



Original Research

Medical waste management at the primary healthcare centres in a north western Nigerian State: Findings from a low-resource setting



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ABSTRACT

Objectives: This study aims to examine medical waste management (MWM) practices and identify the challenges of optimal MWM at the primary healthcare (PHC) level in Kebbi State, Nigeria.

Study design: This study was a cross-sectional survey of 265 primary healthcare workers (PHCWs) and health facilities (HFs) in Kebbi State.

Methods: The study tool used was a questionnaire adapted from the WHO rapid assessment tool on MWM and water sanitation. Descriptive and inferential statistical analyses were conducted using SPSS version 20 software. **Results:** Data generated from 257 HWs were used in this study. Amidst other findings, only 65 (25%) HFs had MWM guideline or policy document; out of these 65 HFs, only 19 (7%) of them had problem with its implementation. Only 42 (16%) HFs had a compensation package or a health insurance policy to take care of their health workers in case of MWM-associated hazards while 22 (9%) HFs had specific budgetary allocation for MWM. Only 105 (41%) HFs had trained staffers on MWM. Sharps, blood/body fluids and domestic wastes were the top three (3) wastes generated among the surveyed HFs. Medical waste treatment was on-site in 124 (48%) HFs and burn-and-bury method was the adopted method of medical waste disposal in 198 (77%) HFs. However, the majority (76%) of the surveyed HWs expressed dissatisfaction about the waste treatment practices adopted in their HFs.

Conclusion: Our study revealed a poor level of MWM practices in Kebbi State, Nigeria. The state government and partners need to urgently address the identified operational and policy gaps in MWM in Kebbi State, Nigeria. Furthermore, our study revealed the negative implication of fragmented governance and leadership structure at the PHC level on policy, practice and administration of medical waste management in the Kebbi State, North-western Nigeria. Addressing the gaps found in this study would contribute to the attainment of the United Nations Sustainable Development Goals in health and well-being, sustainable cities and communities and contribute to poverty eradication.

1. Introduction

Management of medical wastes has been challenging and critical in many developing countries, including Nigeria [1]. Medical wastes are potentially hazardous products of health care and related services rendered at health facilities, clinical research centres, biotechnology centres, and blood banks [2]. Medical wastes also include wastes originating from other variety of sources, such as wastes generated from healthcare undertakings at homes, self-administration of insulin, home

dialysis, and recuperative care as well as rehabilitation care [2]. According to a WHO report in 2005 [2], 85% of the medical wastes are categorised as general (or non-hazardous) wastes. The general medical wastes often come from administrative, kitchen and house-keeping activities, packaging, hospital building, and facility maintenance at healthcare-related settings. The remaining 15% of medical wastes are categorised as infectious wastes (10%) and chemical/radioactive wastes (5%); these wastes are hazardous and may constitute a risk to health and the environment [2].

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Medical wastes are generated at all levels of care, namely: primary, secondary and tertiary levels. Given the volume and potentially hazardous nature of these wastes, they are of high interest to public, occupational and environmental health [2]. Medical wastes are potentially harmful to health workers (HWs), patients, community inhabitants and the environment. Proper handling of medical wastes can minimize the hazards associated with improper waste management [3,4]. Furthermore, medical waste management (MWM) is an integral part of health care service delivery [5]. Good MWM can be an integral part of effective infection control procedures if properly implemented [2]. However, adequate attention has not been paid to MWM practices in many health institutions, especially in Nigeria [1,5,6]. Reports from the literature suggest no strict adherence to the professional ethics of MWM in Nigeria, showing a severe compromise of the internationally acceptable guidelines on MWM [4–6]. The situation appears worrisome at the primary health care (PHC) level. Some of the reasons attributed to the poor MWM are poor financing, weak institutional arrangement and governance [1], little or no capacity-building opportunity on MWM issues [1,6–8], and non-compliance to waste management guidelines or procedures [6–9]. In addition to the above, there is no mechanism in place to monitor adherence or compliance to best practices in MWM as the waste management policy in Nigeria appears to be infantile and barely operational at the health facilities [6].

