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COVID-19 pandemic and emerging plastic-based personal protective equipment waste pollution and management in Africa

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ABSTRACT

The threat of plastic waste pollution in African countries is increasing exponentially since the World Health Organisation declared the coronavirus infection as a pandemic. Fundamental to this growing threat are multiple factors, including the increased public consumption for single-use plastics, limited or non-existence of adequate plastic waste management infrastructures, and urbanisation. Plastics-based personal protective equipment including millions of surgical masks, medical gowns, face shields, safety glasses, protective aprons, sanitiser containers, plastics shoes, and gloves have been widely used for the reduction of exposure risk to Severe Acute Respiratory Syndrome (SARS) Coronavirus 2 (SARS-CoV-2). This paper estimates and elucidates the growing plethora of plastic wastes in African countries in the context of the current SARS-CoV-2 pandemic. A Fourier transform infrared (FTIR) spectral fingerprint indicates that face masks were characterised by natural and artificial fibres including polyester fibres, polypropylene, natural latex resin. Our estimate suggests that over 12 billion medical and fabric face masks are discarded monthly, giving the likelihood that an equivalent of about 105,000 tonnes of face masks per month could be disposed into the environment by Africans. In general, 15 out of 57 African countries are significant plastic waste contributors with Nigeria (15%), Ethiopia (8.6%), Egypt (7.6%), DR Congo (6.7%), Tanzania (4.5%), and South Africa (4.4%) topping the list. Therefore, this expert insight is an attempt to draw the attention of governments, healthcare agencies, and the public to the potential risks of SARS-CoV-2-generated plastics (COVID plastic wastes), and the environmental impacts that could exacerbate the existing plastic pollution epidemic after the COVID-19 pandemic.

1. Introduction

Plastic wastes are ubiquitous and acknowledged as an environmental stressor, adding micropollutants to the world's vulnerable ecosystems burdened by multiple changes. Across the African continent, land-based plastic waste is a notable challenge stemming from increasing plastic production and mismanaged disposal [1,2]. Coronavirus Disease-2019 (COVID-19) has triggered an unprecedented glut of plastics waste globally. Given the abundant and burgeoning array of discarded surgical masks, medical gowns, face shields, safety glasses, protective aprons, sanitiser containers, plastics shoes, food packages, and gloves, it is likely that the threat from plastic pollution is imminent (Fig. 1). The coronavirus pandemic has caused the development of emergency responses and cutting-edge approaches aimed at addressing and overcoming COVID-19 virus while minimising risks of exposures and promoting healthy lifestyles of all citizens. One of such COVID-19 precautionary measure designed to reduce community infection through droplet transmission is the mandatory use of plastic-based personal protective equipment by frontline healthcare practitioners and face masks for people leaving their homes.

In Africa, several countries including Kenya, Morocco, Egypt, Central African Republic, South Africa, Angola, Ethiopia, Equatorial Guinea, DR Congo, Liberia, Benin, Zambia, Sierra Leone, Gabon, Burkina Faso, Cameroun, and Rwanda have gazetted official regulations on the mandatory use of medical-grade or cloth face masks in public spaces and the workplace [3–6]. In West Africa, the use of face mask in the public place has been made compulsory in Nigeria, Chad, Ghana, Mali, Mauritania, Senegal, Liberia, and Guinea Bissau. In contrast, Togo, Niger and Gambia have recommended face masks use in some areas [7]. In most countries, violators could face periods of imprisonment or pay

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fines. These policies became necessary, considering that an increasing number of researches have suggested that face masks serve as an efficacious means of controlling the spread of coronavirus. The prime vehicle of SARS-CoV-2 community transmission is through respiratory droplets when an infected or an asymptomatic patient sneezes, coughs or communicates with others. Hence, the mandatory use of face masks (surgical brands or homemade face coverings act as barriers to prevent or limit the virus-containing droplets from being transmitted from an infected patient to others in public spaces [8–10]. Presently, protecting public safety and conquering the virus remains the priority of governments and healthcare agencies. However, the measures adopted in stemming COVID-19 must not be misconstrued to mean the license to suspend the war on single-use plastics or the government-backed support to pollute our terrestrial and marine environments with disposable plastics.

Africa is the second-largest continent in the world, with a fast population growth estimated at 1.34 billion people for 2020 [11]. According to this estimate, Africa accounts for about 17% of the total world population, with an average of 49% of the people living in the urban and semiurban communities. Besides the unprecedented concentration of people in the urban centres, the burgeoning middle-class population in African countries has created vast consumer markets for plastic products [2,12]. In most countries, traditional methods of food products and shop items packaging have been superseded by plastic food packages and

Fig. 1. Coronavirus-19 generated PPEs and single-use plastics littered or inappropriately discarded along Atlantic Ocean coast and dumpsites in Nigeria (Photo credits: Nsikak Benson).

plastic takeaway containers. In retail outlets, shops, supermarkets, street and food vending businesses, and major markets across Africa, single--use plastics are widely used for packaging merchandises and food products, thus increasing the consumption rate of plastics in the continent [1,13].

In the last few decades, the African continent has witnessed a proportionate increase in plastic production and per capita consumption as its population grows coupled with rapid urbanisation [2,14]. However, given inadequate facilities to manage the large quantity of plastic waste generated coupled with the existence of weak regulation on municipal waste management, a large number of plastic debris end up as inadequately disposed and littered wastes. These mismanaged plastics wastes are at high risk of polluting rivers, waterways, and the ocean.

