

Original Research Article

Patterns of COVID-19 induced bio-medical waste management in Bangladesh: a case study of Chittagong port city

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ABSTRACT

Background: The objective of this study was to investigate effective waste management practices and develop environment-friendly public health guidelines for the target audience.

Methods: A cross-sectional descriptive study was conducted in 14 Upazilas of Chittagong Districts, where 200 community members were physically interviewed during the pandemic. Univariate, bivariate, and multivariate statistical analyses were conducted.

Results: The majority of respondents followed government guidelines for waste management, and plastic containers, poly bags, bio-hazard bags, and metal containers were commonly used to collect waste. The type of container used was significantly associated with the level of education among community members. Non-environmental materials were used to deposit and dispose of COVID-19-induced biomedical waste. The majority of respondents had poor practices regarding the disposal of biomedical waste and were unaware of the standard duration for the disposal of infectious waste. The level of education was associated with awareness of COVID-19 rules and regulations. The recording of COVID-19-induced biomedical waste was insufficient, and the most commonly used methods for treating biomedical waste were biological, thermal, and irradiation. Plastic containers were the most frequently used disposal method for waste during COVID-19, which is hazardous to both the environment and public health.

Conclusions: Community-based BCC activities by engaging community stakeholders in disseminating and raising awareness of key behaviors related to the environment and public health that are impacted by the biomedical waste in the community setting.

Keywords: Bio-medical waste, COVID-19, BCC, University of Chittagong, Chittagong, Bangladesh

INTRODUCTION

Bio-medical waste refers to any waste generated during medical activities that contain infectious agents, which could pose a potential threat to public health and the

environment if not handled properly.¹ Such waste includes used medical instruments, syringes, gloves, pharmaceuticals, and other medical waste.² Improper handling of biomedical waste can lead to environmental pollution, disease transmission, and other health hazards.³

Proper handling and disposal of biomedical waste are essential to ensure the safety of the environment and public health. Healthcare facilities must have a comprehensive waste management plan in place to manage biomedical waste safely. This plan should include the proper segregation, storage, transportation, treatment, and disposal of waste.⁴ It is crucial to raise awareness among healthcare workers, policymakers, and the general public about the importance of proper biomedical waste management to promote sustainable waste management practices. Around 165 million people live in with a density of 156.84 people per square kilometer in Bangladesh.⁵ Despite high density, natural disasters, and social determinants of health, Bangladesh has made rapid achievements in the health and social development sector in the last two decades.⁶ The COVID-19 outbreak is one of the long-time pandemics that produced the largest volume of biomedical waste that has adverse effects on human health and the environment.⁷ Recent evidence reveals that the ongoing pandemic is responsible for producing various bio-medical wastes without managing them scientifically, which continuously creates a serious geo-environmental and public health problem in low-resource settings.⁸ This scenario draws the attention of environmentalists and public health practitioners regarding COVID-19-Induced Biomedical Waste and its management.⁹ The common COVID-19-induced bio-medical waste is medical masks, goggles or face shields, and gowns. The majority of Plastic and medical waste are non-degradable and remain many years in the atmosphere. Statistics show that around 2 million tons of plastic were produced globally in 1950, reaching about 381 tons in 2015.¹⁰ This ongoing uncontrol bio-medical waste negatively impacts low-resource setting like Bangladesh and create a big threat to the fragile public health system. Chattogram is the second largest city where the level of environmental degradation is extremely high. It is essential to explore effective ways of waste management practices with special attention to risk-free handling, transportation, and disposal processes during the pandemic and the need to understand the perception of community people to develop best practices for environment-friendly public health guidelines for the target audience.

METHODS

The study was conducted following a cross-sectional study. Both quantitative and qualitative data were collected through a sample survey and in-depth interviews, respectively. In the sample survey, those variables included primarily provided quantitative information, while qualitative data were those which express feelings, perceptions, and opinions.

