Vol.3, No.5, Page 1229- 1240, 2025 https://doi.org/10.59628/jast.v3i5.1470 ISSN 2958-9568 JAST

SUN PUBLISHER

مجلة جامعة صنعاء للعلوم التطبيقية والتكنولوجيا

Sana'a University Journal of Applied Sciences and Technology

https://journals.su.edu.ye/index.php/jast/

A Survey on Medical Waste Management Practices in Government Healthcare Facilities in Hodeidah City, Yemen

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Abstract

Hodeidah City, the main port on Yemen's western coast, is under severe healthcare strain owing to ongoing conflicts and humanitarian crises. Government hospitals operate under pressure with limited data on healthcare workers' adherence to medical precautions. This study aims to explore awareness and safety practices. It uses descriptive and analytical methods to assess healthcare workers' compliance with medical waste management guidelines, identify knowledge and practice gaps, and evaluate institutional adherence to national and international regulations. Data were gathered through a semi-structured, self-administered questionnaire that was administered to 333 healthcare workers in ten medical institutions in Hodeidah City from January 2022 until January 2023. The present study highlights major gaps in medical waste management and the protection of cleanliness workers in healthcare settings. While medical staff generally follow waste segregation protocols within structured systems, cleanliness workers face challenges such as poor training, limited supervision, inadequate protective gear, and vaccination. Issues such as torn waste bags and lack of medical checkups further expose systemic vulnerabilities. Despite this, many clean workers reported high job satisfaction, reflecting resilience and dedication. To improve safety, healthcare facilities must strengthen their oversight, provide consistent protective equipment, and offer regular health assessments and targeted training. These steps are essential for safeguarding workers, the public, and the environment and for building a more resilient healthcare system in Yemen.

Article Info

Keywords:
Medical Waste, Healthcare Workers, Precautions, Awareness, Hodeidah, Yemen

Article History:
Received: 26-June-2025,
Revised: 30-June-2025,
Accepted: 04-August-2025,
Available online: 28 October 2025.

1. INTRODUCTION

Medical waste, also called healthcare waste, is the waste generated by healthcare facilities, whether governmental or private, such as hospitals, clinics, and laboratories, as well as educational and research institutions concerned with medical specialties [1]. These wastes may include contaminated or infectious materials (gas, liquid, or solid), sharps, pharmaceuticals, chemicals, and radioactive or toxic materials [2, 3]. Medical waste also includes first-aid waste from homes and non-medical facilities, *etc.* This refers to waste generated by healthcare providers at home, such as cotton and gauze contaminated with blood or infectious diseases, which may be entirely or partially composed of biological tissue or body fluids, as well as medication residues and sharp instruments, such as syringes and scalpels. Medical waste poses a threat to human health, pollutes the environment, and spreads diseases and epidemics among communities. Improper handling, segregation, and disposal of medical waste, especially infectious, pathological, chemical, and sharp waste, can lead to the transmission of a wide range of diseases, including hepatitis B and C, HIV, and other bloodborne infections [4–7]. According to [8], the World Health Organization (WHO) estimated that approximately 2.5% of HIV infections and 40% of hepatitis B and C infections among healthcare workers globally are attributed to occupational exposure [9]. However, solid waste produced by medical institutions can include general waste generated from food preparation, housekeeping, and administrative activities [1]. Several studies have shown variable levels

of awareness and compliance among medical institution staff, particularly in low-income and middle-income countries [10, 11]. In the Republic of Yemen, a low-income country suffering from political and economic crises during the last decade, the situation has deteriorated because of several factors such as limited infrastructure and finance, poor waste management, lack of personal protective equipment (PPE), Yemen's ongoing conflict, lack of well-trained staff, and capacity building programs [12–19]. Hodeidah City, which is the major port city on the western coast of Yemen, is facing significant stress in its healthcare system because of the current conflict and humanitarian crises. Its government hospitals and healthcare centers operate under immense pressure, and the adherence of healthcare workers to standard medical precautions remains understudied. This investigation is the first to shed light on the issues of awareness and medical precautionary measures among healthcare workers in the medical institutions of Hodeidah City. This study's findings are expected to contribute to evidence-based policy decisions and capacity-building efforts in Yemen.

