



Assessment of the awareness about COVID-19 and the following-up of guidelines for biomedical wastes in Jaipur city

Chahat Vijay¹ · Kanak Modi² · Nitesh Singh Rajput³ · Vinay Sharma¹ · Jagdish Prasad² · Shweta Kulshreshtha¹

Received: 15 April 2022 / Revised: 23 November 2022 / Accepted: 25 November 2022
© The Author(s) under exclusive licence to Society for Plant Research 2022

Abstract

In this COVID-19 era, isolating people and reviewing their contacts has proven to be insufficient to control the COVID-19 pandemic as there was a huge gap between exposure to the virus and isolation due to the late onset of symptoms. This led to the spread of infection and people faced the consequences not only of viral infection, but also of financial and occupational crises. People followed best management practices, however, new variants emerged that caused infection. With little information on new COVID-19 variants and their transmission, the disease spread rapidly in humans. Until now, the link between the spread of COVID-19 and the disposal of biomedical waste with household waste has not been established. Therefore, the only way to prevent infection is to make people aware. It is still necessary to open the doors for research to find the possible cause of the appearance of a new variant of COVID-19. To cope with the situation, the level of awareness among the public and their action towards the prevention of spread of infection caused by COVID-19 and its emerging variants must be known. Therefore, a survey was conducted in Jaipur from January to February 2022 to find out the status of awareness. Results of the survey revealed that both people are aware about the infection caused by COVID-19 and its variants. They are also aware about the precautions to be followed to protect themselves from acquiring COVID-19 infection. Most of the people are using masks but not gloves to prevent themselves from the infection. Merely, 71.6% of young, 100% of adults, 40% of old people sanitize their masks and gloves before disposal. Only 66.5% people are using separate bags for the collection of wastes. Despite of awareness about biomedical waste, 25% of young never sanitize, and 26.13% of young seldom sanitizes their waste before disposal. Such types of cases were not observed in adults and old age groups. Similarly, 2.3% of young did not sanitize PPE kit prior to disposal. Results of this study revealed that there is awareness about the different strains of corona virus and biomedical wastes. However, some people showed casual behaviour in the waste disposal practices. The strict implementation of rules to dispose biomedical waste will be useful for dealing with biomedical waste in this pandemic period.

Keywords COVID-19 · Biomedical waste · Awareness · Gloves · Masks

✉ Shweta Kulshreshtha
shweta_kulshreshtha@rediffmail.com

Chahat Vijay
chahat.vijay8306@gmail.com

Kanak Modi
kmodi@jpr.amity.edu

Nitesh Singh Rajput
niteshthakur72@yahoo.com

Vinay Sharma
vsharma4@jpr.amity.edu

Jagdish Prasad
jprasad@jpr.amity.edu

¹ Amity Institute of Biotechnology, Amity University
Rajasthan, Jaipur, India

² Amity School of Applied Sciences, Amity University
Rajasthan, Jaipur, India

³ Amity School of Engineering and Technology, Amity
University Rajasthan, Jaipur, Rajasthan, India

Introduction

Due to the disposal of surgical masks, face shields, gloves, shoe covers, and PPE, waste production has increased since the coronavirus epidemic started (PPE). According to Chandrappa and Das (2012), these wastes are known as biomedical waste (BMW) and fall into four main categories: infectious, hazardous, radioactive, and general biomedical waste. Gloves, masks, and PPE kits were used more frequently during the COVID-19 disaster and were afterwards thrown as waste (Vijay et al. 2022). However, these items could be contagious and require proper disposal and treatment. The amount of biological waste produced during the Corona virus outbreak and afterward differed significantly. In 2016, approximately 16,000 kg of biomedical waste was generated per day, which increased dramatically to 20,400 kg per day by 2020 and has now reached 23,500 kg per day in 2021 (<https://timesofindia.indiatimes.com/city/hyderabad/t-stares-at-biomedical-waste-crisis-amid-covid/articleshow/84533758.cms>).

Because it is highly contagious, biomedical waste produced at blood banks, research labs, hospitals, clinics, and nursing homes are disposed of by incineration in accordance with the biomedical waste management guidelines. Contrarily, when biomedical waste is dumped with domestic waste by the public without being separated, it poses intriguing issues. Home-quarantined COVID-19 positive patients who were asymptomatic, disposed off their gloves and masks in dustbins, resulting in the contamination of household garbage with hazardous biomedical waste (Reddy 2020; Sangkham 2020). Improper disposal of masks and gloves by healthy and asymptomatic people after usage, which left them lying all over the street and infected nearby water bodies (Xiang et al. 2020). According to earlier surveys, 70% of participants disposed of their used masks and gloves in the trash after using them (Mejjad et al. 2021). Untreated and incorrectly disposed biomedical waste from the public can be dangerous and transmit disease across society (Healthcare waste (who.int)). In addition to increasing microbial burden, this could also impact the environment by introducing additional plastic and microplastic debris into terrestrial and aquatic ecosystems in the form of discarded masks and gloves. The issue of safety and the long-term effects on the environment are also brought up by this activity (Xiang et al. 2020).

