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# Household waste generation, change in waste composition and the exposure to COVID-19 in Guyana and Nigeria

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## ABSTRACT

The COVID-19 pandemic has disrupted humans' activities across the globe. Measures related to social/physical distancing and lockdown have led to a shift and increase in waste generated at households' level. This study examined waste generation, composition and the implications for exposure during COVID-19 pandemic lockdown in Guyana and Nigeria. The study adopted a mixed-method design to collect qualitative and quantitative data. Owing to adherence to social/physical distancing, an online Google Form survey was administered and phone interviews were conducted with waste managers in Nigeria and Guyana. Findings showed that the volumes of waste had increased and there was a mixture of Personal Protective Equipment (PPE) with the municipal waste. Also, the majority of the respondents in both countries were concerned that solid waste has the potential to contribute to contamination and spreading of the pandemic. A paired sample *T*-test analysis indicated an increase in the use of PPE. The values of  $t = 19.46$  and  $t = 23.73$  at  $p \geq 0.05$  in Nigeria and Guyana, respectively were significant. Waste mostly contaminated, as submitted by the respondents, were cans, bottles, plastics and all biodegradable wastes while the most probable point of contamination as noted by the waste managers occurred at the point of waste collection. Therefore, sorting of waste at household levels and training of personnel involved in waste management should be done with an emphasis on adherence to COVID-19 protocol and enforcement of same to prevent the spread of the virus

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## Introduction

Sources of solid wastes in a community are, in general, related to land use patterns that can be categorized into residential, commercial, institutional, circulation, recreational, industrial, and agricultural ones [1,8]. Except for some industrial waste; wastewater treatment plants, and agricultural processes, most of the waste generated from the listed land use is normally categorized and/or assumed to be a municipal solid waste [2,33]. These wastes include food, paper, cardboard, plastics, textiles, leather, wood, glass, metal, ashes, street leaves and some specific wastes such as hazardous wastes (electronics, light bulbs, batteries, asbestos) and biomedical waste (sharps, soiled waste, disposables, personal protective equipment; anatomical waste) [1,8].

Over the years and with rapid urbanization coupled with the change in lifestyle and food habits, the amount of municipal solid waste generated has been increasing rapidly. Since the global coronavirus disease (COVID-19) outbreak in November 2019, the composition of municipal waste at the household scale has been changing in line with the provision and adherence to the virus protocol. There is an increased composition of hospital-related waste with the waste generated at the household level [9]. This has implications for the collection, transportation and disposal of household solid waste on public health, especially for municipal waste management personnel the general public and the environment [17,19,26,32].

The changes in the configuration of waste could lead to the potential threat of exposure to COVID-19 by waste handlers with significant implications on the citizenry, especially with the second wave of infection. The present admixture of waste as a result of COVID-19 and the concurrent management procedures increases the risk of disease spread from contaminated and infested waste [24]. The waste associated with COVID 19 encompasses medical waste generated at household levels which is inclusive of but not limited to face masks, gloves and used tissues/paper napkins [19,26]. Before the pandemic, it has been documented that the waste sector impacts are significantly devastating on human's socio-economic wellbeing and the environment, especially in the developing countries [8,33,20]. For example, poor waste management practices were estimated to result in between 400,000 and 1 million deaths annually in developing countries resulting in a productivity loss of higher magnitude [31]. The impact of poorly managed waste will be further compounded by COVID-19, especially in the developing countries where the structure for the management of waste is inadequate [5,25,30]. Among unprecedented impacts of COVID-19 pandemic, municipal waste management practice is expected to be one of the main concerns of public health and citizens' wellbeing [29]. It has been suggested that the waste treatment and disposal procedures in healthcare facilities should consider controlled conditions of thermal treatment or the use of traditional biocidal agents effective in destroying coronavirus [7]. Nonetheless, waste generated outside the healthcare facility needs to be addressed inclusive of factors such as the influx of medical-related waste into the household waste stream [12]. Therefore, the WHO guidance/regulation on infectious waste treatment as a result of the influx of PPE into households' waste stream should be adopted. The protocols include: segregate waste at source; dispose infectious waste in foot operated bin; proper handling collection, transport and storage of waste; use PPE (mask, face shield, heavy duty gloves, long sleeve gown, boots) hand hygiene; use safe and environmentally sound treatment methods. Also, to be adopted are on-site chemicals disinfection, encapsulation and sanitary burial; cut masks and other PPE before disposal owing to reports on the illicit resale of used masks and routine disinfection and cleaning protocols for waste bins.

