Evaluation of urban solid-waste generation and safety consciousness of waste collectors amidst COVID-19 pandemic

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Abstract
This study investigates solid-waste handling practices by municipal waste collectors during COVID-19 pandemic period in Osogbo urban areas with the intention of assessing measures put in place for preventing possible spread of the disease. Data for the study were obtained from primary and secondary sources. Primary data were acquired through questionnaire administration on the 5% of waste collectors selected through snowball technique of chain referral. Data collected were analyzed using descriptive statistical methods. Adopted under this technique are cross-tabulation, percentages, index that was used determine waste generation (WGI), and protective material index (PMI) used by waste collectors before and during the lockdown periods. The result showed that rate of waste generation before the pandemic was WGI = 0.69 and during the pandemic was WGI = 0.75. The use of protective materials before COVID-19 was PMI = 2.9 as against (PMI = 3.58) during the lockdown period, with face mask recorded lowest occurrence of use (PMI = −2.91). Crude materials that cannot guarantee the safety of waste collectors are used for transfer of waste into disposal vehicle. The study concludes that solid-waste collectors in the study area are not adequately catered for during COVID-19 pandemic.

Keywords COVID-19 · Lockdown · Pandemic · Safety condition · Solid-waste collectors

Introduction
Solid-waste management has been defined as the control of all activities that seek to reduce the impact of solid waste on the environment and otherwise improve the health and environmental aesthetic [1, 2]. These activities according to [3, 4] include generation, storage, collection, transportation, treatment disposal, and cost recovery. All these activities must be handled in such a way that they are undisruptive to human, plants, animals, the ecology and the environment in general. Solid-waste mismanagement is a global issue in terms of environmental trash, social inclusion, and economic sustainability [5–7]. There is no doubt that management of solid waste has no time limitation. In as much as human existence continue and activities is going on, it results to waste generation, particularly solid which must be followed by proper management. Essence of solid-waste management is to maintain sanitation with the intention of protecting the environment and live of the inhabitants, particularly the generators of such waste [8, 9]. Thus, waste generated must be properly handled. Handling of solid waste generated in urban area in the period of occurrence of epidemic requires special information which needed to be analyzed for the safety of the collectors. Embattling COVID-19 pandemic period is example of such period when such information is required.

Effectively managing waste during COVID-19 pandemic period cannot be overemphasized. First, poor management of solid waste at this critical period is inimical to the waste collectors, their friends, family members, and health of the public in general. Similarly, there are negative consequences on the residents in the immediate vicinity where poor management of waste takes place. It is also believed that if waste generated in the pandemic period is effectively handled and collectors are adequately protected, it follows that it would assist immensely in reducing the risk of infection in the environment and world at large [10]. This is important as waste collectors after daily work hours mixed with the other
members of the society. This might be one of the reasons why WHO suggests that waste generation at home during pandemic while caring for a sick family member or during the recovery period should be packed in strong black bags and close completely before disposal for eventual collection by municipal waste managers [11]. Thus, immediate environment and solid waste generated in form of tissues, nose mask, and other disposable material used by an infected person when sneezing or coughing can serve as a source of transmission to solid-waste collector if not properly handled and protective measures are not put in place.

Studies have been carried out on waste management activities during pandemic period. For instance, the work of [12] presents a mini reviewed of the strategies for solid-waste management during COVID-19 pandemic period, stressed that poor management of healthcare waste could pose a dangerous effect on both health workers, waste collectors, as well as general public. The study submits that proper caring for this waste could reduce spread of COVID-19 pandemic. The strategies recommend by the study includes: compliance with regulations for handling healthcare waste, and training of waste handlers. This recommendation could not represent household waste management operation in developing countries where sorting of solid waste is not common. Similarly, when comparing solid-waste management during the pandemic and other periods established that variation exists in the quantity and quality of waste produced [13]. A study by [14, 15] also justifies the increase in the volume of solid-waste production during pandemic period. However, the studies further showed that no difference was recorded in the frequency of service rendered by organization responsible for waste management before and during COVID-19 pandemic. Information about level of awareness of possible transmission of the disease through poor waste management practices and policies involved was not investigated by the study. Another study by [16] submitted that ineffective policy on waste management aggravates infectious disease transmission.