Since the COVID-19 was discovered and the WHO declared its spread as a public health emergency, several African countries have made it mandatory for its citizens to wear face masks, or face shields especially while in public spaces. Several commercially sold surgical grade masks are manufactured from sheets of plastics intended for use as single-use plastics (SUPs). However, in most countries, these imported surgical grade masks largely made from non-woven polypropylene are expensive and in short supply. As a result, people have resorted to improvisation and homemade production of cloth face covering or masks, sewed commonly from textiles (mainly cotton). These cloth face masks are mostly reusable and are recommended as a substitute for surgical-grade masks to reduce the transmission of coronavirus [15–17]. However, most of these single-use personal protective equipment are mismanaged resulting in indiscriminate disposal and widespread contamination of the terrestrial, atmospheric and aquatic environments. This paper provides a survey of the polymeric characteristics of some commercially available face masks in Africa. We report here the first estimates of single-use face masks generated by countries in Africa during the COVID-19 pandemic, as well as highlight the potential risks mismanaged SUPs could pose to public health and the environment. The paper has also identified some plastic management challenges in Africa and proposes mitigation measures to address the problem of plastic pollution epidemic in Africa.

2. Methodology

2.1. Face masks polymeric characterisation with ATR-FTIR

We collected samples of commercially available surgical-grade (SG) (n = 100) and Filtering facepiece 2 (FFP2) (n = 50) face masks bought from major pharmaceutical companies in Ogun State, while the homemade (HM) (n = 30) face masks were purchased from street hawkers in Lagos and Ogun States. The sample collections were randomly done in June 2020. After collection, the face masks were sorted and cut into 3 × 3 cm using a Sparco stainless steel scissors. It is imperative to note that the face masks used in this work does not represent all the various single-use PPEs in Africa or the multiple products and brands commercially available in African countries. It could however be taken as random representatives of face masks used and discarded in the continent. To determine the types of polymer in the various face masks collected, Fourier transform infrared (FTIR) spectroscopy was used to characterise the SG, HM and FFP2 face masks samples. The characterization was performed in the attenuated total reflectance (ATR) mode using the Agilent 630 Cary FTIR Spectrometer equipped with a diamond crystal at a resolution of 8 cm^{-1}, 32 sample scans and a range of 4000–650 cm^{-1}. For measurement of spectra of face masks samples collected, each sample was introduced directly and clamped onto the ATR diamond crystal after performing the clean check. A relative pressure was applied to close the press, and the analysis was done using the Agilent MicroLab® software for the determination of a spectrum of satisfactory intensity. The Agilent polymer ATR library and the Sigma-Aldrich® Online Infra-red Spectrum Table and Chart were utilised to evaluate the absorptions and vibrations for functional groups in each polymer. The acceptable match quality was fixed at ≥ 80% [18–20]. The representative spectra for samples of SG, HM and FFP2 face masks polymers are presented in Fig. 2.

2.2. Estimation of COVID-19 Face masks generation

The daily single-use face masks generated by each country in Africa is estimated as a function of the total population of a country, daily face mask use per capita and an arbitrary percent of facemask acceptance rate by the urban population [21]. The total monthly and daily estimated face mask generations were computed according to the following equations:

$$\left(Totalmonthlyfacemasksgenerated = \quad 3.0 \times 10^{-3}\left(T_p \times U_p \times A_r \times A_c\right)\right) \tag{1}$$

$$\left(Totaldailyfacemasksgenerated = \quad \left(\frac{T_p \times U_p \times A_r \times A_c}{10,000}\right)\right) \tag{2}$$

Where *Tp* = the estimated population of the country, *Up* = the percentage of urban population of the country, *Ar* = the percent face mask acceptance rate, *Ac* = the average daily face masks per capita. The average number of days in a month per year was estimated as 30 days.

3. Results and discussion

3.1. Polymer characterisation

The spectra established that the textile fibres of the face mask brands were characterised by a combination of natural and artificial fibres including polyester fibres (PE), polypropylene (PP), natural latex resin (NL), polyethylene terephthalate, styrene isoprene, and styrene butadiene rubber. The FTIR spectra verified the appearance of the absorption bands that are typical of polypropylene: vibrations linked with C–C bonding (1200–800 cm^{-1}), CH_2 scissor vibrations and CH_3 symmetric deformation vibrations or CH_3 asymmetric deformation vibrations (1453–1356 cm^{-1}), and CH_2 and CH_3 symmetric and asymmetric stretching vibrations (2950–2830 cm^{-1}) (Fig. 2) [22,23].

Also, the FTIR spectra confirmed the presence of PE synthetic fibres in the FFP2 (3 M) and homemade face masks (Fig. 2). The spectra showed various characteristic absorption bands associated with polyester fibres including the moderately intense C-H stretching (2840–3000 cm^{-1}), strong C-H bending (723 cm^{-1}) and medium C=C out-of-plane bending vibrations of the benzene rings (872 cm^{-1}). The absorption bands that appear at 1013 and 3369 cm^{-1} are linked with the OH out-of-plane bending in the terminal carboxylic groups and intermolecular OH bonded to C=O groups in the polyester chains, respectively, while the peak at 1710 cm^{-1} indicates the appearance of a strong C=O stretching band for the carboxylic group [24–26]. On the other hand, the spectral fingerprints of natural latex rubber (NL) indicated characteristic absorption peaks at 2952, 2914, 2870, and 2836 cm^{-1} and are assigned to moderately intense C–H stretching vibration, medium C=C stretching for alkene at peak 1651 cm^{-1}, while the absorption peaks at 1457 cm^{-1} and 1375 cm^{-1} are attributed to carbon-hydrogen deformation for CH_2 group and carbon-hydrogen deformation for CH_3 group, respectively [27]. Therefore, it is well established that PE, PP and NL were the most dominant fibres in face mask brands.