BMW is dealt by skilled staff in health care facilities, hospitals, and research facilities and disposed of at its source by incineration, chemical disinfection, wet and dry thermal treatment, microwave irradiation, land disposal, and conversion into inert material (Datta et al. 2018). However, there is no strategy in place to handle

BMW emanating from residences that produce household garbage.

BMW is often burned in incinerators that were operating at full capacity when COVID was in place for the disposal of BMW. Mixing garbage presented further challenges because incinerators were overloaded beyond capacity. Such situation was reported in Delhi, Vijaywada, and West Bengal, where these ran out of their capacities (Reddy 2020).

In addition to the rise in disease burden, improper waste management exacerbated BMW's burden (Datta et al. 2018; Reddy 2020). The proper disposal of gloves and masks seems to be another problem. Due to the rapid increase in BMW, several nations have failed to properly handle and dispose of it, posing a risk to front-line employees engaged in handling and treatment as well as to the environment (Datta et al. 2018). In many developing countries, the proper disposal of discarded masks and gloves has been neglected, and no guidance has been given to the public (Poudel 2021).

Waste can be recovered rather than disposed off based on the 3Rs idea, which stands for reduce, recycle, and reuse (ref 2). Reusability options were suggested, such as use of cloth masks repetitively after washing, employing dry heat pasteurization to disinfect N95 respirators and surgical face-masks, to reduce the amount of BMW (Kalina et al. 2022). Additionally, in order to decrease the amount of masks that have been discarded, these were hydrothermally liquefied into renewable fuel oil while ethanol was also being produced (Xiang et al. 2020). These were discarded in the pit latrine disposal system in Morocco (Kalina et al. 2022). Many nations have strict guidelines and systems in place for properly disposing of waste, such as sorting and disinfecting it first, then leaving it for nine days before sorting to reduce the risk of exposing first-line employees to viruses (Das et al. 2021). Only a small number of developed nations, though, were able to hit this goal.

The way people in the community used and disposed of their gloves and masks has an influence on the production of BMW and other environmental effects (Xiang et al. 2020; Mejjad et al. 2021). The management of BMW must take into consideration in human behaviour. By raising awareness about the need for appropriate disposal of masks and gloves, individuals can inspire others to follow the same path (Poudel 2021).

The current study was designed to determine the level of public awareness of the COVID-19 pandemic, biomedical waste, and methods for its disposal. This was a questionnaire-based survey carried out in February 2022. A total of 105 non-experts were selected to fill out the questionnaire about bio-medical waste management. The purpose of this study was to determine the extent of awareness of people about infection caused by COVID-19 and its variant, and biomedical waste management. Despite of their awareness, the precautions they follow to dispose off their used masks

and gloves were recorded. Further, the views of the people about the amendment in waste transportation vehicle and installation of small incinerators in the society to overcome the problem of biomedical waste at societal level were listed. These suggestions of the people will help the government in improving their policies to control the release of biomedical waste at its source.

Methodology

Study design/questionnaire preparation

The questionnaire was developed according to the other surveys conducted by many scientists (Opalinski 2008), (Hone and El Said 2016) (Krithiga et al. 2021). However, the survey included several questions to test various hypotheses that are being tested in this study, which were related to the COVID-19 pandemic and biomedical waste and its disposal practices. The study was cross-sectional and used anonymous online feedback.

The questions of this survey were categorised into three categories: (i) based on their knowledge about COVID-19; (ii) based on their knowledge about biomedical wastes; and (iii) based on the disposal of biomedical waste like gloves and masks.

Data collection

An online survey was conducted using Google Forms in February 2022. It was circulated among the people of Jaipur with a request to fill them. Prior to administering the questionnaire, the purpose of the study was explained to all participating respondents, and their consent were taken. The filled-up responses were divided into three age groups: 14–25 years old (young people), 26–40 years old (middle-aged people), and 40–60 years old (old people). A cross-tabulation was performed to determine the relationship between their knowledge of biomedical waste and its disposal practices.

Data analysis

All statistical tests were performed and found to be adequate to assess the significance of differences. The sample included a random subset of non-expert individuals, and thus, the survey can be considered a representation of a larger population. There were three categories of the questionnaire and respondents were asked to fill out the form for all categories. In this questionnaire-based survey, the different choice-based questions were used to enable the participants to respond based on their agreement with a particular choice. To assess the level of awareness, all responses

were clubbed in to one variable. The respondents, who have responded for all the three categories has been put as “1” otherwise “0” (Golandaj and Kallihal 2021).

