Health Perception and Environmental Risks Related to Biomedical Waste Management at the University Hospital Center of the Renaissance N'Djamena (Chad)

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ABSTRACT

This article presents the results of a survey conducted at the University Hospital Center (CHU) of the Renaissance in N'Djamena on the health perception and environmental risks related to biomedical waste management. A total of 100 respondents were interviewed, including healthcare personnel and the general public. The randomly selected sample is predominantly young, with 74% men and 26% women, with 47% age groups ranging from 18–30 years and 53% over 31 years. The distribution shows an over-representation of healthcare workers (38%) and a critical under-representation of cleaning staff (7%), who are nevertheless the most exposed. Most respondents are newly integrated, with a length of service less than one year (38%) to between one and five years (29%). The results reveal that most personnel are aware of the risks associated with poor waste management: 22% reported being exposed to accidents (needle sticks, splashes), and 46% believe that the waste has a significant environmental impact. The study also highlights a lack of information, the absence of visible procedures, and insufficient protective equipment. However, this study recommends strengthening training, establishing an effective waste management system, and promoting a health and environmental safety culture adapted to the realities of this university hospital Center.

Keywords: Biomedical waste management, Health risks, Healthcare personnel, Environmental impact, Training and safety.

INTRODUCTION

The management of hospital waste is a major public health and environmental protection issue, particularly in developing countries where healthcare facilities face limited resources, insufficient planning, and staff training deficits (Cissé, 2019; Ngamassi *et al.*, 2022). Biomedical waste, produced daily in healthcare facilities, includes a variety of waste that poses a risk to human health and the environment: infectious healthcare waste (IHW), chemical, pharmaceutical, anatomical, sharps, liquid waste among others. When these wastes are not properly sorted, stored, transported, and treated, this waste can lead to the transmission of infectious diseases, soil and water pollution, the production of toxic emissions into the air, or the proliferation of pests (WHO, 2017; Ouzir, 2008).

According to the World Health Organization (WHO), nearly 15% of the waste produced by hospitals is considered hazardous to health and the environment (WHO, 2014). Poor management of this waste is usually caused by a lack of training, appropriate equipment, or regulatory oversight, and thence, exposes not only healthcare professionals but also patients, visitors, cleaning staff, waste collectors, and the local populations to significant risks (Mouankié, 2015; Djocgoue, 2018).

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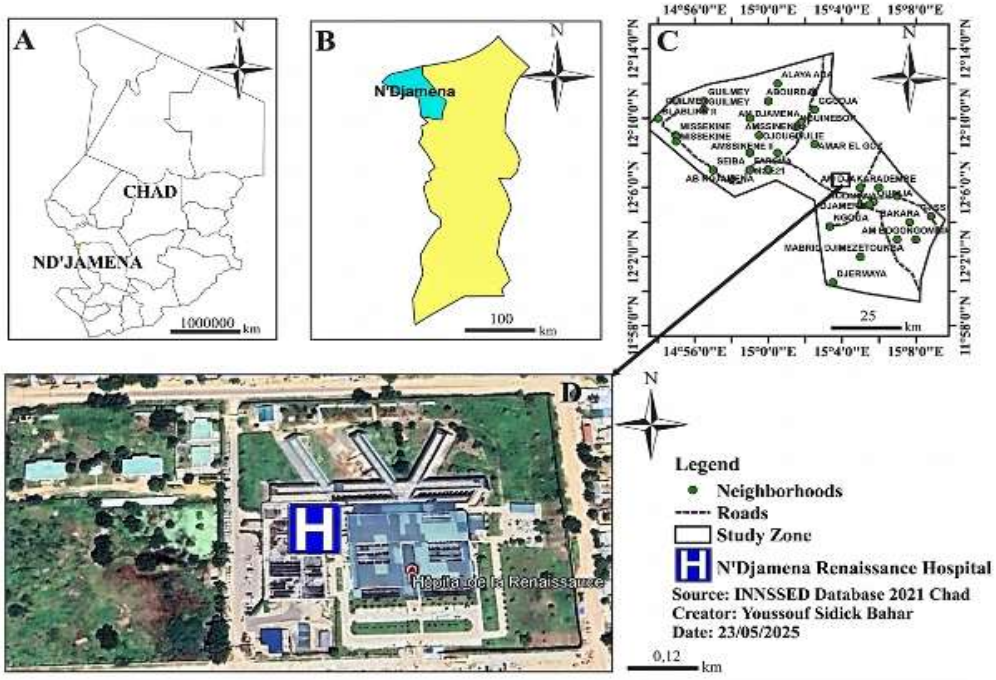
In Chad, although efforts have been made in recent years to develop management guides, pilot projects, and environmental laws (Ministry of the Environment, 2020), the reality on the ground remains worrying. The Renaissance University Hospital Center of N'Djamena, the country's main referral hospital, illustrates these deficiencies. The facility, despite having modern infrastructure and qualified staff, suffers from major shortcomings: lack of effective source separation, a broken incinerator, poorly regulated outsourcing, poor monitoring of liquid effluents, lack of personal protective equipment (PPE), and insufficient knowledge of management protocols (Cissé, 2019; Ngamassi *et al*., 2022).

