A Study on the Surgical Masks and Waste Pollution

Research Question - Due to COVID 19, to what extent have surgical masks caused the increase in waste pollution in Dhaka?

Word Count - 2000

Introduction

Unmanaged biomedical waste is a problem in less-developed countries like Bangladesh. They tend to threaten public health as they tend to spread illness. Approximately 5.2 million people die because of diseases related to unmanaged biomedical waste. 4 million of those are just children[1]. Bangladesh's waste management system is very poorly organised. The country produces about 8000 tons of solid waste per year from all its districts combined. Dhaka contributes to 70% of this. This list makes waste management poor in its collection, transportation, recycling, burning, and landfilling, use laws, lack of knowledge, inadequate technology, and insufficient financial support.[2]

After COVID-19 struck, it might've done wonders for the air quality in Dhaka[3], but it raised another problem. The problem is with the disposing of face masks. As the government implemented rules to wear masks to prevent the transmission of COVID, the use of disposable masks and their waste also increased vastly.[4] Face masks are made from non-biodegradable and non-renewable petroleum-based polymers.

This experiment aims to determine the increase in surgical mask waste. As these masks aren't correctly disposed of, they threaten the environment and cause health issues.[5]

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[1] "For effective management of medical waste | The Daily Star." Accessed November 9, 2021. https://www.thedailystar.net/law-our-rights/law-watch/news/effective-management-medical-waste-1875757.

[2] "Abedin, Md Anwarul, and M Jahiruddin. 2015. "Waste Generation and Management in Bangladesh: An Overview". Asian Journal of Medical and Biological Research" 1 (1):114-20. https://doi.org/10.3329/ajmbr.v1i1.25507. Accessed 30 Nov. 2021.

[3] Ferdous, M. N., M. A. Islam, P. Chakrabortty, and S. Kabir. "Covid-19 Lockdown and Changes of Air Quality in the Most Polluted City of Bangladesh". Journal of Scientific Research, vol. 13, no. 3, Sept. 2021, pp. 707-14, doi:10.3329/jsr.v13i3.50647. Accessed 30 Nov. 2021.

[4] Rahman, Md Hafizur. "Inappropriate use and disposal of face masks may promote the spread of COVID-19 in Bangladesh". Population Medicine 2 no. November (2020): 38. doi:10.18332/popmed/128325. Accessed 30 Nov. 2021.

[5] Rahman, Md Hafizur. "Inappropriate use and disposal of face masks may promote the spread of COVID-19 in Bangladesh". Population Medicine 2 no. November (2020): 38. doi:10.18332/popmed/128325. Accessed 30 Nov. 2021.

Research Question

Due to COVID 19, to what extent have surgical masks caused the increase in waste pollution in Dhaka?

Hypothesis

After COVID-19, the production of surgical masks increased. This resulted in more masks being disposed of and used, thus producing more waste.

What happened in COVID-19

Figure 1 - Dhaka in Lockdown[6]

On March 8, 2020, the first case of COVID-19 was recorded. The following day, the authorities issued preventive measures to stop the virus from spreading. When the number of people

[6] "Bangladesh extends coronavirus lockdown for another week." Accessed November 9, 2021. https://www.aljazeera.com/news/2021/4/19/bangladesh-extends-coronavirus-lockdown-for-another-week.

infected soared, the ministry of education ordered all educational institutions to close on March 16 to prevent the disease from spreading. The first death from COVID-19 occurred on March 18. The government subsequently chose to go into lockdown beginning March 26. Except for the United Kingdom and China, all kinds of transportation were prohibited, and foreign flights were halted. Until further notice, all factories were to be shuttered the following day, March 27. In April, factories reopened, and the closure was extended until May 30. Despite many COVID-19 instances, the lockdown was lifted on June 1, 2020, after a sixty-six-day period. No more lockdowns were implemented until April 2021, and all modes of transportation and factories were reopened under the condition that health requirements be observed and that all personnel wears masks.[7]

Methodology

For the data, I have selected three areas of Dhaka that are concentrated with pharmacies. These areas are considered to be the central market of Dhaka. The areas are Lalbagh, Hazaribag and Gandaria. The maps for the following areas are shown in Figures 2, 3, and 4.

[7] "COVID-19 timeline in Bangladesh - Better Work." https://betterwork.org/portfolio/covid-timeline-in-bangladesh/. Accessed 9 Nov. 2021.

Figure 2 - Map of Lalbagh[8]