Research conducted by [16–18] attribute increases in the quantity of solid-waste generation during pandemic period to the result of intensified of single-use product under the pretense of avoiding concentration of people in a place which is belief could increase transmission chance. Increase of single use of plastic material during the pandemic adversely created unintended environmental effects on solid-waste management in the urban areas. While [19, 20] estimate plastic waste generation resulted from single use to be more than 8 million tons during the pandemic period, 25,000 of such plastics end up in global oceans. Prevalence of more plastic waste material was corroborated by [18, 21]. Contribution of [11] is on the impact of mechanism of household waste separation attitude of student in post-COVID-19 pandemic, making collection activities and condition of waste collectors was not captured by the study. Similarly, focus is on generation activity emphasized on the quantity and components of waste generated in different activity areas of institution [9]. Though, different components were estimated and the study scope is outrightly out of collection and not in COVID-19 period. Studied COVID-19 and solid-waste management in Nigeria [22] substantiates [23] with assertion that despite the number of policies developed against COVID-19, concern was not given to its effect on solid-waste management as there was no inclusive policy toward this. That might be responsible for the opinion of [24] that the majority of household are not satisfied with solid-waste collection and management, while the study concludes that volume of solid waste increased during lockdown period caused by outbreak of corona virus pandemic. Efforts of the stakeholders on solid waste to be inclusive in Government COVID-19 task force, especially in Nigeria, were not given recognition. A study by [25] in the study of solid-waste management practice in the seven cities of Nepal reported poor occupational health and safety practices among the solid-waste workers due to the absence of safety gears and equipment despite high level of awareness of the modes of transmission of the virus. The study substantiates [26] that common problem to solid-waste management in developing nation, especially West Bank, is lack of facilities and inadequate collection system.

Similarly, on the insights into hazardous solid-waste generation during COVID-19 pandemic and sustainable management approaches for developing countries established that waste management in most developing countries still lack adequate management practices and required harmonious gap [27]. The study therefore recommends segregation of solid waste from source of generation. However, how solid waste is collected during lockdown period warranted by COVID-19 pandemic was not considered by the study, which is a task for the current study. Thus, holistic study is required on these environmental challenges that will be more concerned on the safety of the people who directly involved in the collection of solid waste, especially in developing countries where resources are limited.

More research is inevitably needed in addition to the existing ones on the impact of COVID-19 pandemic on solid-waste matters, especially the safety of waste collectors who are members of larger society and directly handling management of this environmental hazard. Caring for their safety is equivalent to limiting the spread of the pandemic, because they also have family members, mingle with them as well as the public at large. Study by [28] asserts that there is progress on concern on the safety of workers at places of work aims at preventing injury and sickness; however, more is still required in other sectors such as solid-waste management. There are both private and government own municipal waste managers in most urban areas in the world.
While most private waste collectors exist as informal sectors, government waste collectors and drivers attached to waste vehicles are usually under the control of municipality. This study intends to investigate different in the quantity and characteristics of solid-waste generation before and during COVID-19 pandemic. The study also examines safety consciousness of urban solid-waste collectors against possible spread of the pandemic within the urban area of Osogbo.