2. MATERIALS AND METHODS

2.1. *The Study Area*

The Hodeidah Governorate is one of ten coastal governorates in the Republic of Yemen. It is located along the western coast of Yemen, with a total shoreline length of 519.7 km, which is considered the longest among the coastal governorates [20]. It has a total area of approximately 117,145 km^2 and consists of 26 districts [7], all of which are located on the western *Tehama* coastal plains of Yemen (Figure 1). It ranks second among the Yemeni governorates, with an estimated total of nearly three million, with an annual growth rate of 3.25% [21]. Hodeidah City serves as the administrative capital of the governorate and is situated approximately in the middle of its coastline. It is one of Yemen's most important cities, hosting the country's main seaport in the Red Sea. The city covers an area of approximately 181 km² and has an estimated population of approximately 604,439 in 2017, based on projections from the 2004 Census by Yemen's Central Statistical Organization (CSO) [22]. Hodeidah City is divided into three districts: Al-Mina, Al-Hali, and Al-Hawak. According to government climate records, the Hodeidah Governorate experiences long, hot summers and short, mild winters. The average monthly maximum temperatures ranged from 37.5°C to 19.6°C in summer and from 24°C to 14°C in winter. Being located along the coast, the area experiences high humidity levels owing to evaporation, with an average relative humidity between 70% and 85%. Evaporation rates exceed precipitation because rainfall in the governorate is low, infrequent, and irregular, typically ranging from 60 to 150 mm annually.

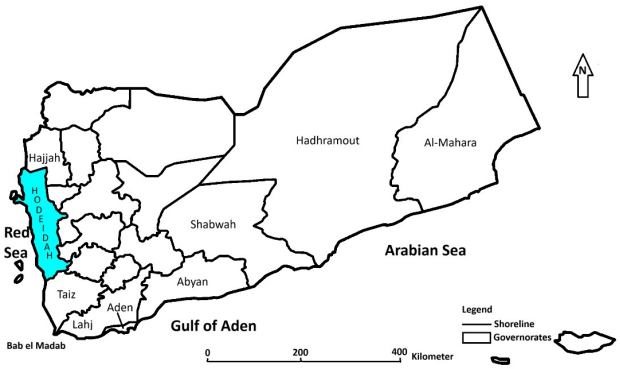

Figure 1. Location of Al-Hodeidah Governorate.

2.2. *Methodology*

The research study was carried out from January 2022 to January 2023 and targeted ten government hospitals and healthcare institutions in Hodeidah City. Those institutions are Al-Thawra General Hospital Authority, September 21st Hospital, Dialysis Center, Al-Tahrir Health Complex, Health Centers of: Al-Yemen, Al Mughtaribeen, Al-Za'afaran, Al-Hawak, and Al-Rabasah areas, and the National Center for Central Public Health Laboratories (Figure 2).