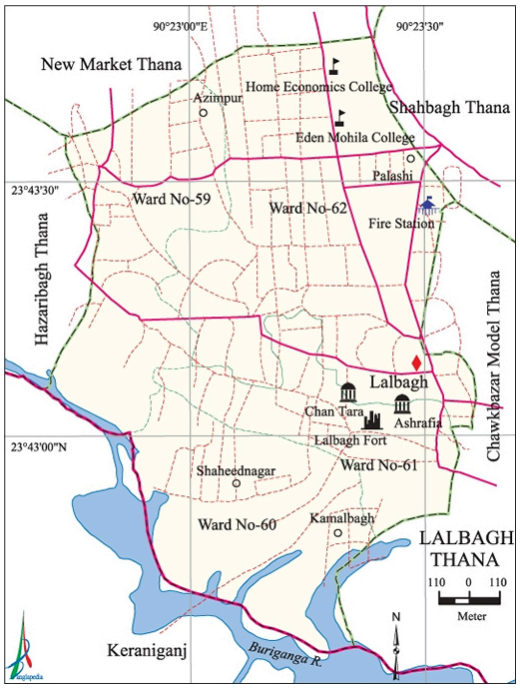
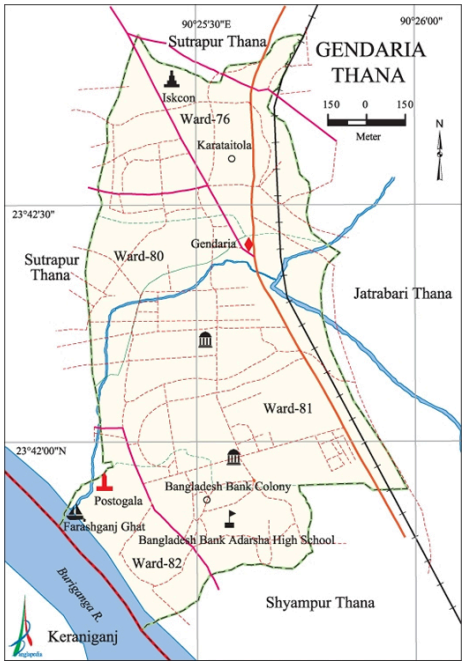
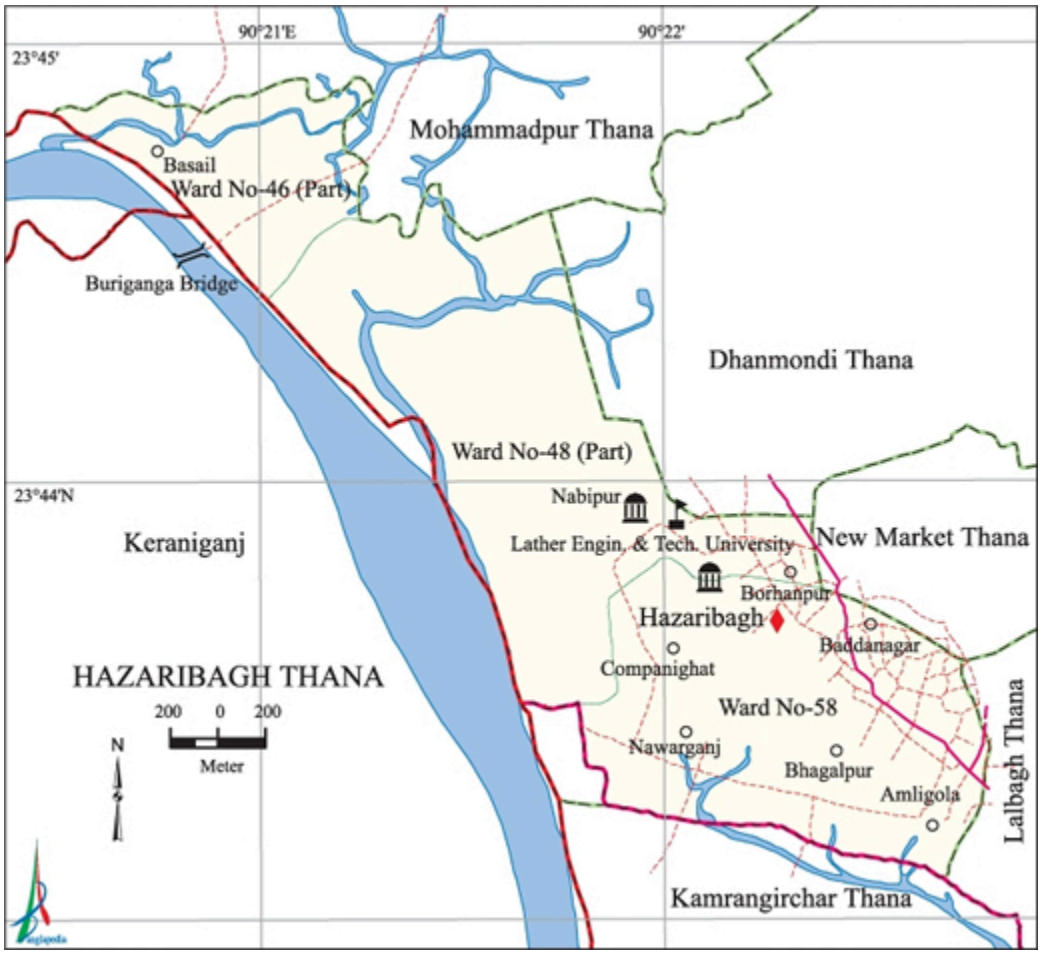


Figure 3- Map of Gandaria[9]



[8] "File:LalbaghThana.jpg - Banglapedia." Accessed November 9, 2021. https://en.banglapedia.org/index.php?title=File:LalbaghThana.jpg.
[9] "File:GendariaThana.jpg - Banglapedia." Accessed November 9, 2021. https://en.banglapedia.org/index.php?title=File:GendariaThana.jpg.