3.2. Single-use face masks consumption across Africa

With the current consumption of SUPs especially surgical masks and homemade (fabric) face masks, if people in the urban and semi-urban areas in all countries in Africa used at least one mask each day at the rate 70% face mask acceptance, the estimated volume of face masks generated and disposed of in a day per capita would be about 412 million pieces, with over 100 million metric tonnes (Mtn) of other

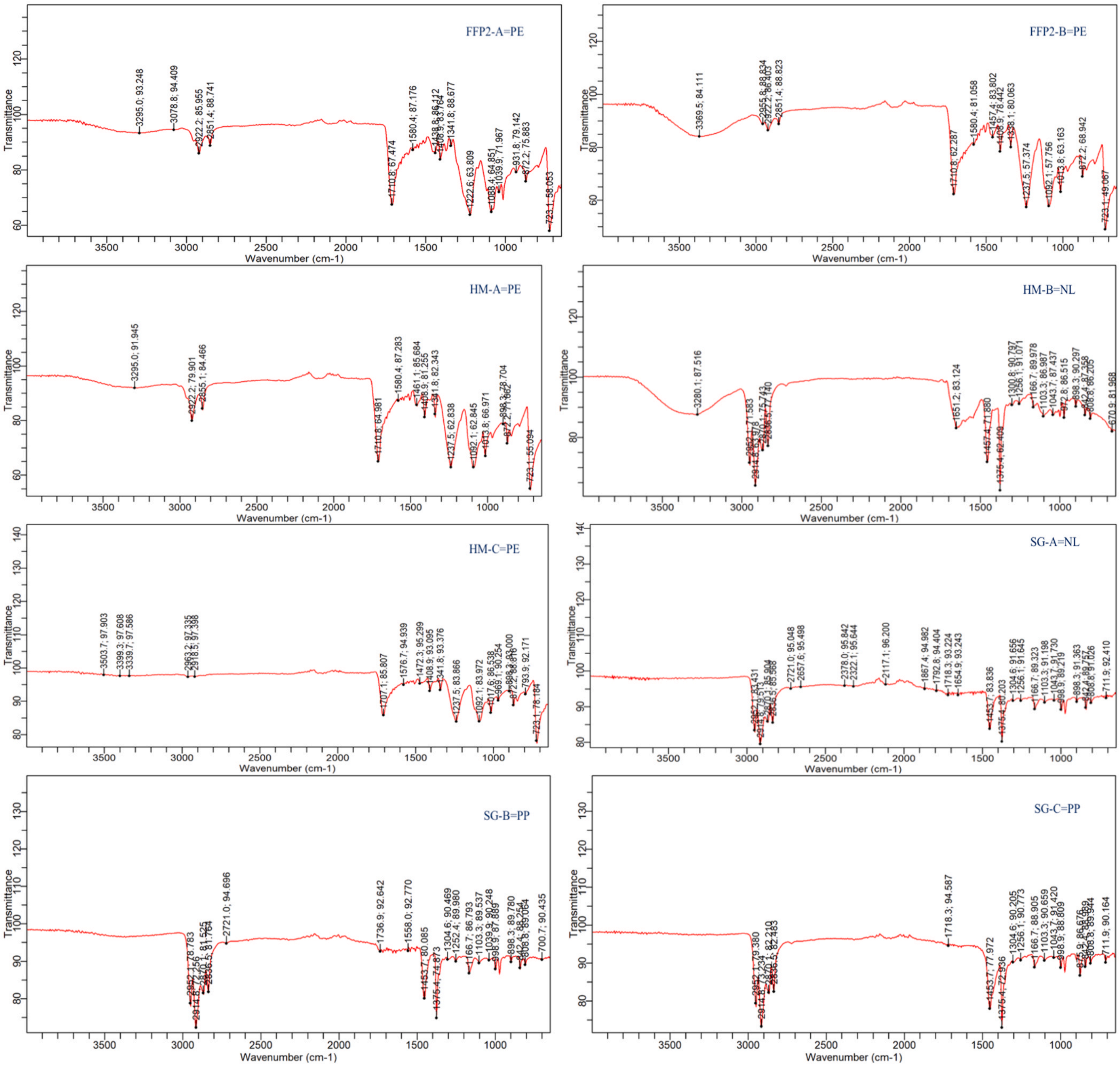

Fig. 2. Representative spectra and absorption bands for surgical-grade (SG), homemade (HM) and Filtering facepiece 2 (FFP2) face masks polymers: polyester fibres (PE), natural latex resin (NL), and polypropylene (PP).