Due to limited funding and paucity of literature in the northwestern region of Nigeria, our study focused on Kebbi State—a mostly rural State that has a population of about 4.7million inhabitants. A recent survey conducted in Kebbi State by Oyekale et al. [5], reported a high level of risky disposal of wastes, particularly sharps, in the State. This demonstrates the need to further investigate this observed challenge to provide a better understanding of the practices, knowledge and other waste management problems at the PHC level in Kebbi State. It is therefore imperative to examine the MWM system at this level of care (i.e., the PHC level) in Kebbi State, as this level of care remains the closest and most accessible source of orthodox healthcare services to the rural population. In an effort to better understand the practice(s) and challenges associated with the management of medical wastes at the PHC level, it is imperative to assess the role of governance and administrative system within the health sector as it affects MWM, using this rural Nigerian State as a case study. This study aims to examine the type of medical wastes and MWM practices at the PHC level in Kebbi State; assess the incidence and management of occupational injury at the PHC level in Kebbi State; assess the availability of waste management guideline, staff health insurance and compensation packages and funding as well as identify the challenges of optimal MWM at the PHC level in Kebbi State.

2. Methods

This study was a cross-sectional survey of PHC facilities in Kebbi State, Nigeria. Kebbi State is in the Northwestern region of Nigeria. The State is situated between latitudes 10° 8' N – 13° 15' N and longitudes 3° 30' E – 6° 02' E, and with an approximate surface area of 36,229 Km² [10]. Kebbi State has both local and international borders. Locally, it borders with Zamfara, Sokoto and Niger States while it has international borders with Niger and Benin Republics. There are 21 Local Government Areas in Kebbi State with 225 political wards [11]. The State is largely rural with a few semi-urban towns. Besides Birnin Kebbi, the State capital, other major towns include Argungu, Yauri, Zuru (all emirate headquarters) and Jega – the commercial capital of the state. Kebbi State is divided into four emirates – Gwandu, Argungu, Yauri and Zuru Emirates.

Kebbi State has a projected population of about 4,671,594 people (for 2018) based on the 2006 census population. Kebbi State enjoys a tropical climate characterized by annual rainfall ranging from 800 mm (northern part of the State) and 1000 mm (in the south) while temperature ranges from 21 to 40 degree Celsius (mean temperature: 26 degrees Celsius) [11, 12]. The State has numerous ethno-linguistic groups with the Hausa/-Fulani as the predominant. Other indigenous linguistic groups that can be

found in Kebbi State are Dakarkari (Lelna), Zabarmawa, Kambari, Duk-kawas and Gunganci. The major occupation of the people is farming and livestock rearing, essentially agrarian [11–13]. Islam is the predominant religion, although many communities in the Southern parts of the State practice other religions, mainly Christianity and traditional religions.

The instrument used for data collection was a paper questionnaire. The questionnaire was an adapted version of the WHO rapid assessment tool on MWM and water sanitation (the adapted tool can be found at http://www.who.int/water_sanitation_health/medicalwaste/ratupd05.pdf). The questionnaire was validated by an expert (one of the authors: MMA) who ensured the words of the questionnaire are easily comprehensible, and suggestions made were effected in the finalized draft that was employed. A pilot study was conducted by giving the questionnaire to 50 conveniently selected PHC workers from two conveniently selected PHCs (note that the PHCs that were used for the pilot study were excluded from the main study in order to avoid bias) to go through for check of clarity and easy comprehension. All suggestions were noted, and corrections were effected. The final draft of the questionnaire had three sections, namely: section A, section B, and section C. Section A obtained information on the socio-demographic characteristic and basic information (such as age, ethnicity, designation, length of year in service, religion, marital status and education level) of each of the study participants. Section B obtained information from the study participants on staffing and available services at the surveyed HFs; training on MWM (any training done and time of the last training); medical waste generation (type of waste generated and quantity); waste storage (color-coding system and segregation methods); off-site transport of waste (system of transport, responsible person and frequency of transport); and final waste disposal/treatment (on-site or off-site treatment, method of waste disposal, ministry or agency responsible, number of incinerator in the State). Section C obtained information from the study participants on MWM regulations (waste management guideline/policy document, budgetary allocation and funding, structure of health system, functional waste management committee, extra-governmental collaboration, annual reporting on waste management and impediments to efficient and effective waste management system).