Figure 4 - Map of Hazaribagh[10]



After the lockdown was over, I collected the data of the number of masks they sold per month to correlate it with the number of masks used after COVID-19 struck. The amount of masks disposed of relies on the number of masks used as the masks being investigated are one-time use only. I also collected data on medical waste before COVID and after COVID to compare the waste situation. The masks under-examination are made out of plastic non-woven fabrics. This is important when discussing the pollution aspect of masks.

[10] "File:HazaribaghThana.jpg - Banglapedia." Accessed November 9, 2021. https://en.banglapedia.org/index.php?title=File:HazaribaghThana.jpg.

To make the research more focused, I created a questionnaire for the pharmacies to be filled every day. This way, I could generate a percentage of the people who bought masks to store them or use them.

To strengthen the research, I also took data from secondary resources such as credible papers to correlate COVID-19 cases and mask disposal in terms of weight.

Variables

Table 1 - Variables

	Named variable	**Unit**	**Justification**
Independent	Time	per Month	This is an independent variable because the others will not influence this variable, and changing this will influence other variables. Therefore this is an independent variable.
Dependant	The number of masks used	per Unit or tonnes	The number of masks used changes with time. It is influenced

			by the situation and the independent variable. The amount of masks used depends on time. Therefore, the amount of masks used is a dependent variable.
Control	The number of shops	per Unit	This variable needs to stay constant throughout the experiment. If changed, the number of shops can influence the dependent and independent variables. Therefore, as this variable is constant, it is a controlled variable.

Waste Management in Dhaka

A The General Idea:

Dhaka produces about 1.65 million metric tons of waste per year. The city has been divided into two sectors; Dhaka North City Corporation (DNCC) and Dhaka South City Corporation (DSCC). DSCC disposes of waste from Lalbag, Hazaribug and Gandaria.

An estimated 40%-60% of waste is collected, and the other is deposited in open spaces. The wastes deposited in open spaces are often left there or burned, which releases toxins and other air-polluting gasses. Private micro-enterprises typically cart the waste from dense neighbourhoods to a centralized location, then loaded onto city-owned trucks. In 2007, one of these sites was turned into a controlled landfill.[11]

B The Plastic Problem

Bangladesh is a rapidly developing riverine country. This means the water bodies in Bangladesh are vast. Despite the country's massive population, Bangladesh has a reasonably good economic growth rate. The country has over three thousand plastic industries and is considered the 12th largest plastic export market in the world. Due to the rapid development, the consumption of plastic has also significantly increased.[12]

The improper disposal of masks has contributed to plastic pollution. The masks that are made from plastic non-woven fabrics tend to release different types to release microplastics into the water.[13] The plastic waste accumulated in the Bay of Bengal has a detrimental impact on the

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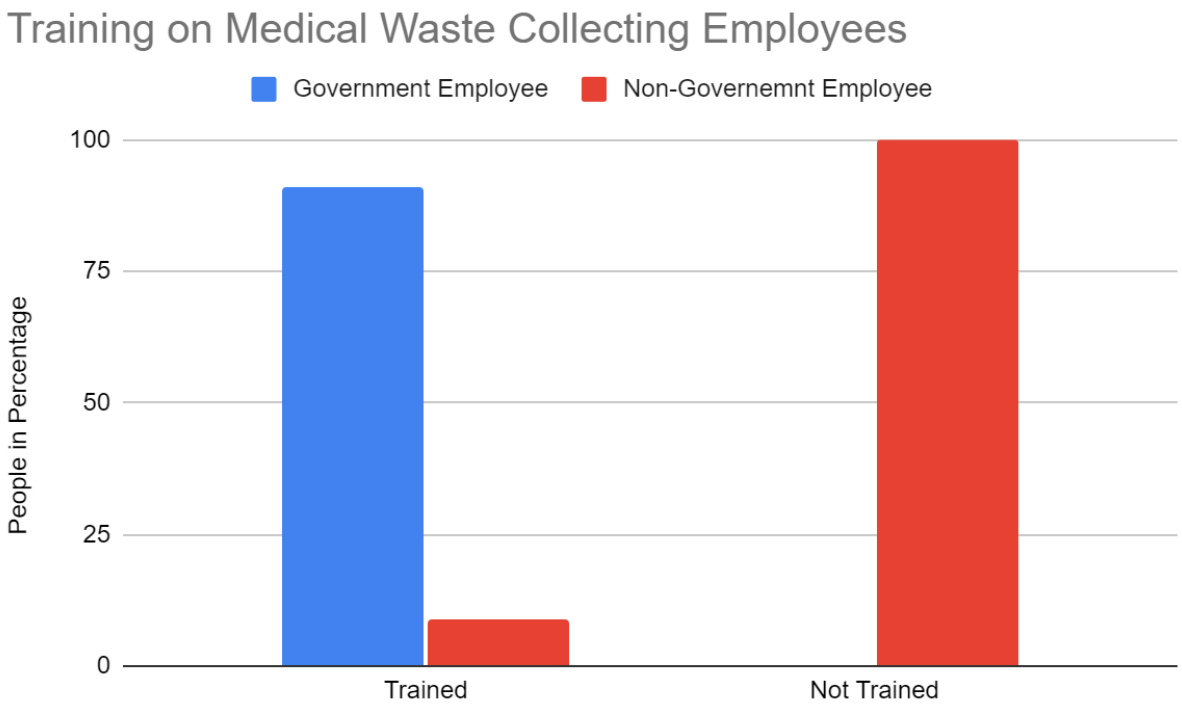
[11] "Solid Waste Management in Dhaka." Accessed November 7, 2021. https://www.waste.ccacoalition.org/sites/default/files/files/city_fact_sheet/Dhaka_MSW_FactSheet_0.pdf.
[12] "Plastic pollution in Bangladesh: A review on current status ...." 7 Dec. 2020, https://www.eeer.org/journal/view.php?number=1245. Accessed 9 Nov. 2021.
[13] "Used disposable face masks are significant sources of microplastics ...." https://search.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov/resource/en/covidwho-1252841. Accessed 9 Nov. 2021.