Study period

The study was carried out from first November 2021 to January 30, 2022.

Inclusion and exclusion criteria

Community people aged above 18 years, and Health care providers working in hospitals who were employed 6 months or longer were included in the study, However, health care workers who were unable to communicate due to illness were not eligible for the study.

Data collection and quality control

A sample survey was conducted for collecting mostly quantitative data. Following the literature review findings and objectives of the study, a structured quantitative survey questionnaire was developed. The developed questionnaire has five domains including socio-economic and demographic factors, KAP on COVID-19-induced bio-medical hazards, knowledge about bio-medical hazards management, and knowledge of government rules and regulations regarding environmental degradation and public health, etc. The interview schedule was pretested and revised on the pre-test findings and feedback from environmental and public health experts. Data collectors were trained in interviewing techniques, rapport building with a respondent, and checking the consistency of responses. The research team members constantly monitored the field data collection. A total of 196 quantitative survey data-was collected from 14 Upazilas of the Chittagong district. A stratified random sampling technique was applied for drawing samples as potential respondents were stratified by age. The study has a proportional representation of all age groups. For in-depth interviews, data was collected with the help of an interview guide, which included unstructured questions having the option to continue to instantly formulate questions for collecting meaningful data. Each in-depth interview was transcribed within 24 hours of the interview lest information is lost. In-depth interview respondents were the community people, service providers, and high official/management authority.

Data analysis

The survey data were analyzed in two ways, univariate and bivariate with the help of statistics like percentage distribution, mean, standard deviation, correlation, and non-parametric tests. Survey data were analyzed with the help of the SPSS statistical package. Qualitative interviews were transcribed within 24 hours of the interview lest information is lost. Two researchers read the transcripts independently to assign a code. The contents under similar codes were read by two researchers to interpret the underlying meaning of the write-ups; if researchers disagree on interpretations, a discussion session of interpreters was held to reach a decision. The verbal consent of quantitative data, FGD, KII, and IDI respondents was obtained from each participant after explaining the purpose and nature of the research. Participation in the study was voluntary; participants were informed of their rights to quit/refuse their participation at any stage of the study if they did not want to participate.

Moreover, the confidentiality of the information was assured by using an anonymous consent form.

RESULTS

About one-third of the respondents are females, which is unusual as certainly many of them are not heads of the family. Nearly 63% of the respondents are between 18 to 45 years old, which means the overwhelming majority of the respondents are middle-aged or young. However, male respondents seemed older (mean age 44 years) than female respondents (mean age 35 years). This could be cultural, as traditionally husbands are older than wives in society.

Table 1: Percentage Distribution of awareness of COVID-19 rules and regulations by the level of education.

Level of education	Yes	Know a little bit	No	Total (n=200)
Primary	1.00	5.00	5.50	11.50
JSC	3.00	6.50	6.00	15.50
SSC	3.50	6.00	3.50	13.00
HSC	5.50	10.00	3.00	18.50
Graduate	18.00	14.50	4.50	37.00
Non-graded	1.00	2.00	1.50	4.50
Total	32.00	44.00	24.00	100.00

$\chi^2=27.60$, $df=10$, $p<0.002$

The overwhelming majority of the respondents are married (75%) and the rest is either widows/widowers or

unmarried. The occupations of the respondents indicate that the people of the lower strata of society as 12% of them either day laborers or drivers of a rickshaw or an automobile, 24.5% were small businessmen, 12.5% were employed in government and 28.5% were non-government jobs at lower levels, 10% engaged in farming as a self-employed one or a wage laborer, and only 12.5% engaged as housewives. The monthly mean and median incomes of a family in the study area are only Tk. 19,570.0 and Tk.15,000.0 respectively. There is no doubt that with this income no family can afford good healthcare for all family members other than government facilities, which have many limitations including quality of service during COVID-19. The present means and median family sizes in the study area population in between 4.6 and 4.0 respectively. The mean size is almost similar to our national family size, which is 4.5 (National, 2020). The respondents who have provided information about the family, 37% of them have primary-level education, 15.5% had junior secondary school certificates, 13% have SSC, 18.5% have HSC, 11.5% have graduate level education and 4.5% had a non-graded education.