It is in this context that the present study is situated, with the main objective of assessing the health perception of the staff at the Renaissance CHU of N'Djamena regarding the health and environmental risks associated with Biomedical waste management. Indeed, the hospital staff's perception of these risks directly influences their behaviors and practices regarding health safety (WHO, 2017). Understanding their representations, difficulties, and needs is an essential prerequisite for any sustainable improvement approach. The study is based on a descriptive and cross-sectional methodology, combining surveys through questionnaires, field observations, and document analysis. It examines the types of waste produced, the conditions of collection and treatment, incidents that occurred, the level of risk awareness, as well as existing preventive measures. The results obtained will not only help identify major deficiencies in the current system but also propose improvement strategies adapted to the Chadian context. Finally, beyond the specific framework of the Renaissance University Hospital, this research aims to contribute to national reflection on biomedical waste management policies, to encourage the integration of environmental risks into public health programs, and to strengthen local capacities in hospital hygiene and the prevention of nosocomial infections (WHO, 2017; Cissé, 2019).

MATERIALS AND METHODS

Research Site

The Renaissance University Hospital Center, inaugurated in 2013 in N'Djamena, is a public reference hospital in Chad. Financially and legally autonomous, its main objective is to manage the most complex pathological cases in order to reduce costly medical evacuations abroad. With a capacity of 240 beds and a modern technical platform, its missions are: to provide high-tech medical and surgical care, train medical staff, conduct health research, and offer quality services focused on patient satisfaction (Figure 1).



Note: A: National border of Chad, B: Chari-Baguirmi region, C: City of N'Djamena

Figure 1. Location of the Renaissance University Hospital Center

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Data Collection and Analysis Technique

The objective is to collect data from healthcare personnel regarding their perception of health and environmental risks related to hospital waste management. This study aims to explore the perceptions, practices, and knowledge of staff regarding biomedical waste management at the Renaissance CHU in N'Djamena. To achieve this, a descriptive and exploratory approach, combining qualitative and quantitative methods, was adopted. Data collection relied on three main techniques: a documentary analysis of regulatory texts and good practice guides, direct observations in the departments, and the responses from distributed questionnaires to a random sample of 100 respondents. The selection of participants was carried out using a purposive non-probability sampling method, targeting exclusively staff in direct contact with waste. The sample size was determined using Slovin's formula to ensure a minimal representativeness:

$$n = \frac{N}{1+Ne^2}$$

Where:

n: sample size;

N: total population size (320,165 inhabitants)

E: desired margin of error (10%).