**Materials and methods**

**The study area**

Osogbo is the capital of Osun State, Southwestern Nigeria. It lies between 7° 42′ 20″ and 7° 49′ 20″ North and Longitudes 4° 34′ 20″ and 4° 38′ 20″ East (Fig. 1). There are two local government areas (LGAs) in Osogbo; Osogbo and Olorunda LGAs. While Osogbo LGA covers the South and part of the western section of the city with the headquarters at Igbona, Olorunda Local Government Area covers the North and the remaining part of the West with the headquarters at Oke Baale, Olorunda Local Government Area and part of the western section of the city with the headquarters at Igbona. Based on the most recent national headcount, Osogbo has a total population of 381,405 people [29]. Therefore, using the official 3% annual growth rate for urban centers in Nigeria, the population of Osogbo in 2020 is estimated to be 576,910. The population projection was calculated using the formula

\[ P(1 + r/n), \]

where

- \( P \) is the population of the base year;
- base year = 2006;
- population of the base year = 381,405;
- \( r \) is the annual growth rate = 3%;
- \( n \) is the number of years between the base year and the study year (14 years);
- base year = 2006;
- study year = 2020;
- number of years = 14 years.

Osogbo became a commercial town on the arrival of railway in 1907 which brought the colonial government of then to the threshold of the town. Osogbo is now a highly commercial town. The city is at the center of the Osun State and the seat of some industries. This among other reasons had made the town to witness increase in population and physical developments. Its status as commercial center and as the state capital of the state led to its expansion to some settlements in the suburb. As expected, such expansion is associated with some environmental consequences such as waste generation calling for proper management. One of the strategies puts in place to arrest the environmental problem was setting up of public and private waste collection sector that engaged in house-to-house collection of solid waste generated in the city.

**Data source, collection, procedure, and analysis**

This study made use of primary and secondary data. Primary data were obtained through administration of structured questionnaire on solid-waste collectors attached to collection vehicles. Preceded questionnaire administration was the familiarization tour of the waste collectors’ central disposal site located in the west by pass of the city. Aim was to study their way of operation for the guide on accessibility and determination of suitable statistical method that is suitable for selection of respondents in such type of service providers. Visual observation of the waste treatment process and operational system of the workers of waste management agents was identified through this visit. Secondary data needed were obtained from the agency responsible for waste management activities named Osun Waste Management Agency where the total number of authorized operators was obtained. A total of 702 registered operators are licensed to collect solid waste in the city, each with one waste collection vehicle. Each of the van has a driver and two waste collectors attached to it. This indicated that 702 drivers and 1404 waste collectors were in the activity of waste collection in the town. For the purpose of this work, 5% of each of the categories was selected for survey. That is, 35 respondents in driver category and 70 respondents among the collector. Therefore, a total of 105 questionnaire were administered. Sampling method adopted for questionnaire administration is snowball technique through chain referral among the respondents. The method is preferred because of the job of the respondents, as well the need to observe corona virus pandemic regulation of prevention which recommends distance from each other. Snowball is particularly suitable in this period when almost every sector is locked and population of interest is hard to reach and poses difficulties for the researcher. Though generates biased samples, because respondents who have great number of social connections are able to provide investigators with a higher proportion of other respondents who have characteristics similar to that initial respondent. The method is, however, allowing the researcher to make asymptotically unbiased estimates from snowball samples Data collected were analyzed using descriptive statistical methods. Used under this are cross-tabulation, percentages index that was used determine waste generation index (WGI) and protective materials index (PMI). While waste generation index (WGI) was used to compare the waste, component generated before and during the pandemic period, protective materials index (PMI) was used to relate the protective materials provided for waste collectors before and during the pandemic period.
Fig. 1 The study area. Accessed, 18th July, 2021
Results

Socio-economic attributes of the waste handlers

To understand who are the waste handlers, their socio-economic characteristics were investigated and summary of finding is presented in Table 1. It could be established that the majority of the waste collectors were youth between the ages of 20 and 30 years which represents 57%. Young adult of between 31 and 40 years accounts for 32%, while adults who are above 40 years of age were the minority. This category of age group represents only 12% of the respondents. Equally sought is the gender of the respondents. Information showed that male was the most important gender considered for waste collection services in the metropolis. This could be established with the majority (59%) were male, while female accounts for 42% of the waste handlers. Energy required for lifting of loads might have responsible for the male majority.

