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Assessment of Medical Waste Management Practices

Musbah. E. Almbsuot[1*], Asraa.H. Ramadan[2], Eman.S. Ali[3], Hibah.A. Husayn[4], Mawada.A. Farag[5], Marwah.A. Gummah[6], Reem.A. Mohamed[7]

[1-7] Department of Medical Laboratories, Faculty of Medical Technology, Azzaytuna University, Tarhuna, Libya

*Corresponding author: E-mail addresses: M.almbsuot@azu.edu.ly

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ABSTRACT

Background: Medical waste management is a critical global concern due to its potential environmental and public health risks. In Tarhuna City, Libya, the lack of comprehensive studies on medical waste management has led to inadequate practices and limited awareness**. Aim of study:** This study evaluates the current state of medical waste management in 23 public and private healthcare institutions in Tarhuna, focusing on waste generation, segregation, treatment, and disposal practices. **Methodology:** A mixed-methods approach, including questionnaires, interviews, and observations, was employed to gather data from 109 healthcare workers. **Results**: Findings reveal significant gaps in training, waste segregation, and adherence to safety protocols, with improper disposal methods posing risks to both workers and the community. the study highlights the urgent need for improved infrastructure, training programs, and regulatory enforcement. Recommendations include raising awareness, adopting modern waste treatment technologies, and establishing a dedicated medical waste landfill. **Conclusions:** This research contributes to the limited literature on medical waste management in Libya and provides actionable insights for policymakers and healthcare administrators.

1. INTRODUCTION

Medical waste, a complex and diverse stream of hazardous and non-hazardous materials, presents significant challenges to environmental sustainability and public health safety. Effective management of medical waste is crucial to minimize adverse impacts and ensure safe disposal practices. This introduction aims to provide an overview of the critical issue of medical waste management, exploring its generation, categorization, treatment technologies, regulatory frameworks, and sustainable management strategies. By understanding the complexities and current practices, we can develop effective solutions to address this global concern (World Health Organization, 2019).

The safe and proper management of medical waste is essential to protect human health and the environment from potential harm. Medical waste, also referred to as healthcare waste, encompasses a wide range of materials generated by healthcare facilities, medical laboratories, and biomedical research institutions. With the continuous growth of the healthcare industry and increasing medical demands, proper handling and disposal of medical waste have become a critical global concern. Improper management of medical waste can lead to environmental pollution, the spread of infectious diseases, and chemical contamination, posing risks to both human health and ecological systems (World Health Organization, 2020). Medical waste is generated from various sources within the healthcare sector, including hospitals, clinics, dental practices, and research facilities. The volume and composition of medical waste can vary depending on the type of healthcare facility, patient load, and specific activities. According to the World Health Organization (WHO), high-income countries produce approximately 0.5 kg to 2.0 kg of medical waste per hospital bed per day, while low- and middle-income countries generate an average of 0.2 kg to 0.8 kg(World Health Organization, 2019) The categorization of medical waste is essential for proper handling and treatment, and it can generally be classified into: Infectious Waste, Pathological Waste, Chemical and Pharmaceutical Waste Non-Hazardous Waste, and Waste that does not pose biological, chemical, or radioactive hazards, such as plastic packaging and paper. The safe treatment and disposal of medical waste require specialized technologies to ensure the destruction of pathogens and the safe management of hazardous components. Various treatment methods are employed, each targeting specific types of medical waste: Incineration: Incineration involves the combustion of medical waste at high temperatures to destroy infectious agents and reduce waste volume (Cai Q, et al., 2018) Autoclaving: Autoclaving uses high-pressure steam to sterilize infectious and biohazardous waste (Chen Y, et al., 2019). Chemical Disinfection: Chemical agents, such as chlorine, are used to treat infectious waste and inactivate pathogens (Li X, Wang F,et.al.,2018) Microwave Irradiation: Microwave energy is utilized to heat and sterilize medical waste(Wang F, Li X,et al.,2017) Plasma Arc Technology: High-temperature plasma is employed to break down medical waste (Yu H, Wang F ,et al., 2021) Mechanical Chemical Disinfection Systems: These integrated systems combine physical and chemical processes for waste treatment(Pradhan B ,et al., 2017). The safe management of medical waste is governed by regulatory frameworks at the international, regional, and national levels. These frameworks provide standards, guidelines, and legal requirements to ensure proper waste handling, treatment, and disposal: International Guidelines: The World Health Organization (WHO) provides global guidance on medical waste management through its publications and guidelines, such as the "Safe Management of Waste from Healthcare Activities. (World Health Organization, 2014) Regional and National Regulations: United States: The Environmental Protection Agency (EPA) regulates medical waste under the Resource Conservation and Recovery Act (RCRA). European Union: The Waste Framework Directive provides a legislative framework for member states. India: The Biomedical Waste Management Rules (2016) regulate the handling, storage, and disposal of biomedical waste. Sustainable management of medical waste involves implementing practices that minimize environmental impacts and promote safe handling throughout the waste management process: Source Reduction and Waste Segregation: Source reduction aims to reduce the volume and toxicity of medical waste generated (Yu H, Wang F, Li X, 2021). Proper waste segregation at the source facilitates effective treatment and disposal. Integrated Waste Management Systems: Integrated systems combine multiple treatment technologies to optimize the handling of various waste streams (Wang F, Li X, Chen Y, 2018). Awareness, Training, and Community Engagement: Education and awareness campaigns play a crucial role in promoting safe medical waste management practices among healthcare workers and the general public (Ahmed SE, Ahmed QK, Ahmed S, 2018). Despite the existence of regulatory frameworks and treatment technologies, challenges remain in the effective management of medical waste. These challenges include inadequate infrastructure and resources, particularly in low- and middle-income countries, insufficient regulatory enforcement, and social and cultural barriers. Addressing these challenges requires collaborative efforts, innovative solutions, and the integration of sustainable practices throughout the healthcare sector. In Libya studies about medical waste are so rare which made information about it unavailable. This study aims to provide a comprehensive vision for medical waste management in the Tarhuna city, with a focus on improving the system based on this management, whether in terms of the safety of workers in this field or in terms of the health and safety of the local community to achieve this goal.