contaminated plastics (surgical masks, medical gowns, face shields, safety glasses, protective aprons, sanitiser containers, plastics shoes, gloves, plastic water containers, flipflops, etc.) wastes produced per year (Table 1). The report by the World Wide Fund for Nature indicated that an average mask weighs approximately 4 g [28,29]. However, in order to ascertain the average weight of mask commonly available in the continent, we collected several samples of gloves, FFP2 (3 M) (Filtering Facepiece 2), surgical-grade and homemade masks and measured their weights. According to our findings, the average weight of face mask varied according to the mask's brand and grade, ranging from 2.5±0.1, 10.58±0.2, and 10.29±4.06 g for surgical-grade, FFP2 and homemade masks, respectively. On the other hand, the average weight of the glove was found to be 5.03±0.01 g. Thus, the current estimate in this research indicated that the average weight of a face masks is 8.58 g. Accordingly, calculations using the present data have shown that 3.5 million kg per capita of plastic wastes from face masks use would be littered or inadequately disposed of each day in urban centers in African countries. This means that with over 12 billion single-use face masks discarded monthly, about 105,000 tonnes of face masks per month could be disposed into the environment by people living in the African continent. This quantity of plastic wastes may exacerbate the existing plastic pollution epidemic after the COVID-19 pandemic.

Given the likelihood that several people in the continent have complied with the governments' directive to use personal protective equipment, and that much of the PPEs (face masks, gloves, and medical gowns) are used for protection of health workers, this could cause littering. Much of these contaminated PPEs may culminate in mismanaged plastic wastes and could pose serious threats to human health and the environment [21,30]. African countries have seen several tonnes of SUPs either inadequately discarded in dumpsites and uncontrolled solid waste landfills, or littered openly in available public spaces including parks, markets, beaches, and sidewalks. The unprecedented rise in the

Table 1
Estimated face masks disposal and plastic waste generation by African countries.

Country	Population[a]	Urban Population (%)[a]	Total cases[a]	Total deaths[a]	Active cases[a]	Rate (%) of face mask acceptance[b]	Face mask / capita[b]	Estimated daily face mask disposed	Estimated weight of face masks (Kg)	Estimated daily plastic waste (Tonnes)
Algeria	43,854,590	73	15,941	952	3497	70	1	22,409,695	190,482	3289,094
Angola	32,863,687	67	346	19	219	70	1	15,413,069	131,011	2464,777
Benin	12,123,248	48	1199	21	845	70	1	4073,411	34,624	909,244
Botswana	2351,786	73	277	1	247	70	1	1201,763	10,215	176,384
Burkina Faso	20,902,979	31	987	53	80	70	1	4535,946	38,556	1567,723
Burundi	11,890,146	14	191	1	72	70	1	1165,234	9904	891,761
Cabo Verde	556,036	68	1421	16	751	70	1	264,673	2250	41,703
Cameroon	26,546,427	56	12,592	313	2179	70	1	10,406,199	88,453	1990,982
Central African Rep.	4830,173	43	3969	48	3007	70	1	1453,882	12,358	362,263
Chad	16,425,296	23	871	74	10	70	1	2644,473	22,478	1231,897
Comoros	869,652	29	309	7	61	70	1	176,539	1501	65,224
Congo	5518,223	70	1557	44	1012	70	1	2703,929	22,983	413,867
Côte d'Ivoire	26,378,877	51	10,462	72	5583	70	1	9417,259	80,047	1978,416
Djibouti	988,091	79	4736	55	101	70	1	546,414	4645	74,107
DR Congo	89,555,575	46	7379	182	4236	70	1	28,836,895	245,114	6716,668
Egypt	102,342,235	43	74,035	3280	50,652	70	1	30,805,013	261,843	7675,668
Equatorial Guinea	1402,824	73	3071	51	2178	70	1	716,843	6093	105,212
Eritrea	3546,748	63	215	–	159	70	1	1564,116	13,295	266,006
Eswatini	1160,266	30	988	13	428	70	1	243,656	2071	87020
Ethiopia	114,966,205	21	5846	103	3313	70	1	16,900,032	143,650	8622,465
Gabon	2225,815	87	5620	44	3021	70	1	1355,521	11,522	166,936
Gambia	2416,608	59	57	2	28	70	1	998,059	8484	181,246
Ghana	31,074,883	57	20,085	122	5093	70	1	12,398,878	105,390	2330,616
Guinea	13,132,670	39	5570	34	1040	70	1	3585,219	30,474	984,950
Guinea-Bissau	1968,072	45	1765	25	1064	70	1	619,943	5270	147,605
Kenya	53,774,120	28	7886	160	5439	70	1	10,539,728	89,588	4033,059
Lesotho	2142,413	31	79	–	68	70	1	464,904	3952	160,681
Liberia	5057,871	53	869	37	463	70	1	1876,470	15,950	379,340
Libya	6871,927	78	989	27	704	70	1	3752,072	31,893	515,395
Madagascar	27,691,313	39	2941	32	1801	70	1	7559,728	64,258	2076,848
Malawi	19,130,121	18	1613	17	1279	70	1	2410,395	20,488	1434,759
Mali	20,250,095	44	2303	118	669	70	1	6237,029	53,015	1518,757
Mauritania	4649,671	57	4827	129	2893	70	1	1855,219	15,769	348,725
Mauritius	1271,795	41	341	10	1	70	1	365,005	3103	95,385
Mayotte	272,823	46	2661	35	251	70	1	87,849	747	20,462
Morocco	36,913,924	64	14,215	235	4255	70	1	16,537,438	140,568	2768,544
Mozambique	31,254,703	38	987	8	723	70	1	8313,751	70,667	2344,103
Namibia	2541,110	55	412	–	387	70	1	978,327	8316	190,583
Niger	24,201,945	17	1088	68	55	70	1	2880,031	24,480	1815,146
Nigeria	206,144,243	52	28,167	634	16,071	70	1	75,036,504	637,810	15,460,818
Réunion	895,376	100	536	2	62	70	1	626,763	5327	67,153
Rwanda	12,952,510	18	1092	3	566	70	1	1632,016	13,872	971,438
Sao Tome & Principe	219,176	74	719	13	439	70	1	113,533	965	16,438
Senegal	16,743,956	49	7400	133	2397	70	1	5743,177	48,817	1255,797
Seychelles	98,353	56	81	–	70	70	1	38,554	328	7376
Sierra Leone	7977,515	43	1533	62	420	70	1	2401,232	20,410	598,314
Somalia	15,892,879	47	2961	92	1896	70	1	5228,757	44,444	1191,966
South Africa	59,314,150	67	187,977	3026	93,724	70	1	27,818,336	236,456	4448,561
South Sudan	11,194,743	25	2021	38	1650	70	1	1959,080	16,652	839,606
Sudan	43,850,981	35	9767	608	4486	70	1	10,743,490	91,320	3288,824
Tanzania	59,732,362	37	509	21	305	70	1	15,470,682	131,501	4479,927
Togo	8279,041	43	676	15	229	70	1	2491,991	21,182	620,928
Tunisia	11,819,657	70	1186	50	90	70	1	5791,632	49,229	886,474
Uganda	45,736,977	26	939	–	48	70	1	8324,130	70,755	3430,273
Western Sahara	597,354	87	10	1	1	70	1	363,789	3092	44,802
Zambia	18,383,527	45	1632	30	254	70	1	5790,811	49,222	1378,765
Zimbabwe	14,864,287	38	698	8	509	70	1	3953,900	33,608	1114,822