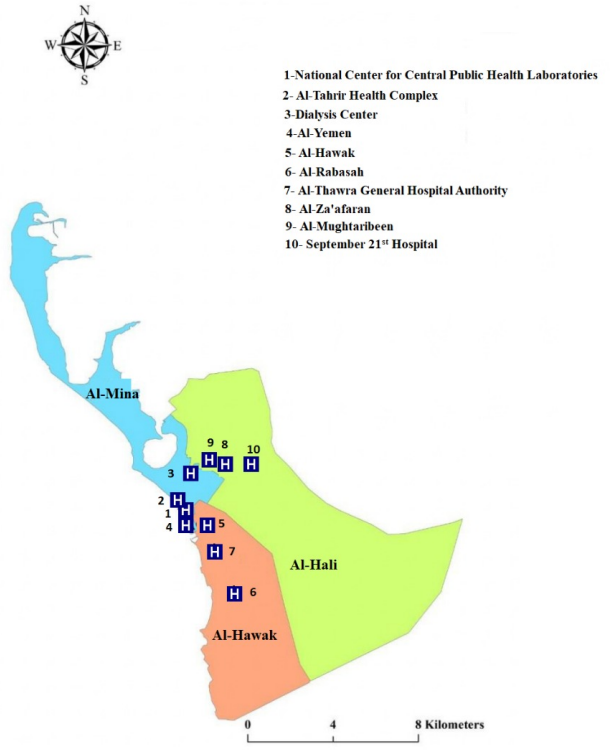

Figure 2. Location of the Investigated Health Care Institutions in the Study Area.

The city of Hodeidah was specifically chosen because most of the main government and private hospitals are located in it to serve the population of the Hodeidah Governorate. It is also the most densely populated area in

the Governorate. Thus, the city provides a good representation of the current situation regarding medical waste management in the rest of the Republic of Yemen to understand the current status of waste management. The present research depends on descriptive and analytical scientific methods, which focus on evaluating the level of adherence to established medical waste management guidelines, identifying gaps in knowledge and practice among healthcare workers, and determining the extent of institutional compliance with national or international waste management regulations. Data were collected using a semi-structured and self-administered questionnaire designed after an extensive literature review. Two questionnaires were prepared, one distributed to the medical staff and the other meant for the cleanliness workers in the selected government medical institutions. The medical staff questionnaire consisted of two divisions. The first contained parameters determining sociodemographic characteristics (*i.e.* occupation, age, gender, years of experience, and qualification). The second part contained multiple-choice questions to assess their knowledge level of laws and regulations on how to manage medical waste in the healthcare sector (*i.e.* existence of laws and regulations dealing with medical waste, compliance monitoring system, guide for workers and signboards, waste segregation, PPE, *etc.*). The cleanliness workers questionnaire contained the same part of sociodemographic characteristics, in addition to the medical waste management part, which consisted of several multiple-choice questions regarding evaluating their knowledge about handling medical waste, and whether they followed the rules and regulations of medical waste segregation and suitable equipment used for this operation, in addition to questions related to the transportation of medical waste throughout the hospital departments, and the places used for collection and storage either inside or outside the healthcare institution. There are also several questions related to their PPE as well as undergoing regular training programs and periodic medical examinations and vaccinations. Several interviews were conducted with members of the study sample to obtain unwritten or unstudied information. Personal interviews were also used to clarify the questionnaire items if necessary and to ensure correct answers. Indirect questions were also posed to gain a general idea of the extent to which safe medical waste management is implemented in the city's governmental health facilities. Collected data were checked for completeness and consistency. Responses to the questionnaires were coded and entered into a statistical software package for analysis (Microsoft Excel). Descriptive statistics, such as frequencies, percentages, and means, were used to summarize the demographic characteristics of the respondents and their responses to key variables related to medical waste management practices and compliance.

3. RESULTS

Three hundred and thirty-three study participants responded to the distributed questionnaires (100%), of which 306 were medical staff and 27 were cleanliness workers from the studied medical government institutions as follows: 68.3% and 70.3% from Al-Thawra Hospital, 15% and 11.1% from the September 21st Hospital, 6.2 % and 7.4% from the Dialysis Center, 2.3% and 3.7% from the Tahrir Health Complex, 6.2% and 3.7% from the Health Centers, and 2% and 3.7% from the National Center for Central Public Health Laboratories. Table 1 shows the demographic characteristics of the medical staff cleanliness workers in this study.

Table 1. The demographic characteristics of healthcare workers in Hodeidah City government hospitals.

