MEDICAL WASTE MANAGEMENT PRACTICE OF PRIVATE HOSPITALS IN IBADAN METROPOLIS, NIGERIA: A PUBLIC HEALTH CONCERN

[1.]OLUWAFEMI MICHAEL ODUNSI; [1.]YUSUF OLANREWAJU ADEJARE; [1.]NATHANIEL OLUWASEUN OGUNSEYE; [1.]AMOS OLUWOLE TAIWO & [2.]MARGARET YEJIDE ONANUGA

[1.]Department of Urban and Regional Planning, Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria.

[2.]Department of Geography and Environmental Management, Tai Solarin University of Education, Ijagun, Ogun State, Nigeria

Abstract

This study examines medical waste management practices of private hospitals in Ibadan metropolis, Nigeria. Cross-sectional survey design was adopted and a multistage sampling technique was used to administer questionnaires to healthcare workers in 132 private hospitals. A Statistical Package for Social Science (SPSS IBM version 21) was used for the data analysis and descriptive methods including tables and charts for presentation. Findings revealed that females dominate the workforce in private hospitals in the Ibadan metropolis with the majority between age 18 to 24 years. Most healthcare workers were literate, earned above the minimum wage of ₦30,000 and were of early- and mid-career status. The medical wastes generated in the private hospitals were mainly perceived as non-hazardous except for chemical, genotoxic and infectious wastes. The use of waste baskets was predominant in the private hospitals and the majority was emptied daily, thus indicating awareness of the World Health Organisation recommendation regarding medical waste storage. The private hospitals also dispose of medical waste through itinerant waste vans though public bins are somewhat significant. Furthermore, most private hospitals manually sort medical waste with most waste generated are not recyclables. The medical treatment facilities in the private hospitals were rated good particularly autoclaving. Healthcare workers perceived medical waste management practices as affecting sanitary workers, health workers, patients, immediate residents and the public if mismanaged. Finally, recommendations towards sustainable medical waste management practices in hospitals were put forward for implementation.

Keywords: Healthcare workers, Oyo State, Medical waste, Sustainable waste management practices

1. Introduction

Health is a vital aspect of human life, and ensuring human wellbeing requires that health institutions are well-developed. This notion is significantly acknowledged by the international community as necessary for achieving significant global health objectives (Bloland, Simone, Burkholder, Slutsker & Cock, 2012). This is because health institutions provide medical care services directly through caring for patients and indirectly through maintaining a clean and healthy environment for their staff, patients, and the public at large (Patil & Pokhrel, 2016). In this light, health institutions in themselves are expected to be safe from all forms of infection or disease-related practices. However, the waste they generate poses threats to staff and patients on the one hand and the public and environment on the other hand. This is such that when the land, air and water are contaminated by medical waste, they culminate into hazards and pose public health risks to the neighbouring communities (Khatib, 2016).

The waste generated by health institutions is referred to as medical waste and they are of varying compositions. Medical waste is any waste produced in hospitals, clinics, dental and veterinary offices, and medical laboratories that is related to the diagnosis, treatment, or immunisation of humans or animals, or in related research and manufacturing (Manyele, 2015). Medical waste primarily consists of pathological, infectious, chemical, pharmaceutical, and domestic waste (Alagoz & Kocasoy, 2018; Pruss et al. 1999 cited in Khan, Cheng, Khan & Ahmed 2019). Such waste is composed of sharps and non-sharps that have been contaminated with blood, infectious agents, tissues, organs, body parts, chemicals, pharmaceuticals, medical devices, and radioactive materials (Chisholm, Zamani, Negm, Said, Abdel Daiem, Dibaj,& Akrami,2021; Kaseva & Mato, 2010). Detailing on this composition, the sharps include syringes, disposable scalpels and blades; the non-sharps include swabs, bandages and disposable medical devices; the blood and anatomic waste include blood bags, diagnostic samples and body parts; the chemicals include solvents and disinfectants, and the pharmaceuticals include drugs and drug packages.

Medical waste is increasingly acknowledged as a significant issue that could have negative and severe impacts on the environment and people through direct or indirect contact (Abdullah, 2013).It is therefore declared the second most harmful waste in the world due to its possible environmental hazards and public health risks (Kumar et al., 2013; Dehghani, Azam, Changani, & Dehghani, 2018). Considering its disposal practices and impact, Ibijoke, Babajide, Williams and Rafid (2013) stated that several hundreds of tonnes of medical waste are openly disposed of in waste dumps and surrounding environments, often alongside non-hazardous solid waste, while this problem has no geographical boundary. Further, Baveja, Muralidhar, and Aggarwal (2015) stated that in the healthcare delivery process, the medical waste generated including sharps, human tissues or body parts, and other infectious materials, found their way into the environment. They are then scavenged from waste disposal areas and dump sites, either to be reused or sold to be used again. The negative health and environmental impacts of medical waste include the transmission of diseases by viruses and microorganisms, defacing the aesthetics of the environment, as well as contamination of underground water table.

The important stages of managing medical waste in any setting safely and scientifically are handling, segregating, mutilating, disinfecting, storing, transporting, and final disposal (Abdullah, 2013). In addition, several methods used in medical waste management include incineration, autoclaving and microwaving, each with its advantages and disadvantages (Nemathaga, Maringa & Chimuka 2015). Several improper approaches are used in medical waste management across the globe. In practice, medical waste is often mixed with municipal solid waste when disposed of in residential waste landfills or improper treatment facilities (U.S. Environmental Protection Agency, 2010; Khatib, 2016). To eradicate this poor practice, several developed countries have good frameworks through legislation and good practice guidelines to map out safe possible ways for collection, transport, storage and disposal of medical waste (Rao, Ranyal, Bhatia, & Sharma, 2011). Most developing countries are however lagging in the proper and effective management of medical waste and its practice (Khatib, 2016; Chisholm et al., 2021). This improper management and practice are very hazardous to healthcare workers who are directly involved in dealing

with medical waste as well as members of the communities as patients or neighbouring residents.

In Nigeria, medical waste management, like the municipal waste counterpart, is barely taken seriously by the public and government. This might be due to a series of factors including inadequate public health impact awareness, and specific government policies and laws to address the menace of medical waste (Toyobo, 2012). Hence, medical waste, if not properly managed, can pose an even greater threat than the original diseases themselves. Despite these obvious consequences, many private hospitals in Nigeria are uncultured regarding their medical waste management practices. More so, the proliferation of these private hospitals in urban areas in Ibadan calls for concern. The implication is that the more they abound with poor medical waste management practices, the more likely the public health challenges. The following research questions, therefore evolved to address the challenges:

(i) What is the information on the sanitary workers in selected private hospitals in Ibadan metropolis?

(ii) What are the types of medical waste generated in the selected private hospitals in the study area?

(iii) What are the collection, disposal, sorting, and storage practices regarding medical waste in the selected private hospitals in the study area?

(iv) What are the types and conditions of medical waste treatment facilities in the selected private hospitals in the study area?

(v) What are the effects of medical waste practices in the selected private hospitals in the study area? Given this background, this study assessed the medical waste management practice of private hospitals in Ibadan Municipality, Nigeria.

2. Methodology

This study was conducted in Ibadan, which is the capital of Oyo State in Southwestern Nigeria. The city is located approximately on latitude 7° 22' and 7° 40'North of the Equator and 3° 53' and 4° 10' East of the Greenwich Meridian. As a metropolis, Ibadan has eleven local government areas (LGAs).These are: Ido, Akinyele, Lagelu, Egbada, Ibadan North, Ibadan North-East, Ibadan North-West, Ibadan South-East and Ibadan South-West, Oluyole and Ona-Ara. The general land use pattern of the metropolis shows dense physical development at its urban LGAs and less dense in the peri-urban areas, with residential land use being the most predominant among all land uses in its built-up areas. Ibadan's administrative and commercial importance has resulted in land being a key investment, asset, and status symbol for the population (Babajide, 2013).