[a] Data retrieved from https://www.worldometers.info/population/ on July 05, 2020.
[b] Hypothetical data.

number of disposable surgical masks and hand gloves can contribute to the plethora of plastic pollution [31,32].

According to our estimations based on the proportion of total plastic wastes (TPWs) in municipal solid wastes, and the quantity of waste generation per capita in African countries, the calculated fraction of mismanaged plastic waste produced by each country is presented in Table 1. However, it should be noted that the estimated TPWs generation by a country is the quantity derived before formal waste management involving sorting, recycling, or incineration. Thus, TPWs does not depict the volume of plastics at risk of polluting the gullies, inland waterways, canals, creeks, rivers, estuarine and the marine ecosystems. (Fig. 3).

The results of this study indicated that 15 out of 57 countries in Africa are major contributors of single-use plastic wastes, contributing about 75% of the TPWs in the continent per year with Nigeria (15%), Ethiopia (8.6%), Egypt (7.6%), DR Congo (6.7%), Tanzania (4.5%), and South Africa (4.4%) topping the list (Figs. 4 and 5). These countries mostly have extensive maritime coastal zones bordering the ocean. Therefore, the existence of poor or limited waste management facilities in these countries could result in the littering and direct introduction of land-based derived plastic wastes into the beaches and ocean.

In most developing countries in Africa, it is a common practice to discard domestic and industrial wastes in open landfills, wastewater gullies, inland waterways, poorly managed and uncontrolled dumpsites, street bins, drainage canals and paved walkways. Over the years, these dumpsites and landfills have become very problematic to manage, and a rallying point where waste scavengers visit to forage for the recovery of waste recyclables. Waste pickers or hunters are essential players in informal waste management, especially in developing countries where waste picking serves as a quick source of income for the urban and semi-urban poor [33–35]. Informal waste management in most African countries is dominated by landfill scavengers, itinerant waste hunters, and neighbourhood waste pickers who primarily engage in uncontrolled activities of waste collection, sorting and recycling [36–38]. The scavenging of littered heaps for potentially recyclable materials is usually carried out without wearing suitable personal protective equipment. In Nigeria, it has been reported that scavengers are engaged in collecting discarded face masks from open dumps for recycling and resale to the