Demographic Characteristics			n	%
A. Medical Staff				
1	**AGE**	Less than 18 years	3	1
		18 – 40 years	251	82
		More than 40 years	52	17
		Total	**306**	**100**
2	**SEX**	Male	133	43.5
		Female	173	56.5
		Total	**306**	**100**
3	**EDUCATION**	Illiterate	0	0
		School Certificate	0	0

		Diploma	60	19.6
		University Certificate	246	80.4
		Total	**306**	**100**
4	**OCCUPATION**	Doctor	19	6.2
		Nurse	146	47.7
		Laboratory Scientist	52	17
		Radiologist	4	1.3
		Pharmacist	20	6.5
		Administrator	65	21.2
		Total	**306**	**100**
5	**EXPERIENCE**	Less than 6 months	15	4.9
		6–12 months	85	27.8
		1 – 3 years	126	41.2
		More than 3 years	80	26.1
		Total	**306**	**100**
B. Cleanliness Workers				
1	**AGE**	Less than 18 years	0	0
		18 – 40 years	19	70.4
		More than 40 years	8	29.6
		Total	**27**	**100**
2	**SEX**	Male	18	66.7
		Female	9	33.3
		Total	**27**	**100**
3	**EDUCATION**	Illiterate	13	48.1
		School Certificate	14	51.9
		Diploma	0	0
		University Certificate	0	0
		Total	**27**	**100**
4	**EXPERIENCE**	Less than 6 months	0	0
		6–12 months	1	3.7
		1 – 3 years	5	18.5
		More than 3 years	21	77.8
		Total	**27**	**100**

Table 2. Responses of the medical staff to survey questions on medical waste management

	Question	Answer	n	%
1	Can you differentiate between hazardous medical waste and non-hazardous medical waste?	Yes	306	100
		No	0	0
		Total	306	100
2	Is hazardous medical waste separated from non-hazardous waste in the department where you work?	Yes	289	94.4
		No	17	5.6
		Total	306	100
3	Are the supplies related to separating medical waste provided within the department in which you work?	Yes	289	100
		No	0	0
		Total	289	100
4	If yes, what are the available requirements? (Special packaging for each type, etc.)	Special packaging for each type	39	13.5
		Protective clothing	0	0
		Special bags	15	5.2
		All of the above	235	81.3
		Total	289	100
5	Where does the medical waste segregation process take place?	At the source of waste production	289	100
		After the waste collection process	0	0
		At the place prepared for storing medical waste	0	0
		Otherwise specify	0	0
		Total	289	100
6	Who separates medical waste in the department you work in?	Cleaning personnel	1	0.3
		Medical Staff	252	87.2
		Both	36	12.5
		Total	289	100
7	Is medical waste fully/partially segregated?	Fully	256	88.6
		Partially	33	11.4
		Total	289	100
8	Are primary treatment methods used before disposing of hazardous medical waste?	Yes	8	2.6
		No	298	97.4
		Total	306	100
9	Knowledge of the existence of laws and regulations requiring the separation of medical waste	Yes	303	99
		No	3	1
		Total	306	100
10	The presence of internal control over the separation of medical waste	Yes	306	100
		No	0	0
		Total	306	100
11	If yes, what are the methods and means of internal control?	Human monitoring	23	7
		Reporting	7	3
		Both	276	90
		Total	306	100
12	Is there a guide for dealing with medical waste?	Yes	244	80
		No	58	19
		I don't know	4	1
		Total	306	100
13	Are there signs posted for handling medical waste?	Yes	306	100
		No	0	0
		Total	306	100

Table 3. Cleanliness workers' responses to survey questions regarding the handling of medical wastes.

	Question	Answer	n	%
1	Is medical waste collected dailv at the end of work?	Yes	27	100
		No	0	0
		Total	27	100
2	How many times is medical waste collected per day?	1–2 times	3	11.1
		3–5 times	5	18.5
		More than 5 times	19	70.4
		Total	27	100
3	Are the waste bags that are transported exposed to tearing?	Always	5	19
		Sometimes	16	59
		Never	6	22
		Total	27	100
4	Are medical waste bags filled beyond their capacity?	Always	0	0
		Sometimes	2	7
		Never	25	93
		Total	27	100
5	Is there a collection (temporary storage) site for medical waste within the department in which you work?	Yes	20	74
		No	7	26
		I don't know	0	0
		Total	27	100
6	Is there a clear sign indicating the waste collection (temporary storage) location?	Yes	1	5
		No	19	95
		I don't know	0	0
		Total	20	100
7	Is the collection site (temporary storage) in the hospital or health center where you work within environmental specifications?	Yes	1	5
		No	16	80
		I don't know	3	15