Handling and disposal of municipal solid waste is a growing global environmental and public-health concern [6]. As a result of poor waste management, it has been observed that about 2.4 billion people will likely be exposed to the risk of avoidable disease and death by 2015 [16,23]. This observation is made worse by COVID-19 waste contaminations [9,12,14,22]. Without a concrete structure to manage municipal solid waste, the risk of further spread of the coronavirus will be considerably high. This presents a greater concern in developing countries where poor waste handling strategies are a product of inappropriate use of personal protective equipment and other unfavourable conditions [9,12]. At the inception of this pandemic in developing countries, there was a paucity of data for its projection and impacts [13,22]. With COVID-19 providing a 'new normal' for and to waste management, this study is designed to examine the composition of waste generation at household scale and the implication of humans exposure to COVID 19 pandemic lockdown in Guyana (South America) and Nigeria (Africa). The study, also, intends to explore the dynamics of waste generation from the household and evaluate waste managers' perspective in addressing the changing composition of household waste generation and management.

## Methodology

This research assessed the exposure to COVID-19 in Nigeria and Guyana stemming from the increase in waste quantity and presence of Personal Protective Equipment (PPE) in household solid waste. The first COVID-19 confirmed case in Nigeria was reported on 27th February 2020 and the first confirmed case for Guyana was reported on 13th March 2020. The number of confirmed cases in the two countries continued to increase significantly. By 31st August 2020, the number of confirmed cases and deaths in Nigeria was 53,865 and 1013, respectively. The confirmed cases for Guyana were 1306 and recorded deaths from the virus were 31.

Owing to a potential increase of medical waste at the household level and similarity in the waste management architecture of both countries [19,22], opinion of respondents on waste disposal patterns since the onset of COVID-19 in various regions and communities across Nigeria and Guyana was ascertained. The study adopted a flexible sampling framework supported by qualitative data from waste managers. With adherence to social/physical distancing coupled with movement restriction, an online Google Form questionnaire was administered in Nigeria and Guyana. The Google Form containing the

questions for the survey was linked to the researchers' Google accounts. A pilot survey was conducted to validate the questionnaire and necessary adjustments were made from the responses obtained. The data and information on the survey were not made public until co-authors reviewed, edited, and corrected the questions where necessary. This survey enabled the researchers to generalise findings from a responding sample of a population [3]. It also allows for descriptive and inferential statistical analysis [15].

The Google Form contained 25 fields and the structure of the form provided flexibility with both open-ended and closed-ended questions. The flexibility provided with the survey ensured that respondents could input text where necessary, while dropdown lists were also made available in addition to radio button provision for the selection of certain variables and parameters. The risks associated with solid waste management were also obtained from waste management personnel using a self-reported interview guide to gain insight into the operations of the waste managers.

#### *Sampling method and response rate*

An online survey instrument, administered from 1 to 7 July 2020, adjudged to be adequate by Malhotra [11], was used to elicit information from respondents in Nigeria and Guyana. A total of 489 persons disaggregated to 273 and 216 responded to the questionnaire in Nigeria and Guyana, respectively. Focal persons were engaged in each geopolitical zone and regions in the countries. They were encouraged to populate the research instrument by eliciting responses from as many as possible respondents by sending the Google Form link to WhatsApp, Facebook, Telegram, emails and professional networks.

In Nigeria, all the six geopolitical zones including the Federal Capital Territory (FCT), Abuja, were covered with the South West zone (84.9%) accounting for the majority of the respondents. About 6.0% of the respondents were from North Central and South East representing 4.8%. Respondents from North West, South South and North East were 1.9%, 1.5% and 1.1% respectively. In Federal Capital Territory, Abuja, 4.0% responded to the research instrument. There are 10 regions in Guyana and eight regions responded to the research instrument. The reason for no response from the two regions (8 and 9) could be attributed to poor internet connectivity. Region 4 represented the majority accounting for about 52.0% of the respondents; this was followed by Region 10 (26.9%) and Region 3 (11.1%). The response rates from other Regions in Guyana accounted for 10%. The response rates were skewed towards the southwestern part and region 4 in Nigeria and Guyana, respectively because as at the time of the survey, these parts of the countries had a higher rate of infections and accounted for about 65 per cent of confirmed cases of COVID 19.