As the resulting dataset would be coded, collated, and analysed in SPSS 17 at a 0.05% significance level, the Chi-square test was performed. The p-values of < 0.01 and < 0.05 were considered to observe statistically significant association between a dependent variable and predictor variables. Cross-tabulation was also used to tabulate some specific questions to find out the correlation of two questions.

Results and discussion

Awareness to COVID-19

The results of the COVID-19 awareness related questionnaire are presented in Fig. 1. To answer the first question, "What precaution do you use frequently to avoid COVID-19 infection?", maximum of 60–80% of people in all three age groups accepted that they were using masks. Many participants (20%) preferred hand sanitizers to soap, whereas the elderly (40%) preferred soap. In response to the second question, which was related to the use of sanitizer, when COVID-19 cases are reducing, 83–100% of participants of all age groups accepted the use of sanitizers and disinfectants. About 36.4–40% of all age groups were also found to be aware of the harmful effects of sanitizer, as they mentioned in response to question 3 (Fig. 1).

In response to question 4, which was related to awareness, 80% of people from all age groups were found to be aware of the fact that they could acquire infection even after vaccination. When were they asked (question 5): "What precautions do you take after being vaccinated?" 80% of the young and old age groups and 100% of adults responded that they used to wear masks despite being vaccinated. About 9.1% of youth and 20% of older people used sanitizer to clean their hands. This demonstrates the level of awareness among all age groups regarding prevention from COVID-19 infection. Everyone was aware of the precautions, such as wearing masks and using sanitizer and soap to clean and wash hands. They were aware of the spread of COVID-19 and therefore followed all precautions even after vaccination.

Awareness about biomedical waste and its disposal

The questionnaire used in the study contains some questions on biomedical waste and its disposal methods to find out the level of awareness of biomedical waste and its disposal. These are presented in Fig. 2. "Are you aware of biomedical waste?" asked question 6; 89.8% of young people, 90% of adults, and 60% of the elderly were aware of biomedical waste. Every day, 18.2% of participants discard masks.

Fig. 1 Responses of questionnaire to analyse the awareness to COVID-19 and precautions to avoid infection among the people

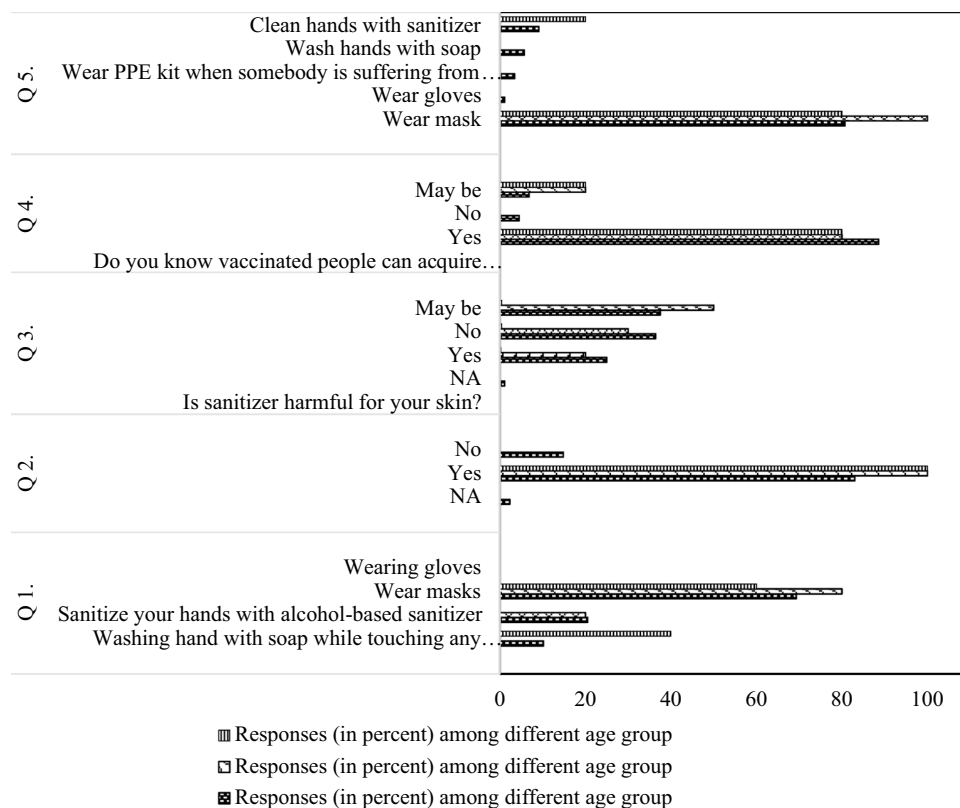


Fig. 2 Questions asked to the participants related to bio-medical waste i.e., masks/gloves disposal