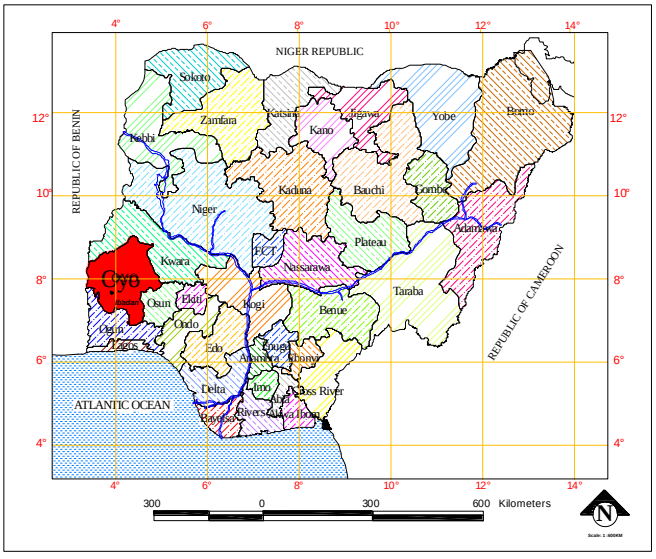


Fig. 1: Map of Nigeria Showing Oyo State

Source: Bureau of Physical Planning and Development Control, Ibadan, Oyo State, 2018

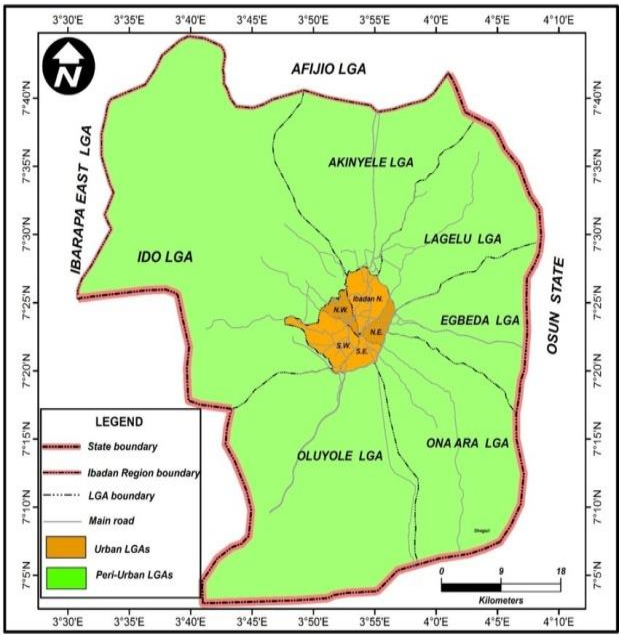


Fig. 2: Map of Ibadan metropolis
Source: Bureau of Physical Planning and Development Control, Ibadan, Oyo State (2018)

This study utilised a quantitative research design anchored on a cross-sectional survey. This design is appropriate because this study purposed to utilise numerical data obtained from study participants within a short time. The study population comprised all the healthcare workers directly or indirectly handling medical waste within the private hospitals in the Ibadan metropolis. They include doctors, nurses, pathologists, social workers, and sanitary officers. A multistage sampling technique was used in the selection of samples. First, the available published record on the number of registered private hospitals was obtained from the Oyo State Government. The data indicated there is a total of 328 private hospitals in Ibadan metropolis (Public and Private Development Centre). The metropolis is further stratified into Ibadan municipality and Ibadan peri-urban. The Ibadan municipality has 177 private hospitals and Ibadan peri-urban has 151 private hospitals. Due to the uniqueness of the demographics of the different settings, 40% of the private hospitals were selected from Ibadan municipality while 35% of private hospitals were selected from the Ibadan peri-urban. These entailed 78 private hospitals in Ibadan municipality while 54 private hospitals in Ibadan peri-urban, totaling 132 private hospitals in Ibadan metropolis. Data on the private hospitals being sampled are contained in Table 1. Further, the primary data were obtained through the administration of a questionnaire on one health worker in each of the private hospitals. At the end of the survey, a total of 132 copies of the questionnaire were retrieved and all were coded into Statistical Package for Social Sciences (SPSS), IBM version 21, and underwent data cleaning. The cleaned data were analysed using descriptive statistics, which is frequency distribution, based on the study objectives.

Table 1. Number of Private Hospitals Sampled

Ibadan metropolis	LGA	Number of Private Hospitals	
		Total	Selected
Ibadan municipality	Ibadan North	49	20
	Ibadan North East	20	8
	Ibadan North West	21	8
	Ibadan South East	36	14
	Ibadan South West	51	20
	Subtotal	177	78
Ibadan peri-urban	Ido	20	7
	Akinyele	13	5
	Lagelu	11	5
	Egbada	69	24
	Oluyole	24	8
	Ona-Ara	14	5
	Subtotal	151	54
Total		328	132

3. Results and Discussion

This section comprises the presentation of the results of this study which are presented according to the objectives. All the results are presented in tables, and figures and all sources are that of the Authors, dated 2023.The results are further interpreted and discussed in this section for contextual understanding.

3.1 Information on the Healthcare Workers

The results of the gender distribution of respondents are presented in Fig. 3. In the Ibadan municipality, the male respondents accounted for 34.6% of the total, while the females constituted 65.4%. In the Ibadan peri-urban, the males were 27.8% while the females were 65.4%. Overall, the male respondents accounted for 31.8% of the total, while the female constituted 68.2%. This implies that the female respondents accounted for the majority of the respondents, which might imply that the medical-sanitary occupation in the selected hospitals is dominated by this gender. The result corroborates the findings of Kasim and Arobo (2015) who explored the compliance level to regulations and awareness of biomedical waste hazards in a maternity in Ibadan.

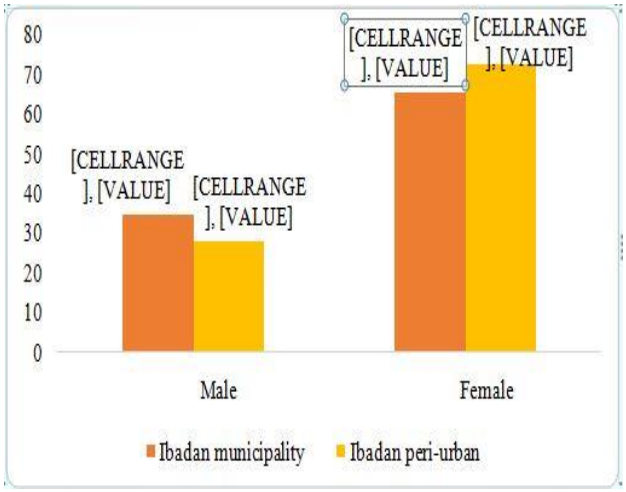


Fig.3: Gender of Respondents

Fig. 4 presents the findings on the distribution of the age group of the sampled respondents. In the Ibadan municipality, respondents with an age group between 18 and 24 years accounted for 64% of the total and recorded the majority within the study area whereas respondents with an age group between 25 and 54 years accounted for 33.3%. Similarly, in the Ibadan peri-urban, the respondents in the age group of 18 and 24 years accounted for 72.2% of the total, while respondents with an age group between 25 and 54 years accounted for 25.9%. Overall, the respondents in the age group 18 and 24 years accounted for 67.4%, and the respondents between 25 and 54 years accounted for 30.3%. This implies that the respondents between the ages of 18 and 24 accounted for the majority of the respondents, indicating that the medical and sanitary staff in the selected hospitals within the Ibadan Metropolis is dominated by this active and young age group.