2. METHOD

Study samples the target sample in this study included 109 questionnaires that were distributed and all distributed forms were received. Descriptive and analytical research was used to collect data from health institutions in the Tarhuna City.

Questionnaire design: The questionnaire aims to collect accurate data on how to deal with and dispose of medical waste. A questionnaire was prepared in the Arabic language, as the questionnaire included a set of questions aimed at measuring the level of awareness and training of workers on how to deal with medical waste and use personal protection methods when dealing with it in the health sectors.

It was designed to include 16 questions, the first part of which dealt with information about the policy of workers in health facilities, while the rest of the questions focused on measuring the level of awareness and training of workers and proposing new ideas and systems for dealing with medical waste effectively and safely.

Duration of study: Data were collected randomly from all health sectors in Tarhuna city during the period from October 2023 to May 2024. The questionnaire distribution targeted about 23 health institutions, whether private or public (public hospitals, health centers, private clinics, private laboratories, pharmacies), and targeted workers in the public and private sectors "nurses, doctors, technicians, pharmacists, cleaners.

The data analysis process relied on the SPSS program version 23, which is one of the well-known tools in statistical data analysis. This program was used to analyze the information collected from the questionnaires in order to obtain accurate results that contribute to enhancing our understanding of medical waste management in the city. In addition, used our observation to evaluate medical waste management according to observations researchers by applying the best steps to do so that are subject to global management

3. ETHIC APPROVAL

Ethical approval was obtained by contacting public and private entities to secure their consent before distributing the questionnaire to the study participants, and these entities agreed to cooperate in this regard.

4. RESULT

Study samples the target sample in this study included 109 questionnaires that were distributed and collected randomly from all health sectors in Tarhuna city during the period from October 2023 to May 2024. The questionnaire distribution targeted about 23 health institutions, whether private or public, as the questionnaire included a set of questions aimed at measuring the level of awareness and training of workers on how to deal with medical waste and use personal protection methods when dealing with it in the health sectors.

Demographics

Job Roles: The respondents included laboratory technicians (32.1%), nursing staff (26.6%), pharmacy personnel (18.3%), administrative employees (11.0%), doctors (7.3%), and members of the infection control team (4.6%)

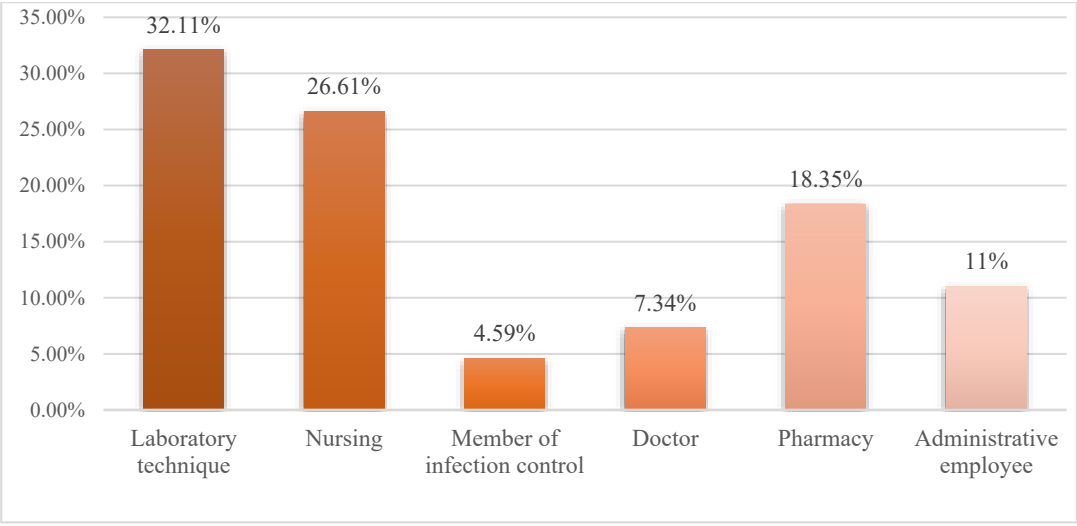

Fig .1 The quality of expressing an opinion in the institution

2. Work Experience: Most respondents had between one month and 10 years of work experience (75.2%), followed by 11-20 years (18.3%), 21-30 years (4.6%), and 31-40 years (1.8%).
Institution Type: The majority of respondents were from private institutions (65.1%), with the remaining from general/public institutions (34.9%)