In practice, it appears as:

$n = 320{,}165 / (1 + 320{,}165 \times 0.10^2)$

$n = 320{,}165 / (1 + 320{,}165 \times 0.01)$

$n = 320{,}165 / (1 + 3{,}201.65)$

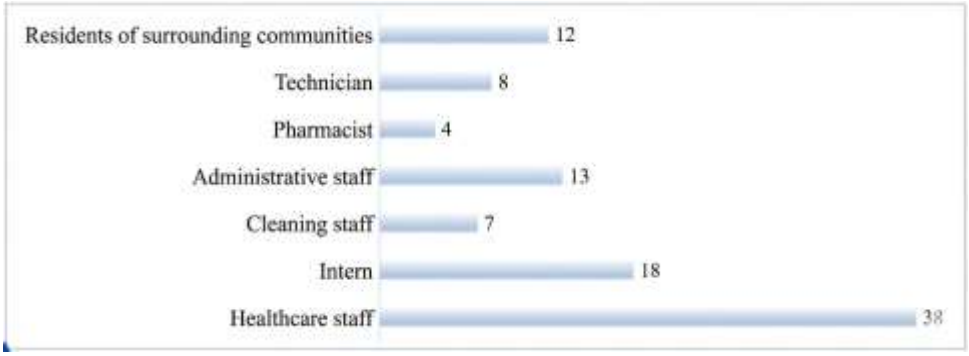
$n = 320{,}165 / 3{,}202.65 = 100$ respondents.

Thus, the final sample size selected for this study is 100 respondents. The collected data were processed using software such as SPSS, and Excel for presentation.

RESULTS AND DISCUSSION

Socio-demographic characteristics of respondents

During this survey, 74% of the respondents were men, while women accounted for only 26%, with their age groups varying respectively between 18-30 years (47%), and over 31 years (53%). Professionally, the majority of respondents are healthcare staff, as shown in Figure 2.



Source: Field survey, 2025

Figure 2: Analysis of professional representation in the surveyed sample

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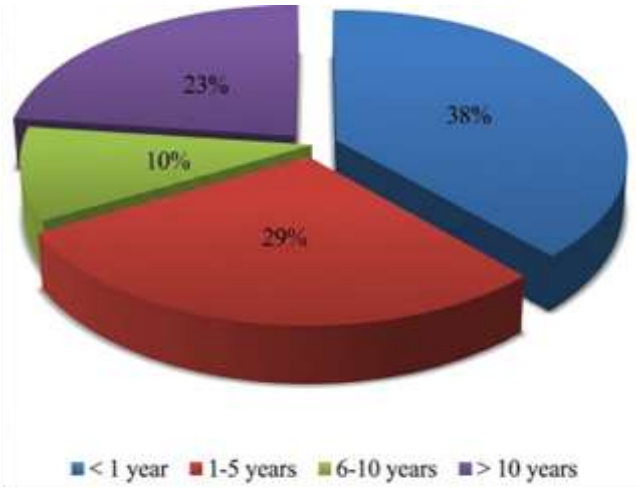
The distribution of respondents shows an over-representation of healthcare staff (38%) and a critical underrepresentation of cleaning staff (7%), who are nevertheless the most exposed to biomedical waste. The inclusion of external residents (12%) possibly dilutes the hospital-focused objective of the study. Regarding their seniority, the majority of the population is new, with the number of years ranging from one year and below (38%), and between one to five years (29%), as shown in Figure 3.



Source: Field Survey,2025

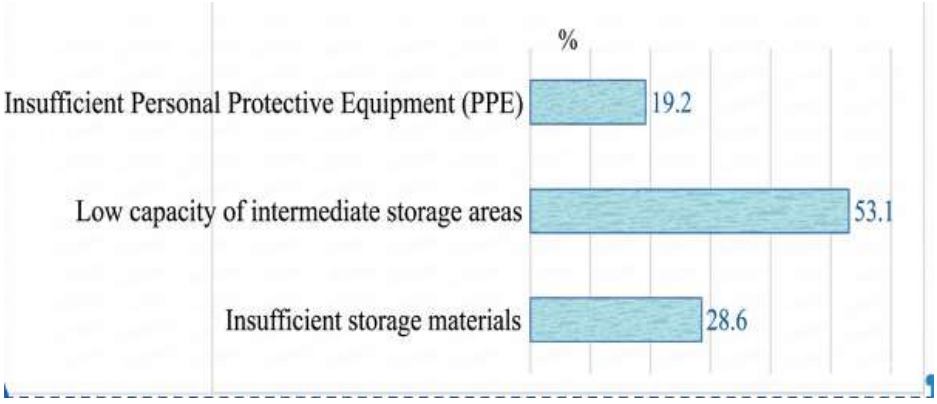
Figure 3. Staff Stability and Turnover: A Predominantly Recent Workforce

This figure shows a significant proportion of recent staff (38% with less than one year of service), indicating notable turnover. However, the substantial presence of experienced staff (23% with more than 10 years) provides a valuable stable core. The low representation of staff with 6 to 10 years of experience (10%) points to a medium-term retention challenge.