Fig. 5 presents the findings on the ethnicity distribution of the respondents in the Ibadan Metropolis. The Yoruba tribe accounted for 89.7% of the population in the Ibadan municipality, with the Igbo tribe accounting for the remaining 10.3%. In the Ibadan peri-urban, 77.2% of the respondents were Yoruba, while 27.8% were Igbo. Overall, the Yoruba ethnic group accounted for 82.6% of the total, while the Igbo ethnic group accounted for 17.4%. This implies that the majority of the respondents were from the Yoruba ethnic group, indicating that the medical and sanitary occupation within Ibadan Metropolis is dominated by the Yoruba ethnic group. This result may also be connected to the study location in southwestern Nigeria, a region dominated by the Yoruba ethnic group.

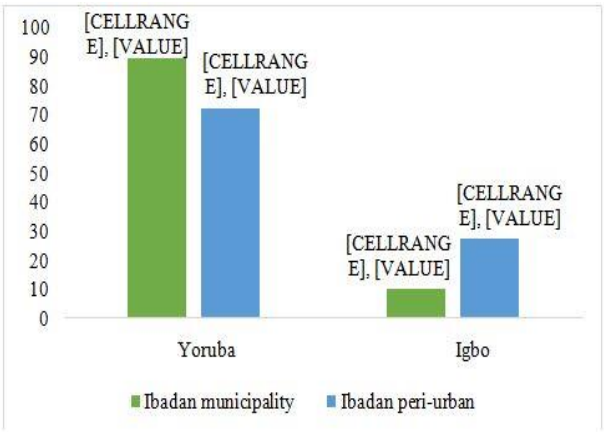


Fig. 5: Ethnicity of Respondents

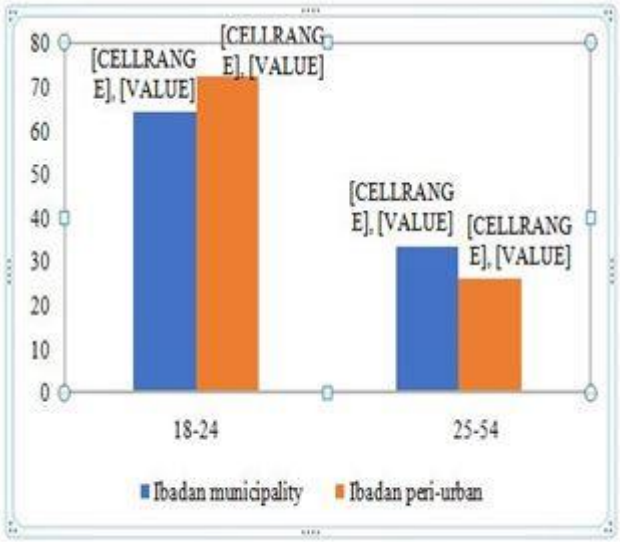


Fig. 4: Age Group of Respondents

The results of the marital status of the respondents are presented in Fig. 6. In the Ibadan municipality, respondents who were single accounted for 48.7%; respondents who were married accounted for 51.3% and recorded the majority; none of the respondents indicated they were divorced or widowed. In the Ibadan peri-urban, the majority of the respondents were single, with a percentage greater than half of the respondents (51.9%), and 40.7% of the respondents were married. 5.6% of the respondents were widowed while 1.9% of the respondents which accounted for the least were divorced. Overall, exactly half (50%) of the respondents were single, indicating a majority. This is followed by the respondents who were married with a percentage close to fifty percent (47%); 2.3% of the respondents were widowed, while respondents with the lowest percentage were divorced. This implies that the medical-sanitary occupation in Ibadan Metropolis is dominated by respondents who are single. This finding supported the fact that the majority of the respondents were aged between 18 and 24 years, thus falling within the category of young adults who are just starting their careers.

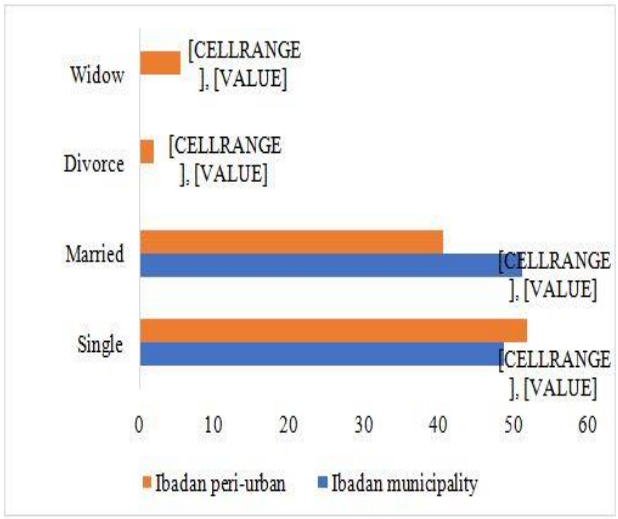


Fig. 6: Marital Status of Respondents

The results of the educational status of the respondents sampled in Ibadan Metropolis are presented in Fig. 7. In the Ibadan municipality, 1.3% of the respondents have no formal education, 23.1% are at the secondary education level, 51.3% of the respondents, which accounted for the majority, have an Ordinary National Diploma or Nigeria Certificate in Education (OND/NCE), while 19.2% have a Higher National Diploma or Bachelor of Science Degree and its equivalent (HND/B.Sc.). In the Ibadan peri-urban, 3.7% of the respondents have no formal education, 1.9% had primary education, 24.1% had secondary education, and 31.5% had HND or B.Sc., while the respondents

with OND or NCE and its equivalent, which accounted for 38.9% of the respondents, recorded the majority in this study area. Overall, respondents with secondary education accounted for 23.5%, 24.2% of the respondents have HND or B.Sc. equivalents, and the majority of the respondents have an OND or NCE and the equivalent with Metropolis. This implies that the medical sanitary occupation in Ibadan Metropolis is dominated by respondents with (OND/NCE) and the equivalent level of education. The results contrast the findings of Kasim and Arobo (2015) in which a greater proportion of respondents had first-degree and postgraduate qualifications.

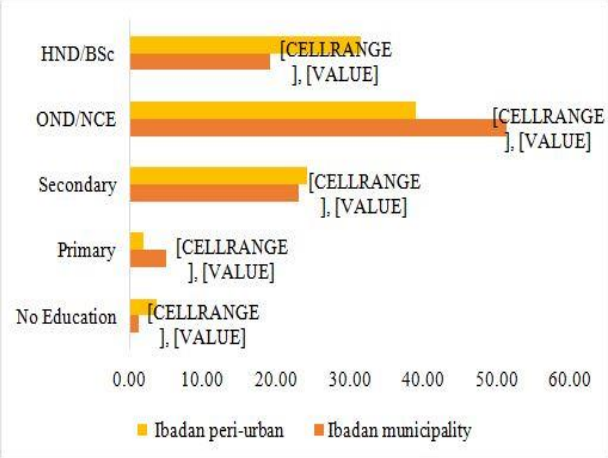


Fig. 7: Education Status of Respondents

In the Ibadan municipality, 44.9% of the respondents were Christian, while the majority, 55.1%, was Muslim. In the Ibadan peri-urban, the majority 61.1% of the respondents were Christian, while 38.9% of the respondents were Muslim. This finding is contrary to that of the results from the Ibadan municipality. Overall, 51.5% of respondents identified as Christian, while the remaining 48.5% identified as Muslim. This implies that the medical-sanitary occupation in Ibadan Metropolis is dominated by the respondents who are Christian faithful.