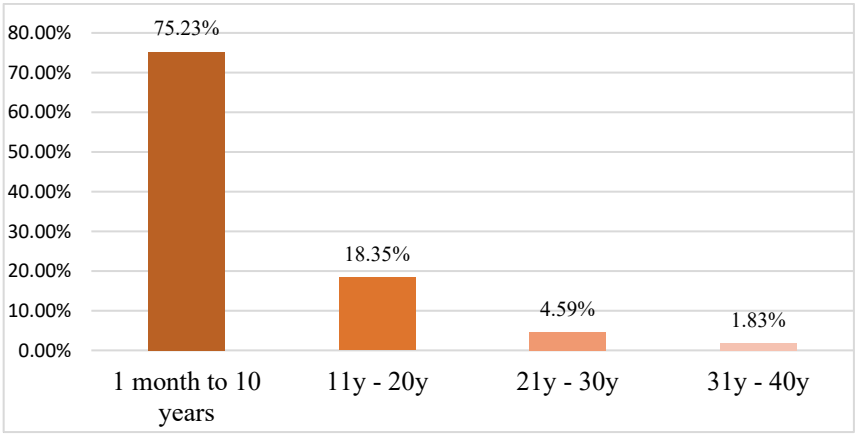

Fig.2.Long Work Experience

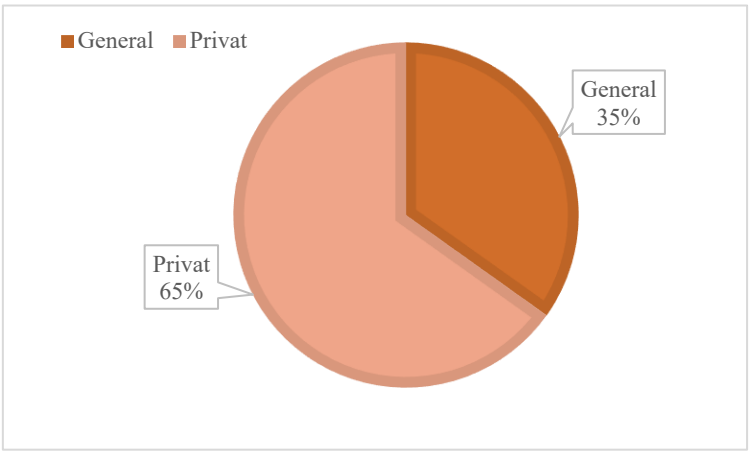

Fig3. Type of institution

The data suggests that the institution that conducted this survey has a higher representation from private healthcare organizations compared to general (public) institutions.

3.Medical Waste Disposal

1.**Training**: 70.6% of respondents receive regular training on safe medical waste disposal, while 29.4% do not

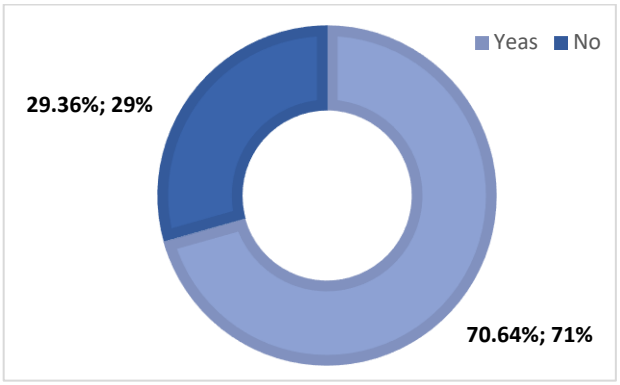

Fig4. parentage of training on safe medical waste disposal

2.Personal Protection: 80.7% use personal protective equipment (PPE) when handling medical waste, while 19.3% do not

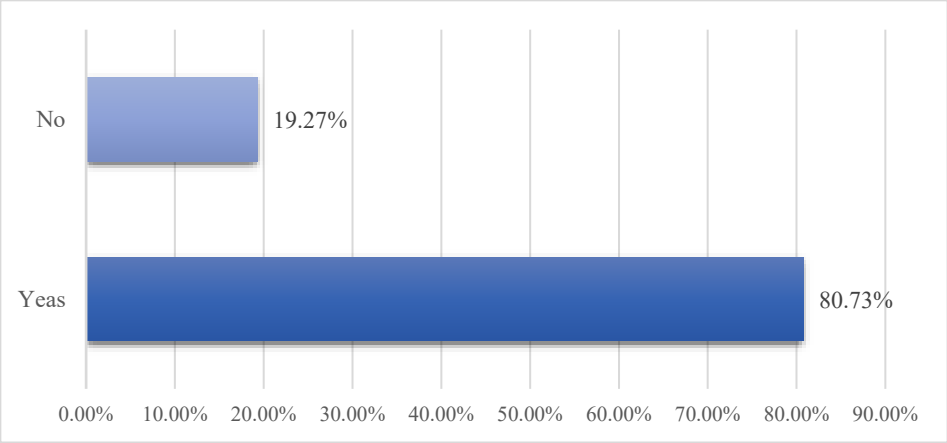

Fig.5 using personal protection when dealing with medical waste

3.Procedures: 56.0% follow correct procedures for separating and storing medical waste, 37.6% follow to some extent, and 6.4% do not

