Information Brief

Additional Burden of Covid-19 Disposable Facemasks (ABCDF) to Ghana’s Plastic Management
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This report is the outcome of an independent research commissioned by the United Nations Development Programme (UNDP) in Ghana. The analysis and recommendations in this report do not necessarily reflect the views of UNDP.
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About this publication
The publication investigates the impacts of increased use of Personal Protection Equipment (PPE), particularly disposable face masks, on the environment, human health, and the economy in Ghana. The study reveals that single-use masks contribute approximately 2% of macro litter on selected beaches, and significant amounts of harmful microplastics are detected in sediment and water samples. The research underscores the need to prioritize microplastics in plastic waste management strategies. The study emphasizes the environmental impact of disposable masks, posing a threat to coastal ecosystems. It calls for policies to address the surge in infectious and plastic waste, safeguarding public health and preventing a plastic waste pandemic. Furthermore, the findings advocate for leveraging lessons from mask-use awareness campaigns to enhance future public health initiatives.

ACKNOWLEDGEMENT
This research on the Additional Burden of Covid-19 Disposable Facemasks (ABCDF) to Ghana’s Plastic Management, commissioned by the United Nations Development Programme (UNDP) in partnership with the Institute for Environment and Sanitation Studies and the Department of Marine and Fisheries Sciences of the University of Ghana, was undertaken under the leadership of Prof. Chris Gordon former Director of the Institute of Environment and Sanitation Studies (IESS) at the University of Ghana. The research team included Dr. Edem Mahu, Senior Lecturer of Marine Biogeochemistry and Ecosystem with the Department of Marine and Fisheries Science Health at the University of Ghana. Dr. Ama Kwansima Essel, Community Health Physician Specialist, School of Public Health, University of Ghana, Dr. Catherine Adodoadji-Dogbe, Programme Analyst with the United Nations Development Programme, Ghana and Alice Sallar Adams, Public Health Specialist with the African Field Epidemiology Network.

UNDP acknowledges all Waste Recovery Platform members who participated in the initial stakeholder consultations to understand the impact of COVID-19 on the waste sector and to discuss possible solutions. We also acknowledge all stakeholders from the government, academia, local and international NGOs, and media partners for their contributions and inputs during the Dissemination Workshop held in December 2021 to present the preliminary findings on the research project.

UNDP Ghana appreciates The Coca-Cola Foundation (TCCF) for the grant provided to implement the study. Finally, sincere thanks to Dr. Stephen Kansuk, Environment & Climate Change Specialist, UNDP for his supervision and to the Resident Representative of UNDP Ghana, Dr. Angela Lusigi for her leadership and guidance.
Acronyms and Abbreviations

ABCDF-GH: Additional Burden of Covid-19 Disposable Face masks to Ghana

FGDs: Focus Group Discussions

HW - High Watermark

LW - Low Watermark

MOH: Ministry of Health

MW - Mid Watermark

PPE: Personal Protection Equipment

SARS-CoV-2: Severe Acute Respiratory Syndrome CoronaVirus 2

SUP: Single-Use Plastic

WHO: World Health Organization

UNIDO: United Nations Industrial Development Organisation
Key messages

- Despite high knowledge levels about mask types and usage, there is a gap between oral acknowledgment and actual mask-wearing behavior among participants.
- Inadequate disposal and management of masks could lead to the outbreak of other diseases, emphasizing the importance of proper handling by waste management entities to ensure public safety.
- There is a need to intensify capacity building for District and Municipal Assemblies in waste management practices to ensure and enhance waste segregation in communities.
- The public needs more education on wearing face masks properly during a pandemic.
- There is a need to standardize and promote reusable face masks.
- There is a need to embark on public sensitization or awareness exercise so that the public knows the importance of prioritizing reusable masks over disposable masks.
- Government should procure and distribute labelled bins for the disposal of used face masks.
- The study recommends discouraging the use of single-use face masks and advocates for responsible disposal to prevent environmental contamination.
- Ongoing monitoring and documentation of plastic and microplastic levels in coastal environments are crucial for informed policy and decision-making regarding plastic usage.
- Larger plastics breaking down into microplastics over time presents a dual threat to aquatic and human health.
- The transport of larger plastics into the ocean increases the likelihood of ingestion or entanglement by fish.
- While the consequences of large plastic ingestion on fish remain largely unknown, there is evidence suggesting potential damage to internal organs, such as the digestive system.
- Microplastics have the capacity to release both added and adsorbed chemicals into organs as they translocate through the blood.
Executive Summary

This information brief contains findings from the "Additional Burden of Covid-19 Disposable Face masks to Ghana project (ABCDF-GH)" as disseminated during a workshop for stakeholders on the 12 of December 2021 and the deliberations of the workshop participants.

The "Additional Burden of Covid-19 Disposable Face Masks to Ghana Project" aimed to investigate individuals' effective use and proper disposal of face masks and the contribution of disposable masks to coastal pollution.

Additionally, it assessed improper disposal, leading to increased environmental microplastics. Microplastics have a physical impact on the marine environment and present toxic implications to the aquatic environment and its functioning because these plastics have the tendency of causing cancer additives such as phthalates.

The project highlighted the need to reevaluate previous estimates of single-use plastic (SUP) waste due to the widespread use of disposable face masks during the COVID-19 pandemic.