The sample size of the HFs to be surveyed in this study was determined from the Leslie formula stated below [14]:

$$n = \frac{(Z_{\alpha/2})^2 pq}{e^2}$$

In the above formula, n depicts the base sample; and $Z_{\alpha/2}$ (equal to 1.96) is the value of Z score obtained from the confidence level. P stands for prevalence rate of MWM. The value of p is usually estimated at 50% to reflect the assumption that impact is anticipated in 50% of the population, while q is the complement of p (i.e. 1- p). “e” is the margin of error usually estimated at 0.05.

$$n = \frac{(1.96)^2 (0.5 \times 0.5)}{(0.05)^2}$$

$$n = 384$$

Given the total number (N = 851) of functional health facilities (HFs) situated in all the LGAs in Kebbi State, an adjusted sample size was estimated as follows:

$$n_f = \frac{n}{1 + \frac{n}{N}}$$

$$n_f = \frac{384}{1 + \frac{384}{851}} = 265$$

Thus, the study was based on a sample size of 265 HFs.

The HFs that were selected for the survey were randomly picked from a sampling frame which contains a total of 851 functional HFs in all the

LGAs in Kebbi State. Having obtained the study's sample size, proportionate stratified sampling technique was employed for the selection of the surveyed HFs in each LGA, hence eliminating selection bias and assuring wider coverage.

From March to April 2018, data on each of the selected HF was obtained from health workers within each facility, using the pre-tested self-administered questionnaire. Only one informant was recruited per HF. All informants interviewed in this study were HWs at each of the surveyed HFs. We used a table of random numbers in the selection of the HW serving as the study participants from the list of all HWs in each facility. Prior to data collection, each study participant was informed about the purpose and benefits of the study, and he/she was also informed that his/her participation is strictly voluntary and unanimous. Also, verbal informed consent was obtained from all the study participants before their participation. We also took some pictures of the waste disposal sites visited, for evidence (Supplementary file 2).

Data collected was cleaned, coded and entered in the SPSS version 20 software for analysis. The frequency distribution of all variables was determined. The test of association between variables was determined using a chi-square test, using a p-value of <0.005 to determine the level of statistical significance. Results from the data analysis were presented using tables.

3. Results

A total of 265 study participants were recruited in this study. However, eight (8) workers dropped out of the study due to failure to return their filled questionnaires to the investigators during the study period. Hence, the response rate for the survey was 97% (257/265).

Out of the 257 successfully interviewed participants, only 89 were within the age bracket of 35–44 years, 193 were males, 215 had ordinary national diploma (OND), 77 had 1–10 years working experience, 212 were married, and 220 were Muslims (Table 1).

Not all the study participants responded to all the questions they were asked about their: HFs, knowledge of MWM practices; and opinion on MWM practices (see Tables 1–11). However, based on the data they provided, only 214 HFs had <10 health workers, 3 had no non-technical staffers, 108 operate 24-hour services, 64 had no bed, 172 render immunization services, and only 226 had a village/ward development

Table 1
Socio-demographic profile of informants.

Variables	Frequency	Percentage
Age [in years] (N=237)		
18–24	3	1.3
25–34	79	33.3
35–44	89	37.6
45–54	59	24.9
55 and above	7	2.9
Sex (N=236)		
Male	193	81.8
Female	43	18.2
Qualifications (N=221)		
BD	2	0.9
OND	215	97.3
HND	4	1.8
Length of service [in years] (N=179)		
1–10	77	43.0
11–20	66	36.9
21–30	31	17.3
31–40	5	2.8
Marital status (N=230)		
Never married	18	7.8
Married	212	92.2
Religion (N=234)		
Islam	220	94.0
Christianity	14	6.0

BD – Bachelor's Degree; OND- Ordinary National Diploma; HND – Higher National Diploma; N – Total number of responses per category.

committee (Table 2).

Only 105 HFs were reported to have a positive history of staff training on MWM, and the training activity was conducted at only 55.2% (58/105) of these facilities (Supplementary file 1, Table S1).

Sharps, blood/body fluid, and domestic wastes were the top three wastes generated among the surveyed HFs (Supplementary file 1, Table S2).

Only 31 HFs had specific colour coding system (Supplementary file 1, Table S3).

Only 65 HFs adopted the use of motorcycle in transporting their wastes to the disposal sites; HF workers were the people that transported these wastes in most (224/257) of the surveyed HFs; and these wastes were often moved to disposal sites, on a daily basis, only at 128 HFs (Supplementary file 1, Table S4).