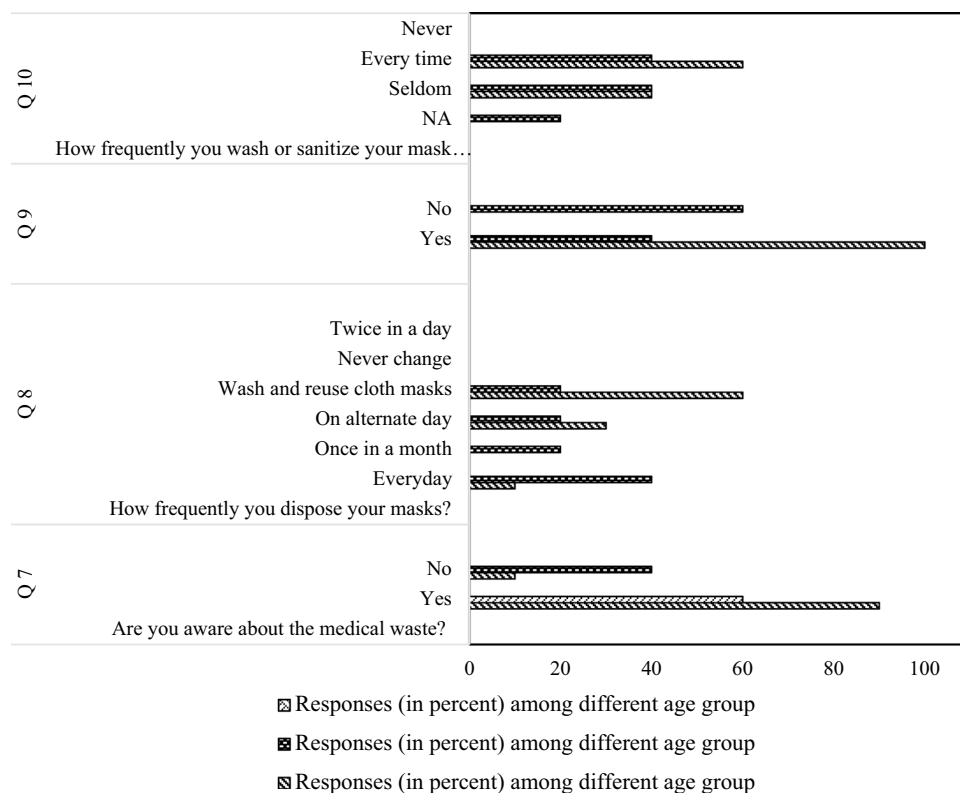
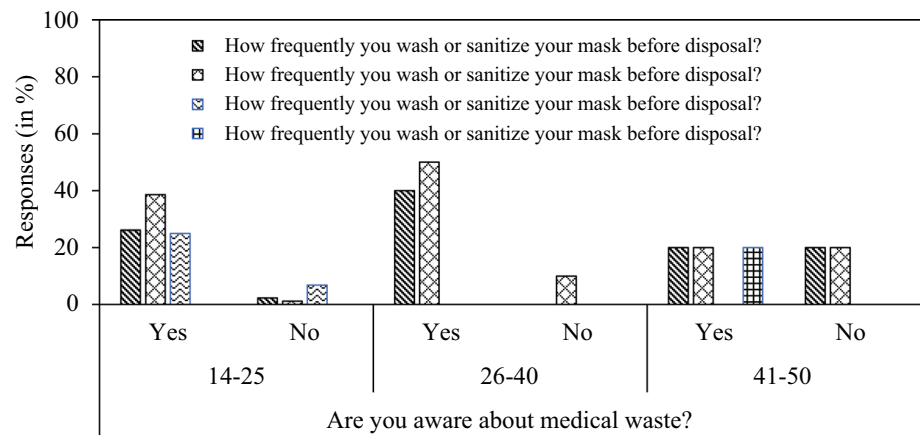


Fig. 3 Cross-tabulation between the questions to show the relationship of participant's awareness and their action to wash or sanitize their masks (* reveals significant result i.e. $p < 0.05$)



However, 39.8% of participants used cloth masks, which were washed and reused (Question 7, Fig. 2). However, only 71.6% of young people, 100% of adults, and 40% of the elderly sanitise their masks and gloves before throwing them away (question 8, Fig. 2). It is pertinent to note that 31.8% of the young participants never sanitized their mask before disposal (Question 9, Fig. 2).

A cross-tabulation (Fig. 3) of people's awareness of biomedical waste (Question 6, Fig. 2) and the frequency of washing or sanitising masks before disposal (Question 9, Fig. 2) revealed that 6.81% of the young are unaware and, as a result, do not sanitise their masks before disposal (Fig. 3). Despite their awareness of biomedical waste, 25% of young people never sanitised their waste before disposal, and 26.13% only rarely sanitised it. Such types of cases were not observed in adults or older age groups (Question 9, Fig. 2). Similarly, 2.3% of the young did not sanitise PPE kits prior to disposal (Question 10, Fig. 2). This shows the casual behaviour of young people towards the disposal of gloves and masks, despite their awareness about biomedical waste.