#### *Data collection and analysis*

The Google Form was used to obtain personal information on age and gender, estimation of the quantity of waste generated, presence of/ types of PPE (sanitizers' containers, face masks and gloves) and waste contamination. In addition to the administration of the Google Form online, qualitative data was also obtained from waste handlers/managers. Interviews designed for this purpose were conducted using telephones. To analyse the data obtained from the research instrument, the Google Form was downloaded into excel format. This was later transferred into the SPSS software to generate descriptive statistics such as frequency and percentage and inferential statistics such as student's *T*-test at  $p = \leq 0.05$ .

#### *Limitations*

Owing to adherence to COVID 19 protocol, especially, social/physical distance, systemic process of questionnaire administration could not be achieved. This, invariably, skewed the data towards some locations. Qualitative data were collected using telephone interviews, therefore, body language, as an essential component of an oral interview, could not be captured to validate and/or refute the submission of the interviewees. Also, data were collected from mostly urban areas, therefore, the findings cannot be generalized for rural areas.

## **Result**

### *Socio-Economic characteristics of respondents in Nigeria and Guyana*

**Table 1** presents the gender and age cohort of respondents in Nigeria and Guyana. From the Table, about 64.0% of respondents in Nigeria were males and about one-third (36.3%) were females; while in Guyana, about one-third (31.9%) were males and about two-thirds (68.1%) were females. Majority of respondents (73.3%) in Nigeria were above 28 years while about 45.8% were above 28 years in Guyana. Thus, it can be implied that the majority of respondents in the two countries were above 28 and capable of providing informed opinions on the focus of the study.

The change in waste quantity in Nigeria and Guyana as a result of COVID-19 and presence of PPE in solid waste is presented in **Table 1**. In Nigeria, about two-thirds (60.8%) of respondents ascribed the noticed increase in the volume of waste generated to COVID-19 pandemic while over one-third (39.2%) stated that the volume of waste generated had not increased. Similarly, in Guyana, two-thirds (63.4%) of respondents also affirmed an increase in the volume of waste generated while about one-third (36.6%) had a contrary opinion. The analysis of the presence/absence of PPE in Household solid waste in Nigeria showed that almost 60.0% of the respondents submitted that there was the presence of PPE in solid waste. In

**Table 1**  
Demography of respondents and changes in the composition of waste.

Variables	Nigeria		Guyana	
	Respondents	Percentage	Respondents	Percentage
Sex				
Male	174	63.7	69	31.9
Female	99	36.3	147	68.1
<b>Total</b>	<b>273</b>	<b>100.0</b>	<b>216</b>	<b>100.0</b>
Age cohort				
Less than 18	1	0.4	18	8.3
19–23	14	5.1	53	24.5
24–28	58	21.2	46	21.3
Above 28	200	73.3	99	45.8
Total	273	100.0	216	100.0
<b>Change in Quantity</b>				
Increment in waste	166	60.8	137	63.4
No increment in waste	107	39.2	79	36.6
<b>Total</b>	<b>273</b>	<b>100.0</b>	<b>216</b>	<b>100.0</b>
Presence of PPE	157	57.5	137	63.4
Absence of PPE	116	42.5	79	36.6
<b>Total</b>	<b>273</b>	<b>100.0</b>	<b>216</b>	<b>100.0</b>

**Table 2**  
Paired sample *T*-test.

Paired	Mean	Std. Deviation	<i>T</i>	Df	Sig.
Increase in PPE (Nigeria)	0.788	0.669	19.455	272	0.000
Increase in PPE (Guyana)	1.009	0.625	23.733	215	0.000

Guyana, the majority (63.4%) of the respondents stated that there was a presence of PPE in solid waste generated in recent times. From the interview conducted with the waste managers, they were of the opinion that waste generated during the lockdown had not significantly increased. They, however, corroborated the submission from the respondents that there was a spike in presence of PPE in the waste stream generated at the household scale during the COVID-19 pandemic.