Medical waste treatment was on-site in 124 HFs while the burn-and-bury method was the adopted method of medical waste disposal in 198 HFs (Supplementary file 1, Table S5).

Furthermore, only 65 HFs had MWM guidelines or policy documents; out of these 65 HFs, only 19 of them had a problem with its implementation. There were cases of occupational hazards (such as needle prick, nosocomial infection, etc.) in 42 HFs. Only 42 HWs reported having a compensation package or health insurance policy to take care of them in case of occupational hazards. Only 78 HFs had functional waste management committees. Only 22 HFs had specific budgetary allocation for MWM. Only 50 HFs had reports on MWM practices in their facility (Table 3).

Also, very vital information was provided by the health workers based on their own opinion (and knowledge) regarding MWM practices at their HFs and Kebbi State at-large. Based on the information provided, we noted that: (1) only 109 study participants knew the quantity of wastes generated, on daily basis, at their HFs (Supplementary file 1, Table S2), (2) only 48 study participants understood the colour coding system or

Table 2
Information on staff strength, daily operational hours, bed availability, and kind of services rendered at the surveyed HFs.

Variables	Frequency	Percentage
How many health workers are in the HF? (N=254)		
<10	214	84.3
11–20	34	13.4
21–30	3	1.2
31–40	2	0.8
41–50	1	0.4
How many non-technical staff are in the HF? (N=243)		
None	3	1.3
1–10	226	93.0
11–20	11	4.5
31–40	2	0.8
41 and above	1	0.4
Does the health facility operate 24-hour services (in and out-patient)? (N=256)		
Yes	108	42.2
No	148	57.8
How many beds are in the health facility? (N=232)		
None	64	27.6
1–10	148	63.8
11 and above	20	8.6
Which kind of health services are rendered at this Health Facility?* (N=257)		
ANC/Delivery	116	45.1
Medicine	85	33.1
Oral health	73	28.4
Children services	98	38.1
Immunization	172	66.9
Radiology	13	5.1
Laboratory	24	9.3
Surgery	7	2.7
Is there a functional Village/Ward Development Committee at this level? (N=254)		
Yes	226	89.0
No	28	11.0

N – Total number of facilities whose respondents responded to the variable; ANC – Antenatal care; *Multiple response variable.

Table 3

Information on medical waste management policy and regulations among the surveyed HFs.

Variables	Frequency (N)	Percentage (%)
Is there any medical waste management guideline or policy document available at this level? (N=242)		
Yes	65	26.9
No	177	73.1
If yes, is there any problem with its implementation? (N=65)		
Yes	19	29.2
No	46	70.2
Are there reported cases of occupational hazards such as needle pricks, cuts/laceration, nosocomial infection etc.? (N=241)		
Yes	42	17.4
No	199	82.6
In the event of an occupation injury/hazard, is there an existing compensation package or health insurance policy to take care of the health worker? (N=239)		
Yes	42	17.6
No	197	82.4
Is there a functional waste management committee at this level? (N=247)		
Yes	78	31.5
No	169	68.4
Do you think the current structure of the health system affect the governance of medical waste management in Kebbi State? (N=224)		
Yes	149	66.5
No	75	33.5
Is there funding allocation to the health facility? (N=235)		
Yes	31	13.2
No	204	86.8
Is there specific budgetary allocation for medical waste management at this level? (N=243)		
Yes	22	9.1
No	221	90.9
If yes, do you think it is sufficient for effective medical waste management? (N=22)		
Yes	15	68.2
No	7	31.8
Is there any partner that works with government on medical waste management? (N=216)		
Yes	56	25.9
No	160	74.1
Is there any report (annual or biannual) on medical waste management at this level (HF, LGA and State)? (N=219)		
Yes	50	22.8
No	169	77.2
What are the impediments to efficient and effective medical waste management at this level? (N=257)		
No/Inadequate Funding	32	12.5
Lack of training or awareness of proper handling and disposal of medical wastes	75	29.2
Absence of waste regulatory policy or guideline	48	18.7
Governance and leadership	18	7.0
Inadequate waste treatment facilities	35	13.7

^a Multiple response variable; HF – Health facility; LGA – Local Government Area.