The knowledge regarding how the SUP waste value chain directly contributes to climate change and the secondary impacts of plastic transportation from land-based sources to the sea is currently lacking.

Furthermore, the implications of the increased SUP load on plastic waste management in Ghana and the potential threats to existing recycling initiatives are not yet understood.

Introduction

Face mask usage dates to the early nineteenth century and remains an indispensable personal protection equipment within the medical field. However, until the global outbreak of the COVID-19 pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in January 2020, the usage of facemasks and face coverings in public was unpopular among the large masses of people. By March 2020, the World Health Organization (WHO) had estimated that 89.0 million single-use medical masks were required each month in response to COVID-19 with a projected 40% increase in production. This projection came at a critical time when the world was already witnessing an unprecedented surge in plastics production from 1.5 million metric tonnes in 1950 to 367 million metric tonnes in 2020, mostly in the form of single-use plastics, whose disposal into the environment presented numerous toxic implications to the oceans and their coastal ecosystems. More than 8000000 tons of pandemic-associated plastic waste have been generated globally, with more than 25,000 tons entering the global ocean.

The COVID-19 pandemic has led to a significant increase in the use of disposable face masks worldwide as a crucial measure to prevent the spread of the virus.

While face masks play a vital role in protecting public health, their widespread use has resulted in a new environmental challenge: managing face mask waste. With billions of disposable face masks being used and discarded globally, there is growing concern about the environmental implications of this waste stream.

Additionally, the sheer volume of face mask waste generated during the pandemic has strained waste management systems, particularly in areas with limited infrastructure or resources.

The presence of discarded face masks in the environment raises concerns about potential long-term impacts. As face masks break down, they can release microplastics and other harmful substances into the soil and water, contributing to pollution and threatening ecosystems.

The improper disposal and accumulation of face masks in public spaces can harm the aesthetics of communities and create a sense of environmental degradation.

It is essential to develop effective management strategies to address the environmental challenges associated

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with face mask waste. This involves promoting responsible disposal practices, encouraging reusable face masks where feasible, and improving waste collection and recycling infrastructure.

Furthermore, raising awareness among the public about the environmental consequences of improper face mask disposal and fostering a sense of individual responsibility can play a crucial role in minimizing the environmental impact. Under the ACBDF-GH project, the two pilot studies conducted are;

- To identify the impact of the use and misuse of face masks on Public Health
- To assess the abundance, and distribution of microplastics and PPE in some selected coastal areas in the Greater Accra region.

The findings from these pilot studies indicate a substantial presence of Personal Protection Equipment (PPE) and microplastics within the evaluated coastal regions.

Moreover, a significant proportion of individuals exhibit improper face mask usage by wearing masks incorrectly or neglecting to wear them altogether, thereby leading to severe health implications. Notably, a predominant preference for disposable face masks over reusable alternatives is observed, thus exacerbating the issue of plastic pollution.

It is imperative to emphasize the importance of wearing face masks correctly to ensure personal protection. Compliance with mask-wearing mandates imposed by the government is prevalent among the Ghanaian population. Though it is apparent from the ACBDF-GH project that the poor management and disposal of single-use face masks during the COVID-19 pandemic have caused a significant additional burden of plastics and hence microplastics to the marine and coastal environment in Ghana, the actual impact on the marine ecosystem is yet unknown so the precautionary principle must be applied to help save Ghana's coastal resources and livelihoods.
The onset of the COVID-19 pandemic led to a surge in the use of face masks globally. Studies investigating strategies to control its spread suggested face masks as an important tool to be used in both community and health care settings. To reduce the spread of the disease as economic activities returned to normal, the Government of Ghana implemented the WHO’s guidelines that were suggested by the national health committee on COVID-19.

The wearing of face masks was made compulsory in April 2020. Nzediegwu and Chang estimated that a mandated compulsory facemask use in Ghana, would result in a total number of about 28,338,521 face masks used daily based on 80% acceptance rate and an average of 2 daily face masks per capita. Although the government was taking active measures to contain and reduce the spread of the disease, strategies to manage the waste produced from the use of these masks were inadequate.

Data

Globally about 129 billion disposable masks were used monthly during the

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2 MacIntyre and Chughtai 2020; Matuschek et al., 2020.
3 Bonful et al., 2020; Ofori et al., 2021

4 Nzediegwu and Chang (2020)
Adusei-Gyamfi et al.,\textsuperscript{6} estimate that the number of nose mask waste generated in Africa per day during the pandemic was about 352 million. In Ghana, like many other countries, the increased demand and use of disposable face masks can be attributed to the directive by the Government on the use of face masks in public places.