Factors exacerbating risks at CHU-R

Poor management of materials (containers, storage areas, protective equipment).

The management of biomedical waste presents a real problem. Indeed, the containers available in the departments, generally color-coded, are severely insufficient in terms of their number in relation to the volumes of waste generated. Intermediate storage areas do exist, but they are often cramped, poorly ventilated, and do not always meet hygiene standards. Regarding personal protective equipment (PPE), although gloves, gowns, masks, and shoes are theoretically provided, their availability is inconsistent, sometimes forcing staff to work without adequate protection (Figure 4).



Source: Field Surveys, 2025

Figure 4: Critical material failures in biomedical waste management

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The inadequate capacity of interim storage areas (53.1%), directly exposing staff to biological risks. This is followed by insufficient storage containers (28.6%) and lack of Personal Protective Equipment is the primary concern (19.1%). This deficient trio highlights systemic flaws in worker protection and hazardous waste handling.

Adherence to waste management protocols: between theoretical knowledge and practical application

Knowledge of waste management protocols at CHU-R remains fragmented among staff. While some employees acknowledge their existence, others are completely unaware of them. Even more concerning, even informed personnel often do not know the specific applicable rules. This gap between theory and practice reveals a crucial flaw in training and the adoption of procedures, compromising the overall effectiveness of the management system (Figure 5).

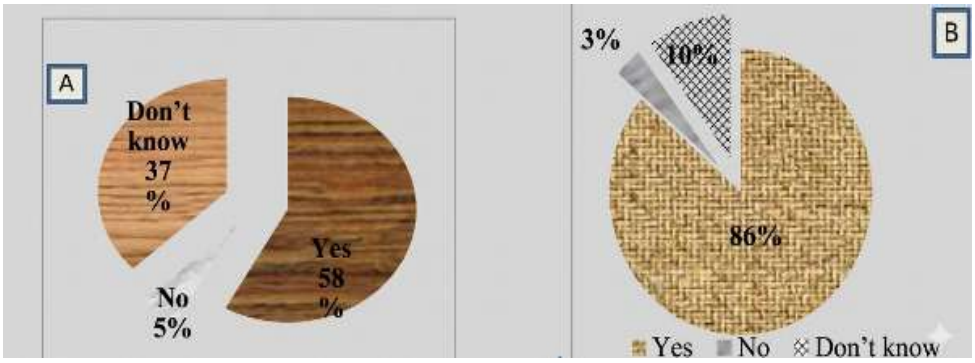

Figure 5: Existence of procedures versus actual application: a worrying gap

Although 58% of staff confirm the existence of waste management protocols at CHU-R, more than a third (37%) are unaware of them. Among those familiar with the procedures, a large majority (86%) states that they are followed, but this perception masks a fragmented reality: 10% uncertainty and 4% denial regarding their actual implementation, revealing a significant deficit in communication and collective ownership.

Worrying gaps between observed practices and biomedical waste management standards

Biomedical waste management at CHU-R significantly deviates from standards, with sorting unevenly applied across departments and transport relying on unsuitable carts. Temporary storage areas lack security, favoring the proliferation of pests, while the absence of signage and the failure to use PPE increases the risks. These gaps reflect a trial-and-error management approach, driven more by material constraints than by compliance with health and environmental safety standards. The results show that all staff handle medical and hazardous healthcare waste, while 62% to 46% manage other categories of dangerous waste, reflecting the complexity of the system. While 81% have PPE, 19% work without adequate protection, and nearly a quarter of the staff are unaware of emergency procedures or report that they are not posted. Figure 6 confirms the real exposure to risks despite the partial measures in place.