Findings on the average monthly income group of respondents in the Ibadan Metropolis showed that in Ibadan municipality, respondents who earn an average income between ₦50,000 and ₦100,000 accounted for 64.1% and recorded the majority; those who earn an average income between ₦80,000 and ₦150,000 accounted for 14.1%; respondents who earn an average income between ₦150,000 and ₦200,000 accounted for 21.8%; and those who earn an average income above ₦200,000 accounted for 0%. In the Ibadan peri-urban, respondents who earn between ₦50,000 and ₦100,000 accounted for 79.6% and recorded the majority; those who earn between ₦100,000 and ₦150,000 accounted for 9.3%; respondents who earn an average income between ₦150,000 and ₦200,000 accounted for 7.4%; and those who earn an average income above ₦200,000 accounted for 3.7%. Overall, the respondents who earn between ₦50,000 - ₦100,000 accounted for 70.5%, those who earn between ₦100,000 - ₦150,000 accounted for 12.1% of respondents who earn between₦150,000 - ₦200,000 accounted for 15.9%, while respondents who earn above ₦200,000 accounted for 1.5%. From these findings, it is clear that the majority of the respondents earn between ₦50,000 - ₦100,000 while those who earn above ₦200,000 accounted for the least. This implies that the medical sanitary occupation in Ibadan Metropolis is dominated by respondents who earn above the average monthly minimum wage of ₦30,000 in Nigeria.

The results of the work experience of respondents within the medical-sanitary occupation in Ibadan Metropolis are presented below. In the Ibadan municipality, the respondents who are of early career status (less than 7 years) accounted for the majority (50.0%), respondents who are of mid-career status (8–14 years old) accounted for 46.2%, and those who are senior career status (15-to-21-year-olds) made up 3.8% of the total, while

respondents with the highest level of seniority made up the rest (above 21years), accounted for 0%. In the Ibadan peri-urban, the respondents who are of early career status accounted for 57.4% and recorded the majority. Respondents who are of mid-career status accounted for 35.2%, those who are of senior career status accounted for 1.9%, and respondents who are of the most senior career status accounted for 5.6%.

Overall, the majority of the respondents who accounted for 53.0% were of early career status; this was closely followed by those who were mid-career status (41.7% of respondents) and senior career status (41.7% of respondents), accounted for 3.0%, while those who were not of senior career status accounted for 2.3%. This implies that the majority of the respondents were of early career status, indicating that they are the dominant group of medical and sanitation practitioners in Ibadan Metropolis.

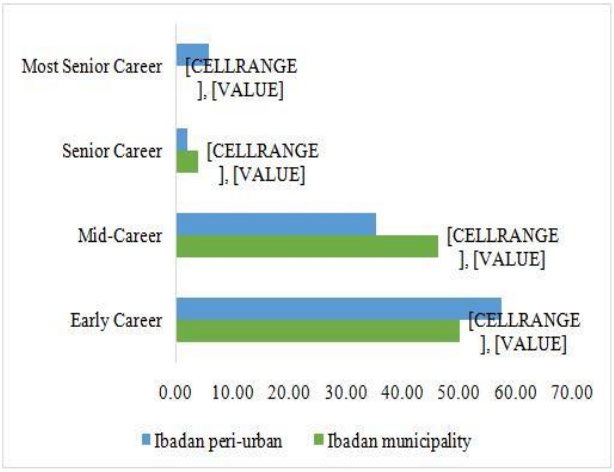


Fig. 8: Work Experience of Respondents

Fig. 9 presented the hospital size/capacity in Ibadan Metropolis. In the Ibadan municipality, the small-capacity size hospital accounted for 64.0% and scored the highest, while the large-capacity size hospital accounted for 35.9%. In the Ibadan peri-urban, the small-capacity size hospital accounted for 44.4%, while the large-capacity size hospital accounted for 55.6%, which is contrary to the results of the Ibadan municipality. Overall, the small-capacity hospital accounted for 56.1% of the total and recorded the majority, while the large-capacity hospital accounted for 43.9%. This implies that the dominant hospital size among the selected hospitals in the Ibadan Metropolis is small.

3.2 Types of Medical Waste Generation

To understand the predominant types of medical waste generated in Ibadan Metropolis, medical sanitary practitioners across selected hospitals were asked to evaluate the types of waste mostly generated in their hospitals to determine those that are hazardous and not hazardous. Table 2 presents the findings on the types of predominant medical waste generated in the Ibadan municipality. Based on the respondents' perceptions of the hazardous and non-hazardous nature of the generated waste, it is noteworthy that most of the evaluated medical waste generated in the Ibadan municipality was perceived to be non-hazardous. These include: waste sharp objects (98.7%), waste fruit peels (100%), waste food remnants (96.2%), waste pathological items (80.8%), waste paper cartons (100%), waste infectious items (55.1%), waste pharmaceutical items (56.4%), waste metal contents (74.4%), waste pressurized containers (96.2%), and waste packaging materials (93.6%). While only two (2) of the twelve evaluated medical waste types were perceived to be hazardous. They include waste chemicals (53.8%) and waste genotoxic items (52.6%). This implies that the majority of medical waste types, ten (10) out of the twelve (12), were non-hazardous waste and accounted for 83.3%, while the remaining 16.7% were hazardous waste.

Table 2: Types of Medical Waste Generated in the Ibadan municipality

Waste	Non-Hazardous	Hazardous	Total
Waste Sharp Object	77(98.70)	1(1.30)	78(100.00)
Waste Fruit Peels	78(100.00)	0(0.00)	78(100.00)
Waste Chemical	36(46.20)	42(53.80)	78(100.00)
Waste Food Remnants	75(96.20)	3(3.80)	78(100.00)
Waste Pathological	63(80.80)	15(19.20)	78(100.00)
Waste Paper Cartons	78(100.00)	0(0.00)	78(100.00)
Waste Infectious	43(55.10)	35(44.90)	78(100.00)
Waste Pharmaceutical	44(56.40)	34(43.60)	78(100.00)
Waste Metal Content	58(74.40)	20(25.60)	78(100.00)
Waste Genotoxic	37(47.40)	41(52.60)	78(100.00)
Waste Pressurized Containers	75(96.20)	3(3.80)	78(100.00)
Waste Packaging Materials	73(93.60)	5(6.40)	78(100.00)

Table 3 furthers investigations on the type of medical waste generated in the Ibadan peri-urban based on the respondents' perceptions of the hazardous and non-hazardous nature of the predominant medical waste generated. It is worth knowing that the majority (8 out of 12), equivalent to 66.7% of the evaluated medical waste generated in the Ibadan peri-urban, was perceived to be non-hazardous. The rated non-hazardous waste includes waste sharp objects (68.5%), waste fruit peels (100%), waste food remnants (100%), waste paper cartons (96.3%), waste pharmaceutical items (75.9%), and waste metal content (70.4%), waste pressurized containers (74.1%), and waste packaging materials (100%). Objectively, three (3) out of twelve (12) equivalents, or 25% of the evaluated, were perceived as hazardous waste; they include waste chemicals (59.3%), infectious waste (55.6%), and genotoxic waste (68.5%). In other words, the perceptions of waste pathological items were perceived as both hazardous (50%) and non-hazardous (50%) as respondents believed. This implies that the majority of the predominant medical waste type in the Ibadan peri-urban was perceived to be non-hazardous.

Overall, the findings presented in Tables 2 and 3 indicating the medical waste types generated in the Ibadan municipality and the Ibadan peri-urban showed that the dominant medical waste types evaluated by the medical sanitary practitioners in Ibadan Metropolis were perceived to be non-hazardous.