waste segregation method (Supplementary file 1, Table S3), (3) only 196 study participants expressed dissatisfaction about the waste treatment options adopted in their HFs (Supplementary file 1, Table S5), (4) only 65 study participants reported that the Kebbi State Primary Health Care Development Agency was responsible for the treatment of medical wastes (Supplementary file 1, Table S5), (5) only 45 study participants reported that Kebbi State has only one or two functional incinerators (Supplementary file 1, Table S5), (6) only 15 study participants, out of the 22 study participants working in those HFs (N = 22) having specific budgetary allocation for MWM, reported that the allocation was sufficient (Table 3), (7) only 56 study participants reported that the government partners with external bodies in MWM (Table 3), (8) “lack of training or awareness of proper handling and disposal of medical wastes”, “absence of waste regulatory policy or guideline”, and “inadequate waste treatment facilities” were the top three factors, as reported by the health workers, impeding efficient and effective MWM at the HF level (Table 3).

Table 4

Associations between history of health workers' training on medical waste management and characteristics of the surveyed HFs.

Variables	Has any training been done at this HF on medical waste management?		p-value (χ^2)
	Yes (%) [N = 105]	No (%) [N = 151]	
How many health workers are in the HF?			
–10	88 (83.8)	126 (83.4)	0.107
11–20	12 (11.4)	22 (14.6)	
21–30	2 (1.9)	0 (0)	
31–40	2 (1.9)	0 (0)	
41–50	1 (0.9)	0 (0)	
Total ^a	105 (100.0)	148 (98.0)	
How many non-technical staff are in the HF?			
None	0 (0)	3 (1.9)	0.131
1–10	91 (86.7)	135 (89.4)	
11–20	7 (6.7)	3 (1.9)	
31–40	1 (0.9)	1 (6.6)	
41 and above	1 (0.9)	0 (0.0)	
Total ^a	100 (95.2)	142 (94.0)	
Does the health facility operate 24 hours services (in and out-patient)?			
Yes	54 (51.4)	53 (35.1)	0.010
No	51 (48.6)	97 (64.2)	
Total ^a	105 (100.0)	150 (99.3)	
How many beds are in the health facility?			
None	13 (12.4)	51 (33.8)	<0.001
1–10	70 (66.7)	77 (50.9)	
11 and above	11 (10.5)	9 (5.9)	
Total ^a	94 (89.5)	137 (90.7)	
Is there a functional Village/Ward Development Committee at this level?			
Yes	102 (97.1)	123 (81.5)	<0.001
No	1 (0.9)	27 (17.9)	
Total ^a	103 (98.0)	150 (99.3)	

^a Total number of respondents that responded to the two cross-tabulated variables; HF – Health facility; N – Total number of respondents in each category.

Lastly, we performed bivariate analysis, comparing associations between the history of health workers' training on MWM and characteristics of the surveyed health facilities, which yielded noteworthy results (Tables 4–6). Only statistically significant relationships (i.e., p-values <0.005) exist between operating hours, bed spaces, and the existence of a functional village/ward development committee, and history of MWM training at the surveyed HFs (Table 4).

Also, no statistically significant relationship was recorded between methods of medical waste disposal and characteristics of the surveyed HFs (Table 5).

Finally, amongst other comparisons, a statistically significant relationship exists between operating hours of the surveyed HFs and the existence of a functional waste management committee at the HF level (Table 6).

4. Discussion

The majority of the study participants were Ordinary National Diploma holders and in the age range of 25–44 years. A similar finding on this socio-demographic profile was reported by Umar et al., who conducted a study at Fagge LGA, Kano State, Nigeria, involving PHCs [15]. This is, however, in contrast to a study conducted at PHCs at Zaria, Kaduna State, Nigeria, where nurses constituted the majority [16]. Other studies conducted at various or mixed levels of healthcare delivery had reported varying proportions of participants' professional cadres [3,7–9, 17].

In the HFs that were surveyed in this study, the types of waste generated there were sharps, domestic wastes, blood and body fluid, chemical and radioactive wastes. Roughly half of the wastes being generated were sharps, followed by domestic wastes, then blood and body fluids, while little chemical and radioactive wastes were also generated. This finding is similar to findings in a study conducted at the primary health care level at Fagge Local Government Area of Kano State

Table 5

Associations between methods of medical waste disposal and characteristics of the surveyed HFs.