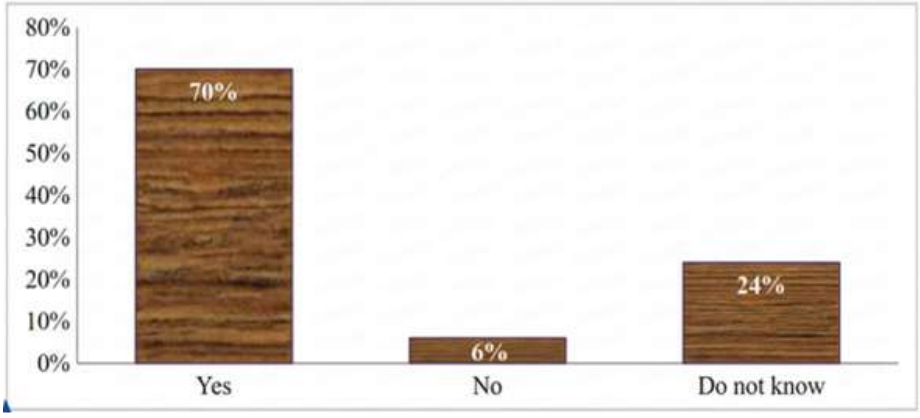

Figure 6. Staff exposure rate to accidents related to hospital waste management

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IV April 2026

The above Figure illustrates the level of staff exposure to accidents related to hospital waste management. It can be observed that many staff members report having experienced incidents (70%) such as needle sticks or splashes, revealing a notable vulnerability. These accidents concern mainly personnel in direct contact with biomedical waste. The results highlight the need to strengthen protection and safety measures within the hospital.

Typology of waste risks

Perception of health risks

The study highlights a unanimous concern among healthcare staff regarding health risks, with 98% of respondents fearing exposure to pathogens when handling waste. Needle stick injuries (NSIs) are the most immediate threat, particularly affecting cleaning staff (72%) and nurses (45%), generating constant occupational stress related to diseases such as HIV and hepatitis. Field observations confirm these risks, revealing that in 65% of the departments, sharps safety boxes are inadequate or absent, leading to dangerous practices. Beyond the staff, 80% of patients are concerned about cross-contamination, particularly regarding the presence of infectious waste in areas accessible to the public, increasing the risk of nosocomial infection spread and creating a general sense of insecurity.

Perception of environmental risks

The results highlight a significant gap between the regulatory requirements for biomedical waste management and the reality observed on the ground at the Renaissance University Hospital. They also reveal a growing awareness of risks among the staff, as well as an urgent need for capacity building, investment in equipment, and the effective implementation of existing protocols (Figure 7).