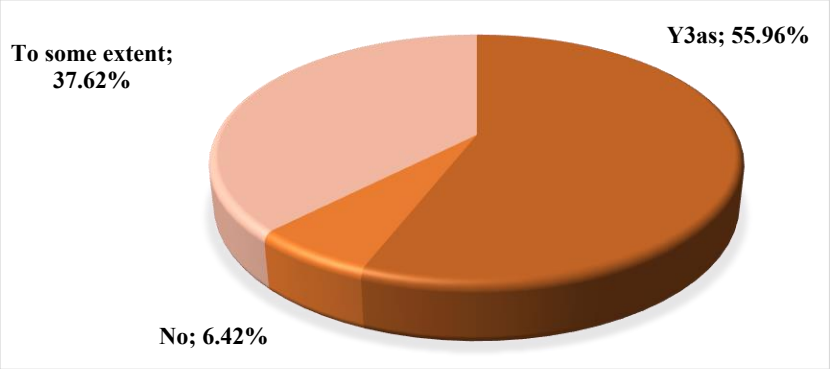

Fig6.following the correct procedures for separating and storing medical waste

4. Compliance: 74.3% comply with laws and regulations, 19.3% comply to some extent, and 6.4% do not

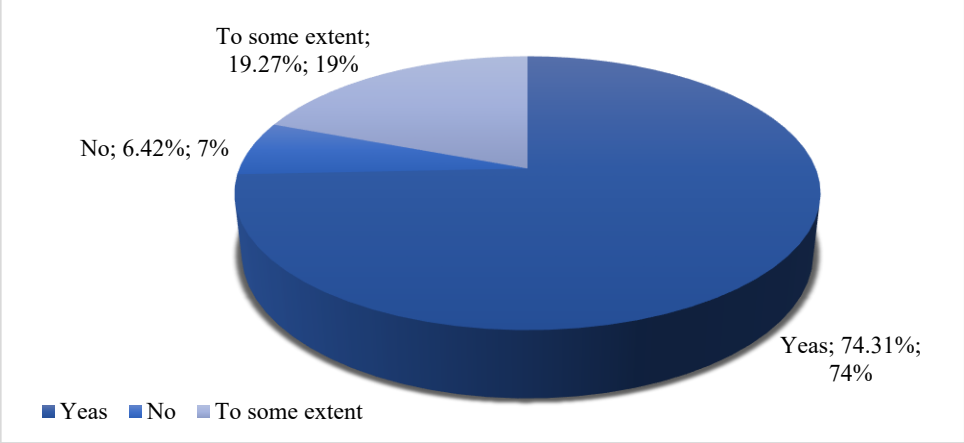

Fig7. comply with the laws and regulations regarding medical waste disposal

5.Improvement: 83.5% believe there's a need to improve waste disposal procedures, while 16.5% are satisfied with current procedures

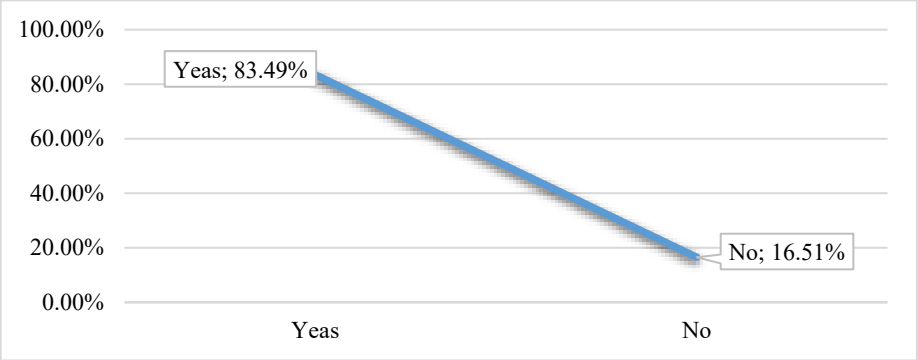

fig8. Thinking there is a need to improve medical waste disposal procedures in your organization

6.Environmental Impact: 89.0% are concerned about the environmental and health impacts of improper disposal, while 11.0% are not