marine environment and its inhabitants. Also, the debris in the soil can have a damaging impact on the soil environment and fertility.[14]

C Managing Biomedical Waste

Waste in Bangladesh is managed by the government and private companies. The demographic data in a research paper shows the following data presented in Figure 5.

Figure 5 - Training on Medical Waste Collecting Employees[15]



[14] "Plastic pollution in Bangladesh: A review on current status ...." 7 Dec. 2020, https://www.eeer.org/journal/view.php?number=1245. Accessed 9 Nov. 2021.
[15] "Awareness on Medical Waste Management and Occupational ...." Accessed November 9, 2021. http://www.jett.dormaj.com/docs/Volume7/Issue%203/Awareness%20on%20Medical%20Waste%20Management%20and%20Occupational%20Health%20Safety%20among%20the%20Employees%20Related%20to%20Medical%20Services%20at%20Upazila%20Level%20in%20Bangladesh.pdf.

The figure, as labeled, shows the number of trained and those who are not trained to collect medical waste. The majority of the government employees are trained, while the non-governmental employees aren't. This proves that the employees are not capable enough to collect and dispose of medical waste, leaving a massive chance of spreading illness by improper disposal.

Questionnaire

What are the types of masks you have sold?		
N95	**Surgical**	**Other**
How many did you sell?		
Per Unit	**Per Box**	
If you sold boxes, how many units did the box have?		
30 unit box	**50 unit box**	
Purpose of purchase?		
Storage	**Usage**	

Data Collection

Section A: Conclusion of Questionnaire

What are the types of masks you have sold?

As mentioned before, the areas under investigation are Lalbagh, Hazaribagh, and Gandaria. All pharmacies under investigation just sold surgical masks in all of these areas. The pharmacies were not selling N95's and other types of masks as they were 'too hard to find' according to the owners of each shop. Therefore, as stated by the RQ, the investigation will be done on surgical masks and their pollution only.

How many did you sell per day?

The question itself is pretty straightforward. Shops had to write down how much they sold per day. At the pandemic's start, people opted to buy more boxes than units in April, May, June, and July. From July to January 2021, people bought single units and boxes.

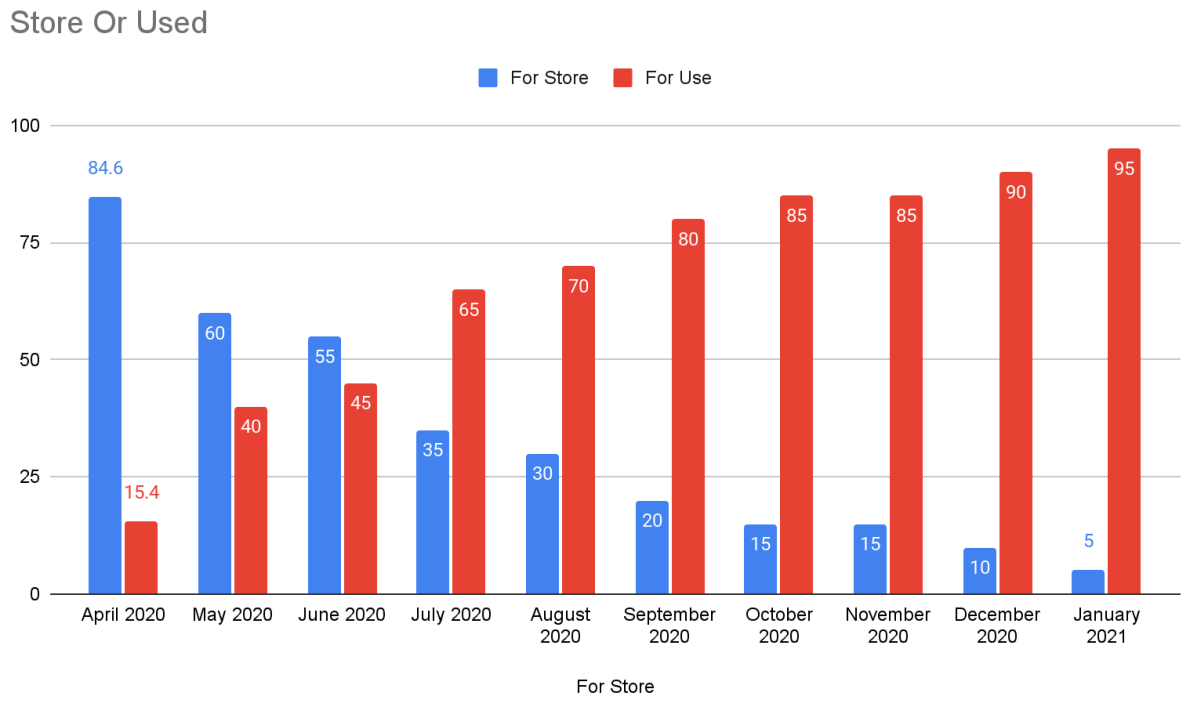
If you sold boxes, how many units did the box have?