Variables	Which kind of waste disposal method is being used?				p-value (χ^2)
	Open dump (%) [N = 24]	Burn and bury pit (%) [N = 198]	Transport to a pre-defined site (%) [N = 23]	Incineration (%) [N = 4]	
How many health workers are in the HF?					
1–10	21 (87.5)	161 (81.3)	21 (91.3)	4 (100.0)	0.137
11–20	2 (8.3)	30 (15.2)	1 (4.3)	0 (0.0)	
21–30	0 (0.0)	3 (1.5)	0 (0.0)	0 (0.0)	
31–40	0 (0.0)	1 (0.5)	1 (4.3)	0 (0.0)	
41–50	1 (4.7)	0 (0.0)	0 (0.0)	0 (0.0)	
Total ^a	24 (100.0)	195 (98.5)	23 (100.0)	4 (100.0)	
How many non-technical staff are in the HF?					
None	0 (0.0)	2 (1.0)	1 (4.3)	0 (0.0)	0.879
1–10	22 (91.7)	175 (88.3)	18 (78.3)	4 (100.0)	
11–20	1 (4.2)	9 (4.5)	1 (4.3)	0 (0.0)	
31–40	1 (4.2)	1 (0.5)	0 (0.0)	0 (0.0)	
41 and above	0 (0.0)	1 (0.5)	0 (0.0)	0 (0.0)	
Total ^a	24 (100.0)	188 (94.9)	20 (86.9)	4 (100.0)	
Does the health facility operate 24 hours services (in and out-patient)?					
Yes	10 (41.7)	85 (42.9)	7 (30.4)	2 (50.0)	0.688
No	14 (58.3)	112 (56.6)	16 (69.6)	2 (50.0)	
Total ^a	24 (100.0)	197 (99.5)	23 (100.0)	4 (100.0)	
How many beds are in the health facility?					
None	8 (33.3)	43 (21.7)	10 (0)	0 (0.0)	0.200
1–10	12 (0.5)	119 (60.1)	10 (0)	2 (50.0)	
11 and above	2 (8.3)	15 (7.6)	2 (0)	1 (25.0)	
Total ^a	22 (91.7)	177 (89.4)	22 (0)	3 (75.0)	
Is there a functional Village/Ward Development Committee at this level?					
Yes	22 (91.7)	175 (88.4)	18	4 (100.0)	0.321
No	2 (8.3)	20 (10.1)	5	0 (0.0)	
Total ^a	24 (100.0)	195 (98.5)	23	4 (100.0)	

^a Total number of respondents that responded to the two cross-tabulated variables; HF – Health facility; N – Total number of respondents in each category.

[15] and selected hospitals in southeast Nigeria [8]. Other studies, particularly those that were conducted in secondary health care facilities, and bigger hospitals found domestic wastes constituting the highest proportion of wastes generated, followed by sharps [17,18]. These disparities in findings are essentially a reflection of the nature of services being rendered as it was found in this study that roughly one-third of the services rendered were immunisation activities. This was followed by ante-natal care/delivery services. Furthermore, the report of chemical and radioactive wastes generated among the study participants, though very minute, might result from an inadequate understanding of the question. Nevertheless, this is insignificant or too little to alter the overall outcome of the study. Based on responses from the study participants, a larger proportion of the surveyed HFs did not measure the daily wastes being generated, as shown in this study. This is an indication of the low standard of MWM practices in this setting. A similar finding had been documented in a study conducted in a South African Hospital where medical wastes were not quantified, and no reliable records were found [19].

The majority of the surveyed HFs did not segregate wastes by colour

Table 6

Associations between existence of a functional waste management committee and characteristics of the surveyed HFs.