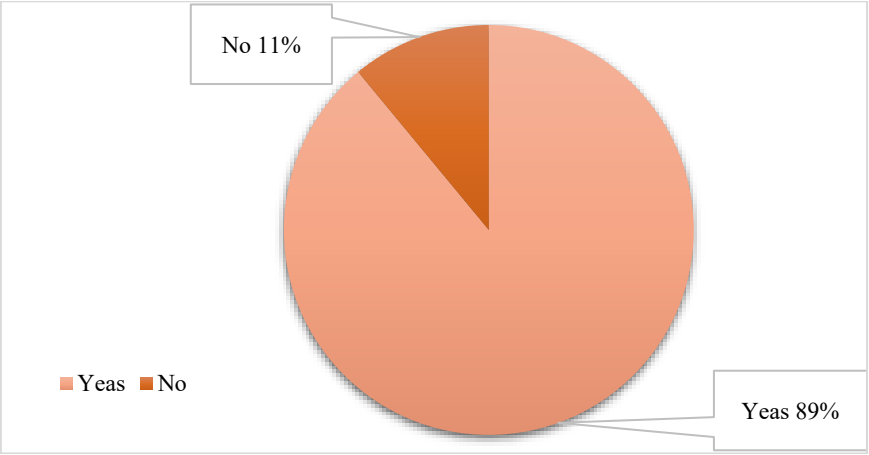

Fig9. percentage of concerned about environmental and health impacts of improper disposal

7.Education: 93.6% think employees need to be educated about proper waste disposal, with 6.4% disagreeing

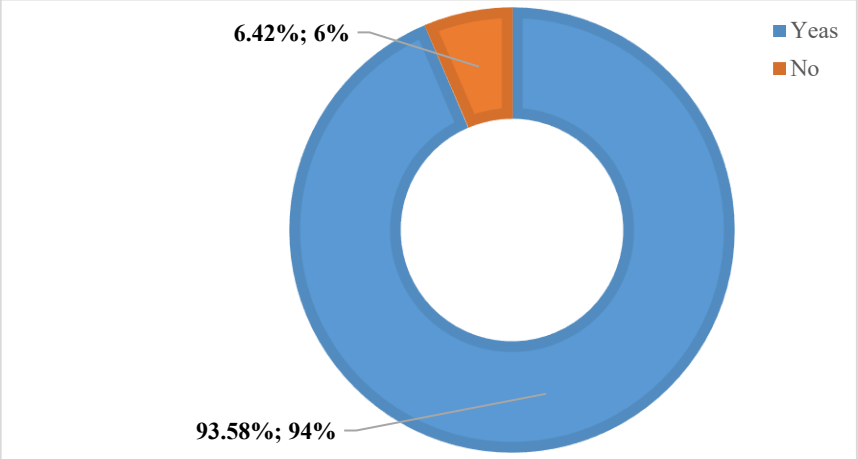

Fig.10. importance of proper disposal of medical waste

8.Knowledge Gap: 44.9% perceive a lack of knowledge among employees about safe disposal, 12.8% disagree, and 42.2% believe it's to some extent

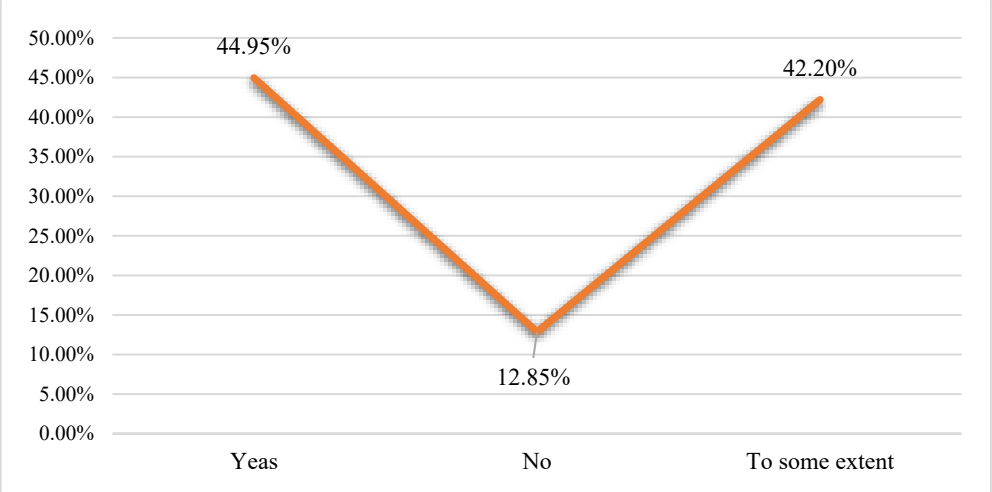

Fig.11. feeling that there is a lack of knowledge among employees about how to safely dispose of medical waste

9. **Technology**: 75.2% support increasing modern technologies for proper disposal, 4.6% disagree, and 20.2% agree to some extent.