A UNIDO and the Ministry of Health (MoH) national assessment of PPEs and hygiene products supply chains in Ghana\textsuperscript{7} report that the value of imported surgical face/nose masks in Ghana increased from US$10,702,297.00 in 2016 to US$41,320,281.00 (Figure 1). The market value for 2020 (US$41,320,281.00) increased about 4 times the value of 2019 (9,832,121.00).

\begin{figure}
\centering
\includegraphics[width=\textwidth]{Value_and_Quantity_of_Face_Masks_imported_into_Ghana_from_2016-2020.png}
\caption{Value and Quantity of Face Masks imported into Ghana from 2016 - 2020}
\end{figure}

**Masks Disposal**

Findings from existing literature show that in many developing countries there is no specific waste stream for face masks disposal. Masks are disposed of haphazardly. Used face masks are mostly thrown in the streets or

\textsuperscript{5} Prata et al. 2021
\textsuperscript{6} Adusei-Gyamfi et al., (2022)
\textsuperscript{7} UNIDO, 2022
collected as a mixed waste\textsuperscript{8}. They are disposed of in landfill and dump sites or littered in public spaces. People also burn or flush the masks in toilets\textsuperscript{9}. Face masks have become a common type of litter on beaches in many countries\textsuperscript{10}. Amuah et al.,\textsuperscript{11} present similar findings from their study of some communities in Ghana. Their studies show evidence of masks in water bodies, along beaches, streets, inside vehicles and in open spaces. The masks are also mixed with general waste. About 80% of the waste that ends up in the ocean and in water streams comes from the land\textsuperscript{12}.

![Breakdown times of common plastics. Source: Statista](image)

**Picture 2** Breakdown times of common plastics. Source: Statista

Face masks have been identified as a potential source of plastic and microplastic pollution\textsuperscript{13}. Disposable face masks are made of different types of

\textsuperscript{8} Selvanranjan et al., 2020; Torres and Dela torres 2021
\textsuperscript{9} Abbasi et al. 2020
\textsuperscript{10} Hadad et al., 2021; Haque et al., 2020; Thiel et al., 2020; Torres and Dela torres, 2022
\textsuperscript{11} Amuah et al. (2022)
\textsuperscript{12} Aragaw et al., 2020; Haque et al., 2021
\textsuperscript{13} Klemes et al., 2020; Aragaw, 2020; de Albuquerque et al., 2021; Shen et al., 2021; Shruti et al., 2020; Xu and Ren, 2021
plastic, which are not decomposable\textsuperscript{14}. They are produced from polymers such as polypropylene, polyurethane, polyacrylonitrile, polystyrene, polycarbonate, polyethylene, or polyester\textsuperscript{15}. They have a slow rate of degradation consequently creating large reservoirs of microplastic pollutants\textsuperscript{16}.

Research, by Swansea University revealed that disposable masks have high levels of potentially harmful pollutants within their silicon-based and plastic fibre these include lead, antimony and copper\textsuperscript{17}.

**Compliance**

In Ghana several studies have assessed the compliance to face mask-wearing amongst the general population, mainly amongst commuters during COVID. Bonful et al.,\textsuperscript{18} conducted an observational study to assess compliance with recommendations to prevent the spread of COVID-19 in selected transportation stations in Ghana. Their study was done before the mandatory use of face masks in public spaces. In over 90\% of the stations they studied, face masks were either not worn or were only worn by a few passengers. Agyemang et al\textsuperscript{19}, also studied face mask use among commercial drivers during the COVID-19 Pandemic in Accra. Their study showed a high compliance with the face masks directive amongst survey participants particularly older drivers. This was as a result of a high knowledge of the disease, and increased awareness of the occupational hazard associated with the disease.

Apana and Kumbeni \textsuperscript{20} on the other hand assess the adherence to COVID-19 preventive measures among pregnant women in Ghana. Their analysis revealed poor compliance. Only 18.0\% of the 527 pregnant women they surveyed wore a face mask. They emphasized the need to educate pregnant women on COVID-19 so they could comply with the recommended preventive measures.

**Correct/ Incorrect Usage**

The review of literature by Howard et al., \textsuperscript{21} and Sim et al.,\textsuperscript{22} conclude that facemasks play an important role in the prevention and control of infectious respiratory disease transmission. However, the way in which they are used determines their efficacy. WHO provides some guidelines on the correct use of masks\textsuperscript{23}.

In this guideline individuals are instructed to place masks carefully ensuring that it covers the mouth and nose. However, a study by Ogoina\textsuperscript{24} showed evidence of people wearing face masks on their jaws and neck, without covering their mouth or nose, or covering only their mouth while the nose is left open. Contrary to the guidelines, for individuals to avoid touching the mask and to practice hand hygiene after removal or touching the mask. People were observed to repeatedly touch the front of their face masks in a bid to adjust the mask, to

\textsuperscript{14} Aragaw, 2020; Fadare and Okkoffo, 2020; Selvaranjan et al., 2021
\textsuperscript{15} Fadare and Okkoffo, 2020
\textsuperscript{16} Hasan et al., 2021
\textsuperscript{17} Science Daily, 2021
\textsuperscript{18} Bonful et al. (2020)
\textsuperscript{19} Agyemang et al., (2021)
\textsuperscript{20} Apana and Kumbeni (2021)
\textsuperscript{21} Howard et al. 2020
\textsuperscript{22} Sim et al. (2014)
\textsuperscript{23} WHO 2019
\textsuperscript{24} Ogoina, 2020
remove it, or during reflex touching of the face. The Guide also recommends for people to discard the mask immediately after use. However, studies by Ogoina shows evidence of face masks being kept with personal belongings. Scalvenzi et al. also observe people putting their mask on their wrist or arms when not in use, some fold and put the masks in the pocket of their trousers.