Despite of their awareness on biomedical waste, 31.8% of young people, 40% of adults, and 60% of the elderly did not use separate bags for waste disposal (Question 11; Fig. 4). To determine their level of awareness regarding the use of separate waste bags, 5.68% of adults and 20% of the elderly were found to be unaware and, as a result, did not use separate waste bags ($p < 0.05$) (Fig. 4). In order to avoid the risks posed by any person infected with COVID-19, they were kept in isolation and provided with appropriate medical care (Question 12, Fig. 5). The result of the cross-tabulation of question 6 with question 11 revealed that participants didn't used separate bags for waste disposal (Question 11, Fig. 6), despite their awareness. This is a matter of concern, as improper disposal may lead to the spread of infection through infected materials and may give rise to mutants. Only 2% of young people used personal protective equipment (PPE) kits and disposed of them in separate bags ($p < 0.05$) (Fig. 6). This depicted the lack of awareness about

the use of separate bags for disposing of infected material, i.e., biomedical waste. These findings are in contrast to the study conducted in Tamil Nadu about biomedical waste, which reported the use of separate containers by 72.8% of health care workers (Krithiga et al. 2021) (Dalui et al. 2021).

People were aware of biodegradable masks, and thus, they would purchase them regardless of their price (Question 14, Fig. 4). This reveals the need of training the public about biomedical waste and the disposal of masks after use.

Suggestions to Government

The people were asked about their views on including a separate section in a waste transportation vehicle for biomedical waste, 87.5% of youth, 100% of adults, and 100% of old age persons agreed, and 5.7% of youth remained unanswered (Question 14, Fig. 7). When asked, "Should the government include a section of a medical waste transportation vehicle?" 100% of adults and seniors agreed that a separate section in a waste transportation vehicle should be included. However, 90.99% of people agreed that the government should incorporate a separate section in waste transportation vehicles (Question 15, Fig. 7).

A cross-tabulation of these two questions revealed that 100% of adults and older people desired a separate section for biomedical waste disposal in waste transportation vehicles. Only 2.27% people were unaware of this and not recommended it to the government ($p < 0.05$) (Fig. 8). This data showed that people were aware of the segregation of waste in waste transportation vehicles. There has been no report published on the public's demand for a separate section for biomedical waste, as well as the need for training and awareness in this area.

In addition to this, 90% of youth, and 100% of adults and older people preferred the installation of incinerators in colonies for masks and gloves to prevent the spread of infection (Question 16, Fig. 7). This reveals the status of disposing masks and gloves among them by incineration.

Fig. 4 Questions asked to the participants related to bio-medical waste and their way of avoidance to risk