In response to a question, follow the guidelines suggested by GoB during any pandemic; about 79.5 % of the respondents reported that they followed it and 20.5% did not follow it. We found an association between awareness of COVID-19 rules and regulations of the level of education ($\chi^2=27.60$, $df=10$, $p<0.002$). The study's aim was to assess the knowledge of respondents about COVID-19 and its impact on bio-medical waste production.

Table 2: Respondents' opinions on COVID-19-induced bio-medical waste and its environmental and public health problems.

Issues	Opinion of the Respondents % (N)			
	Agree	Strongly agree	Disagree	Strongly disagree
After COVID-19 there is a massive increase in bio-medical waste production	53 (106)	30 (60)	15.5 (31)	1.5 (3)
Improper management of COVID-19-induced waste causes various environmental and public health problems	56 (112)	39.5 (79)	4 (8)	5 (1)
Waste segregation at the source has a high risk to waste handlers	40 (80)	51.5 (103)	8.5 (17)	-

Regarding this, we seek respondents' opinions and through the question that after COVID-19 there is a massive increase in bio-medical waste production. About 53% agreed, 30% strongly agreed, 15.5% disagreed, and 1.5% strongly disagreed. Respondents seem very aware of the massive increase in bio-medical waste during COVID-19 and cross-table analysis reveals that the level of education influence of community people's understanding of bio-medical waste and rate of increase of products ($\chi^2=30.80$, $df=15$, $p\leq 0.009$). The question of whether improper management of COVID-19-induced waste causes various environmental and public health problems, 56% agreed, 39.5% strongly agreed, 4% disagreed, and 5% strongly disagreed. Respondents also gave an opinion on

segregation sources that may have a high risk to waste handlers, 40% agreed, 51.5% strongly agreed, and 8.5% disagreed. About 59.5% of respondents said that they used plastic containers to collect or deposit the bio-medical waste, 27% used poly bags, 9% used bio-hazards bags, and 4.5% used metal containers to collect or deposit the bio-medical waste during the COVID-19 pandemic. About 44% of respondents treated or disposed of the bio-medical waste within 6-12 hours, 28% did it within 13-18 hours, 18.5% of respondents takes 19-24 hours to treat or dispose of the bio-medical waste and 9.5% took 24 hours or above time to treat or dispose of the bio-medical waste induced from COVID-19. About 32% are aware of bio-medical

waste rules and regulations, 44% are confused, and 24% said no.

Table 3: Respondents' opinions regarding COVID-19-induced bio-medical waste

Issues	Opinion of the Respondents % (N)		
	Yes	Maybe	No
Whether COVID-19-induced waste is mixed with non-infected waste in your institution/hospital/ resident	68 (136)	20 (40)	12 (24)
People are aware of bio-medical waste rules and regulations	32 (64)	44 (88)	24 (48)
Separate bins for collecting COVID-19 patient waste are important	31.5 (63)	15.5 (31)	53 (106)
COVID-19 patient waste handlers should have the training to collect waste	53.5 (107)	22.5 (45)	48 (24)
Improving waste management techniques is important during any pandemic	86 (172)	12 (24)	2 (4)
COVID-19-induced bio-medical waste disposal policy is available in your institution/hospital/resident	21 (42)	26.5 (53)	52.5 (105)
Maintaining records of COVID-19-induced bio-medical waste is mandatory in your institution/hospital/resident	29 (58)	25 (50)	46 (92)
Notice for proper disposal of COVID-19-induced bio-medical waste is available at your dust bins	39 (78)	-	61 (122)
Sufficient bins are available in your institution/hospital/resident	61 (122)	-	39 (78)
City corporation/authority has the initiative to follow the correct COVID-19-induced waste management	29.5 (59)	32.5 (65)	38 (76)

Table 4: Respondents' opinions regarding COVID-19-induced bio-medical waste and its management policy and awareness.