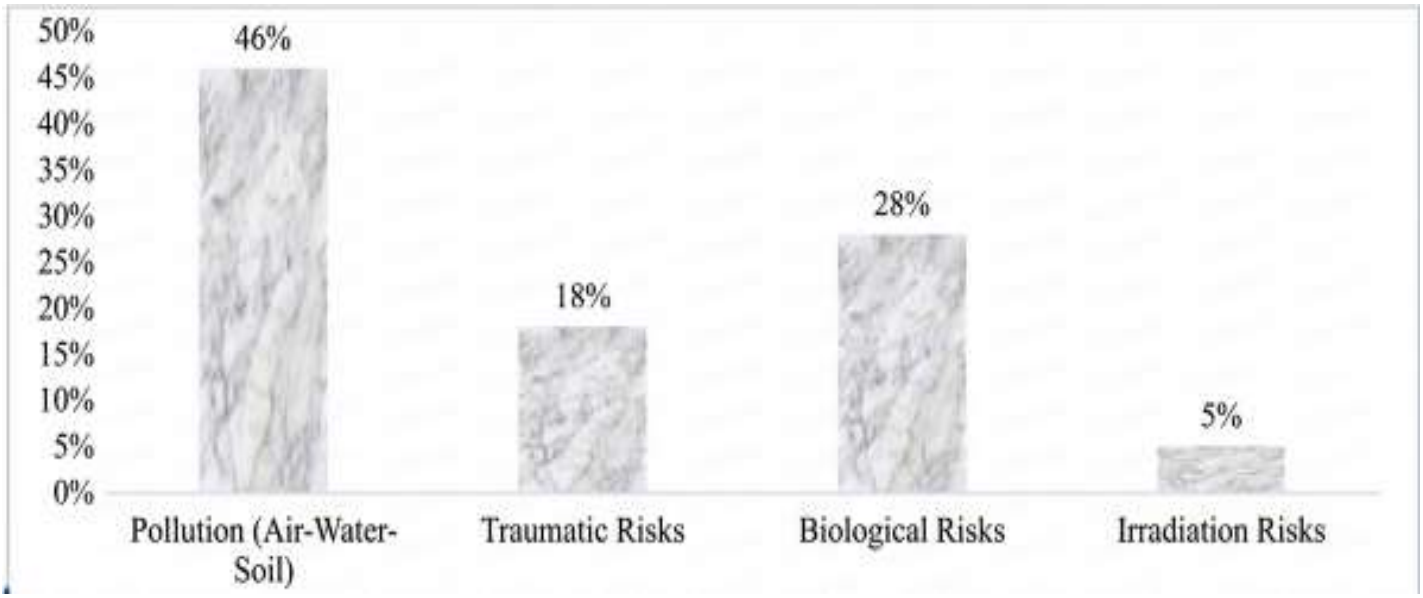

Figure 7. Perception of environmental risks due to poor management of biomedical waste

The above figure highlights the environmental impacts. 46% of respondents believe that hospital waste contributes to environmental pollution, 18% report traumatic risks, 28% mention biological risks, and a small number, 5%, refer to irradiation risks. This is particularly due to improper incineration, unsafe storage, and the lack of treatment of liquid effluents. Nearly half (47%) report the absence of a treatment facility in their department, thus exposing the immediate environment to contaminated discharges, as shown in Figure 8.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue IV April 2026

Photo 1. DASRI in Yellow bag

Photo 2. DASRI in black bag

Photo 2. DAOM in Yellow bag

Photo 3. DAOM in black bagand Yellow bag

Figure 8: Non-compliance with sorting at the source

These data highlight the issue of the negative effects of biomedical waste management. Over 85% of respondents expressed concerns on this matter, noting that soil and water pollution is the main worry, particularly due to the lack of dedicated treatment sites, which leads to the uncontrolled disposal of waste in opened dumps. Moreover, open-air incineration practices are also seen as problematic, as they produce toxic emissions that affect air quality and cause respiratory issues among exposed staff (91%). The central storage is not monitored, cleaned daily, and does not have an impermeable floor or proper drainage (Figure 9).

a. Local waste storage

b. Vehicles used in transport hospital waste

Figure 9: Non-compliance with the principle of storage and disposal of hospital waste.
These observations indicate a failure at the level of the overall management system, as shown by the following histogram (Figure 10).

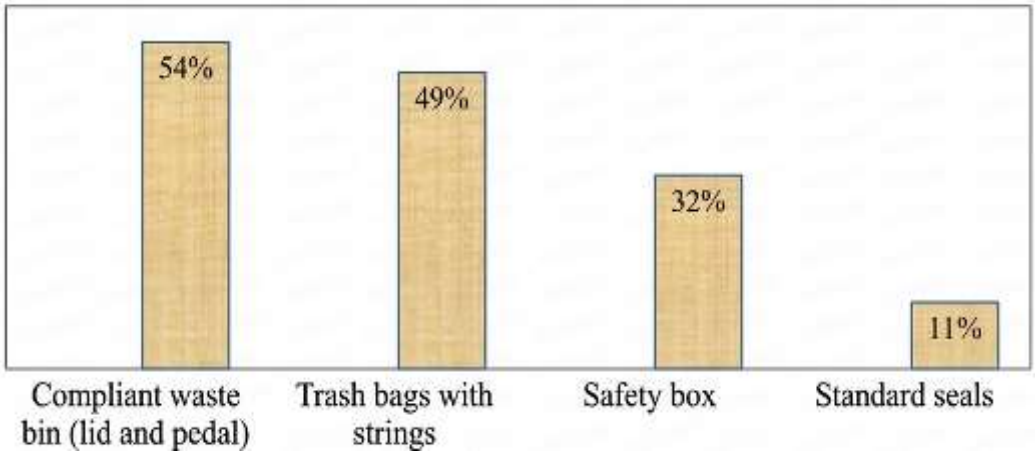

Figure 10. Rate of equipment used for waste collection at CHU-R

The Histogram (figure 10) illustrates the different equipment used for collecting solid waste produced at CHU-R. Compliant bins (with lid and pedal) are the most used equipment (54%). Garbage bags with ties stand out with a rate of 49%, while safety boxes account for 32%. Simple buckets, on the other hand, are not used much (11%).