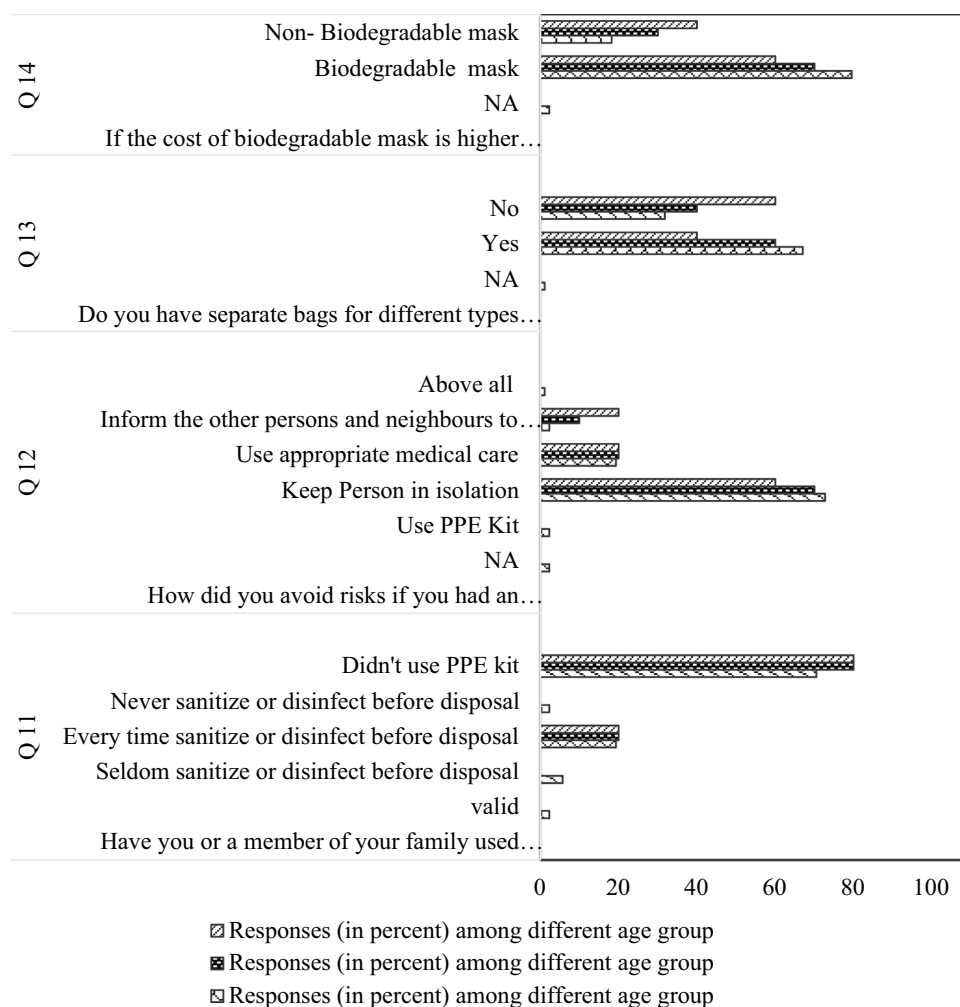


Fig. 5 Cross-tabulation to know the relationship between the participants' awareness about the medical waste and use of separate bags for different types of wastes (* reveals significant result i.e. $p < 0.05$)

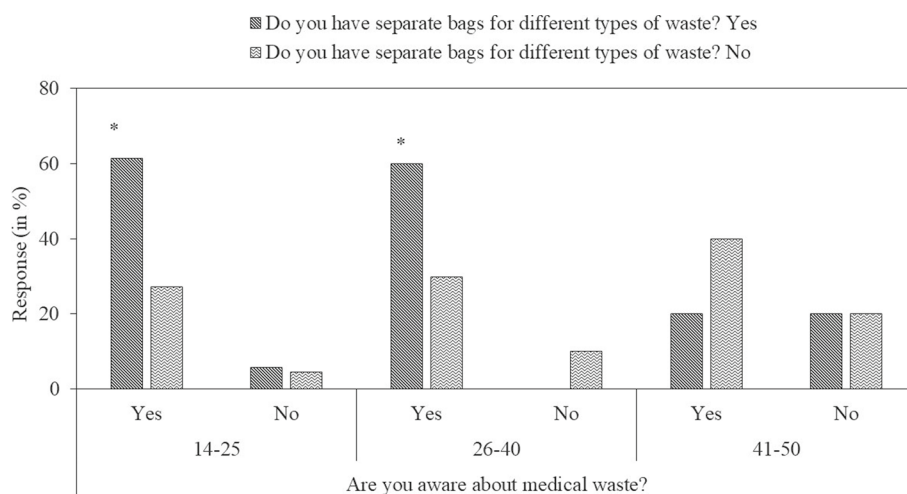


Fig. 6 Cross-tabulation to know the relationship between the participants' awareness about the way of avoiding the risk of COVID-19 and use of separate bags for the disposal of waste (* reveals significant result, $p < 0.05$)