Issues	Opinion of the Respondents (%) N	
	Yes	No
Do you know about the government initiative for COVID-19-induced waste management guidelines?	51 (102)	49 (98)
Do you maintain a bio-medical waste disposal policy?	28 (56)	72 (144)
Do you use any color bins in your institution/hospital/resident?	22 (44)	78 (156)
Do you think that the bio-medical waste management process is correct in your area?	30 (60)	70 (140)
Do you think that all members of your family are aware of bio-medical waste?	77 (154)	23 (46)

The knowledge of the collection of waste is a big concern and 31.5% said that separate bins for collecting COVID-19 patient waste are important, 15.5% are not sure and 53% said no. Respondents opined that COVID-19 patient waste handlers should have the training to collect waste, yes (53.5%), maybe (22.5%), and no (48%) respectively. About 21% said that COVID-19-induced bio-medical waste disposal policy is available in their institution/hospital/residence, whereas 26.5% are confused and 52.5% said no. The majority of the respondents (86%) said that improving waste management techniques is important during any pandemic, 12% are confused whereas 2% said no. Respondents also give an opinion on whether maintaining records of COVID-19-induced bio-medical waste is mandatory in your institution/hospital/residence and data reveal that 29% said yes, 25% said maybe and 46% said no.

About 39% of respondents observed noticeable for proper disposal of COVID-19-induced bio-medical waste available in their dust bins, while 61% did not notice it. Regarding sufficient bins, about 61% of the respondents said yes and 39% said no. In response to a question on whether the City corporation/authority has the initiative to follow the correct COVID-19-induced waste management, 29.5% said, 32.5% are confused and 38% said no. The results reveals that about 51% of the respondents are informed about the government initiative for COVID-19-induced waste management guidelines and 49% do not aware of it. The vast majority of the respondents (72%) do not maintain the bio-medical waste disposal policy and only 28% followed it. The big concern is that 22% of the respondents use any color bins in their institution/hospital/residence and 78% do not use them. The majority of the respondents (70%) opined that the

bio-medical waste management process is not correct in their area and 30% said it is correct.

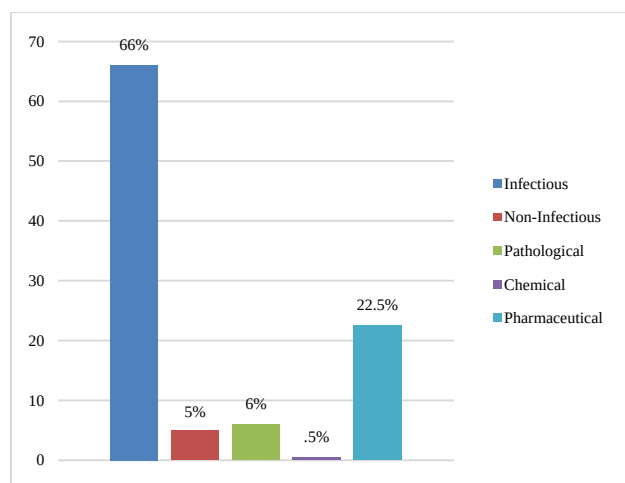


Figure 1: Percentage distribution of opinion of respondents about the types of waste produced during the COVID-19 pandemic.