With regards to the guideline on replacing the mask when it becomes damp. There were incidents of individuals wearing masks for long periods and not replacing them when they are wet or stained. Although the guideline cautions against the reuse of masks. There are reports of people reuse masks because of perceived feelings of having inadequate face masks. Additionally, knowledge of mask usage played a role in the reuse of disposable masks. There are also cases of people who did not follow the appropriate technique to remove masks because they were not aware of how to do so. Lee et al. argue that the assumption of knowing how to use face masks leads to a reduction in the desire to learn the proper technique of taking off a face mask. Following the correct procedures to remove a face mask is vital to limiting the transmission of respiratory diseases.

Management approaches

Several authors have proposed solutions on how mask waste could be managed. Selvaranjan et al., propose the use of biodegradable face masks. They suggest replacing the polypropylene in the mask with other organic substitutes that have high biodegradable potential. Cloth masks have also been suggested as a more sustainable option to help reduce the influx of single-use face masks. However, there is the need to provide standardized protocols on their creation and use.

Upstream responses such as waste management have also been recommended. As discarded masks are considered infectious waste, they require a separate collection and disposal system. There is the need to install labelled bins in public places and public transportation systems solely for disposal. There is also the need to build the capacity of local authorities in waste management practices to ensure and enhance waste segregation in communities. This will help reduce the indiscriminate disposal and prevent further transmissions of pathogens.

Other proposals include downstream responses such as environmental clean-ups and face mask upcycling. Selvaranjan et al., and Tesfaldet et al., discuss the upcycling of mask waste to produce construction materials such as artificial aggregates, lightweight plastic blocks and ecological mortar.

1. Environmental

Microplastics from degraded facemasks can lead to land degradation. It can decrease the abundance of soil fauna,
including the species that maintain soil fertility\textsuperscript{35}. A study by Wan et al.,\textsuperscript{36} also indicates that microplastics can increase the rate of soil water evaporation which may exacerbate soil water shortages and cause cracking on soil surfaces. Toxic plastic chemicals can also be released into the soil during the degradation processes of microplastics\textsuperscript{37}. Qi et al.\textsuperscript{38} studied the effects of plastic residue on sandy soil. Their findings show a significant change in the soils bulk density, porosity, saturated hydraulic conductivity, field capacity and soil water repellency. A decrease in soil quality would negatively affect the livelihood of crop farmers as it leads to a decline in crop productivity and reduced incomes for farmers.

The indiscriminate disposal of facemasks is placing a large pollution burden on aquatic ecosystems\textsuperscript{39}. The waste can be transported from land into freshwater and marine environments by surface run-off, river flows, oceanic currents, wind, and animals\textsuperscript{40}. As they degrade microplastic from used facemasks enter food chains via ingestion. Ingestion of microplastics affect the physiology of aquatic organisms\textsuperscript{41}. Studies by Adika et al. and Mahu et al.,\textsuperscript{42} confirm the occurrence of microplastics in the guts of fish along the coast of Ghana and Nigeria. Similarly, Blankson et al.\textsuperscript{43} confirm microplastics prevalence in water, sediment in an urban riverine system in Ghana. Ingested microplastics can be harmful to human health. They enter the food web and expose humans to harmful chemicals which could lead to chronic diseases, cancers, adverse impact on reproductive health as well as to developmental delays in children. The indiscriminate disposal of face masks could also lead to entanglement. Fish, invertebrates, birds, mammals, reptiles, and turtles often get entangled in discarded face masks\textsuperscript{44}. Entanglement may cause injury, infections, reduced ability to swim, fatigue, drowning or starvation. Some animals choke to death or suffer physical trauma. Entanglement can also lead to malnutrition when it affects the ability of the aquatic species to feed properly.\textsuperscript{45} Floating face masks could also help transport invasive marine species, thereby threatening marine biodiversity and the food web\textsuperscript{46}.

2. Socio - Economic

Waste from face masks also causes significant loss to the tourism industry\textsuperscript{47}. Pollution of aquatic environments or shores with plastic particles reduces the aesthetic and recreational value of beaches\textsuperscript{48} consequently reducing activities that could take place at beaches and the revenue that can be collected from coastal tourism.

The improper disposal of used infectious waste masks also poses a health risk to waste pickers and waste

\textsuperscript{35} Yin et al., 2020  
\textsuperscript{36} Wan et al. (2019)  
\textsuperscript{37} Selvaranjan et al., 2020  
\textsuperscript{38} Qi et al. (2020)  
\textsuperscript{39} Aragaw 2020 ; Hasan et al 2021; Shen et al 2021  
\textsuperscript{40} Xu and Ren, 2021  
\textsuperscript{41} Hasan et al., 2021  
\textsuperscript{42} Adika et al. (2020) and Mahu et al (2023)  
\textsuperscript{43} Blankson et al. (2022)  
\textsuperscript{44} Hasan et al., 2021  
\textsuperscript{45} Oceana, 2020  
\textsuperscript{46} IUCN, 2021  
\textsuperscript{47} Selvaranjan et al., 2020; Tesfeldet et al., 2022  
\textsuperscript{48} Hadad et al 2021; Haque et al 2020
service workers\textsuperscript{49}. Masks disposed indiscriminately could serve as breeding grounds for mosquitos and a potential media for transporting pathogens increasing the spread of diseases like malaria. This will increase healthcare spending and reduce labour hours and wages of individuals and households.

