environmental health officers visit their houses once in two months and 39 (18.5%) households in Bodija consented same. In Agbowo 58 (27.5%) households responded that they visit their houses once in three months, and 33 (15.6%) in Bodija. In Agbowo 17 (8.1%) respondents said they visit their houses once in a month and 9 (4.3%) in Bodija. 25 (11.8%) household in Agbowo reported they visit more than once a month and 17 (8.1%) in Bodija. However, 87 (41.2%) households and 113 (53.6%) in Agbowo and Bodija respectively reported environmental health officers never visit them in the past one year. 185 (87.7%) households in Bodija consented that they are ready to pay for waste collection and 204 (96.7%) households respondents in Agbowo reported they are ready to pay for waste collection. Very few of the respondents; 6 (2.8%) in Agbowo and 26 (12.3%) in Bodija are not willing to pay for waste collection.

3.3 Any Significant Difference in the Environmental Characteristics between Agbowo and Bodija?

To determine if there is any significant difference in the environmental characteristics between the two study areas, data collected through response from our household respondents were further analyzed using the Student t-test tool of IBM SPSS statistical package version 21. Results from our t-test analysis were presented in Tables 3 and 4 below:

Result of the analysis shown in Table 3 reveals that there is a significant difference between the environmental characteristics of Agbowo and Bodija. Our *P* value is taken at point ($P < 0.05$).

The Bodija has the highest mean score (12.43) while Agbowo has the lowest (12.06).

3.4 Any Significant Difference in the Waste Disposal Methods and Management between Agbowo and Bodija?

Result of the analysis shown in Table 4 reveals that there is a significant difference between the waste disposal methods and management between Agbowo and Bodija. Our *P* value is taken at point ($P < 0.05$). The Bodija has the highest mean score (23.74) while Agbowo has the lowest (22.65).

Table 3 Data analysis on significant difference in environmental characteristics between Agbowo and Bodija

	N	MEAN	S.D ± E	t	Df	Sig
AGBOWO	210	12.06	5.62 ± 0.39	31.12	209	0.00
BODIJA	211	12.43	5.47 ± 0.38	32.98	210	0.00

Source: Field Survey Analysis, (2017)

Table 4 Data analysis on significant difference in disposal methods and management between Agbowo and Bodija

	N	MEAN	S.D ± E	t	Df	sig
AGBOWO	210	22.65	6.14 ± 0.42	53.42	209	0.00
BODIJA	211	23.74	5.47 ± 0.38	47.22	210	0.00

Source: Field Survey Analysis, (2017)

3.5 Health Problems and Conditions Associated with the Environmental Characteristics of Study Areas

Results from our field survey states that environmental characteristics of both Agbowo and Bodija are significantly different and in fact clearly indicate the possibility of threats to population health. Public health at both study locations when investigated reveals traces of the presence of some environmentally related illness among the people living at both study locations. In a situation where 57 (27%) households in Agbowo practice open burning of waste and 59 (28%) respondents in Bodija dispose waste via open burning. In Bodija the most common means of waste management is open dumping. The number of households that practice open dumping is 87 (41.2%) in Bodija and 47 (22.3%) in Agbowo. This waste management practices at these study locations definitely give room for disease carrying organisms to be manifesting in their households. This is evident in the responses of sampled households on the most common disease carrying vector that they experience most in their various households. Rate of infestation of selected diseases carrying organisms- rats, mosquitoes, cockroaches, flies and bedbugs, strongly proof and support the status of health conditions as been reported by our household respondents. Take for instance, rats are present in most houses in Agbowo when compare to Bodija (see fig. 1), presence of mosquitoes are heavily high at both locations while bedbugs and Cockroaches are more common in Bodija houses when compared to houses in Agbowo. This is an indication that most households in Bodija appear dirtier and always un-kept compare to houses in Agbowo. Bodija as well has the largest population of flies in their surroundings- one of the confounding factors for this is due to the open market situated closer to our study areas. The state of solid waste management in this open market in Bodija is nothing to write home about. This is evident in heaps of food waste that dotted the nooks and crannies of the market and mountainous waste packed in sacks and polythene bags beside roadsides. Nevertheless, Agbowo houses has the largest population of rats and mosquitoes- one of the factors for the highest number of malaria illness in Agbowo.

Data on the health conditions and symptoms of some selected environmentally related illness were gathered from household respondents. Respondents were asked to indicate all the environmental illness and symptoms that they have

experienced in the last one year. The result is clearly shown in Fig. 2 above. From the above result; environmental illness and symptoms like passage of watery stools, vomiting, skin infections, cough and sore throat were investigated among other environmentally related health conditions. Results states that health conditions like frequent passage of watery stools, typhoid, skin infections, vomiting, sore throat, abdominal pains and malaria are more dominant in Agbowo when compared to Bodija.