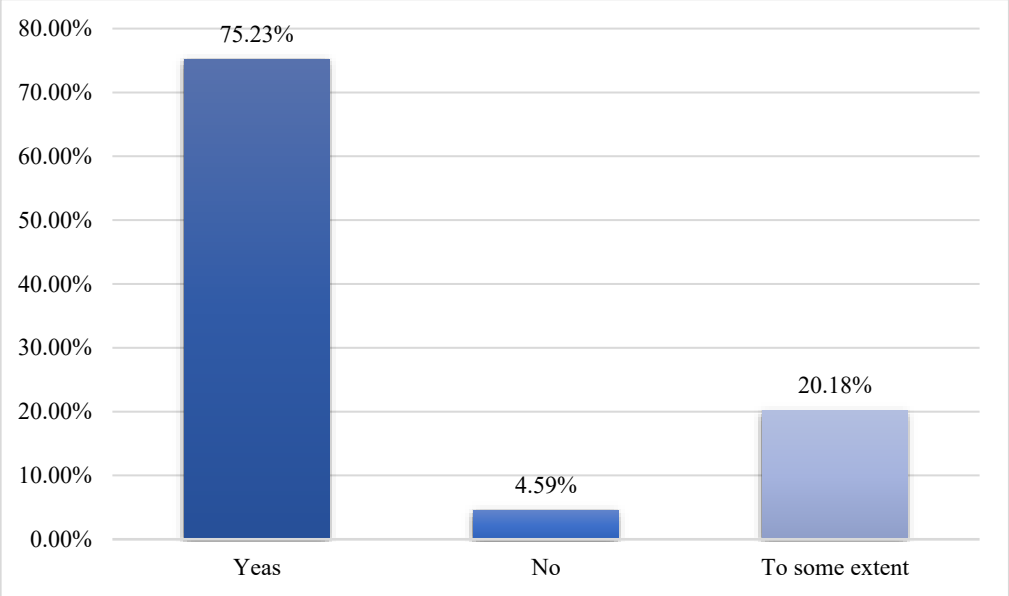

Fig4. 12. thinking there is a need to increase the provision of modern technologies that help in the correct disposal of medical waste in your institution

4.Types and Disposal of Medical Waste

Common Types: Used needles, syringes, and gloves (50.5%) are the most common type of medical waste,

A significant portion of respondents (34.9%) indicated that all the mentioned types of medical waste (used needles/syringes/gloves, contaminated sterilization/cleaning materials, hazardous chemicals, and damaged medical devices) are generated within the organization.

. Smaller percentages of respondents identified specific types of medical waste, such as contaminated sterilization and cleaning materials (5.5%), hazardous chemicals (4.6%), and damaged medical devices (4.6%).

Table 1. type of medical waste is generated within your organization

Types of medical waste	Frequency	Percentage
Used needles, syringes and gloves	55	50.46%
Contaminated sterilization and cleaning materials	6	5.50%
Hazardous chemicals	5	4.59%
Damaged medical devices	5	4.59%
All mentioned	38	34.86%
Total	109	100%

Disposal Procedures: 56.9% use specialized companies for disposal, 25.7% dispose of waste in regular trash, 7.3% burn it, 0.9% bury it, and 9.2% use other methods.

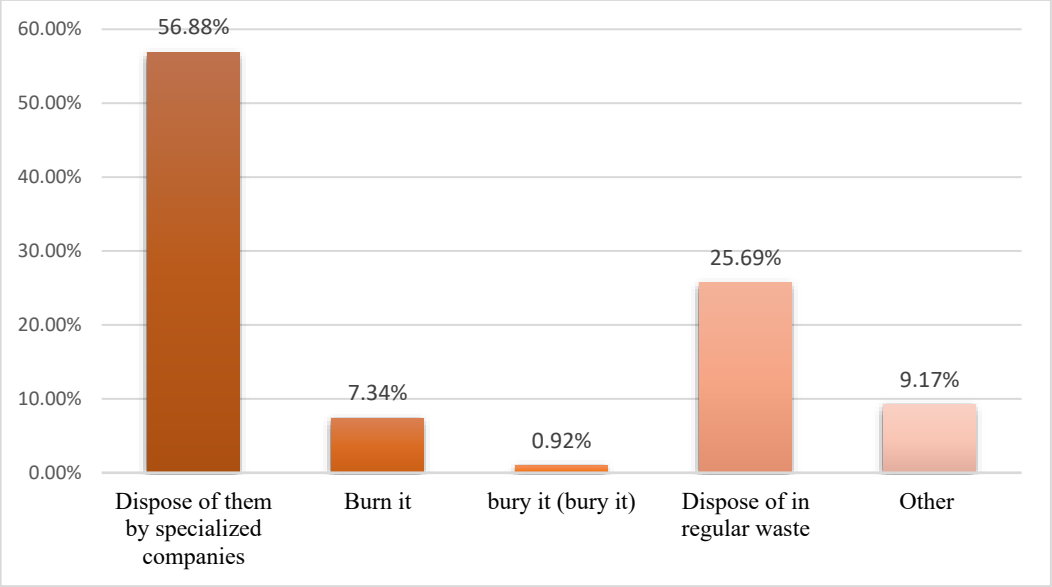

Fig 13. procedures follow in disposing of medical waste

14. Challenges and Satisfaction

Challenges: Lack of awareness and training (53.2%) is the biggest challenge, followed by other unspecified challenges (27.5%), cost of disposal (17.4%), and complex legislation (1.8%)