As people tended to stock up during the first months of COVID, they opted more for the boxes that had 50 units boxes, and when they were out of stock, they bought the boxes containing 30 units.

Purpose of purchase?

The following data has been presented in Figure 6.

Figure 6 - Stored or Used Graph



As mentioned before, people tended to stock up more in the early stages of COVID. Therefore, the gradual decline can be seen in the percentage of people buying to store than use. In April, the percentage of people brought for storing was 84.6 percent, which dropped in May to 60 percent. The gradual decline trend is seen in June when the number dropped from 55% to 35%. The trend continues in the following months from July to January as the numbers decrease. In July it was 35%, August it was 30%, September 20%, October and November 15%, December 10% and January 5%.

People who wanted to buy to use the masks had seen an opposite trend. The numbers gradually increased from April to January 2021. In April, the percentage of people brought for usage was

15.4%, which increased in May to 40 percent. The gradual increase trend is seen in June when the number rose from 45% to 65%. The trend continues in the following months from July to January as the numbers decrease. In July, it was 65%, August 70%, September 80%, October and November 85%, December 90%, and January 95%.

Section B: Summed up data for Questionnaire

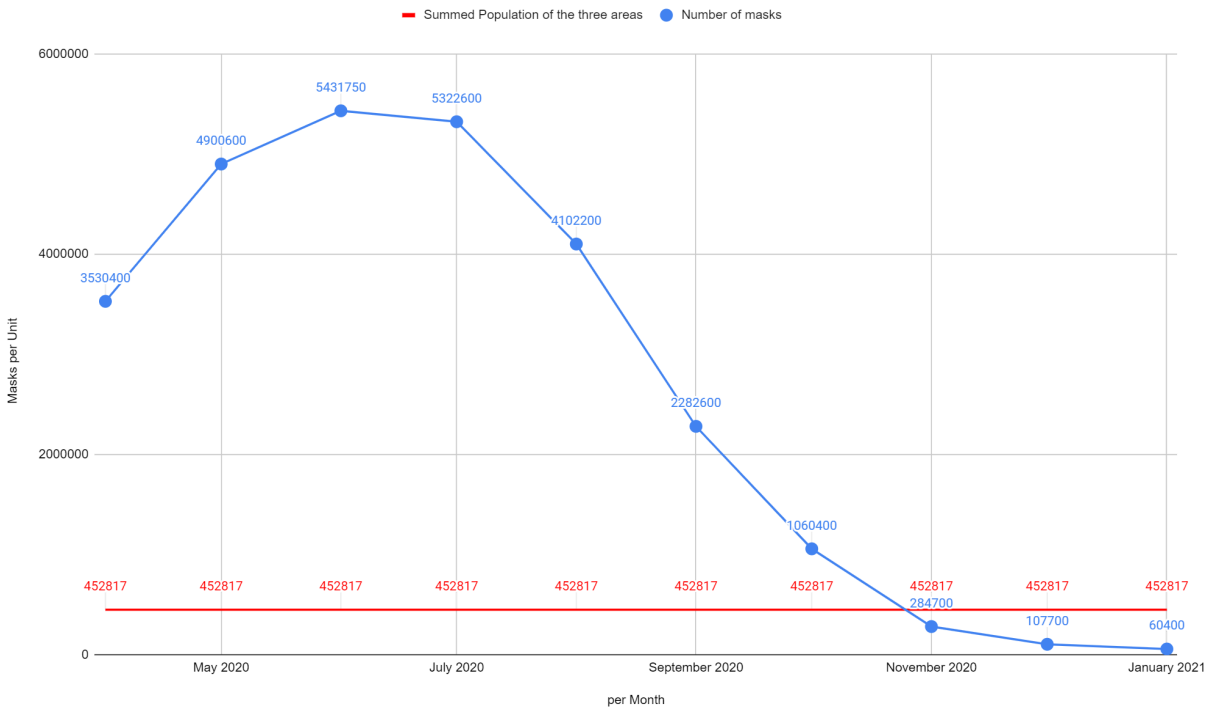
<table>
<tr><th colspan="3">What are the types of masks you have sold?</th></tr>
<tr><th>N95</th><th>Surgical</th><th>Other</th></tr>
<tr><td>Not Sold</td><td>Only type of mask sold by all the pharmacies under investigation.</td><td>Not sold.</td></tr>
<tr><th colspan="3">How many did you sell?</th></tr>
<tr><th colspan="2">Per Unit</th><th>Per Box</th></tr>
<tr><td colspan="3">Varied with time. Results can be found in ‘Section C: Overview of Total Sold’</td></tr>
<tr><th colspan="3">If you sold boxes, how many units did the box have?</th></tr>
<tr><th colspan="2">30 Units</th><th>50 Units</th></tr>
<tr><td colspan="3">Sold boxes containing 30 units when the 50 unit boxes were sold out.</td></tr>
<tr><th colspan="3">Purpose of purchase?</th></tr>
<tr><th colspan="2">Storage</th><th>Usage</th></tr>
<tr><td colspan="3">Results are shown in Section A: Conclusion of Questionnaire.</td></tr>
</table>