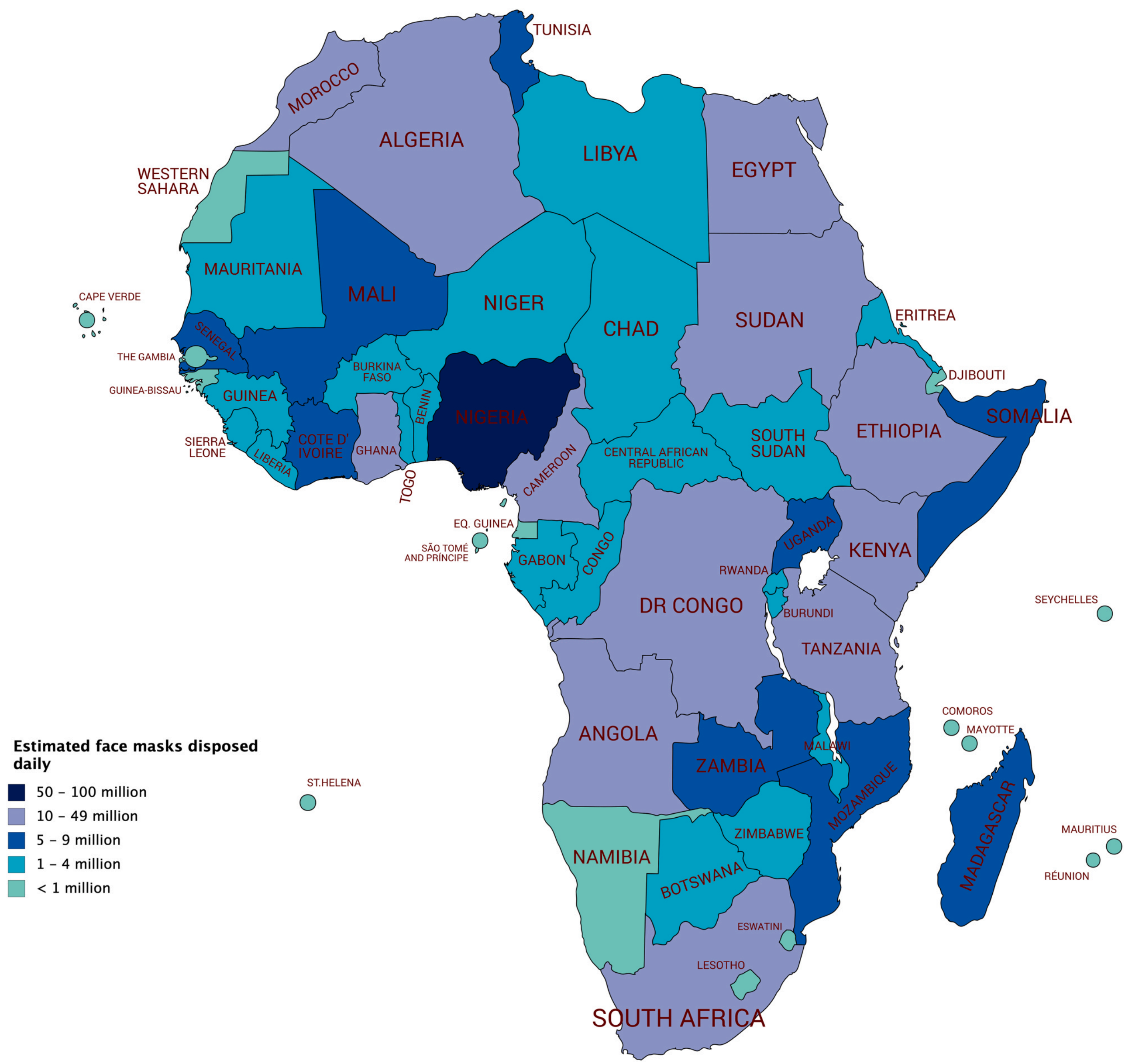

Fig. 3. Projected share of face masks generated daily per country Map created with mapchart.net©.

Fig. 4. Major contributors of plastic waste that is inadequately managed in 2020 Map created with mapchart.net©.

unsuspecting public [39]. Although waste picking in third world countries may serve as a means of livelihood and escape from poverty for the impoverished few, it could potentially be a vehicle for the spread of infectious diseases including COVID-19 [40–42]. Recent reports have identified the stability and survivability of COVID-19 virus on contaminated fomites including plastics, banknotes, stainless steel, cardboard, copper, wood, and face masks [40,43]. The studies showed that the infectious viral particles of SARS-CoV-2 is exceptionally contagious and could remain viable on a range of surfaces for several minutes and up to 9 days [30,40]. Coronaviruses on plastics and stainless-steel surfaces were found to be more viable and stable for 2–3 days than cardboard, wood, banknotes and copper [40,43]. Therefore, the spread and infectivity of COVID-19 through inadequately disposed or littered wastes could be filliped by scavengers and informal waste collectors upon exposure to contaminated materials.

The question surrounding how COVID-19 virus is transmitted and the strategies to stop the virus from spreading has generated a growing global concern over the use of single-use plastics, thus dampening the war against plastic pollution. Over the past months, millions of people around the world have been compelled to observe the government-issued directives on lockdown as a measure of reducing the spread of the virus. COVID-19 has been described as a zoonotic disease that originated at the end of December 2019 in Wuhan in Hubei Province, China and has spread to over 212 countries and territories around the world and two international conveyances [11,44–46]. As of early July 2020, the outbreak recorded over 12 million confirmed coronavirus cases worldwide, with at more than half a million deaths [11]. In Africa, over 500,000 and 12,000 confirmed COVID-19 cases and deaths have been recorded as at early July 2020 (Fig. 6, Table 1). According to the WHO, SARS-CoV-2 virus is primarily transmitted via saliva droplets or release from the nostril when an infected patient sneezes or coughs [47].

Past investigations have shown that contaminated surfaces are principal vehicles for the spread of viral infections [48,49]. The presence of COVID-19 ribonucleic acid on surfaces of inappropriately released single-use clinical materials has been reported [40,43]. As indicated by reported studies, COVID-19 RNA has been discovered to be more stable and potent for 2–3 days on plastics and treated steel surfaces than on cardboard, wood, banknotes and copper [40,43]. In addition, the