Table 3: Types of Medical Waste Generated in the Ibadan Peri-urban

Waste	Non-Hazardous	Hazardous	Total
Waste Sharp Object	37(68.50)	17(31.50)	54(100.00)
Waste Fruit Peels	54(100.00)	0(0.00)	54(100.00)
Waste Chemical	22(40.70)	32(59.30)	54(100.00)
Waste Food Remnants	54(100.00)	0(0.00)	54(100.00)
Waste Pathological	27(50.00)	27(50.00)	54(100.00)
Waste Paper Cartons	52(96.30)	2(3.70)	54(100.00)
Waste Infectious	24(44.40)	30(55.60)	54(100.00)
Waste Pharmaceutical	41(75.90)	13(24.10)	54(100.00)
Waste Metal Content	38(70.40)	16(29.60)	54(100.00)
Waste Genotoxic	17(31.50)	37(68.50)	54(100.00)
Waste Pressurized Containers	40(74.10)	14(25.90)	54(100.00)
Waste Packaging Materials	54(100.00)	0(0.00)	54(100.00)

Medical Waste Management Practices

The management practices of medical waste in Ibadan Metropolis were evaluated based on the perceptions of the medical sanitation practitioners. The findings were discussed under the collection method, disposal method, and sorting and storage practices in the medical-sanitary occupation both in the Ibadan municipality and the Ibadan peri-urban. Table 4 presents the results on the type of container used for medical waste collection in the Ibadan Metropolis, in the Ibadan municipality. The use of carton paper and or other related materials accounted for 19.2%, while waste baskets, plastic, and metals accounted for the majority (80.8%) of the type of container used for collecting medical waste. Similarly, in the Ibadan peri-urban, carton accounted for 25.9% of the type of container used for collecting medical waste, while waste basket accounted for the majority 74.1%. Overall, the use of cartons accounted for 22.0% of the types of containers used for collecting medical waste, while the use of waste baskets accounted for 78.0%. This implies that the use of waste baskets dominated the type of container used for collecting medical waste in Ibadan Metropolis.

Table 4: Type of Container Used for Medical Waste Collection

Study Area	Type		Total
	Carton	Waste basket	
Ibadan municipality	15(19.20)	63(80.80)	78(100.00)
Ibadan peri-urban	14(25.90)	40(74.10)	54(100.00)
Total	29(22.00)	103(78.0)	132(100.00)

Table 5 presents the results on the frequency of waste disposal using the waste container in Ibadan Metropolis. In the Ibadan municipality, it is interesting to note that the waste disposed of once per day accounted for 93.6% and recorded the majority. Waste disposed once in two days accounted for 5.1%, while waste disposed once in three days accounted for 11.3% and recorded the least. Similarly, in the Ibadan peri-urban, the waste disposed of once per day accounted for

83.8% of the total and recorded the majority. Waste disposed once in two days accounted for 16.7%, while waste disposed once in three days accounted for 0%. Overall, waste containers disposed of once per day accounted for 89.4% of total waste and recorded the majority. This is followed by waste containers disposed of once in two days, which accounted for 9.8%, while waste containers disposed of once in three days accounted for 0.8% and recorded the least. This implies that medical waste containers are frequently disposed of every day, which to a great extent indicates the health workers' awareness level of the need to remove the waste generated from the point of generation. More importantly, the disposal practice seems to align with the WHO recommendation stating that waste storage in warmer climates should not exceed 48 hours in the cool season and 24 hours in the hot season (Chartier et al., 2014).

Table 5: Frequency of Emptying Medical Waste Collected

Study Area	Frequency			Total
	Once a day	Once in two days	Once in three days	
Ibadan municipality	73(93.60)	4(5.10)	1(1.30)	78(100.00)
Ibadan peri-urban	45(83.30)	9(16.70)	0(0.00)	54(100.00)
Total	118(89.40)	13(9.80)	1(0.80)	132(100.00)

Table 6 presents the results on the method of medical waste disposal in the Ibadan Metropolis. In the Ibadan municipality, medical waste disposed of in the public bin accounted for 38.5%, medical waste disposed of by the itinerant waste van accounted for 60.3%, those disposed of in the valley, lakeside, river, or roadside accounted for 0.0%, and medical waste incinerated accounted for 1.3%. In the Ibadan peri-urban, medical waste disposed of in the public bin (6.7%), itinerant waste van (70.4%), in the valley, lakeside, river, and roadside (3.7%), and through incineration (9.3%). Overall, the waste disposed of in the public bin accounted for 29.5%, those disposed of by the itinerant waste van, which accounted for 64.4%, recorded the majority, the medical waste disposed of in the valley, lakeside, river, or road recorded 1.5%, and the waste disposed off through incineration accounted for 4.5%. This implies that the waste disposed through the itinerant waste van accounted for the most dominant method of medical waste in Ibadan Metropolis, indicating that most of the selected hospitals appropriately disposed of the medical waste through the provided itinerant waste van.

Table 6: Method of Disposing Medical Waste

Study Area	Method				Total
	Public bin	Itinerant waste van	Valley/ lakeside /river /road	Incineration	
Ibadan municipality	30(38.50)	47(60.30)	0(0.00)	1(1.30)	78(100.00)
Ibadan peri-urban	9(16.70)	38(70.40)	2(3.70)	5(9.30)	54(100.00)
Total	39(29.50)	85(64.40)	2(1.50)	6(4.50)	132(100.00)

Findings on the method of storage of medical waste in Ibadan Metropolis were presented in Table 7. In the Ibadan municipality, the majority (85.5%) of the respondents store their medical waste in containers. 3.8% of the respondents indicated a dump site, and 10.3% of the respondents noted that they use an incinerator as a method of storing their medical waste. Similarly, the Ibadan peri-urban, majority 74.1% of the respondents do store their medical waste in a container, 16.7% of the respondents indicated dumpsite while 9.0% indicated incinerator. Overall, 81.1% of the medical wastes in Ibadan Metropolis based on the information from the sample respondents are mostly stored in the container while less than 10% of the respondents indicated dumpsite and incinerator 9.8%. This implies that the majority of the medical waste in Ibadan Metropolis is stored in containers before final disposal.

Table 7: Method of Storing Medical Waste Collected

Study Area	Method			Total
	Container	Dumpsite	Incinerator	
Ibadan municipality	67(85.90)	3(3.80)	8(10.30)	78(100.00)
Ibadan peri-urban	40(74.10)	9(16.70)	5(9.30)	54(100.00)
Total	107(81.10)	12(9.10)	13(9.80)	132(100.00)

Table 8 presents the results about the method of sorting medical waste in Ibadan Metropolis. In the Ibadan municipality, 97.4% of the respondents accounting for the majority, indicated or use manual methods of waste sorting, while the remaining percentage accounted for automated waste sorting methods. This finding is similar to that of the results from the Ibadan peri-urban, which revealed that the majority of 96.3% sort their medical waste through the manual method, while less than 4% use the automated method of waste sorting. Overall, the manual method of waste sorting accounted for 97.0% which is the majority, while the automated method accounted for 3.0%. This implies that the manual method of waste sorting is most commonly used for sorting medical waste in Ibadan Metropolis.

Table 8: Method of Sorting Medical Waste

Study Area	Method		Total
	Manual	Automatic	
Ibadan municipality	76(97.40)	2(2.60)	78(100.00)
Ibadan peri-urban	52(96.30)	2(3.70)	54(100.00)
Total	128(97.00)	4(3.00)	132(100.00)

The findings on medical waste recycling in Ibadan Metropolis are presented in Table 9. In the Ibadan municipality, less than 40% of the respondents indicated that medical wastes are recyclable, while the majority of over 60% indicated that medical wastes are not recyclable. Similar results were observed in the Ibadan peri-urban, where slightly above 40% of the respondents indicated that medical wastes are recyclable, while about 60% (59.3%) indicated no, meaning medical wastes are not recyclable. Overall, as shown in Table9, the majority of the sampled medical sanitary practitioners noted that medical waste is not recyclable (60.6%), while 39.4% of these group respondents indicated that medical waste is recyclable.