		Total	20	100
8	What is the period of time that medical waste remains in temporary collection storage?	2 hours	3	15
		6 hours	17	85
		Total	20	100
9	Where is medical waste stored (centrallv)?	Outside	1	4.7
		Inside	4	14.8
		Storage Room	22	81.5
		Total	27	100
10	Is there a sign indicating the presence of a central medical waste storage facility? medical waste storage facility?	Yes	2	7.4
		No	25	92.6
		I don't know	0	0
		Total	27	100
11	What is the method of transporting medical waste within the hospital or health center where you work within your facility?	By hand	10	37
		Special trolley	6	22.2
		Both	11	40.7
		Total	27	100
12	Do you notice any fluid leakage during transportation?	Always	2	7.4
		Sometimes	3	11.1
		Never	22	81.5
		Total	27	100
13	Do you feel comfortable using your waste disposal vehicle?	Yes	17	63
		No	10	37
		Total	27	100
14	Are you trained to handle medical waste?	Yes	20	74
		No	7	26
		Total	27	100
15	Are the clothes you wear while handling medical waste protective?	Yes	9	33.3
		Kind of	6	22.2

		No	12	44.4
		Total	27	100
16	Are gloves used when handling medical waste?	Always	23	85
		Sometimes	4	15
		Rarely	0	0
		Never	0	0
		Total	27	100
17	Have any of your cleaners been exposed to needle sticks while handling medical waste at your facility?	Always	0	0
		Sometimes	9	33
		Rarely	15	56
		Never	3	11
		Total	27	100
18	Are any of the cleaners subject to medical examination?	Before	0	0
		After	8	30
		Never	19	70
		Total	27	100
19	Are cleaners regularly vaccinated against infectious diseases?	Yes	3	11
		No	24	89
		Total	27	100
20	Are officials regularly check about the health and safety of cleanliness workers?	Always	10	37
		Sometimes	7	26
		Never	10	37
		Total	27	100
21	How satisfied are cleaners with the tasks they perform?	Very satisfied	13	48.1
		Satisfied	12	44.4
		Not satisfied	2	7.4
		Total	27	100

Table 2 shows the responses of the participants to questions regarding the segregation of waste produced by healthcare institutes. Table 3 shows the responses of the cleanliness workers regarding the process of dealing with medical waste.