In Agbowo 158 (75.24%), 163 (77.62%), 168 (80%), 109 (51.9%), 94 (44.76%), 129 (61.43%) respondents reported to have had watery stools, typhoid, skin infections, vomiting, sore throat, abdominal pains respectively in the past one year. But when compared to Bodija the number of respondents who had watery stools, typhoid, skin infections, vomiting, sore throat, abdominal pains in the past one year stood at 132 (62.56%), 124 (58.77%), 54 (25.59%), 73 (34.6%), 69 (32.7%), 97 (45.97%), respectively. This result is an evidence that Agbowo and Bodija communities' residents are highly exposed to water and food borne diseases hence the prevalence of acute gastrointestinal illness and acute respiratory illness at both study locations. The high rate of skin infection, typhoid and abdominal pains are indications of contaminated portable water present at both

locations. This is effective due to the irritable environmental behaviour and poor hygiene coupled with low level of environmental sanitation. Open dumping of waste and dumping of waste in streams and lakes around the communities are results of high rate of water/food borne illness reported at our study locations.

However, acute respiratory illness is observed among our respondents due to the prevalence of health conditions like cough 61(29.05%) in Agbowo and 91 (43.13%) in Bodija and Sore throat 94 (44.76%) in Agbowo and 69 (32.7%) in Bodija. Air pollution via open dumping, indiscriminate waste disposal in streams and lakes and presence of poorly managed dumpsites and pit latrines can be held responsible for these acute respiratory illness. Data gathered from the administration of questionnaires states that 69 (32.86%) respondents visited a hospital for environmentally related illness in less than a year, 108 (51.43%) respondents visited hospital between 1 and 5 years, 33 (15.71%) respondents visited hospital more than 5 years ago in Agbowo while in Bodija 74 (35.07%) respondents reported that they had visited a hospital in less than a year to complain about an environmentally related illness, 84 (39.81%) respondents visited hospital in 1–5 years and 53 (25.12%) had visited hospital more than 5 years ago.

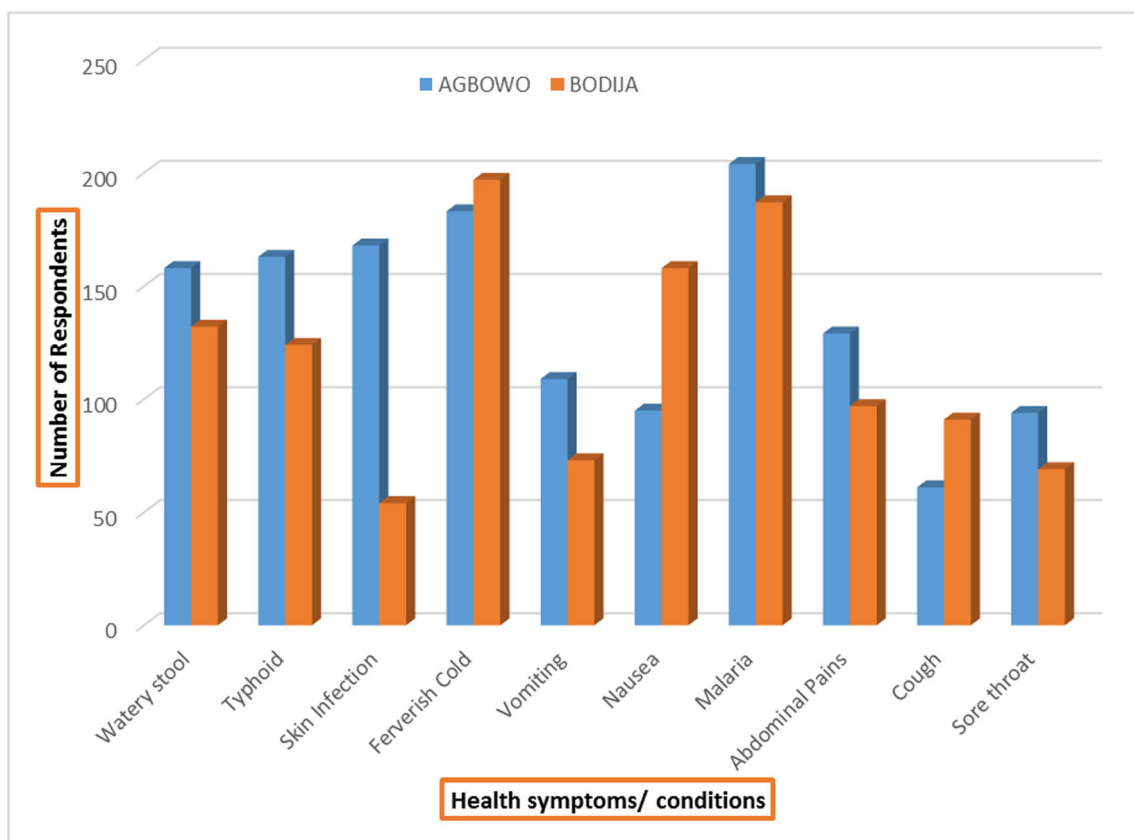


Fig. 2 Prevalence of environmentally related health symptoms and illness at both study locations. Source: Field survey, (2017)

Table 5 Summary of PPMC showing relationship between environmental characteristics and health conditions reported by household respondents in Agbowo

Variable	Mean	Std.D	N	R	Sig	remark
Environmental Characteristics	12.06	9.74	210	-0.91	0.00	Significant
Health conditions and symptoms	23.20	5.62				

3.6 Is there any Relationship between Environmental Characteristics and Health Conditions Reported by Household Respondents in Agbowo?