Table 9: Medical Waste Recyclable

Study Area	Medical Waste Recyclable		Total
	Yes	No	
Ibadan municipality	30(38.50)	48(61.50)	78(100.00)
Ibadan peri-urban	22(40.70)	32(59.30)	54(100.00)
Total	52(39.40)	80(60.60)	132(100.00)

3.4 Types and Conditions of Medical Waste Treatment Facilities

In ensuring quality medical sanitation management practices, there is a need to understand the condition of medical waste treatment facilities. In view of this, the types and conditions of medical waste treatment facilities in Ibadan Metropolis were examined, and the results are presented. Table 10 presents the results of the condition of medical waste treatment facilities in the sampled hospitals in the Ibadan municipality and the Ibadan peri-urban. In respect to the incinerator, 24.4% of the respondents indicated very good, 43.6% indicated good, and 32.1% indicated just good, while no one indicated bad or very bad. Hence, the majority of the respondents observed that the incinerator was good (43.6%). In respect to chemical disinfection, 11.5% indicated very good, 62.8% indicated good, 25.6% indicated just good, while 0.0% was observed for bad and very bad. Hence, the majority of the respondents observed that the chemical disinfection facilities are good (63.8%). In respect to autoclaving, 37.2% indicated very good, 39.7% indicated good, 23.1% indicated just good, and none for bad and very bad. Hence, the majority of the respondents observed that the autoclaving facilities are good. Findings on encapsulation showed that 23.1% of the respondents noted that the facility is very good, 35.9% indicated good, 41.0% indicated just good, and none for bad and very bad. Hence, the majority of the respondents observed that the encapsulation facilities are just good. Results on inertisation showed that 10.3% of the respondents noted that the facility is very good, 56.4% noted good, 33.3% noted just good, and none indicated bad and very bad. Hence, the majority of the respondents observed that the inertisation was good (56.4%). Regarding the land disposal facility, 25.6% indicated very good, 35.9% indicated good, 38.5% indicated just good, while none for bad and very bad. Hence, the majority of the respondents observed that the land disposal facility is just fine. Overall, out of the six (6) types of medical waste treatment facilities evaluated in the Ibadan municipality, four (4) different facilities, which accounted for 67%, are good. These include incinerators, chemical disinfection, autoclaving, and inertisation. The remaining two (2) evaluated medical facilities, encapsulation and land disposal, which accounted for 33%, are just good. This implies that all the evaluated medical waste treatment facilities in the Ibadan municipality are good.

Table 10: Conditions of Medical Waste Treatment Facilities in the Ibadan municipality

Types	Very good	Good	Just good	Bad	Very bad	Total
Incinerator	19(24.40)	34(43.60)	25(32.10)	0(0.00)	0(0.00)	78(100.00)
Chemical Disinfection	9(11.50)	49(62.80)	20(25.60)	0(0.00)	0(0.00)	78(100.00)
Autoclaving	29(37.20)	31(39.70)	18(23.10)	0(0.00)	0(0.00)	78(100.00)
Encapsulation	18(23.10)	28(35.90)	32(41.00)	0(0.00)	0(0.00)	78(100.00)
Inertisation	8(10.30)	44(56.40)	26(33.30)	0(0.00)	0(0.00)	78(100.00)
Land disposal	20(25.60)	28(35.90)	30(38.50)	0(0.00)	0(0.00)	78(100.00)

Table 11 presents the results of the condition of the medical waste treatment facilities in the Ibadan peri-urban. Results on the incinerator show that 44.4% of the respondents indicated that the incinerator are very good, 51.9% indicated good, 3.7% indicated just good, while none of the respondents indicated bad and very bad. Hence, the majority of the respondents indicated that the incinerator facilities are good (51.9%). Concerning chemical disinfection, 29.6% indicated very good, 66.7% indicated good, and 3.7% indicated just good, while none of the respondents indicated bad or very bad. Hence, the majority of the respondents observed that the chemical disinfection was good. Results on autoclaving show that 38.9% of the respondents indicated that autoclaving is very good, 48.1% indicated good, and 13.0% indicated just good, while none of the respondents indicated bad or very bad. Hence, the majority of the respondents noted that autoclaving is good (48.1%). In respect to encapsulation, 42.6% indicated very good, 37.0% indicated good, and 20.4% are just good, while none of the encapsulation facilities are bad or very bad. Hence, the majority of the respondents rated that the encapsulation facilities are very good. With respect to inertisation, 27.8% of the respondents observed that the inertisation facilities are very good, 40.7% are good, and none of the facilities is bad or very bad. Hence, the majority of the respondents observed that the inertisation facilities are good. Further, on land disposal, respondents observed that 33.3% are very good, 31.5% are good, and 35.2% are just good, while none of the land disposals are bad or very bad. Hence, the majority of the respondents thought that the land disposal facilities were just fine. Overall, it is noteworthy that out of the six (6) types of medical waste treatment facilities evaluated in the Ibadan peri-urban, only one (1), encapsulation, accounted for 16.7% of the very good condition, while four (4) different facilities, equivalent to 66.7%, are in good condition. These are the incinerator, chemical disinfection, autoclaving, and inertisation. The remaining one (1) land disposal, which accounted for 16.7%, is just good. This implies that all the evaluated medical waste treatment facilities in the Ibadan peri-urban are good. This finding is similar to that of the Ibadan municipality.

Table 11: Types and Conditions of Medical Waste Treatment Facilities in the Ibadan peri-urban

Types	Very good	Good	Just good	Bad	Very bad	Total
Incinerator	24(44.40)	28(51.90)	2(3.70)	0(0.00)	0(0.00)	54(100.00)
Chemical Disinfection	16(29.60)	36(66.70)	2(3.70)	0(0.00)	0(0.00)	54(100.00)
Autoclaving	21(38.90)	26(48.10)	7(13.00)	0(0.00)	0(0.00)	54(100.00)
Encapsulation	23(42.60)	20(37.00)	11(20.40)	0(0.00)	0(0.00)	54(100.00)
Inertisation	15(27.80)	22(40.70)	17(31.50)	0(0.00)	0(0.00)	54(100.00)
Land disposal	18(33.30)	17(31.50)	19(35.20)	0(0.00)	0(0.00)	54(100.00)

3.5 Effects of Medical Waste Management Practices

The perceived effect of medical waste management practices on sanitary workers, health workers, patients, immediate residents, and general public health were evaluated. Table 12 presents the results of the effect of medical waste practices on sanitary workers in Ibadan metropolis. In the Ibadan municipality, the majority (92.3%) of the respondents indicated that the effect of medical waste management practice is detrimental to the health of the sanitary workers, 3.8% indicated somewhat detrimental, and 3.8% indicated not detrimental to the health of the sanitary workers. In the Ibadan peri-urban, 70.4% of the respondents indicated that the effect of the medical waste management practice is detrimental to the health of the sanitary workers, 13.0% indicated somewhat detrimental, and 16.7% indicated that it is not detrimental to the health of the sanitary workers. Overall, the majority of the respondents (83.3%) observed that the effect of the medical waste practices on the health of sanitary workers in Ibadan Metropolis is detrimental, 7.8% observed that it is somewhat detrimental, and9.1% indicated not detrimental. This implies that the respondents perceived the medical waste practices to have a detrimental effect on the health of the sanitation workers.