\textsuperscript{49} Das et al., 2021
The Use of Masks in Ghana

The World Health Organization (WHO) published an outbreak of the novel coronavirus disease (COVID-19) on 5th January 2020 and declared it a pandemic on 11th March, 2020. Since then, the disease has caused 170,707 infections and 1,460 deaths in the country, as of October 2023. To curb the spread of the disease, the government of Ghana introduced protocols such as regular handwashing, use of sanitizers, wearing of face masks and physical distancing, in line with WHO’s recommendations. There were also partial lockdowns in parts of the country and bans on social gatherings.

As the restrictions began to ease up, the wearing of face masks was declared mandatory in all public places. The demand for disposable masks increased all over, with the accompanying risk of improper disposal, which could potentially impact the environment, the economy, as well as the country’s commitments to international climate and environmental agreements.

This study assessed the use of face masks during the COVID-19 pandemic, to identify the types of masks, frequency of use and the factors driving the use of disposable and non-disposable masks. We also assessed knowledge on plastic content of masks and mask disposal habits.

Survey - use and disposal of masks
This cross-sectional study was conducted in Accra and Tema in the Greater Accra region. Nine field officers were recruited and trained for data collection. Data was collected among the following target populations:

1. Students in educational institutions (SHS and tertiary)
2. Healthcare workers in health facilities/laboratories
3. Workers – government and private organizations
4. Staff at the ports
5. Hospitality industry – hotels and restaurants
6. Market women
7. Drivers - (taxis, tro-tros, buses, etc)
8. Churches and other religious institutions

Participants were interviewed with a 10-minute semi-structured questionnaire. Data collected was on the types of masks used, frequency of use, factors influencing mask selection, knowledge on mask contents, mask disposal habits, frequency of disposal and media involvement in information dissemination during the COVID-19 pandemic. The key findings from the survey are as follows:

**Background and Demographics**
Majority (69.6%, 748/1075) of the participants were between 14 and 35 years old, employed (78.1%, 839/1075) and lived in urban areas (96%, 1032/1075), as shown in table 1.
Table 1 Background and demographic characteristics of study participants

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
</tr>
<tr>
<td>14 to 25 years</td>
<td>382 (35.53)</td>
</tr>
<tr>
<td>26 to 35 years</td>
<td>366 (34.05)</td>
</tr>
<tr>
<td>36 to 45 years</td>
<td>192 (17.86)</td>
</tr>
<tr>
<td>46 to 55 years</td>
<td>92 (8.56)</td>
</tr>
<tr>
<td>56 to 65 years</td>
<td>35 (3.26)</td>
</tr>
<tr>
<td>66 to 75 years</td>
<td>7 (0.65)</td>
</tr>
<tr>
<td>76 to 85 years</td>
<td>1 (0.09)</td>
</tr>
<tr>
<td><strong>Employment status</strong></td>
<td></td>
</tr>
<tr>
<td>Unemployed</td>
<td>236 (21.95)</td>
</tr>
<tr>
<td>Employed</td>
<td>839 (78.05)</td>
</tr>
<tr>
<td><strong>Educational status</strong></td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>262 (24.37)</td>
</tr>
<tr>
<td>Non-student</td>
<td>813 (75.63)</td>
</tr>
<tr>
<td><strong>Level of education</strong></td>
<td></td>
</tr>
<tr>
<td>No formal education</td>
<td>17 (1.58)</td>
</tr>
<tr>
<td>Primary</td>
<td>24 (2.23)</td>
</tr>
<tr>
<td>JHS</td>
<td>285 (26.51)</td>
</tr>
<tr>
<td>SHS</td>
<td>386 (35.91)</td>
</tr>
<tr>
<td>University</td>
<td>319 (29.67)</td>
</tr>
<tr>
<td>Other tertiary institution</td>
<td>44 (4.09)</td>
</tr>
<tr>
<td><strong>Occupation category</strong></td>
<td></td>
</tr>
<tr>
<td>Student in educational institution</td>
<td>119 (16.7)</td>
</tr>
<tr>
<td>Healthcare worker in hospital/lab</td>
<td>120 (11.16)</td>
</tr>
<tr>
<td>Worker in government organization</td>
<td>60 (5.58)</td>
</tr>
<tr>
<td>Worker in private organization</td>
<td>61 (5.61)</td>
</tr>
<tr>
<td>Staff at the port</td>
<td>120 (11.16)</td>
</tr>
<tr>
<td>Hospitality industry</td>
<td>120 (11.16)</td>
</tr>
<tr>
<td>Market woman</td>
<td>175 (16.28)</td>
</tr>
<tr>
<td>Driver (trotro, taxi, bus)</td>
<td>180 (16.74)</td>
</tr>
<tr>
<td>Church/other religious institution</td>
<td>120 (11.16)</td>
</tr>
<tr>
<td><strong>Residence</strong></td>
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</tr>
<tr>
<td>Urban</td>
<td>1032 (96.00)</td>
</tr>
<tr>
<td>Peri-urban</td>
<td>4 (0.37)</td>
</tr>
<tr>
<td>Rural</td>
<td>39 (3.63)</td>
</tr>
</tbody>
</table>