Variables	Is there a functional waste management committee at this level?		p-value (χ^2)
	Yes (%) [N = 78]	No (%) [N = 169]	
How many health workers are in the HF?			
1–10	64 (82.1)	141 (83.4)	0.643
11–20	11 (14.1)	22 (13.0)	
21–30	2 (2.6)	1 (0.6)	
31–40	1 (1.3)	1 (0.6)	
41–50	0 (0.0)	1 (0.6)	
Total ^a	78 (100.0)	166 (98.2)	
How many non-technical staff are in the HF?			
None	1 (1.3)	1 (0.6)	0.761
1–10	72 (92.3)	148 (87.6)	
11–20	3 (3.8)	8 (4.7)	
31–40	0 (0.0)	2 (1.2)	
41 and above	0 (0.0)	1 (0.6)	
Total ^a	76 (97.4)	160 (94.7)	
Does the health facility operate 24 hours services (in and out-patient)?			
Yes	40 (51.3)	63 (37.3)	0.041
No	38 (48.7)	105 (62.1)	
Total ^a	78 (100.0)	168 (99.4)	
How many beds are in the health facility?			
None	16 (20.5)	45 (26.7)	0.157
1–10	53 (67.9)	89 (52.7)	
11 and above	4 (5.1)	15 (8.9)	
Total	73 (93.6)	149 (88.2)	
Is there a functional Village/Ward Development Committee at this level?			
Yes	73 (93.6)	143 (84.6)	0.089
No	5 (6.4)	23 (13.6)	
Total ^a	78 (100.0)	166 (98.2)	

^a Total number of respondents that responded to the two cross-tabulated variables; HF – Health facility; N – Total number of respondents in each category.

coding, and indeed the majority of the study participants did not understand the color-coding system in MWM. This is a clear indication of training deficit and poor MWM practices at this level. This finding agrees with several other studies conducted in Nigeria, where waste segregation was either non-existent or poorly observed [1,7–9,16,17,19,20]. Similarly, studies conducted in other developing countries had reported poor or incorrect segregation of medical wastes [4,18,19,21,22]. However, very few studies showed a high level of waste segregation in this environment [3,6]. These are essentially studies done in Lagos State, a State which seems to have a more organised and established MWM practice, involving the public waste management authority [3,6].

The treatment of wastes was mostly on-site, as mentioned by the study participants, and the majority indicated that burn-and-bury technique was the method of waste disposal being practised at their HFs. Also, incineration, which is the preferred method of MWM was infrequently used in Kebbi State. The use of incinerators in the final disposal of medical wastes in Nigeria was minimal and comparatively lower at the PHC level. Previous studies in Nigeria that have assessed the use of incinerators indicated very low use of incinerators [6,23]. At the primary health care level, incinerators are usually deployed to destroy massive medical wastes generated from vaccination campaigns (mass immunisation) where funds are earmarked for waste management.

In this study, the transport of medical wastes was mainly done by the PHCWs using motorcycles to a pre-defined site for onwards destruction. Kebbi State Primary Healthcare Development Agency rarely provides logistics support for the evacuation to the pre-defined site. Furthermore, the involvement of public waste management authority or the Ministry of Environment was significantly low in this study setting. This study's finding is contrary to published studies from Lagos State, where there existed a partnership with Lagos State Waste Management Authority (LAWMA) in the final medical waste disposal [3,6]. A similar partnership or concession was also reported in a publication from Malaysia, where concession companies were involved in waste management [18].

However, this study finding corroborated older studies demonstrating poor waste transportation and disposal practices in Nigeria [1,7,8,17, 23].

Furthermore, medical waste guidelines or policy documents were hardly available or known to the study participants. In the HFs where there are guidelines, the implementation levels were low amidst numerous challenges. This study data showed that few cases of occupational hazards had occurred in the sampled HFs. This study investigated the existence of insurance and compensation packages for victims of occupational hazards within the PHC services and found no insurance policy or compensation package in place to take care of injured or victims of occupational hazards. Similarly, in 2017, another study reported the non-availability of insurance and compensation packages for occupational hazards victims [7]. The finding calls for the protection of health workers' rights to compensation and insurance packages in the event of injuries or deaths due to occupational hazards.

Regarding the existence of a functional waste management committee at the HF level, the majority of the HFs did not have a functional waste management committee. This finding corroborated a previous study conducted in Nigeria [8]. The waste management committee oversees the administration of waste management activities within the HF.

The governance of PHC services could affect the administration of MWM at the operational level (from the point of generation to final disposal) as most of the study participants indicated that the current structure affects the governance of MWM in Kebbi State. Regarding funding, most of the study participants indicated no funding allocation to the HFs for waste management. Further, nearly all the studies reported that was no funding allocation for MWM at the HF level [1,17].

This study also found that there was a minimal level of partners' involvement in MWM in Kebbi State for routine PHC services. No previous study has investigated the involvement of development partners in medical waste management. Our field experience indicated that the development partners usually provide funds for MWM only during mass immunisation. This mitigated or prevented hazards the communities and environments would have been exposed to as a result of huge wastes (domestic and sharps) that were generated from such a large-scale immunisation exercise.