Section C: Overview of Total Sold

Table 2 - Total Sold

	Lalbag	Hazaribag	Gandaria	Total Boxes	Total Units
Sells in April 2020	30840	30580	9188	70608	3530400
Sells in May 2020	40617	45960	11435	98012	4900600
Sells in June 2020	44550	50840	13245	108635	5431750
Sells in July 2020	46886	48112	11454	106452	5322600
Sells in August 2020	41168	31961	8915	82044	4102200
Sells in September 2020	22870	18060	4722	45652	2282600
Sells in October 2020	9330	9272	2606	21208	1060400
Sells in November 2020	2905	1720	1069	5694	284700
Sells in December 2020	660	840	654	2154	107700
Sells in January 2021	289	560	359	1208	60400

Figure 7 - Masks Sold per Month



From Table 2, we can draw Figure 7. The population in Lalbagh, Gandaria, and Hazaribagh are 188,794[16], 160,541[17], and 103,482[18], respectively. Figure 7 shows the red line that has a value of 452,817 is the population of the three areas combined. The blue line represents the number of masks sold per month. Sales in April were 3,530,400 and 4,900,600 in May. These sales records were when the public was not allowed to step outside their houses. Only hospital workers and factory workers were allowed to step outside their house. The numbers peaked in June and July with 5,431,750 and 5,322,600, respectively. These results were recorded when lockdown protocols were lifted and mandatory wearing a mask. Over the next few months, sales declined

[16] "Lalbagh Thana - Banglapedia." Accessed January 23, 2022. https://en.banglapedia.org/index.php/Lalbagh_Thana.
[17] "Gandaria Thana - Banglapedia." Accessed January 23, 2022. https://en.banglapedia.org/index.php/Gandaria_Thana.
[18] "Hazaribagh Thana - Banglapedia." Accessed January 23, 2022. https://en.banglapedia.org/index.php/Hazaribagh_Thana.

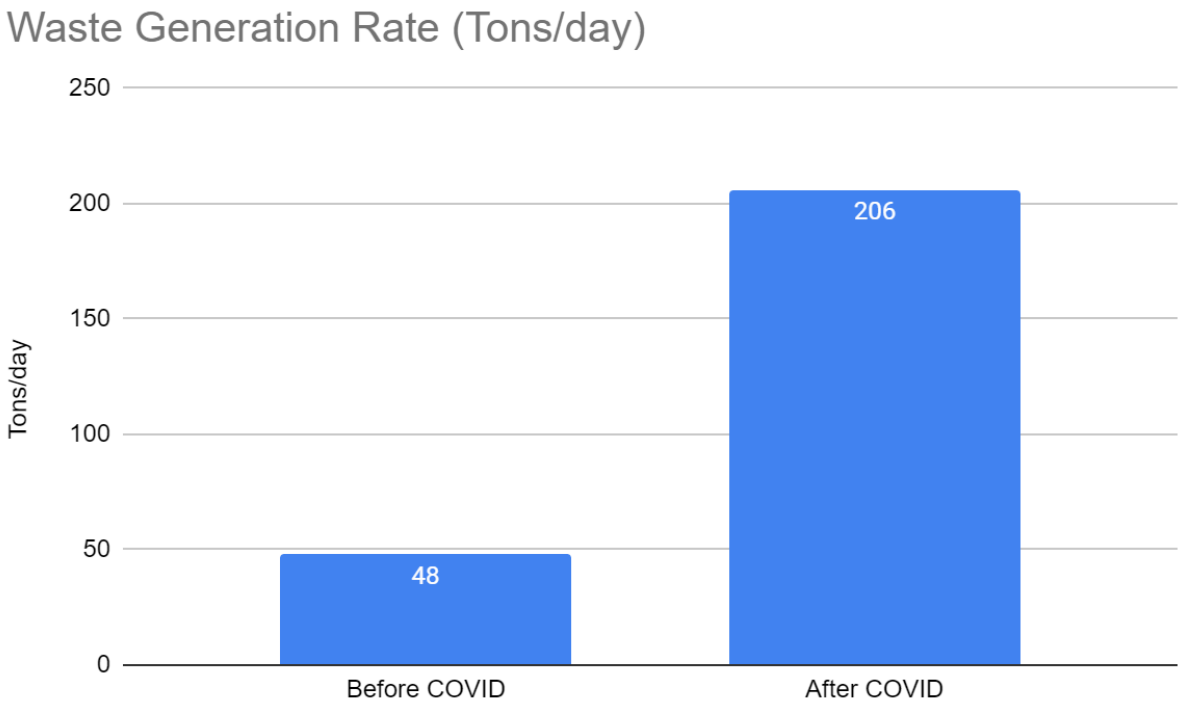
with 4,102,200 sales in August, 2,282,600 sales in September, 1,060,400 sales in October, 284,700 sales in November, 107,700 sales in December, and 60,400 sales in January of 2021. The decline in the numbers can be because most people buy masks in bulk. The questionnaire determined the number of people who bought the mask to store or use.