**Mask selection, usage and disposal**  
Participants were interviewed on the types of masks they had knowledge about, the ones they regularly used and the factors that affected their choice of masks. Majority of participants preferred disposable masks (84.3%, 906/1075) as shown in figure 2. This was attributed mainly to availability (60.4%, 649/1075) and ease and comfort of use (41.6%, 447/1075) as shown in figure 3.
Table 2 Frequency of mask usage and disposal habits of participants

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of times washable masks are worn in a week</td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>1 (0.74)</td>
</tr>
<tr>
<td>Once a week</td>
<td>16 (11.85)</td>
</tr>
<tr>
<td>Two to three days a week</td>
<td>24 (17.78)</td>
</tr>
<tr>
<td>Four to six days a week</td>
<td>26 (19.26)</td>
</tr>
<tr>
<td>Every day of the week</td>
<td>62 (46.67)</td>
</tr>
<tr>
<td>Once in a while</td>
<td>5 (3.70)</td>
</tr>
<tr>
<td>Number of times surgical masks are worn in a week</td>
<td></td>
</tr>
<tr>
<td>Once a week</td>
<td>31 (2.33)</td>
</tr>
<tr>
<td>Two to three days a week</td>
<td>76 (5.91)</td>
</tr>
<tr>
<td>Four to six days a week</td>
<td>215 (22.37)</td>
</tr>
<tr>
<td>Every day of the week</td>
<td>633 (55.87)</td>
</tr>
<tr>
<td>Once in a while</td>
<td>6 (0.62)</td>
</tr>
<tr>
<td>Number of times respirators (KN95, N95) are worn in a week</td>
<td></td>
</tr>
<tr>
<td>Once a week</td>
<td>2 (0.33)</td>
</tr>
<tr>
<td>Two to three days a week</td>
<td>5 (0.83)</td>
</tr>
<tr>
<td>Four to six days a week</td>
<td>8 (25.00)</td>
</tr>
<tr>
<td>Every day of the week</td>
<td>8 (37.50)</td>
</tr>
<tr>
<td>Once in a while</td>
<td>2 (8.33)</td>
</tr>
<tr>
<td>Disposal of face masks</td>
<td></td>
</tr>
<tr>
<td>By the wayside</td>
<td>24 (2.34)</td>
</tr>
<tr>
<td>In a covered bin</td>
<td>121 (11.80)</td>
</tr>
<tr>
<td>In an uncovered bin</td>
<td>867 (84.59)</td>
</tr>
<tr>
<td>Flush down the toilet</td>
<td>4 (0.39)</td>
</tr>
<tr>
<td>Frequency of mask disposal (surgical, KN95)</td>
<td></td>
</tr>
<tr>
<td>Daily</td>
<td>853 (88.03)</td>
</tr>
<tr>
<td>Every other day</td>
<td>60 (6.26)</td>
</tr>
<tr>
<td>Every three to six days</td>
<td>27 (2.79)</td>
</tr>
<tr>
<td>After a week or more</td>
<td>9 (0.93)</td>
</tr>
<tr>
<td>Frequency of mask disposal (non-disposable)</td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>56 (41.79)</td>
</tr>
<tr>
<td>Daily</td>
<td>26 (19.49)</td>
</tr>
<tr>
<td>Every other day</td>
<td>11 (8.21)</td>
</tr>
<tr>
<td>Every three to six days</td>
<td>14 (10.45)</td>
</tr>
<tr>
<td>After a week or more</td>
<td>13 (17.16)</td>
</tr>
<tr>
<td>Waste worn out</td>
<td>4 (2.99)</td>
</tr>
<tr>
<td>Disposal of household waste</td>
<td></td>
</tr>
<tr>
<td>Waste collection company, e.g., Zoomlion</td>
<td>794 (76.85)</td>
</tr>
<tr>
<td>Open dump site nearby</td>
<td>213 (20.62)</td>
</tr>
<tr>
<td>Burn</td>
<td>26 (2.52)</td>
</tr>
</tbody>
</table>
Majority of participants (727/1025) did not know that disposable face masks had plastics as a content (figure 5).

**Figure 5 Participants’ knowledge about plastics as a content of masks.**

**Findings - Observational Survey**

Observations were done at various locations across Accra, including malls, schools, marketplaces, bus stations, bus stops, banks and hospitals. Ten trained field officers were stationed at vantage points at the various study sites, for a minimum of 2 hours at each site, to observe people going about their daily activities. They looked out for whether observers were masked or unmasked. For those who wore masks, they observed if the masks were properly worn.

An average of 7 people were observed per minute at the various locations, summing up to 69,394 observers over the duration of the study.

Of the total people observed, 49.3% (34,217/69,394) were masked. About 82% of these (27,998/34,217) had disposable masks on, (figure 6) while the other 18.2% (2005/34,217) wore non-disposable/cloth masks (figure 7).

**Figure 6 Representation of masked and unmasked observees.**

**Figure 7 Type of mask worn by observers represented in a pie chart.**
Findings - Focus Discussion Groups

Four focus group discussions (FGDs) were conducted; two each in Accra and Tema. Each FGD had an average of 20 participants. Study sites were 2 markets (Madina market and Tema Community 1 market) and 2 hospitals (St. Andrews Hospital, Airport Residential Area and Tema Community 1 Maternity Hospital). Participants were market women, healthcare workers in the markets and hospitals respectively. This section highlights some of the key comments from participants.