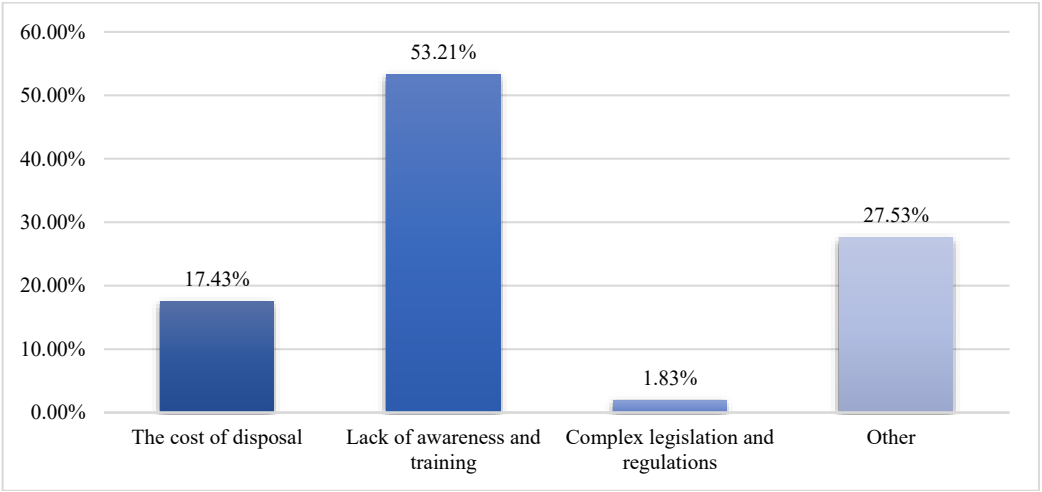

Fig 14. challenges facing in the process of disposing of medical waste

15. Satisfaction: Slightly more than half 53.2% are not satisfied with the current system, while 46.8% are satisfied a majority of the respondents are not satisfied with the current system.

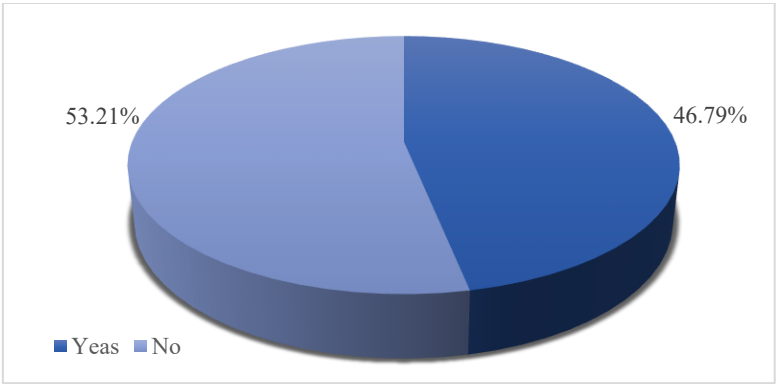

Fig15. Persons satisfied with the current system

Initially, study faced many challenges and obstacles while distributing the questionnaires, as we did not receive any response or cooperation from workers or administrators in the health sectors, which may be due to concerns related to data privacy or not obtaining official approval from the competent authorities, which made it difficult for obtain sufficient information to conduct the research.

Through visits to public hospitals and private clinics as part of this study, noticed that there is a lack of awareness among workers about how to properly deal with medical waste, as it is treated as ordinary waste, which contradicts the results of the questionnaire. It was found that many workers are not aware of the risks they may face as a result of not to conduct the research.

Through our visits to public hospitals and private clinics as part of this study, we noticed that there is a lack of awareness among workers about how to properly deal with medical waste, as it is treated as ordinary waste, which contradicts the results of the questionnaire. It was found that many workers are not aware of the risks they may face as a result of not using personal protection methods such as gloves, masks, and medical uniforms.

With regard to age groups, it was found that workers with more than 10 years of experience were more aware of how to deal with medical waste compared to those with little experience.

Study concluded that there are concerns among some workers about the spread of epidemics resulting from improper disposal of medical waste. This is partly due to the negligence of some officials in the institution, as clear laws and regulations are not put in place to manage this waste, in addition to the lack of modern technologies necessary to deal with it. In cases where these laws are available, we found that some workers do not fully comply with them.

In some health institutions, the available instructions and posters were limited to how to prevent infection and methods of hand washing (as show fig16)

Fig. 16. Instructions and Stickers

During the survey period, it was found that medical waste is often disposed of by merging it with regular waste without separation, and is disposed of in a landfill behind the institution. We also found that the available containers do not accommodate the volume of waste generated by the institution, which prompts them to use plastic bags not designated for this purpose .

After about three months, the management of the public health institution contracted with private companies to improve the waste disposal process, which led to significant progress in dealing with it, including providing containers suitable for the volume of waste generated (as show figure.17) .