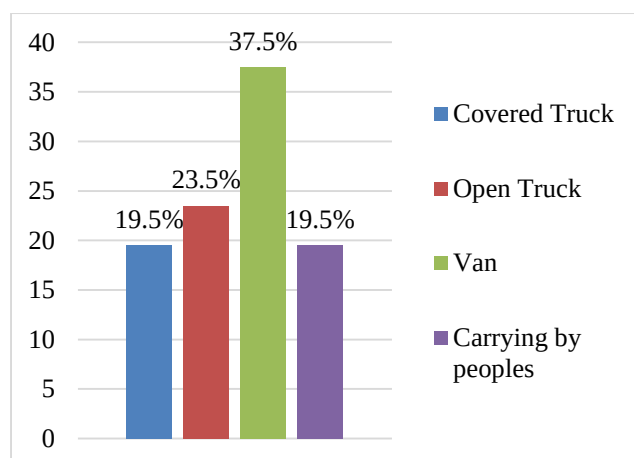


Figure 2: Percentage distribution of mode of transport used for COVID-19-induced waste management.

Although 77% of respondents think that all members of your family are aware of bio-medical waste whereas 23% said no. About 72% followed the municipal landfill, 21.5% were buried in the open space, 4.5% followed the incineration technique, and 2% were buried in the hospital ground. The above table reveals the mechanical (66.5%) was the most popular method to treat bio-medical waste, followed the biological (25.5%), Thermal (7.5%), none of them (7.5%), and Irradiation (0.5%) respectively. Masks (92%) were the highest waste produced during the COVID-19 pandemic, followed by sanitizer (6%), PPE (.5%), gloves (.5%), and others (1%). Plastic containers (42.5%) were the most useful disposal places for waste during COVID-19, followed by Buried in an open field (18%), Bio-hazard bags (10%), Through open space (15%), and confused disposal places (14.5%). The above figure indicates that the waste disposal distance was not

fixed following the standard distance. About 46% were moderate distance, 32.5% were short distance and 21.5% were long distance. Distance and production of infectious is the critical issue. Our data reveals that 66% of respondents opined waste may be produced infectious during the pandemic, and 22.5% said it may produce pharmaceutical hazards, pathological issues (6%), non-infectious (5%), and chemical (.5%). About 44.5% of respondents consulted with the local committee for waste management, 24% followed the daily routine, 21.5% had their own plan and 10% followed the 3R concept. The Van was the most useful vehicle for waste transport during COVID-19, followed by open trucks (23.5%), covered trucks (19.5%), and carrying by people (19.5%). Finally, we asked respondents to rate ongoing waste management in their locality. About 46% give 51-75 marks, 31% give 26-50 marks, 12% give 75 and above marks and 11% give 10-25 marks.

Qualitative findings

The majority of the FGD participants have opined that there are no planned waste management services, treatment facilities, and standard waste management. Usually, Open vans, Open trucks, and people open hands carrying such infectious waste that may be dangerous for the environment and public health. The FGD and IDI respondents have expressed their concerns about the ongoing poor level of bio-medical waste management and limited-skill waste handlers and poor attitudes toward an environment-related determinant of health. Therefore, some feel that they cannot depend on authority for quality waste management and found their services unacceptable. The majority of the waste management worker does not have any training on quality waste management regarding bio-medical hazards. Participants suggest technical training for the waste management workers on modern methods and quality environment and public health promotion. The waste handlers are key workers and service promoters at or community level. FGD and IDI information indicate that city corporations or municipalities should provide training and how to use PPE during handling waste treatment and disposal. Effective communication materials are essential for waste handlers to increase knowledge, stimulate community dialogue, promote an essential attitude change, reduce stigma, create a demand for information and services, advocate, promote services for prevention, cure, and support, and improve skills and sense of self-efficacy. Keeping these points in mind qualitative data have been collected. The majority of the IDI participants have opined about BCC&M materials and mentioned that effective communication materials have motivated community people to attend quality waste management during a pandemic. Most of the FGD participants have mentioned that posters, display of the banner, advertisements in the local paper, miking, airing in the C&S and national TV channel, distribution of handbill/leaflet, Jari Gan, display through the projector at crowded places, dissemination through social media (Facebook, YouTube), engaging

religious leader (Mosque Imam), M-health services, poster, courtyard meeting, Festoon, and Flip chart are useful communication materials. Assessment has been made through IDI to know about effective promotional activities that influence community people to change their key behaviors and motivate them to manage bio-medical waste addressing the environment and public health.