Knowledge about types of masks

Participants mentioned two broad types of masks (i.e., disposable and cloth/non-disposable).

A market woman at Madina, aged 42 confirmed her knowledge about mask types, she stated that “There are masks that are made of rubber and masks that are made of cloth”.

Also, a 32-year-old female nurse at the Tema Community 1 Maternity Hospital stated that “We have disposable nose masks and those made of cloth.”

Factors determining mask selection.

Reasons for selecting disposable masks over non-disposable ones included comfort (ease of breathing, disposable (no need to wash), safety, affordability).

With regards to ease of breathing and ability to dispose of easily, a 53-year-old trader at the Madina market, shared her thoughts “We don’t like wearing the masks made with cloth. We prefer the disposable ones because we feel free in those. The nose masks made of cloth can be washed, but produces more heat compared to the disposable ones.”

A 28-year-old male nurse at the St. Andrews Hospital indicated his preference, stating “I prefer the disposable nose mask. You don’t need to wash it like that of the cloth.”

Concerning safety and affordability a 36-year-old female nurse at the Tema Community 1 Maternity Hospital, who felt safe using disposable nose masks explained her reason: “The surgical one is very good. It covers your mouth and nose well. So, I think that’s the best one.”

Also, a market woman aged 41, at the Tema community 1 market confirmed her ability to buy disposable nose masks, she said “The price is affordable now so a box can be bought, and I can wear it for a longer period of time.”

Knowledge about contents of disposable face masks

Participants had little knowledge about the content of disposable masks.

A market woman aged 40 at Madina, unsure of the content stated, “It looks like a thick tissue, but the back of it looks like it will melt when it comes into contact with fire.”

Mask disposal habits

All participants mentioned they disposed of their masks in waste bins either at home or at the market.

A market woman, aged 40, at the Tema Community 1 market stated that “I put it into the waste bin in my house and cover it.”
Another market woman at the Madina market, aged 59 explained that “When we are in the market, we drop the mask in the bin the tricycle “Aboboyaa” comes for it.”

A midwife at the Tema Community 1 Maternity Hospital also indicated, “I put the used masks into a waste bin then we burn them later on.”

**Knowledge on consequences of mask disposal habits**

Participants mentioned that improper disposal would lead to the spread of COVID-19 and other diseases.

A market woman aged 56 at the Tema Community 1 market stated “There are lots of consequences that come with it. Since the covid is airborne, if we do not dispose our nose masks well, anyone who comes in contact with the used nose mask can be infected.”

A 30-year-old Female nurse, at St. Andrews Hospital added that, “If we don’t dispose it well, we can’t do away with the pandemic.”

Another market woman aged 56 at the Madina market underscored the potential health risk with improper disposal stating, “…if you wear it and you don’t tie it and throw it away properly, if the mask is infected, you will end up infecting other people around you. It can bring about more diseases.”

At the Madina market, a 38 year old market interviewed, highlighted that improper disposal could lead to the spread of other diseases, she stated “It can bring about more diseases including malaria...”

**Implications/ Recommendations**

According to results from this study, knowledge about the types and use of masks was high among participants. However, orally admitting to wearing masks did not translate to actual mask usage. Most people who wore masks preferred and actually used disposable ones. This translates into an increase in infectious and plastic waste in the country, which could potentially exacerbate the effects of COVID-19 on the country’s human resource and environment. It could also lead to the outbreak of other diseases, if masks are not properly disposed of and also handled appropriately by waste management companies, to ensure public safety.

For future pandemics, National Pandemic Plans need to include the following recommendations:

We recommend that during future pandemics the Ghana Health Service implements early onset of mass vaccination to ensure large coverage, thereby, inching the country towards herd immunity at the very early stage. There is the need for early sustained mass education on the importance of observing the COVID-19 protocols in all public spaces by the National Commission for Civic Education, NCCE and all national relevant stakeholders. The Plans should clearly identify the National organizations to be responsible for the education. A clear communication strategy should also be included in the plans. The government should also develop policies that ensure proper management of plastic and infectious waste in the country, to ensure the COVID-19 pandemic does not give rise to another pandemic of plastic waste and its accompanying health impacts on the citizenry.
End of Life of Disposal

As with all single-use plastics, improperly disposed face mask has the potential to be transported from landfill sites either via rivers, drainages, surface run-offs or via transport by air into the coastal environment\textsuperscript{54}, where they impact marine life in various ways including entanglement and ingestion\textsuperscript{55}. Once in the environment, large plastic items fragment into smaller plastics known as microplastics under the action of UV radiation, waves and currents\textsuperscript{56}. Microplastics, defined as plastics below a size of 5mm and greater than 1 nm have been found in water, sediment and biological organisms in the aquatic environment. They have been detected in fish and various human organs and body parts including the human placenta\textsuperscript{57}. Microplastics have been reported to comprise various shapes with the commonest shapes being pellets, fragments, and microfibers. Increased consumption and disposal of single-use facemask has been linked to an increase in microfiber pollution in the environment\textsuperscript{58} with negative consequences for humans and aquatic organisms.

This section reports on work carried out along the eastern coast of Ghana (Sakumono, Laboma, Art Center and Krokrobite) between August and September 2021 to document the abundance and distribution of macro and microplastics in beach sediment and water.