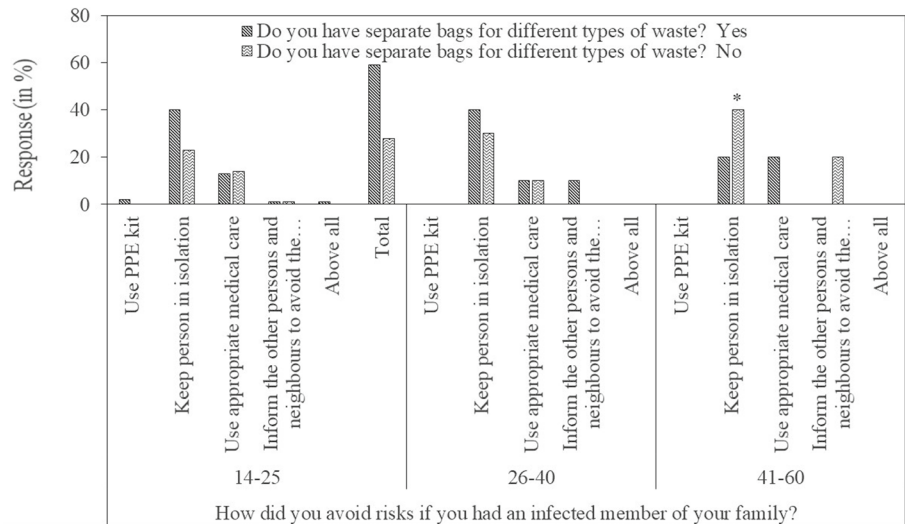
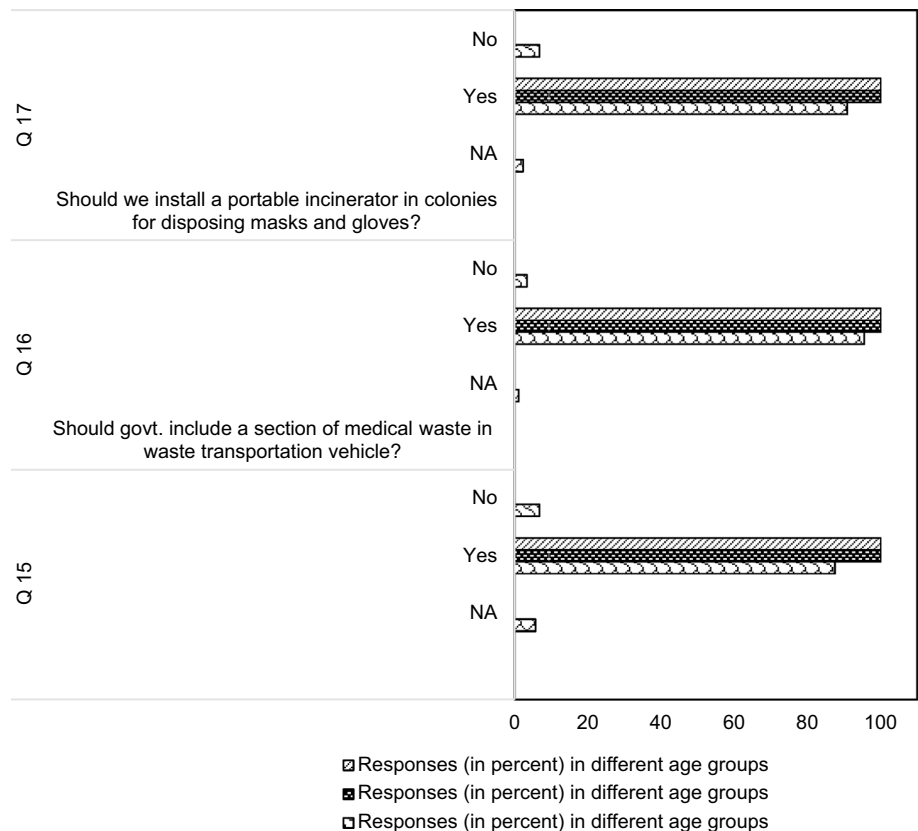


Fig. 7 Questions related to their suggestion to control the exposure of waste to the workers dealing with it

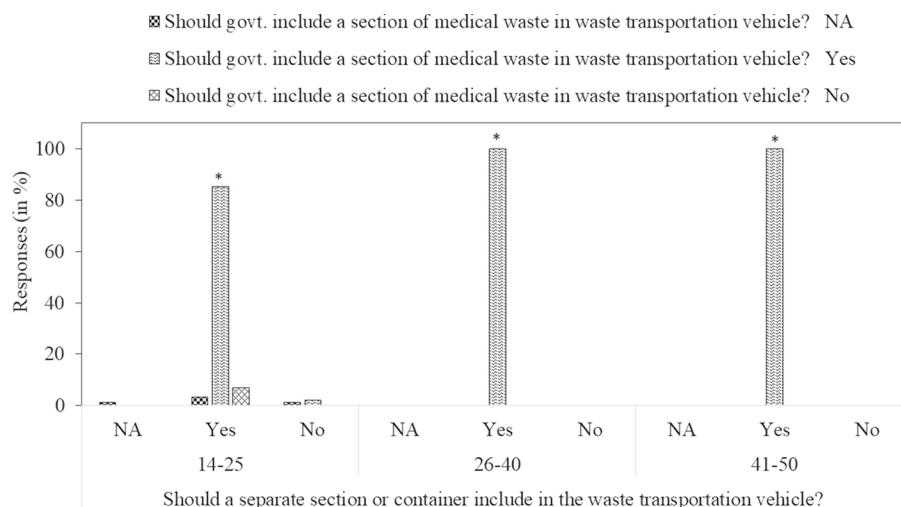


Conclusion

Biomedical waste, generated by the public during the COVID-19 pandemic, is an important problem that needs to be addressed properly, and the public must be aware of it. Improper disposal and ignorance of the waste accumulation

may give rise to several problems, including the spread of infection. Awareness among the people can be a major tool to combat issues related to the disposal of masks and gloves during the COVID-19 pandemic. Regardless of the person's symptoms, waste disposal requirements must be properly observed. This study reveals that people are aware of the

Fig. 8 Cross-tabulation of two questions i.e., should a separate section or container be included in waste transportation vehicle with should government include a separate section in waste transportation vehicle



pandemic and biomedical wastes, their consequences, and the precautions that need to be taken to cope with the situation. A broad public awareness campaign may be beneficial in making people aware of the importance of strictly adhering to biomedical waste guidelines.