Table 12: Perceived Effects of Medical Waste Practices on Sanitary Workers

Study Area	Perceived Effects			Total
	Detrimental	Somewhat Detrimental	Not Detrimental	
Ibadan municipality	72(92.30)	3(3.80)	3(3.80)	78(100.00)
Ibadan peri-urban	38(70.40)	7(13.00)	9(16.70)	54(100.00)
Total	110(83.30)	10(7.60)	12(9.10)	132(100.00)

Table 13 presents the findings of the effect of the medical waste management practices on health workers in the Ibadan Metropolis. In the Ibadan municipality, 93.6% of the respondents, who accounted for the majority, indicated that the effect of the medical waste management practices is detrimental to the health of the health workers, 1.3% indicated somewhat detrimental effects, and 5.1% indicated that the practices are not detrimental to the health of the health workers. In the Ibadan peri-urban, 81.5% of the respondents, which accounted for the majority, indicated that the effect of the medical waste management practices is detrimental, 11.1% indicated somewhat detrimental, and 7.4% indicated not detrimental to the health workers. Overall, the majority of the respondents 88.6% observed that the medical

waste management practice has a detrimental effect on the health workers, 5.3% observed that its effect is somewhat detrimental, and 6.1% believed that it is not detrimental to the healthcare workers health. This implies that the medical waste management practices are perceived as detrimental to the health of the healthcare workers or medical sanitation workers in Ibadan Metropolis.

Table 13: Perceived Effects of Medical Waste Practices on Health Workers

Study Area	Perceived Effects			Total
	Detrimental	Somewhat Detrimental	Not Detrimental	
Ibadan municipality	73(93.60)	1(1.30)	4(5.10)	78(100.00)
Ibadan peri-urban	44(81.50)	6(11.10)	4(7.40)	54(100.00)
Total	117(88.60)	7(5.30)	8(6.10)	132(100.00)

Table 14 presents the results of the effect of the medical waste management practices on the patients in Ibadan Metropolis. In the Ibadan municipality, 91.0% of the respondents stated that the medical waste management practice has a detrimental effect on the patients. 3.8% of the respondents indicated somewhat harmful, while 5.1% indicated no harm to the patients. In the Ibadan peri-urban, 81.5% of the respondents indicated that the medical waste management practice has a detrimental effect on the patients. 5.6% of the respondents indicated somewhat negative effects; and13.0% indicated no negative effects. Overall, the majority of the respondents 87.1% observed that the medical waste management practice have a detrimental effect on the patients; 4.5% observed that its effect is somewhat detrimental; and 8.3% indicated that it is not detrimental. This implies that the medical waste management practices are perceived as detrimental to the patient if not properly managed in the study area "Ibadan Metropolis".

Table 14: Perceived Effects of Medical Waste Practices on the Patients

Study Area	Perceived Effects			Total
	Detrimental	Somewhat Detrimental	Not Detrimental	
Ibadan municipality	71(91.00)	3(3.80)	4(5.10)	78(100.00)
Ibadan peri-urban	44(81.50)	3(5.60)	7(13.00)	54(100.00)
Total	115(87.10)	6(4.50)	11(8.30)	132(100.00)

Table 15 presents the results of the effect of medical waste management practices on the health and quality of life of the immediate residents of Ibadan Metropolis. In the Ibadan municipality, 94.9% of the respondents opined that the effect of the medical waste management practices is detrimental to the health and quality of life of the immediate residents. 1.3% of the respondents indicated that it is somewhat detrimental, while about 4% (3.8%) of the respondents indicated that it is not detrimental to the health and quality of life of the immediate

residents. In the Ibadan peri-urban, 87.0% of the respondents, which accounted for the majority, indicated that the effect of the medical waste management practices is detrimental to the health and quality of life of the immediate residents; 7.4% of the respondents indicated that it is somewhat detrimental; and 5.6%, which is less than one-tenth of the respondents, indicated that it is not detrimental to the health and quality of life of the immediate residents. Overall, the majority of the respondents (91.7%) observed that the effect of the medical waste management practices across various hospitals in Ibadan Metropolis is detrimental to the health and quality of life of the immediate residents; 38% of the respondents observed that its effect is somewhat detrimental; and less than 5% (4.5%) of the respondents indicated that it is not detrimental to the health and quality of life of the immediate residents. This implies that the medical waste practices across Ibadan Metropolis are perceived as detrimental to the health of the immediate residents.

Table 15: Perceived Effects of Medical Waste Practices on the Immediate Residents

Study Area	Perceived Effects			Total
	Detrimental	Somewhat Detrimental	Not Detrimental	
Ibadan municipality	74(94.90)	1(1.30)	3(3.80)	78(100.00)
Ibadan peri-urban	47(87.00)	4(7.40)	3(5.60)	54(100.00)
Total	121(91.70)	5(3.80)	6(4.50)	132(100.00)

Table 16 presented the results of the effect of medical waste management practices on the general public's health in Ibadan Metropolis. In the Ibadan municipality, 84.6% of the respondents which accounted for the majority indicated that the effect of the medical waste management practices is detrimental to the quality of public health in the study area, 5.1% of the respondents believe it is somewhat detrimental, while slight above one-tenth of the respondents (10.3%) indicated that the medical waste management practices is not detrimental to the quality of the public health. In the Ibadan peri-urban, 70.4% of the respondents which accounted for the majority indicated that the effect of the medical waste management practices is detrimental to the quality of the public health in the study area. 14.8% of the respondents indicated that it is somewhat detrimental, and the remaining 14.8% of the respondents indicated that the medical practices across the study area are not detrimental to the general public's health. Overall, it is worthy of note that the majority, 78.8% of the respondents, observed that the effect of the medical waste management practices across Ibadan Metropolis is detrimental to public health. 9.1% which is less than one-tenth of the respondents indicated it is somewhat detrimental, while the remaining percentage 12.1% which is slightly above one-tenth of the respondents indicated that the effect of the medical waste practices is not detrimental to the public health. This implies that the medical waste practices in Ibadan Metropolis are perceived as detrimental to the general public's health.

Table 16: Perceived Effects of Medical Waste Practices on General Public Health

Study Area	Perceived Effects			Total
	Detrimental	Somewhat Detrimental	Not Detrimental	
Ibadan municipality	66(84.60)	4(5.10)	8(10.30)	78(100.00)
Ibadan peri-urban	38(70.40)	8(14.80)	8(14.80)	54(100.00)
Total	104(78.80)	12(9.10)	16(12.10)	132(100.00)

4. Conclusion

Medical waste practices have remained a global concern as their effects are found on various aspects of human life and our immediate environment specifically. The medical waste practices, particularly in developing communities including Nigeria, are poorly handled, treated, stored, and disposed of. These cause Nigerian communities to be prone to various forms of environmental hazards and endangered with enormous health risks. Due to the risks and sanitary health environmental hazards associated with medical waste, the government, non-governmental organizations, researchers, practitioners, and international organizations continue to advocate the need to appropriately handle, treat, store, and dispose of medical waste generated by health centres, clinics, laboratories, and hospitals. Unfortunately, despite the increasing level of global advocacy, medical waste is poorly advocated in Ibadan Metropolis. The city is still found with streets littered with medical waste and disposal of untreated medical waste in city drains and landfills, and these practices could contaminate not only environmental resources such as surface and underground water but also the health and quality of life of the people in Ibadan Metropolis. Meanwhile, the insufficiency of recent studies on the medical waste practices in Ibadan Metropolis also aggravates the observed practices. Hence, this study from the perspective of medical sanitary practitioners or workers, examined the medical waste management practices in Ibadan Metropolis towards improving how medical waste is handled, stored, treated and disposed of without compromising environmental health.

It is noteworthy that the medical sanitary workers were dominated by females, in their active age and within their early and mid-career status.Again, most of the medical waste generated within their facilities was non-hazardous. Meanwhile, the most generated medical waste is collected through the use of waste baskets and stored in containers, which are usually disposed of on a daily basis through a public itinerant waste van. The study found and concluded that the medical waste management practices in the study area still use the manual method of waste sorting. Hence, the use of automation is less adopted since most of these wastes are not recyclable. The study also concluded that most of the medical waste treatment facilities in the metropolitan area are in good condition but not in very good condition as expected. Furthermore, the study concludes that the improper management practices (handling, treating, sorting, and disposal) of medical waste have detrimental effects on sanitary workers, health workers, patients, immediate residents, and the general public health. Hence, advocacy and strict adherence to best practices are encouraged.