3.1. Discussion

Management of medical waste is necessary and has become a critical issue worldwide. The increasing amount of medical waste, which contains infectious, hazardous, and radioactive materials produced by healthcare services, demands strict regulatory procedures. However, the process of dealing with medical waste is completely different from that of dealing with municipal waste, either during their segregation, storage, transportation, treatment, or disposal [23]. The complexity of medical waste and its characteristics can pose significant risks to human health and the surrounding environment [24]. Exposure to infectious materials, sharp injuries, and toxic substances can lead to disastrous health trauma, including the spread of hepatitis and HIV among healthcare workers and solid waste handlers [25]. Moreover, inappropriate disposal, either by burning or dumping, can contribute to water and soil contamination, air pollution, and the deterioration of surrounding ecosystems [7]. With respect to the demographic characteristics of medical staff in the present study, there were slightly more female responders (56.5%) than male responders (43.5%). This indicates that both males and females among the medical staff are enthusiastic about participating in such studies voluntarily. Among the medical staff, nurses were the top respondents to the distributed questionnaire, with a percentage of 47.7% (Table 1). This result agrees with an earlier study by [17], who stated that nurses are still eager to volunteer in such studies, which was also similar to a previous study conducted in South Africa by [26]. On the other hand, the majority of respondents among cleanliness workers were male (66.7%), whereas females accounted for 33.3%. This demonstrates a greater workforce among males than among women. The present study revealed a marked difference in educational attainment between medical staff and cleanliness workers within the government healthcare facilities surveyed. While the majority of medical staff has bachelor degree (80.4%), and 19.6% of them has diploma degree, education among cleanliness workers were notably low as 51.9 % have got secondary school certificate, and the remaining (48.1%) are illiterate. The high level of formal education among medical staff is consistent with the qualifications typically required for clinical roles and reflects a workforce that is generally well prepared to deliver healthcare services. In contrast, cleanliness workers possessed significantly lower levels of education, revealing a clear gap in educational background compared to medical staff. This low educational level may have reduced their ability to comprehend written instructions, safety signs, or training materials related to medical waste handling and sanitation. The majority of participants in the study of cleanliness staff had more than three years of experience in healthcare institutes (77.8%), whereas 18.5% of them had between 12 months and 3 years of experience. On the other hand, only 3.7% of them had experience between 6 and 12 months in the healthcare field. This level of experience indicates long-term involvement in healthcare roles, which may contribute positively to institutional knowledge and consistency in cleaning and waste-handling activities. With respect to medical staff, the majority (41.2%) have an experience from one–three years, indicating a relatively early to mid-career stage for many participants. About 27.8% had experience between 6 and 12 months, indicating recent employment or recruitment, and 26.1% had experience of more than three years, indicating a smaller but significant group of seasoned professionals. Only 4.9 had less than six months of experience. The present investigation evaluated healthcare workers' knowledge of handling medical waste in accordance with WHO standards and recommendations [27]. Although all medical staff can differentiate between hazardous and non-hazardous medical waste, approximately 5.6% stated that hazardous medical waste is not separated from non-hazardous waste in the department where they work, even though supplies related to separating medical waste are provided. This indicates a gap between knowledge and actual practice in some departments. This issue requires not only providing supplies, but also reinforcing adherence to proper waste segregation protocols through supervision and accountability. About 88.6% responded that medical waste was fully segregated, which indicates strong compliance with the standards. The other 11.4% said that medical waste is partially segregated in their departments, which could be a potential risk to healthcare workers, patients, and the environment, as this could lead to contamination and the spread of infections [28]. Particularly, when we found in the present survey that 97.4% of the medical staff said that no primary treatment methods are used before disposing of hazardous medical waste in their departments. The survey of medical staff also indicated that the majority showed proper knowledge and demonstrated good practices for handling medical waste. Approximately 99% of them were aware of the laws and regulations requiring the separation of medical waste, and100% stated that there was internal control over the separation of medical waste, either by human monitoring or reporting. Approximately 80% reported knowledge of the existence of a specific guide for dealing with medical waste, while all participants (100%) reported that there were instruction signs that were visibly posted for handling medical waste. The results of the present investigation showed a well-informed medical staff and a