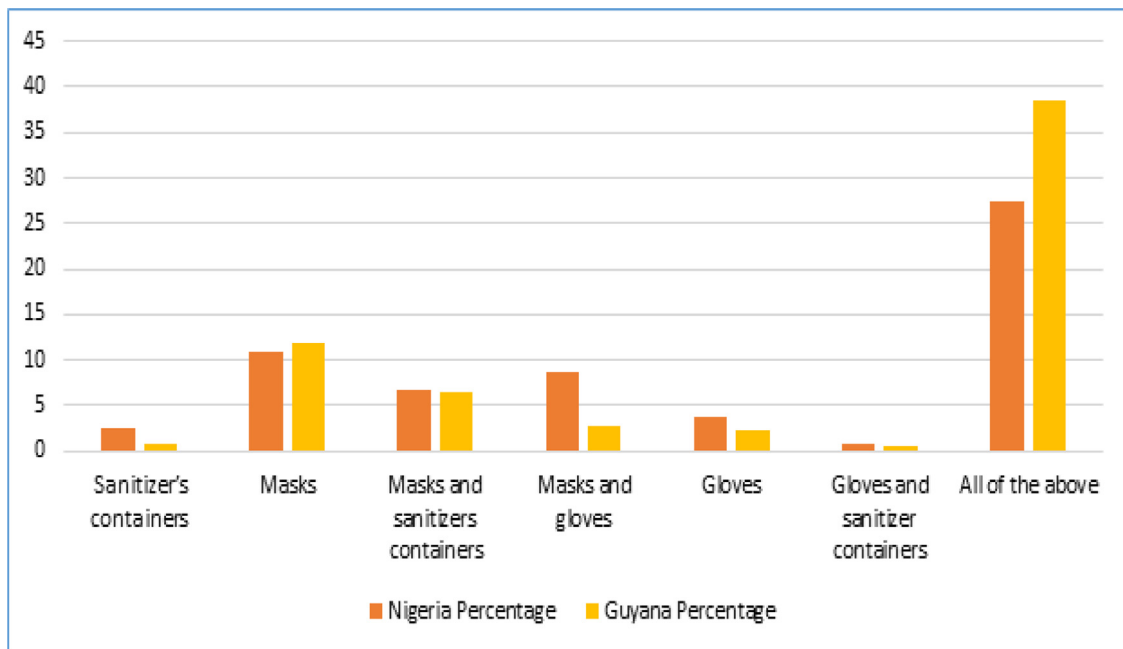
A paired sample *T*-test analysis was used to test significant differences in the observed increase in PPE. The results, as shown in Table 2, revealed a mean of 0.788,  $df = 272$  and a  $t = 19.46$  which is statistically significant at  $p \geq 0.000$ . These results indicated that in Nigeria, there was statistically significant in the opinions of residents on the observed increase in PPE. Also, in Guyana, the paired sample *t*-test revealed a mean of 1.00,  $df$  at 215 and a  $t = 23.73$  which was statistically significant at  $p = 0.000$ , as shown in Table 2. With the observed increase in PPE in the waste stream which could have been contaminated, there is a high likelihood of exposure of waste workers to COVID-19 who could also transmit the virus to other administrative staff, neighbours, family members and the general public.

#### Presence of PPE in household solid waste

Analysis of PPE in waste, as shown in Fig. 1 indicated that about 27.0% and 39.0% of the respondents in Nigeria and Guyana, respectively agreed that all types of PPE (sanitizers' containers, face masks and gloves) were disposed of with household solid waste during the COVID-19 pandemic. In Nigeria, face masks alone, as submitted by the respondents, accounted for about 11.0% of PPE disposed of with household solid waste, while in Guyana, it accounted for 12.0% of the PPE in waste. These views were also substantiated by managers. From the interviews conducted, the waste managers submitted that there had been an admixture of, hitherto, medical-related waste with municipal waste. This was because the waste generated in both countries had not been sorted from the source before disposal. The most obvious of these types of waste was the face mask as a result of its mandatory usage in public places and the frequency of discarding it as recommended by WHO COVID 19 protocol (Fig. 1). Other PPE identified were gloves, sanitizer containers and face shields.