Other Risks

Perception of Chemical and Safety Risks

These risks are increasingly perceived more acutely by technical and laboratory staff in several ways, notably: exposure to chemicals and safety risks. Regarding exposure to chemicals, with 90% of respondents being laboratory technicians, they report not having a clear procedure for the disposal of solvents, expired chemical reagents, and disinfectants concentrated. And yet, these products are more often diluted and then discharged into the sewers without prior neutralizing treatment. As for safety risks, including theft and reuse of equipment, they are also sharply perceived. The risk of theft and reuse of medical devices is seen as one of the major safety concerns. It appears that about 40% of the staff report having observed containers of used needles being emptied into the environment, posing a dual problem, namely: the exposure of (informal) collectors and the promotion of the circulation of contaminated medical equipment in the area. This situation leads to severe health impacts (reuse of syringes).

Perception of socioeconomic risks

The perception of risks related to hospital waste from a socioeconomic standpoint is reflected in infections resulting from needle stick injuries (NSIs) at a rate of 55%. And yet, they generate additional costs in terms of serological testing, post-exposure prophylaxis, and work stoppages. It appears that the lack of a system for tracking needle stick injuries prevents accurate quantification. For this reason, respondents believe that these incidents represent a significant financial burden for the facility. 70% of patients associate dirt and the presence of waste with poor-quality service. It also leads to conflicts within the organization through recurring tensions reported between hospital staff and the workers responsible for waste collection. Each party blames the other for poor management, creating a conflictual environment that hinders any attempt to improve practices.

For Controlled Hospital Waste Management at the Renaissance University Hospital

At the Renaissance University Hospital, the management of biomedical waste relies on several initiatives that are still partial and not systematized. The facility has implemented source separation through coded containers and outsources incineration to a private provider, although these measures suffer from issues of standardization and traceability. A modern incinerator provided by a partner remains unused due to a lack of trained personnel, and the temporary storage area has weaknesses in layout and security (Figure 11).

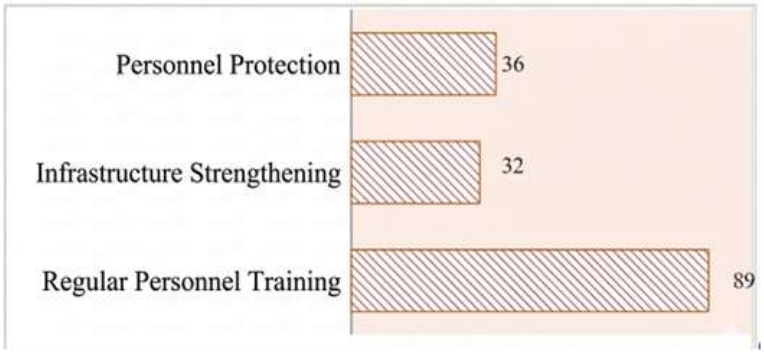

Figure 11: Proposal for better management of hospital waste

Facing these limitations, staff expressed a predominant need for regular training (89%), followed by requests for strengthened protective equipment (36%) and improved infrastructure (32%), thus highlighting the necessity for a more structured and sustainable approach.

Strengthening staff capacities contributes to the improvement of the hospital waste management system at CHU-R. For this reason, more than 66% of respondents request capacity building, but the frequency of training for them remains very variable, as highlighted in Figure 12.