D Biomedical Waste Status Before and After COVID-19

There are around 654 government hospitals and 5055 private hospitals and clinics in Bangladesh, with 141,903 beds and an additional 9061 diagnostic centre beds, all of which generate massive amounts of biomedical waste.[19] Before COVID, approximately 48 tonnes of medical waste was generated per day, and after COVID, 206 tonnes of medical waste was generated per day[20]. Figure 8 shows the medical waste generation before and after covid in Bangladesh. From the data from figure 7, we can see the increase in the use of medical masks. As the use increases, it makes sense that the waste increases.

[19] "Biomedical waste amid COVID-19: perspectives from Bangladesh." Accessed November 9, 2021. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7426104/.
[20] Patwary, Muhammad & Hossain, Atm Zakir. (2021). COVID-19 Impacts on Waste in Bangladesh. 10.13140/RG.2.2.31994.21449. Accessed November 9, 2021.

Figure 8 - Medical Waste generation per day, before and after COVID-19 in Bangladesh[21]

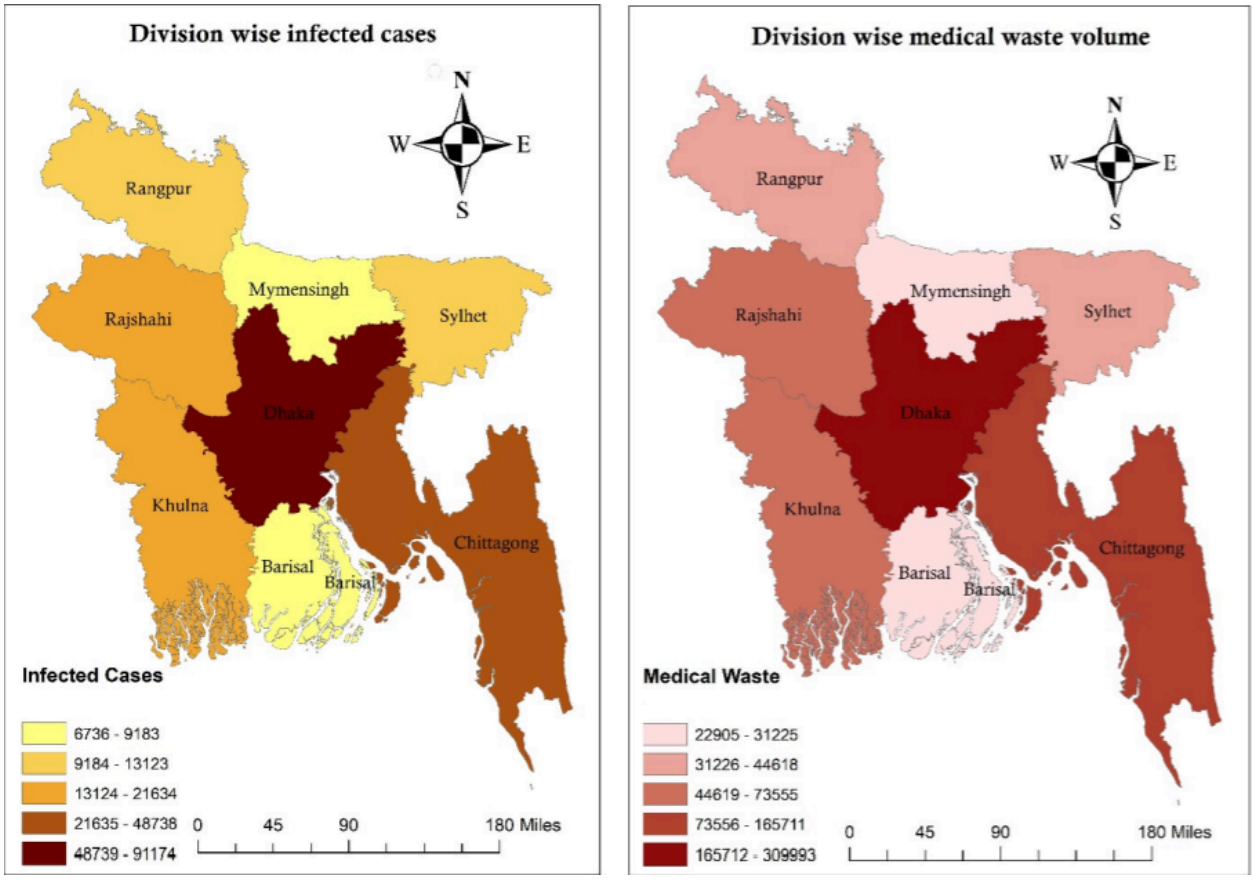


Looking at the secondary sources, from March 8 to November 18, 2020, Bangladesh dumped a total of 139 million face masks into the environment, which is 392,970 tons of garbage at a rate of 1535 tons per day. One of the major cities producing the most waste is Dhaka sitting at 63630 tonnes of Dhaka.[22]

[21] Patwary, Muhammad & Hossain, Atm Zakir. (2021). COVID-19 Impacts on Waste in Bangladesh. 10.13140/RG.2.2.31994.21449. Accessed November 9, 2021.
[22]Patwary, Muhammad & Hossain, Atm Zakir. (2021). COVID-19 Impacts on Waste in Bangladesh. 10.13140/RG.2.2.31994.21449. Accessed November 9, 2021.