Fig.17. Some container to keep waste safety offered by private company

In private health institutions, the most common method of disposing of medical waste was burial, especially with regard to medicines, which contributes to environmental

Pollution. Although some institutions provided special sharps boxes, these boxes were not used properly, as materials were not properly separated .Interestingly, some workers preferred to use 7-litre bottles to dispose of reactive chemicals and blood-containing tubes, as they are tightly sealed and provide better protection than regular disposal boxes. These bottles prevent the leakage of gases resulting from chemical reactions and limit the spread of harmful germs that may cause health damage through contact or inhalation, thus reducing the likelihood of infection for cleaning workers also noticed .

that syringes, needles and medicines are thrown through windows, which may cause injuries to cleaning workers (as show figure.18) .

Fig 18؛ show some wrong practices for dealing with medical waste have been observed

5.DUCUSSIONS

The study conducted regarding medical waste management in Tarhuna. City the aim of the research was to evaluate medical waste management in private and public health institutions.

relied for evaluation in this study on the questionnaire that was distributed to workers in these institutions with various job specialties in addition to the interviews and observations that we conducted in accordance with the questionnaire, in which we relied on internationally recognized standards for evaluation.

Medical waste management in hospitals occupies a large area of interest for those in charge of health services, environmental protection, occupational safety, and biosafety due to its direct and indirect impact on the health of individuals and society in general, as most countries pay special attention to it. This interest varies according to environments and regions depending on health awareness and the level of cognitive and civilizational progress, as a clear improvement in medical waste management is observed in developed countries compared to third world countries.

This study included 23 health institutions using a questionnaire that covers medical waste, treatment and disposal, which collected 110 of the workers in these health institutions. Training on medical waste management, in addition to the absence of proper separation methods and sites designated to get rid of them.

In comparison, a 2011 Nigeria study of 20 hospitals and 200 workers was conducted in Nigeria, showing similar results in terms of poor medical waste management. It also showed that inappropriate separation and disposal of waste were key issues, in addition to other challenges such as lack of funding and poor health regulations. (**Nnorom IC, Ohakwe J, 2011)**

In 2015, researchers conducted a survey in Lebanon that included 42 hospitals, and found that most hospitals had medical waste management policies, and the burning was the basic way to dispose of them. However, problems with lack of training and proper waste separation were noted, as well as limited access to alternative techniques(**Naja GB, Chalak L, 2015)**

In Delhi, India, a 2019 study was conducted that included 50 hospitals, and revealed that most hospitals had waste management systems, but improper separation problems, lack of training, and non-compliance with regulations were still in place. Burning was the basic way to get rid of waste, with techniques such as steam and microwave sterilization.(**Gupta S, Garg P, 2019)**

In 2022, a study was conducted at Tripoli Central Hospital in Libya, highlighting the great challenges in medical waste management, as it revealed a lack of training, insufficient separation of waste, and unsuitable ways to get rid of it, as well as the absence of personal protective equipment for workers. The study recommended the need to improve waste management systems, train employees better, and invest in modern medical waste treatment techniques**.(adi NM, Abusitta AA, 2022)**

When comparing these studies, find that there are frequent challenges in most countries that have been studied, such as lack of training and improper separation of waste. However, some details differ, as studies in Nigeria and Lebanon focused on funding and enforcement issues, while Libya's studies highlighted the logistical and infrastructure challenges. The issue of heavy reliance on burning is also a key means of waste disposal in several countries, indicating the urgent need to Improve practices and techniques in this field.

6. CONCLUSION

within Tarhuna's private and public health institutions. By utilizing questionnaires, interviews, and observations, we were able to evaluate the current state of medical waste management against internationally recognized standards.

Our findings highlight the importance of effective medical waste management, as it directly impacts the health and well-being of individuals and the environment. While developed countries have made significant progress in this area, there is still a noticeable gap when compared to third-world nations. Thus, it is imperative for Tarhuna and similar regions to prioritize and improve their medical waste management systems.

This study serves as a foundation for further action and improvement. We recommend that health institutions in Tarhuna implement comprehensive training programs to educate staff on proper waste segregation and disposal practices. Additionally, investing in advanced waste management technologies and infrastructure can significantly reduce the health and environmental risks associated with inadequate medical waste management. By taking these steps, Tarhuna can work towards achieving medical waste management practices that align with international standards, ultimately contributing to a healthier and safer environment for its residents and the wider community. Further research and continuous evaluation will be essential to monitor the progress and effectiveness of these implemented strategies.

7.RCOMENDTIONS

Based on the results of the study, we recommend the following:

- Raise awareness and training: Organize periodic workshops and training courses for health personnel in all institutions on the risks associated with medical waste and safe handling methods.
- Develop infrastructure: Provide the financial resources and infrastructure necessary to transport and treat medical waste in healthy and safe ways.
- **Emphasize control:** The need to establish strict control systems to ensure that health institutions adhere to the implementation of protocols for managing medical waste.
- Recycling and waste treatment: Encourage the adoption of medical waste recycling and treatment technologies to reduce negative environmental impacts.
- Provide a landfill for incinerating medical waste in the city

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