structured environment that supports compliance with medical waste management protocols. With regard to cleanliness laborers, who are responsible for collecting hazardous waste from the departments and transporting it to the temporary storage area inside their medical institution, their responses revealed concerning issues with the ways of handling and quality of bags that they used for this process. Approximately 59% reported that the bags were *sometimes* torn during the process, 19% indicated that they were *always* torn, and only 22% stated that they *never* observed any tearing. These findings highlight the significant risk of exposure to hazardous materials owing to the weak containment. Such incidents could be due to poor-quality bags, improper handling techniques, heavy waste, sharp objects, or overfilling, although 93% of them stated that medical waste bags never filled beyond their capacity. Addressing this issue requires ensuring the use of durable high-quality waste bags. In addition, safe waste handling practice training should be provided to minimize health and environmental risks. Regular training workshops should be conducted to ensure that healthcare staff fully understand the importance of medical waste management [29, 30]. The results of this study also showed that all government institutions studied, with the exception of the National Center for Central Public Health Laboratories, do not place identification tags on waste bags or containers to indicate the type and source of waste. This makes it difficult to track waste and identify shortcomings in the departments from which it originates. The results of this study are consistent with those of most studies conducted in several countries such as Sudan [31] and Palestine [32]. The weak economic situation in these countries places a burden on medical waste management, forcing officials to purchase lower-quality and cheaper collection bags, in addition to the weak legal framework for medical waste in these countries. Occupational health and safety are weak in Yemen [7]. During the present study, 44.4% of cleanliness workers were not provided with protective clothes to handle medical waste. On the other hand, 22.2% said that the clothes they wore while handling medical waste were somewhat protective, while 33.3% stated that they were provided with protective clothes. About 85% of them were provided with proper gloves during the handling of medical waste, and 15% denied the support of gloves by their management. However, during the field visits to the targeted medical institutions, many cleanliness workers did not wear gloves while handling the medical waste. Furthermore, the quality of gloves, if used, is very thin and unsuitable for their work, potentially putting them at risk. The lack of protective clothing and gloves among nearly half of cleanliness workers greatly increases the risk of exposure to infectious agents and hazardous materials [33]. This risk appeared in their responses, as 33% of them were sometimes exposed to needle sticks while handling medical waste, whereas 56 % stated that they rarely experienced this incident. A previous investigation [7] indicated that several workers handling medical waste have been exposed to various infections, including HIV, hepatitis viruses, and injuries from sharp objects. Medical examination of hospital cleaners before and during their employment is essential to ensure that they are free of infectious diseases, especially because they interact with patients, healthcare staff, visitors, and others. The findings of the present study revealed serious gaps in occupational health monitoring and preventive healthcare for clean workers. During the survey, approximately 70% of respondents said that they had never been subjected to medical examinations, while only 30% underwent medical checks after employment. However, none of the patients had undergone a pre-employment medical examination. The absence of routine health assessments puts these workers at risk, particularly when considering their exposure to potentially infectious materials. Similarly, the study indicates that there is serious negligence from the administration of cleanliness workers with regard to preventive measures. For instance, 89% of the workers stated that they had not been vaccinated against infectious diseases, with only 11% confirming that they were regularly vaccinated. The lack of vaccination programs reflects systemic failures in worker protection and requires urgent attention from health care authorities and facility managers. When asked about official oversight regarding their health and safety, responses were evenly divided: 37% reported that monitoring is always conducted, 26% stated it occurs occasionally, and another 37% indicated that no monitoring takes place at all. This variation suggests the absence of consistent and standardized protocols across healthcare facilities. Regular oversight is crucial not only to ensure compliance with safety regulations but also to reinforce proper practices and enable early identification of occupational health risks [27]. In contrast, the reported job satisfaction among cleanliness workers in the present study was remarkably high. Approximately 48.1% described themselves as very satisfied with their duties, 44.4% expressed satisfaction, and only 7.4 % reported dissatisfaction. Although these satisfaction levels are encouraging, they should not overshadow the significant occupational hazards. Positive attitudes may reflect factors such as job security or supportive work environments; however, they must not replace the need for adequate health protection and safety measures.

4. CONCLUSIONS

This study revealed significant shortcomings in the management of medical waste and the protection of cleanliness workers in healthcare settings. While medical staff tend to exhibit a strong understanding of waste segregation procedures and operate within relatively organized control systems, cleanliness workers often contend with

serious challenges. These include inadequate training, irregular supervision, and insufficient access to essential protective gear and vaccines. Additional concerns, such as the frequent tearing of waste bags, the absence of routine medical check-ups, and inconsistent health and safety oversight, further highlight the systemic weaknesses affecting this vulnerable group. Nonetheless, the high levels of job satisfaction reported among cleanliness workers suggest a notable sense of resilience and commitment, which deserves recognition. To promote the safety and well-being of all personnel involved in medical waste handling, healthcare institutions must reinforce regular monitoring, ensure consistent provision of protective equipment, and implement ongoing medical assessments and tailored training programs. Taking action on these fronts is crucial not only to safeguard worker health but also to protect the broader public and sustain safe and environmentally responsible waste management practices. Advancing a more inclusive and standardized approach is vital for achieving a safer, healthier, and more resilient healthcare system in Yemen.

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