Bivariate analyses were conducted to explore the predictors of few outcomes such as training on waste management, waste disposal method and the existence of functional waste management committees.

Regarding the likelihood of training, the analysis showed that HFs with 24-hour services were more likely to conduct waste management training. Also, the presence of a functional village/ward development committee could be a predictor of the likelihood of implementation of waste management training. This study also found that the greater the number of beds in a facility, the more likely the health facility would have had medical waste management training. The variables or characteristics that predicted the likelihood of training are plausibly related to the functionality of the health facilities. For example, only health facilities that provided comprehensive primary health services operate 24hours' services-such facilities often run in-patient services, have beddings, and more likely to be supported by a functional village/ward development committee (given the degree of functionality). The existence of functional VDC/WDCs reflects the strength of community linkage with PHCs. On the other hand, the number of health workers, the number of non-technical staff and the type of services rendered did not predict the likelihood of having medical waste management training.

The study tested the association between plausible potential predictors of waste management disposal method, i.e., number of health workers, number of non-technical workers, 24-hour operation, number of beds and functional village/ward development committee. However, there was no significant association between the test and outcome variables. This finding may be due to the extremely low use of acceptable disposal methods. Essentially, most PHC facilities use the burn-and-bury method while other methods, such as incineration and open dumping,

were employed on a lesser scale. Similarly, the tested variables did not predict the likelihood of having a functional waste management committee at the health facilities.

Furthermore, this study investigated the possible impediments to effective and efficient waste management at the PHC level. The study revealed a lack of training or sensitisation on proper handling and disposal of medical wastes, inadequate treatment facilities, inadequate funding as well as governance and leadership problems. Previous studies had identified the above-listed challenges-local and international-in other developing countries [4,8,9,17-22], except the PHC system's governance, as applied to the study area.

5. Conclusion

This study showed that medical waste management practices are grossly sub-optimal at the PHC facilities in Kebbi State, Nigeria. The study revealed the dire need for the government and partners to urgently address the operational and policy gaps in medical waste management in Kebbi State, Nigeria, given its public health and environmental implications. We recommend the speedy implementation of primary-health-care-under one-roof (PHCUOR) in Kebbi State to address the fragmented management system and weak governance that impeded optimal PHC activities, including medical waste management. Further, the Kebbi State Government should consider public-private partnerships in managing medical waste to improve efficiency and mitigate potential health and environmental hazards. Addressing the gaps found in this study would contribute to the attainment of the United Nations Sustainable Development Goals in health and well-being, sustainable cities and communities and contribute to poverty eradication.

6. What is already known on this topic

- Good MWM can be an integral part of effective infectious control procedure, if properly implemented.
- Adequate attention has not been paid to MWM practices in many health institutions in Kebbi State, Nigeria.
- There is no strict adherence to professional ethics of MWM in Kebbi State, Nigeria.

7. What this study adds

- Acceptable medical waste management practices are lacking at the PHC facilities in Kebbi State, Nigeria
- There is a need for government and other relevant stakeholders to urgently address the identified operational and policy gaps in medical waste management in Kebbi State, Nigeria, given its public health and environmental implications
- The fragmented governance and leadership structure of the PHC system has grave implications for the policy and practice of medical waste management in Kebbi State, Nigeria
- Kebbi State Government should consider public-private partnerships in managing medical waste to improve efficiency and mitigate potential health and environmental hazards
- Overall, addressing the gaps found in this study would contribute to attaining the United Nations Sustainable Development Goals in health and well-being, sustainable cities and communities, and contributing to poverty eradication.

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Authors' contributions

SAO conceptualised, designed, managed and interpreted the study

data and drafted the first version of the manuscript. NU contributed to the design, supervised and critically reviewed the manuscript drafts. KKK contributed to data management and reviewed the manuscript drafts while MMA reviewed the manuscript drafts. All authors read and approved the final draft before submission.

Ethical consideration

This study was conducted under the strict guidelines of the Helsinki Declaration of 1964. The study protocol was approved by the Kebbi State Research Ethics Committee, Kebbi State Ministry of Health, Kebbi State, Nigeria.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhip.2021.100092>.

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