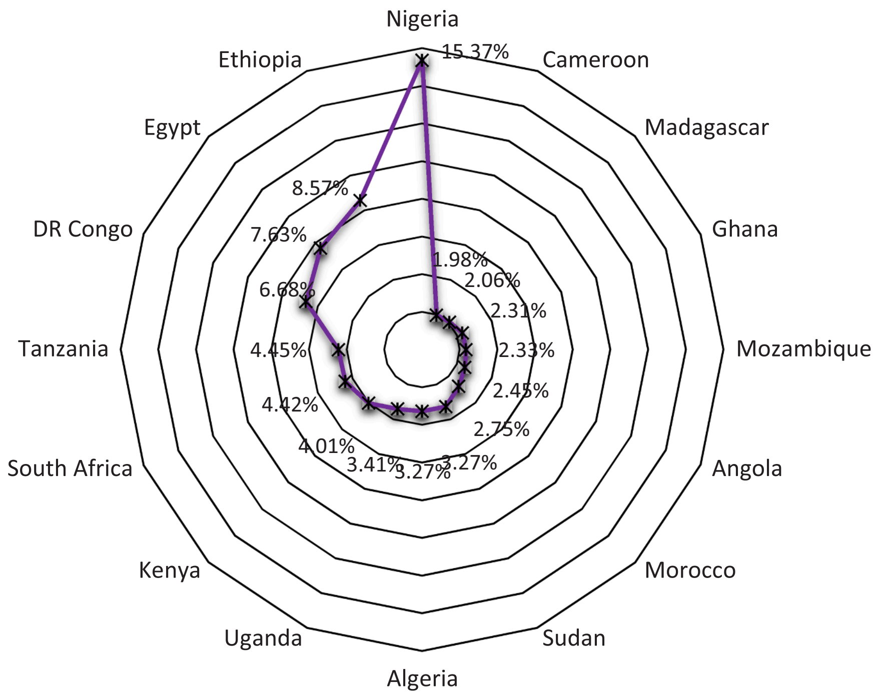

Fig. 5. Continental percent share of plastic waste generation per country measured in metric tonnes per year.

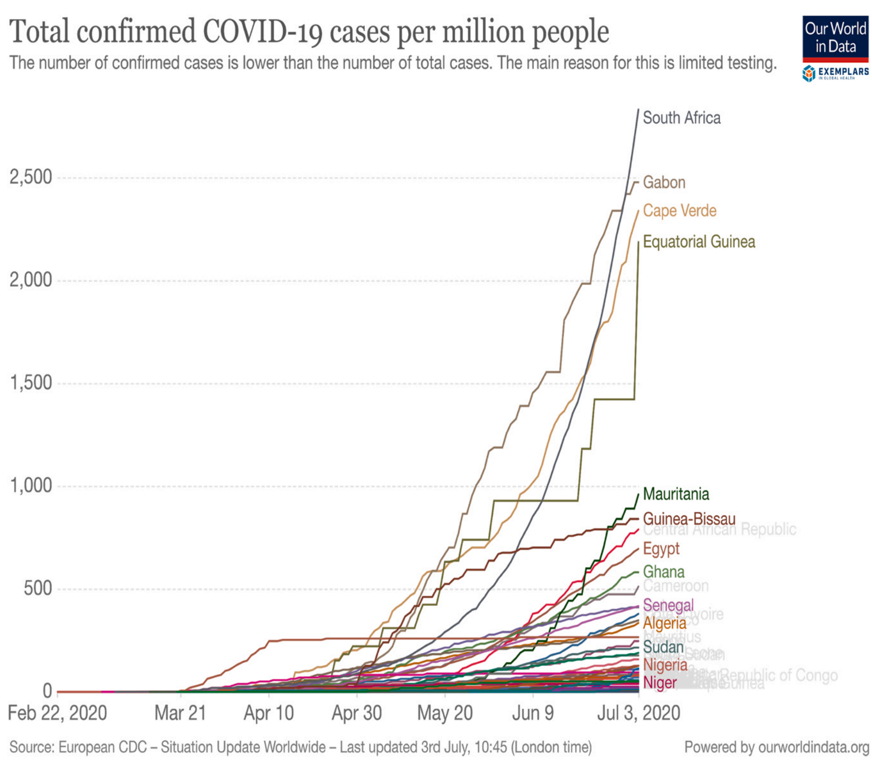

Fig. 6. Total confirmed COVID-19 cases per million people in African countries.

epidemiological information from the studies revealed that coronavirus could be detected on the outer surfaces of face masks for a few minutes and as long as 2.8 days after exposure (Fig. 7). These data confirm the stability and viability of COVID-19 infection through infected face masks and other clinical wastes [40,50,51]. Thus, it is imperative to reappraise existing waste management in Africa countries to avoid community infection of people through exposed surfaces and disposed contaminated face masks. Additionally, inappropriate collection and management of COVID-19 wastes, including littering, disposal in uncontained landfills and open dumps may likely exacerbate the current plastic waste pollution in the continent.

4. Conclusion and recommendations

Plastic pollution has been identified as a growing environmental and public health challenge. The sorption of carcinogenic and endocrine-