Results

\textit{Distribution of Macroplastic along the East Coast of Ghana}

A total of 35,167 macroplastics were counted, compromising 34,468 debris (98%), and 699 Personal protective equipment (2%). The personal protective equipment counted consisted mainly of disposable facemask. The numbers of macroplastic decreased towards the low watermark in all four locations with Kpeshie beach recording the highest number of plastics followed by Art Center beach, then Krokrobite and Sakumono beaches (Figure ).

\textsuperscript{54} Okuku et al., 2021
\textsuperscript{55} Gall & Thompson, 2015
\textsuperscript{56} Efimova et al., 2018
\textsuperscript{57} Braun et al., 2021; Liu et al., 2023; Ragusa et al., 2021
\textsuperscript{58} Rathinamoorthy & Raja Balasaraswathi, 2022
Images of plastics on the beach

**Distribution and Abundance of Microplastics in Beach Sediments**

A total of 1343 microplastics were counted in sediment across all four beaches with Kpeshie beach having the highest number of items while Sakumono and Kokrobite beaches recorded the least (Table 3). Microplastics identified comprised of pellets, burnt films, foam, fragments and microfibers (Figure ).

Microfibers dominated the counts in all beaches except in Kpeshie where fragments were in high numbers. Similar to the trend observed in the macro litter distribution, an increasing trend in microplastic counts, towards the high water mark was observed.

Figure 8 Distribution of Macrolitter at (A) Sakumono (B) Kpeshie (C) Art Center and (D) Krokrbite beaches
Table 3: Total numbers of microplastic counted in sediment across the four beaches.

<table>
<thead>
<tr>
<th>Position</th>
<th>Sakumono</th>
<th>Kpeshie</th>
<th>Kokrobite</th>
<th>Art Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Watermark (HW)</td>
<td>120</td>
<td>132</td>
<td>125</td>
<td>116</td>
</tr>
<tr>
<td>Mid Watermark (MW)</td>
<td>73</td>
<td>139</td>
<td>92</td>
<td>103</td>
</tr>
<tr>
<td>Low Watermark (LW)</td>
<td>80</td>
<td>215</td>
<td>61</td>
<td>87</td>
</tr>
<tr>
<td>Total</td>
<td>273</td>
<td>486</td>
<td>278</td>
<td>306</td>
</tr>
</tbody>
</table>

**Distribution and Abundance of Microplastics in Seawater**

A total of 1686 microplastics comprising pellets, burnt film, foam, fragments and microfibers were counted in all seawater sampled (Figure ). Microfibers dominated all the counts with as high as 450 items per gallon of seawater filtered. Sakumono recorded the highest numbers of both microplastic and microplastic, we also found high numbers of microplastics in seawater from the Sakumono beach.

![Composition of Microplastic per gallon of seawater sampled in all four beaches.](image)

**Implications/ Recommendations**

Plastic and subsequently, microplastics have the potential to harm aquatic and human health in several ways. Large numbers of macroplastic have been reported off the East coast of Ghana. These larger plastics have the potential to be transported into the ocean where they are likely to be ingested or entangled by fish. While the effects of large plastic ingestion on fish are largely unknown, their potential to damage internal organs such as guts has been reported. Larger plastics shredded into microplastic over time present toxic impacts to both aquatic and human health as these have the potential to release both added and adsorbed chemicals into organs and body parts as they translocate them. The high number of microfibers documented in the study could be a consequence of fibers released from disposed clothing into the environment. The disposal of single-use face masks into the environment has the potential to increase the microfiber loads in the marine environment as these fibers decay and shred over time. The study recommends prudent management of plastic at its source to prevent its transport into the coastal environment. The importation of used clothing must be guided by the fact that these worn-out clothing have the potential to be releasing loads of microfibers into the environment. Use of single-use facemask should be discouraged, and where needed be properly disposed of to avoid transfer into the coastal environment. Monitoring and documentation of plastic and microplastic in the coastal environment is highly recommended for informing policy/decision-making on plastic use.
The study assessed the impact of the increased use of Personal Protection Equipment (PPE), including disposable face masks on the environment human health and the economy in Ghana. Findings from the study show that PPEs comprising mostly of single-use masks constitute approximately 2% of macro litter collected along four beaches. Significant numbers of microplastics, were detected in sediment and water samples taken from these beaches. Microplastics are very toxic and difficult to clean and must be a priority in our plastic waste management plans. Major waste disposal companies have experienced increase waste post COVID-19. Prior to Covid-19, these companies were collecting 309 tons of waste daily. However, During Covid-19, 349-369 tons of waste was collected daily (these include household waste, hospital waste and office or corporate waste).

Results from the study also showed that most people wearing masks preferred the disposable masks which translates to increase in infectious waste and plastic waste. There is the need to consider the impact of single-use masks on the coastal environment. The population is at risk from health implications of plastic waste including exacerbation of environmental impacts (climate change). Policies must also ensure that in the wake of managing COVID-19 we do not start another pandemic of plastic waste and its environmental health impacts. Lessons learned from public education campaigns on mask use, could serve as a guide to improve future public health awareness programmes.

The Way Forward
Picture 3 Breaking the Plastic Wave: System Change Scenarios to manage Plastic.

Source: Pew Charitable Trusts and SYSTEMIQ (2020) ⁵⁹