To determine if there is any relationship between the environmental characteristics of our study areas as reported by correspondents during the filed survey and as indicated on our check list in the process of the survey, and the health conditions reported by our household respondents at the two study areas, a Pearson Product Moment Correlation was carried out with our response data on IBM SPSS statistical package version 21. The Tables 5 and 6 below shows the result of our analysis.

Table 5 shows that there is significant relationship between environmental characteristics and health conditions ($r = -0.91$; $p < 0.05$).

3.7 Is there any Relationship between Environmental Characteristics and Health Conditions Reported by Household Respondents in Bodija?

Table 6 shows that there is significant relationship between environmental characteristics and health conditions ($r = -0.91$; $p < 0.05$).

4 Conclusion

From our study, we have been able to statistically conclude that there is a significant difference in the environmental characteristics of Agbowo and Bodija locations. Our study as well shows that a significant difference exist between waste disposal methods and management in Agbowo and Bodija communities. With this investigative research, we have been able to demonstrate that there is a statistical relationship between environmental characteristics and health conditions reported at both study locations. This further affirm the claim of (Loredana and Maria 2010) on the statistical relationship between two main health outcomes found to be statistically associated with waste exposure: cancer and congenital malformations. This study has been able to show that improper handling of waste and poor environmental hygiene or sanitation

can influence the likelihood of developing illness like acute respiratory illness and acute gastrointestinal illness such as Sore-throat, nausea, Typhoid, Watery stool, Acute abdominal pains etc. Exposure to air pollution, too, is associated with health conditions like asthma, sore throat, and the likelihood of associated lung diseases. There are co- founding factors that can cause vomiting. However, our study has clearly shown the association of vomiting with food- borne diseases as experienced among respondents in our study locations.

Lack of access to qualitative drinking water free of contaminants can be associated with the prevalence of Typhoid, Skin infections and Abdominal pains in our study area. In Agbowo for instance, poor environmental sanitation and absence of portable water for food preparations and drinking can be held responsible for prevalence of watery stools, vomiting and other related gastrointestinal diseases. High population of flies is an indication of poor environmental sanitation; numbers of respondents that had malaria is very dominant at both study areas- an indication that our study areas are highly infested with mosquitoes causing malaria.

This study has therefore reveals that poor MSW disposal methods and management constitute high risk factor to public health. Improper handling of waste- both liquid and solid- especially from the ranks of waste collectors and scavengers increases the risk to human health. This study is a preliminary research on the community participation in waste disposal and its management. We have been able to establish a scientific proof that environmental characteristics and poor hygiene are statistically associated with environmentally related illness. It is thereby needed to further the research to include the prevalence of environmentally related diseases among the population inhabiting Agbowo and Bodija.

5 Recommendation

There is no gain saying that Nigeria has too many environmental laws, environmental agencies and private waste contractors. It is thereby important for proper implementation and enforcement of all established environmental laws. Environmental laws enforcement agencies and personnel must be well trained to boost the

Table 6 Summary of PPMC showing relationship between environmental characteristics and health conditions reported by household respondents in Bodija

Variable	Mean	Std.D	N	r	Sig	remark
Environmental Characteristics	12.43	9.79	210	-0.91	0.00	Significant
Health conditions and symptoms	21.85	5.47				

chance of proper handling, management and enforcement of environmental laws and defaulters. Dumpsites located at our study areas are too close to residential houses and open market places. Dumpsites should be properly located and managed to minimize its effects on the environment. Dumpsites should be well fenced in and away from human settlements. There should be a follow up in the functioning of the dumpsites to avoid pollution on the environment and health hazards.

An integrated waste management system must be adopted by governments at all levels. Waste management must go beyond mere collection and dumping at landfills. Government must begin the process to formulate and adopt an integrated waste management system to enhance proper management and handling of municipal solid waste.

From our study, it was revealed that private waste contractors and collectors, including those concessioned, by the government are part of the environmental problems that Nigerian societies are facing. This is seen in the poor condition, due to neglect, of vehicles used for waste collection and neglect on the safety of their workers who, due to improper handling of waste, are exposed to various gastrointestinal diseases and respiratory illness. This is why government at all levels must remain responsible to environmental management and governance. Government must provide adequate facilities and infrastructures for waste disposal and management. This ensure environmental sustainability.

Government must begin to adopt a policy agenda and strategic action plans to sensitize community people and their mode of participation in municipal waste disposal and management. In this manner, community people will be enlightened on sorting out waste before disposal, self- monitor waste disposal methods to ensure that indiscriminate waste disposal is prohibited among communities.

Health educators need to be trained and properly engaged to give public education about the effects of dumpsites on population health and public health in general. A public orientation and awareness must be organized for communities and municipalities on proper handling of municipal waste (both solid and liquid) and disposal methods in a bid to stop open dumping of refuse, indiscriminate disposal of waste in streams and lakes. Putting heaps of waste in open spaces and by roadsides must be stopped.

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