#### Type of waste material easily contaminated with COVID-19

In terms of materials in waste mostly contaminated with COVID-19 in Nigeria, as shown in Table 3, about 95.0% of respondents listed cans, glass including bottles and ceramic, plastics, fabrics, and paper as easily contaminated materials, while a relatively few (4.1%) submitted that all types of wastes and biodegradable materials could be easily contaminated by the virus. Similarly in Guyana, almost 96.0% of the respondents identified cans, glass, ceramic, plastics, fabrics and paper and slightly about 2.4% mentioned all types of waste. From the interview conducted, the waste managers agreed with the submissions of the respondents. They stated further that the most probable point and source of contamination with COVID-19 were at the points of collection. This submission was informed by the quantum of PPE noticed in waste deposited at the household level.



**Fig. 1.** Type of personal protective equipment in solid waste in Nigeria and Guyana  
Source: Authors' Analysis, 2020.

**Table 3**

Type of waste material that can be easily contaminated with COVID-19.

Contaminated material	Nigeria		Guyana	
	Respondent	Percentage	Respondent	Percentage
Drink cans, glass, ceramic, plastics, fabrics, paper All and biodegradable materials	256	94.8	201	95.7
None	11	4.1	5	2.4
	3	1.1	4	1.9
<b>Total</b>	270	100.2	210	100.0

**Table 4**

Respondents' level of concern for solid waste contamination.

Level of concern	Nigeria		Guyana	
	Respondent	Percentage	Respondent	Percentage
Indifferent and or unconcerned	15	5.5	19	8.8
Not a source of transmission	86	31.5	56	25.9
Fairly concerned as a source	75	27.5	67	31.0
Extremely concerned as a source	97	35.5	74	34.3
<b>Total</b>	273	100.0	216	100.0

#### Concern for solid waste contamination during this pandemic

From Table 4, more than one-third (35.5%) of respondents in Nigeria and about one-third (34.3%) respondents in Guyana were extremely concerned about solid waste as source contamination of COVID-19 and spread of the pandemic. In Nigeria, 27.5% and in Guyana 31.0% of the respondents were fairly concerned that waste could be a source of COVID-19. From the submission, about 32.0% of the respondents in Nigeria had not thought about it while 5.5% of respondents were indifferent to it. In Guyana, 25.9% of the respondents had not thought about waste as a source of contamination of COVID 19 while 8.8% revealed that they were unconcerned.

The waste managers also raised some concerns about household waste being contaminated with COVID-19 infested materials. The risk of exposure to the virus, according to the managers, was not serious owing to the provision of PPE to waste handlers and other staffers. However, from observations, most of the waste handlers did not wear the PPE appropriately as it should be worn. The face masks were not worn or worn inappropriately on the chin leaving the mouths and noses exposed. The reasons adduced for this by the waste handlers were tedious nature of the job, breathing difficulty while wearing the



mask, inclination of the mask to be soiled by the work environment, and general inconveniences associated with usage of protection. None of the waste handlers from observation wore protective goggles or face shields while handling waste.

## Discussion

The stages of generation, storage, collection, processing, transportation and disposal of waste are important stages which involve the use of human labour in conjunction with machines and equipment. Although the statistics of occupational-related diseases are poorly documented the developing countries appear to have the greatest rate of occupational injuries and disease [21]. The primary waste management concerns are largely unexplored but pose as one of the greatest avenues in spreading COVID-19 with the proliferation of disposable PPE. The rampant increase in confirmed cases worldwide indicates a significant portion of the population undiagnosed, especially the asymptomatic cases could be using and disposing of PPE daily. The governments of many developing countries have taken measures to contain the spread of COVID-19. One of such measures adopted in Nigeria and Guyana is the use of face masks which is compulsory in public places. Because of this mandate and enforcement, hundreds of thousands of PPE, especially face masks are used daily. There is an increasing probability that the high volume of PPE disposed daily can be contaminated and a higher possibility of the contaminated PPE ending up in the municipal waste stream poses serious environmental and health risks [7,9,12].