E Correlating COVID-19 cases with mask disposed of

Figure 8 - Map showing the correlation in medical waste volume and infected cases[23]



To show the correlation between COVID-19 cases and medical waste or mask disposed of, we will be taking the whole of Bangladesh into account. The timeframe was from March 8-November 23, 2020. Barisal and Mymensingh had 6736-9183 infected cases and 22905-31225 medical waste being in the lowest quartile. Sylhet and Rangpur had 9184-13123 infected cases and 31226-44618 medical waste in the 2nd lowest quartile. Rajshahi and Khulna had 13124-21634 infected cases and 44619-73555 medical waste being in the middle quartile. Chittagong had 21635-48738 infected cases and 73556-165711 medical waste in the 2nd highest quartile.

[23] Patwary, Muhammad & Hossain, Atm Zakir. (2021). COVID-19 Impacts on Waste in Bangladesh. 10.13140/RG.2.2.31994.21449. Accessed November 9, 2021.

Lastly, Dhaka had the most infected cases and medical waste produced with a range of 48739-91174 and 165712-309993 respectively[24]. After analysing the data, it is clear that the COVID-19 cases correlate with the amount of medical waste produced.

Conclusion

From the data collected, we can conclude that the hypothesis of this experiment is valid. The pandemic did raise the waste pollution in Dhaka. This conclusion is proven in Figure 8 where it shows a clear value difference in medical waste before and after the pandemic. The pandemic caused the selling of the masks, which caused them to be disposed of more. This can be seen in Figure 7. The selling period and units differed by the time of the pandemic; however, the primary data does coincide with the secondary data collected. Ultimately, the pandemic caused the increase in the disposal of medical wastes and added to the pollution problem in Dhaka. To top it all off, the management process of the medical waste is inadequate, leaving the residents of Dhaka prone to diseases.

[24] Patwary, Muhammad & Hossain, Atm Zakir. (2021). COVID-19 Impacts on Waste in Bangladesh. 10.13140/RG.2.2.31994.21449. Accessed November 9, 2021.

Bibliography

1. "For effective management of medical waste | The Daily Star." Accessed November 9, 2021. https://www.thedailystar.net/law-our-rights/law-watch/news/effective-management-medical-waste-1875757.
2. "Abedin, Md Anwarul, and M Jahiruddin. 2015. “Waste Generation and Management in Bangladesh: An Overview”. Asian Journal of Medical and Biological Research” 1 (1):114-20. https://doi.org/10.3329/ajmbr.v1i1.25507. Accessed 30 Nov. 2021.
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6. "Bangladesh extends coronavirus lockdown for another week." Accessed November 9, 2021. https://www.aljazeera.com/news/2021/4/19/bangladesh-extends-coronavirus-lockdown-for-another-week.

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9. "File:GendariaThana.jpg - Banglapedia." Accessed November 9, 2021. https://en.banglapedia.org/index.php?title=File:GendariaThana.jpg.
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11. "Solid Waste Management in Dhaka." Accessed November 7, 2021. https://www.waste.ccacoalition.org/sites/default/files/files/city_fact_sheet/Dhaka_MSW_FactSheet_0.pdf.
12. "Plastic pollution in Bangladesh: A review on current status ...." 7 Dec. 2020, https://www.eeer.org/journal/view.php?number=1245. Accessed 9 Nov. 2021.
13. Used disposable face masks are significant sources of microplastics ...." https://search.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov/resource/en/covidwho-1252841. Accessed 9 Nov. 2021.
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15. "Awareness on Medical Waste Management and Occupational ...." Accessed November 9, 2021. http://www.jett.dormaj.com/docs/Volume7/Issue%203/Awareness%20on%20Medical%20Waste%20Management%20and%20Occupational%20Health%20Safety%20among%20t

he%20Employees%20Related%20to%20Medical%20Services%20at%20Upazila%20Level%20in%20Bangladesh.pdf.

16. "Lalbagh Thana - Banglapedia." Accessed January 23, 2022. https://en.banglapedia.org/index.php/Lalbagh_Thana.
17. "Gandaria Thana - Banglapedia." Accessed January 23, 2022. https://en.banglapedia.org/index.php/Gandaria_Thana.
18. "Hazaribagh Thana - Banglapedia." Accessed January 23, 2022. https://en.banglapedia.org/index.php/Hazaribagh_Thana.
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20. Patwary, Muhammad & Hossain, Atm Zakir. (2021). COVID-19 Impacts on Waste in Bangladesh. 10.13140/RG.2.2.31994.21449. Accessed November 9, 2021.
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22. Patwary, Muhammad & Hossain, Atm Zakir. (2021). COVID-19 Impacts on Waste in Bangladesh. 10.13140/RG.2.2.31994.21449. Accessed November 9, 2021.
23. Patwary, Muhammad & Hossain, Atm Zakir. (2021). COVID-19 Impacts on Waste in Bangladesh. 10.13140/RG.2.2.31994.21449. Accessed November 9, 2021.
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