DISCUSSION

Both quantitative and qualitative data are collected for the study. The average age of the respondents is 38 years. About 63% of the respondents are between 18 and 45 years. This means the majority of the respondents are middle-aged and very few elderly. The vast majority of the respondents are married and Muslim. These statistics indicate that married young males and females are the main respondents of the study. The study's findings are similar to a study conducted by Mostafizur et al which finds 70% of the respondents are young and middle-aged.¹¹

The COVID-19 pandemic has brought about unprecedented challenges in the healthcare sector, particularly in terms of managing bio-medical waste. The sharp rise in the number of COVID-19 cases has led to an exponential increase in the amount of medical waste generated, including used personal protective equipment (PPE), masks, gloves, and other disposable medical items. This has put an immense strain on the existing healthcare infrastructure, and the proper management of bio-medical waste has become more important than ever before. Improper handling and disposal of bio-medical waste can have significant negative impacts on the environment and public health. The study highlights that the use of non-environmental materials to deposit and dispose of COVID-19-induced bio-medical waste is a common practice among community people. This is particularly concerning as such waste can contain hazardous materials, including infectious pathogens, toxic chemicals, and radioactive substances. If not handled properly, these substances can contaminate the soil, water, and air, and potentially lead to the spread of infectious diseases. In addition to environmental concerns, poor bio-medical waste management can also have serious public health implications. The study found that a majority of respondents had poor practices when it comes to treating or disposing of bio-medical waste. This can increase the risk of disease transmission, particularly in densely populated areas where the proper waste management is not practiced. Moreover, the lack of awareness regarding the standard duration of disposal of bio-medical waste induced by infectious diseases further highlights the need for improved public education and awareness-raising activities. Furthermore, the study shows that plastic containers were the most commonly used disposal places for waste during COVID-19. Plastic waste has become a major environmental issue globally, and its impact on the environment and public health cannot be ignored. Plastic waste can take hundreds of years to decompose, and its accumulation in landfills, water bodies, and other areas can

have significant negative impacts on the environment and public health. Therefore, the proper disposal and management of plastic waste, particularly in the context of bio-medical waste, is crucial.

The study highlights the urgent need for community-based BCC activities and engagement of community stakeholders to disseminate and create awareness of key behaviours of the environment and public health induced by bio-medical waste in the community setting. The study further emphasizes the importance of following proper waste management practices, including the use of environment-friendly materials for waste collection and disposal. The findings of the study can serve as a guide for policymakers and healthcare professionals to develop effective waste management policies and practices, and to promote environmental sustainability and public health. BCC activities have been shown to be effective in improving the attitude and practice of community people in urban areas, particularly in relation to bio-medical waste management. BCC activities involve the use of various communication strategies, such as interpersonal communication, mass media, and community mobilization, to promote positive behavioral changes and create awareness among the target population. The study highlights the importance of community-based BCC activities in improving the attitude and practice of community people towards bio-medical waste management. Community-based activities can be tailored to the specific needs and context of the target population and can be more effective in creating lasting behavioral changes. Engaging community stakeholders, such as local government officials, healthcare workers, and community leaders, is also crucial in creating awareness and promoting positive behavioral changes.

Limitations

The study was conducted in one metropolitan city 14 Upazilas' which does not covered all population in city. But there may be socially desirable bias for the practice of randomization during data collection time. In this study, the quantification of the generation rate of biomedical wastes couldn't measure.

CONCLUSION

Findings suggested that community-based BCC activities by engaging community stakeholders in disseminating and raising awareness of key behaviors related to the environment and public health is important and this can improve biomedical waste management in the community setting.

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