From the study, as submitted by the respondents and the waste managers, there was an increase in the volume of waste generated in both countries with the notable presence of PPE in the waste at the household level. This could be attributed to mobility restrictions and other policy measures put in place in managing the pandemic. Hence, people were forced to be at home which led to an increase in the quantity of solid waste generated at the household level. The outcome of the study is in tandem with other studies such as UN-Habitat [32] and Kulkarni and Anantharama [9] which indicated an increase in the amount of solid waste generated at household scale and increase in PPE in waste. Also, the presence of PPE in the waste stream at the household scale could be attributable to adherence to global COVID-19 protective protocol. With about 80% acceptability rate of face mask, the average of number of face masks used daily in Nigeria and Guyana as noted by Nzediegwu and Chang [19] and Oyedotun et al., [22] were 171,908,091 and 339,790, respectively. The presence of PPE and changes in the composition of waste generated and increasing probability of contamination [7] have implications on the socio-economic wellbeing and exposure of waste handlers and the general public to COVID-19 in Guyana and Nigeria.

Waste management is associated with several adverse occupational safety and health effects owing largely to inadequate waste management methods adopted from collection to disposal [18]. Diseases emanating from poor household solid waste handling present risks that can be fatal to more than 5.5 million people [4,34]. In this scenario, solid waste workers are at high risk of contracting occupational diseases and injuries including exposure to COVID-19 during waste management activities [9,17,27]. To curb the exposure of waste handlers to the virus there is a need for proactive strategies such as waste segregation and sorting from the household scale which has, hitherto, not been practised as observed from the interviews with the waste managers. The admixture of waste as currently practised would not be effective in reducing the level of exposure to the virus. Therefore, PPE related waste and other perceived contaminated material should be sorted and separated from other waste, placed in plastic bags and daubed with methylated spirit or bleach before disposal for collection by waste handlers. This will greatly reduce the risk of exposure.

There is a need to adequately and safely dispose of the collected waste from households because uncollected waste is a major source of a disease outbreak. Therefore, municipalities need to continue their waste management services and make temporary changes in waste management operations using existing resources and find quick-win solutions for maintaining continuity in operations as well as efficiency. This will only be possible if the policy makers and urban managers take the lead in mitigating risks to people involved formally and informally in the cities' waste management operations and those benefiting from such services. Majority of waste handlers are poor and the sole breadwinners of their families. Exposure to COVID-19 could further compound the already precarious livelihood.

For example, increased awareness of the risks associated with PPE waste can result in an improvement on the precautionary measures adopted by the waste handlers in dealing with the inclusion of PPE with municipal waste [14]. This elevated level of awareness can only be achieved if the government, waste managers and other critical stakeholders collectively recognize the risk inherent in waste management and waste as a veritable source and point of spread of COVID-19. This awareness is important to avoid the experience of South Korean Case 31 who was adjudged to be responsible for "super spreading event" [28]. It has been documented that a single person with poorly managed novel coronavirus infection could spread the virus to about 2.2 additional people on average [10,35]. Therefore, training of personnel involved in waste management should be done with an emphasis on adherence to COVID-19 protocol and enforcement of the same to prevent super spreading effects taking into consideration the current precarious economic outlooks of most of the developing countries.

## Conclusion

Fundamentally, solid waste management is anchored on the need to protect the environment. However, the present realities brought to the fore by the novel COVID-19 have created an urgency to understand the inter-relations between municipal waste management and the spread of the pandemic. Presently, the available antiviral drugs and vaccines to respond to the pandemic could only suppress the symptom and cannot guarantee reinfection. During lockdown, interventions have been

non-pharmaceutical approaches targeted at reducing rates of social contact through diverse social distancing policies and reduction and or eradication of at source contamination. However, waste management structure in Guyana and Nigeria is fraught with improper waste disposal and handling. The household survey indicated an upsurge in the volume of personal protective equipment in the municipal waste stream. Waste managers and residents, in the face of the second wave of infection, are faced with a greater responsibility of curtailing the spread of the virus and risks of exposure to the virus. The overview of waste management structure provided by this paper can contribute to the development of a broader COVID-19 pandemic management plan that will include the relatively overlooked issue of waste generation, collection and disposal. Owing to the documented inter-relations between the exposure to pandemic and municipal waste management, there is a need for collaborative efforts starting from the household level sorting of waste that is supported by the adherence to COVID-19 protocols by the waste management system. The proposed collaboration should be strengthened by public policy to mitigate the spread of the virus.

### 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 manuscript.

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