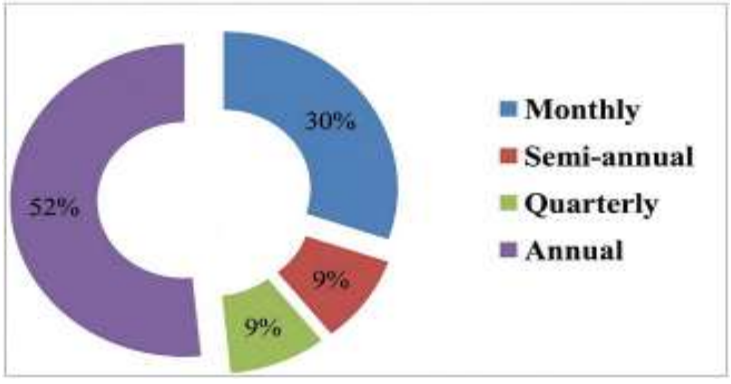

Figure 12: Frequency of capacity building for health personnel

From the figure above, it shows that a large portion, over 50%, highlights quarterly training, while 30% report a monthly frequency. Only 9% choose semi-annual and/or annual training.

DISCUSSION

The results shed light on the perspective that stakeholders have on waste management within the CHU de la Renaissance. The variety of waste produced, with a marked prevalence of Infectious Risk Healthcare Waste (DASRI) at 100% and liquid waste at 58%, highlights the challenge of managing it and the need for an approach tailored to each department.

These perceptions align with the work of Djocgoue (2018) and Mouankié (2015), who emphasize that African hospital facilities generate a wide range of waste, often mixed from the outset, which complicates its treatment. Similarly, Ouzir (2008) in Morocco and Cissé (2019) in Senegal highlighted the lack of source segregation and the inadequacy of equipment. These shortcomings promote cross-contamination, exposing staff, patients, and the environment to risks that could otherwise be avoided. A striking example is that of the healthcare personnel, wherewhere more than 19% work without Personal Protective Equipment (PPE). This confirms what the WHO (2014) and Mbonigaba (2016) had already stated, citing these risky behaviors as a key factor in the transmission of occupational infections. The risks are very real for nearly half of the respondents (46%), who believe that this waste contributes significantly to environmental pollution. This sentiment reflects a lack of awareness regarding proper waste management practices. The findings are supported by research from Ngamassi et *al*. (2022) and Ibrahima et *al*. (2021), which show that environmental awareness in hospitals remains very limited, often due to a lack of ongoing training and internal communication. Similarly, the absence or failure of treatment facilities, particularly for liquid effluents, constitutes a major structural weakness. As demonstrated by the work of Akter et *al*. (2012) in Bangladesh and Cissé (2019) in Senegal, the lack of functional wastewater treatment plants leads to the direct discharge of pollutants into the environment, worsening health and ecological risks. Ultimately, these findings illustrate a systemic and universal problem, which developing countries experience more acutely, with low budget allocation, lack of monitoring and evaluation, poorly enforced regulatory frameworks, and insufficient technical partners, as highlighted by Prüss-Ustün et al. (2016). This is why the issue of risks associated with hospital waste remains a crucial matter that deserves sustained attention. It is imperative to improve the management of biomedical waste through structural, organizational, and regulatory measures to ensure a healthy, livable, and sustainable hospital environment for all. Conclusion This study made it possible to assess the perception of environmental, health, and other risks related to hospital waste at the University Hospital Center of Renaissance (CHU) in N'Djamena. This risk perception varies according to gender, with men representing a large proportion (74%) and women 26%; their age groups vary respectively between 18-30 years (47%) and over 31 years (53%); the distribution of respondents shows an overrepresentation of healthcare staff (38%). The inclusion of residents (12%) possibly dilutes the hospital-specific objective of the study. It appears that men perceive environmental risks more, while women mainly highlight infectious risks. The results reveal a partial understanding of the risks, as well as many gaps both in practices and in the technical and institutional resources mobilized. Although efforts are being made at the waste management system level, the results show significant shortcomings, including the lack of effective sorting, insufficient protective equipment, non-functioning incinerators, absence of effluent treatment, limited training, and inadequate supervision. Therefore, for proper waste management, it would be commendable to strengthen personal and technical capacities, implement coherent health policies, mobilize sufficient resources, provide continuous staff training, equip with adequate infrastructure, and rigorously monitor practices.

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