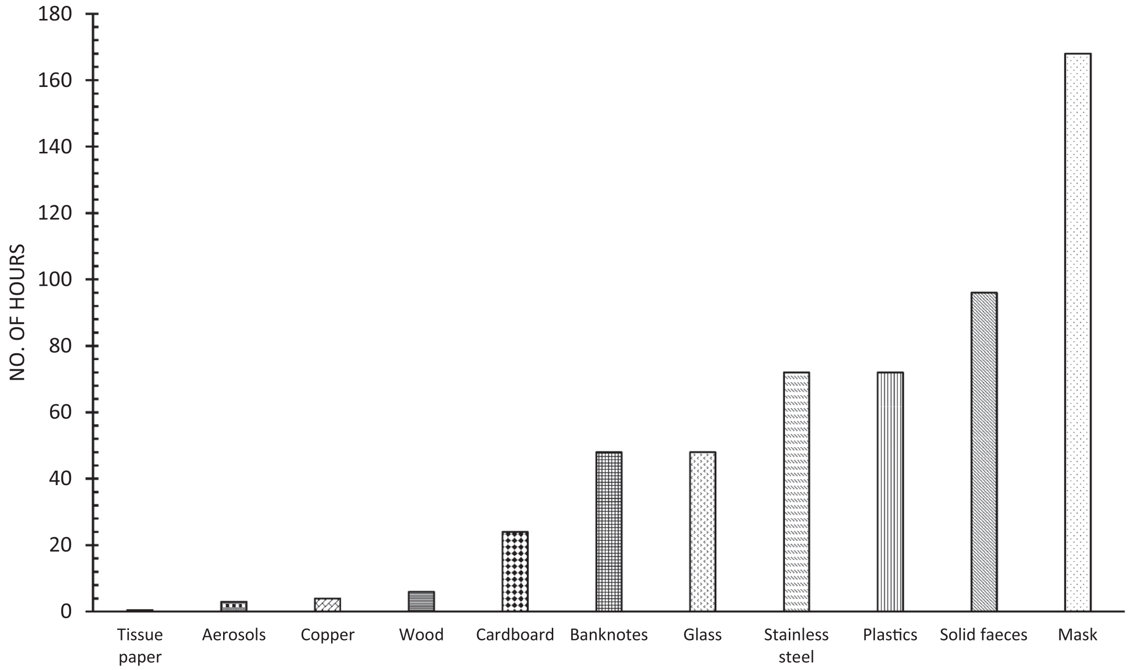

Fig. 7. Epidemiological data on the stability of COVID-19 on contaminated surfaces.

disrupting chemicals onto bulk plastics and micro-, meso-, and macroplastics in the terrestrial environment and marine ecosystems has been widely reported [52–57]. However, the magnitude of this problem and the call for measures to address the worsening plastic pollution crises have grown only lately to a higher level of public consciousness, especially since the inception of the COVID-19 pandemic. To address the problem of plastic pollution epidemic in Africa, the following recommendations are advocated:

a) The disposal of contaminated PPEs should be meticulously handled by trained waste collectors and rightly bagged, discarded or recycled to prevent infection and associated health risks, environmental pollution, and injuries to marine mammals and other marine wildlife.
b) The regular and thorough cleaning of surfaces in public places and isolation centers using 60–71% ethanol or 0.1% sodium hypochlorite would significantly degrade the infectivity of COVID-19 virus within a minute of application of a disinfectant.
c) Due to the growing consumption of plastics globally, a glut of SUPs would likely end up as mismanaged plastic wastes. Therefore, emphasis should be placed on the intentional reduction in discarded plastic wastes before mismanagement. This could drastically reduce the millions of PPEs that could have been littered the gutters, thus preventing the blockage of waterways and flooding of urban areas as well as support the reduction in transmission of infectious diseases.
d) The government of the various African countries should urgently create a working infrastructure for the collection, transportation, recycling, or incineration of plastic medical wastes at designated facilities far away from the urban areas. Besides, a functional and efficient on-site healthcare waste management facility should be installed in rural areas for the disposal of hazardous biomedical wastes to forestall the community spread of human coronaviruses and other infectious diseases. Additionally, this approach will replace the existing practice of open incineration or burying of biomedical wastes.
e) We advocate the use of reusable face masks by the general populace as this could significantly reduce plastic wastes as well as the impacts of the post-COVID-19 pandemic on the marine environment resulting from policy obligations of wearing face masks.
f) Given that people in the various countries are determined to adhere to the mandatory face mask order and other related COVID-19 policy regulations by taking personal responsibility to contain the community spread of COVID-19, now it is imperative for everyone to be fairly responsible in managing the disposal of their used personal protection equipment and not dispersed into the environment.
g) Africa is nearly losing its quintessence and environmental magnificence to burgeoning waste pollution from single-use plastics. The volume of plastic wastes generation, especially SUPs is expected to double in the coming years as the size and population of its urban communities increase. In order to address plastic waste pollution, public education about efficient and sustainable approaches to waste management needs to be adopted. Public awareness education targeted on behavioural change and improving people's knowledge toward reducing plastic wastes, open dumping of used face masks, and the promotion of recycling, reuse, and source reduction activities are of most extreme significance.
h) Furthermore, we suggest that designated waste receptacles should be provided at marked points in public places, healthcare facilities, shopping malls, markets, banks, worship centres, schools, and residential estates to collect used PPEs. In view of this, periodical emptying and routine decontamination of the waste containers must be carried out by trained hazardous waste handlers in line with laid down guidelines [58–60].
i) In general, as the coronavirus pandemic continues, a strong recommendation to the government, health workers, medical experts, and the public would be to prevent plastic pollution by being individually, communally and globally responsible.

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CRediT authorship contribution statement

Nsikak Benson, David Bassey: Conceptualization; **Nsikak Benson:** Data curation; **Nsikak Benson, Omowunmi Fred-Ahmadu:** Formal analysis; **Nsikak Benson, David Bassey:** Investigation; **Nsikak**

Benson, Omowunmi Fred-Ahmadu, David Bassey, Aderemi Atayero: Writing - original draft; **Nsikak Benson, Omowunmi Fred-Ahmadu, David Bassey, Aderemi Atayero:** Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data sharing

All data used in this study are publicly available and are referenced in the manuscript.

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