Acknowledgements We are thankful to the Director, Amity Institute of Biotechnology, Amity University Rajasthan, Jaipur for providing all the facilities for conducting the present work. We are also thankful to the Central Instrumentation facility of University of Rajasthan, Jaipur for providing FTIR facility.

Funding This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

There is no declaration related to this manuscript.

Data availability The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest There are no competing interest related to this manuscript.

References

- Chandrappa R, Das DB (2012) Biomedical waste. In: Solid Waste Management. Environ Sci Eng 9783642286803:147. https://doi.org/10.1007/978-3-642-28681-0_6
- Dalui A, Banerjee S, Roy R (2021) Assessment of knowledge, attitude, and practice about biomedical waste management among healthcare workers during COVID-19 pandemic in a health district of West Bengal. Indian J Public Health 65(4):345. https://doi.org/10.4103/IJPH.IJPH_2103_21
- Das AK, Islam MN, Billah MM, Sarker A (2021) COVID-19 and municipal solid waste (MSW) management: a review. Environ Sci Pollut Res Int 28(23):28993–29008. <https://doi.org/10.1007/s11356-021-13914-6>
- Datta P, Mohi GK, Chander J (2018) Biomedical waste management in India: Critical appraisal. J Lab Phys 10(1):6–14. https://doi.org/10.4103/JLP.JLP_89_17
- Golandaj JA, Kallihal KG (2021) Awareness, attitude and practises of biomedical waste management amongst public health-care staff in Karnataka, India. Int J Humanit Appl Soc Sci 3(1):49–63. <https://doi.org/10.1108/JHASS-08-2019-0041>
- Health-care waste (who.int) Accessed on 2nd April 2022
- Hone KS, El Said GR (2016) Exploring the factors affecting MOOC retention: a survey study. Comput Educ 98:157–168. <https://doi.org/10.1016/J.COMPEDU.2016.03.016>
- Kalina M, Kwangulero J, Ali F, Tilley E (2022) “You need to dispose of them somewhere safe”: Covid-19, masks, and the pit latrine in Malawi and South Africa. PLoS ONE 17(2):e0262741. <https://doi.org/10.1371/journal.pone.0262741>
- Krithiga P, Sudharsana V, Sribalaji R, Snega C. Covid 19 (2021) Pandemic: Assessment of Knowledge and Attitudes in Biomedical Waste Management among Health Care Professionals in Tamil Nadu. Asia Pacific J Heal Manag. 16(3):154–164. <https://doi.org/10.24083/APJHM.V16I3.987>
- Mejjad N, Cherif EK, Rodero A, Krawczyk DA, El Kharraz J, Moumen A, Laqbaqbi M, Fekri A (2021) Disposal behavior of used masks during the COVID-19 pandemic in the Moroccan community: Potential environmental impact. Int J Environ Res Public Health 18(8):4382. <https://doi.org/10.3390/ijerph18084382>
- Opalinski L (2008) Older Adults and the Digital Divide: Assessing Results of a Web-Based Survey. J Technol Hum Serv 18(3–4):203–221. https://doi.org/10.1300/J017v18n03_13
- Reddy A (2020) Biomedical Waste in India has Increased Exponentially as a Result of COVID-19 (vidhilegalpolicy.in) accessed on 12th November 2022
- Sangkhram S (2020) Face mask and medical waste disposal during the novel COVID-19 pandemic in Asia. Case Studies in Chemical and Environmental Engineering 2:100052. <https://doi.org/10.1016/j.csee.2020.100052>
- Sonika P (2021) Disposing of face masks: The next environmental problem? | UNICEF Nepal. accessed on 12th November 2022
- Sribala V (2021) Telangana stares at biomedical waste crisis amid Covid. <https://timesofindia.indiatimes.com/city/hyderabad/t-stares-at-biomedical-waste-crisis-amid-covid/articleshow/84533758.cms>. Accessed 01 April 2022

- The Third Pole (2021) Biomedical waste and Covid-19: 'People on the front line are facing serious issues' (thethirdpole.net) accessed on 12th November 2022
- Vijay C, Sharma A, Kulshreshtha S (2022) Heeded and Unheeded Attentions about Covid-19 Viral Transmission with Special Reference to Biomedical Wastes. *Int j biol pharm allied sci* 11(1):48–58. <https://doi.org/10.31032/IJBPAS/2022/11.1.5805>
- Xiang Y, Song Q, Gu W (2020) Decontamination of surgical face masks and N95 respirators by dry heat pasteurization for one hour at 70 °C. *Am J Infect Control* 48:880–882. <https://doi.org/10.1016/j.ajic.2020.05.026>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.