Based on the findings of the study and conclusion, certain recommendations are made. Firstly, since the early-career health workers dominated the private medical facilities in the

study areas, it is recommended that the more experienced and senior-career workers be engaged with better or improved work conditions and salaries. If this were put in place, it would improve the quality of the health sector's activities, including sanitary practices. Secondly, since medical waste is frequently generated and collected through waste baskets, this study recommended that the generated medical waste be disposed of at regular intervals or immediately after generation to avoid unnecessary accumulation and littering. Thirdly, since medical waste comprises both hazardous and non-hazardous waste materials, this study recommended that the medical waste be properly collected, sorted, separated, and stored in well-labelled or coded containers named shredder to ensure that hazardous wastes are not mixed with non-hazardous waste and that they are well sorted and separated. Fourthly, the study recommended that medical waste treatment facilities should improve upon these various options, including medical waste container washers and integrated autoclaves with shredders, and should encourage all healthcare facilities to use them. Fifthly, the use of automated waste management practices that sort and recycle medical waste easily should be encouraged among health facilities in the city to improve medical waste practices and reduce the associated experiments. Sixthly, the management of the healthcare facilities and the government should ensure strict monitoring and adherence to standards for the health condition of medical waste treatment facilities. For example, the incineration practices that are mostly used should have a well-spaced and guided environment for their process and ensure waste is completely burned to ashes. Lastly, the number of standard mobile medical waste treatment modules or trucks should be increased to encourage best practices for medical waste management and reduce the negative effects of medical waste on people, health workers, and the environment.

This study has added recent information to the existing literature on medical waste management practices in Nigerian communities. Specifically, it has been able to provide information on the types of medical waste mostly generated in Ibadan Metropolis. The condition of the medical waste treatment facilities and the effects on the sanitary health workers, patients, residents of the health facilities, and general public health in Ibadan Metropolis. The perceptions of the patients and residents on the effect of the medical waste management practices are not captured in this study, thus this study only relies on the perception of the health care workers. The attitude of the health workers toward filling out and administering the questionnaire constrains the ease of questionnaire administration and response rate. The time and funds required to administer the questionnaire also posed constraints and limited the unit of research sampled. Further investigation should be conducted on the methods of medical waste treatment facilities mostly used in the study area. This is to determine which treatment facilities are commonly used by the healthcare facilities in Ibadan Metropolis. The medical hazardous waste could also be studied to determine the effect of medical waste on the public health of the Ibadan Metropolis using the perceptions of the health sanitary workers, patients, and immediate residents.

References

Alagoz, A. Z. & Kocasoy, G. (2018). Improvement and modification of the routing system for the health-care waste collection and transportation in Istanbul. *Journal of Waste Management, 28,* 1461–1471.

Baveja, G., Muralidhar, S., & Aggarwal, P. (2015). Hospital waste management. An overview.*Hospital Today*, *5*(9), 485–486.

Bloland, P., Simone, P., Burkholder, B., Slutsker, L.,& De Cock, K.M. (2012). The role of public health institutions in global health system strengthening efforts: the US CDC's perspective. *PloS Medicine*, *9*(4). e1001199. doi:10/1371/journal/pmed.1001199

Chartier, Y., Emmanuel, J., Pieper, U., Prüss, A., Rushbrook, P., Stringer, R., Townend, W., Wilburn, S., & Zghondi R. (Eds) (2014). *Safe management of wastes from health-care activities (2nd ed.)*. Geneva: World Health Organization. Retrieved from https://www.ircwash.org/sites/default/files/9789241548564_eng.pdf

Chisholm, J. M., Zamani, R., Negm, A. M., Said, N., Abdel Daiem, M. M., Dibaj, M. & Akrami, M. (2021). Sustainable waste management of medical waste in African developing countries: A narrative review. *Waste Management & Research*, *39*(9) 1149-1163.DOI: 10.1177/0734242X211029175

Dehghani, M.H., Azam, K., Changani, F., & Dehghani, E.F. (2018). Assessment of medical waste management in

Kumar, R., Gorar, Z., Ahmed, J., Ali, Z., Chandio, A., Magan, M., Ahmed, N., Shaikh, B., &Somrongthong, R. (2013). Assessment of health care waste management practices and knowledge among health care workers working at tertiary care setting of Pakistan. *Journal of Health Research*, *27*(4), 233-236.

Manyele, S.V. (2015). Medical waste management in Tanzania: Current situation and the way forward. *African Journal of Environmental Management*, *8*(1), 74-99.

educational hospital of Tehran University Medical Sciences. *Iranian Journal of Environmental Health Science and Engineering*, *5*(2), 131-136.

Ibijoke, I., Babajide, A., Williams, A., & Rafid, A. K. (2013). Profile of medical waste management in two healthcare facilities in Lagos, Nigeria. *Journal of Waste Management and Research*, *31*, 494-501.

Kaseva, M. E., & Mato, R.R.A.M. (2010). Critical review of industrial and medical waste practices in Dar es Salaam City. *Journal of Waste Management*, *25*, 271–287.

Kasim, O. F.,& Arobo, A. K. (2015). Level of compliance to regulations and awareness of biomedical waste hazards among health workers in Adeoyo maternity hospital, Ibadan, Nigeria.*Ibadan Planning Journal*, *4*, 52-57.

Khan, B. A., Cheng, L., Khan, A. A.,& Ahmed, H. (2019). Healthcare waste management in Asian developing countries: A mini review. *Waste Management & Research*, 37(9), 863–875. DOI: 10.1177/0734242X19857470

Khatib, R. A. (2016). Assessment of medical waste management in Palestinian hospital. *Eastern Mediterranean Health Journal*, *12*(3-4), 359-371.

Nemathaga, F., Maringa, S., & Chimuka, L. (2015). Hospital solid waste management practices in Limpopo Province, South Africa: a case study of two hospitals. *Journal of Waste Management, 28,* 1236–1245.

Patil, G.V., & Pokhre, K. (2016). Biomedical solid waste management in an Indian Hospital: A case study. *Journal of Waste Management*, *25*, 592–599.

Public and Private Development Centre - PPDC (n.d). List of coded health facilities in Oyo State. Retrieved from https://library.

procurementmonitor.org/backend/files/List%20of%20Coded%20Health%20Facilities%20in%20Oyo%20State.pdf

Pruss, A., Girout, E., & Rushbrook, P. (2020). *Safer management of waste from Health care activities.* Geneva: WHO.

Rao, H.P. (2018). Hospital waste management-awareness and practices: a study of three states in India. *Journal of Waste Management and Research,26*, 297-303.

Rao, L., Ranyal, W., Bhatia, L., & Sharma, L. (2011). Biomedical waste management: an infrastructural survey of hospitals. *Journal of Medical Armed Forces India*, *60*, 379- 382.

Tenglikar, P.V., Kumar, A.G., Kapate, R., Reddy, S. & Vijayanath, V. (2012). Knowledge, attitude, and practices of health care waste management amongst staff of nursing homes of Gulbarga City. *Journal of Pharmaceutical and Biomedical Sciences*, *19*(19), 1-3.

Toyobo, A. E., Baba, A. O. & Oyeniyi, A. B. (2015). Appraisal of university teaching hospital medical waste management in Nigeria: Case Studies of University College Hospital (UCH) Ibadan and Obafemi Awolowo University Teaching Hospital (OAUTH) Ile-Ife. *Universal Journal of Education and General Studies*, 1(9), 290-297.

U.S. Environmental Protection Agency (USEPA, 2010). Characterization of municipal solid waste in the United States. Washington, DC: USEPA.

World Health Organization (WHO, 2019). *Waste from health-care activities.* Geneva: WHO. Retrieved from http://www.who.int/mediacentre/factsheets/fs253/en/