Related to gender is the marital status of the respondents. This study shows that married were the majority accounts for 49%, single represents 47%, and divorced represents only 4% of the total. This indicates that almost half of the waste handlers were responsible family men and women who still have one or more family members depending on them for living. Further study from summary on the table established that the majority of the respondents could read and write. This could be justified by the fact that only 4% of the respondents were not with formal education. Others were with primary education (8%), secondary education (44%), and tertiary education with 43%. This indicates that most of the waste handlers have basic educational qualification that is required of such kind of job engaged in. Further investigation showed that N10,000 which is less than one dollar per day is the monthly income of the 93.3% of the respondents. It connotes that almost all of the waste collectors interviewed are living below global poverty line of $1.90 per day, based on [30].

Information about COVID-19 pandemic

Information about awareness of the virus and its perceived transmission mode was inquired and the finding is presented in Table 2. It could be established from the summary presents on the table that only 3.8% of the waste handlers did not have information about the pandemic. All other waste collectors had adequate information about dreaded corona virus that if used could protect them against infection. Major source of awareness of 92.4% of the respondents was through radio and television, friends, and social media which accounts for 3.8% each. Similarly, 96.2% of the waste handlers understood that the virus is contagious, while 3.8% of the respondents are not aware. Indeed, 86% of the respondents are fully informed that poor sanitation arising from poor solid waste handling could be source of corona virus transmission. The remaining 14% of the waste handlers are not adequately informed about possible transmission of this disease through poor waste handling practice. Major source of awareness of the majority of the respondents is through broadcasting media (radio and television). About 92% of the respondents sourced information through this mean, while 3.8% each aware through friends and social media. It could be established that solid-waste collectors in the study area are adequately informed of the occurrence of the pandemic.

Table 1 Socio-economic characteristics of solid-waste collectors
Source: author field 2020

| Attributes     | Parameters | Frequency | Percentage (%) |
|----------------|------------|-----------|----------------|
| Age            |            |           |                |
| 20–30          |            | 60        | 57             |
| 31–40          |            | 33        | 32             |
| > 40           |            | 12        | 11             |
| Total          |            | 105       | 100            |
| Gender         |            |           |                |
| Male           |            | 61        | 58             |
| Female         |            | 44        | 42             |
| Total          |            | 105       | 100            |
| Marital status |            |           |                |
| Married        |            | 51        | 49             |
| Single         |            | 50        | 47             |
| Divorced       |            | 4         | 4              |
| Total          |            | 105       | 100            |
| Education      |            |           |                |
| Primary        |            | 8         | 8              |
| Secondary      |            | 46        | 44             |
| Tertiary       |            | 45        | 43             |
| No formal ed    |            | 4         | 4              |
| Total          |            | 105       | 100            |
| Monthly income |            |           |                |
| Income         |            |           |                |
| ≤ N10,000      |            | 98        | 93.3           |
| N11,000–N15,000|            | 7         | 6.7            |
| Total          |            | 105       | 100            |

Table 2 Waste collector-level awareness of COVID-19 pandemic
Source: Authors field 2020

| Awareness                  | Frequency | Percentage (%) |
|----------------------------|-----------|----------------|
| Awared                     | 101       | 96.2           |
| Not aware                  | 4         | 3.8%           |
| Total                      | 105       | 100            |
| Sources of information     |           |                |
| Friends                    | 4         | 3.8            |
| Radio/television            | 97        | 92.4           |
| Social media               | 4         | 3.8            |
| Total                      | 105       | 100            |
Perceived waste component generated

Basic to this study is the common solid waste products generated in the study area. To determine the different waste components generated and comparative level of their generation before and during corona virus pandemic lockdown periods, waste collectors were requested not only to identify the different waste components perceived to be mostly collected in the study area, but also to rate the perceived level of generation using Likert scale. They were expected to rate the level of generation perceived of each identified waste component using one of very high, high, just high, not high, and not at all high for each component. To arrive at waste generation index (WGI), each rating was attached with a value of 5, 4, 3, 2, and 1, respectively. This statistical method is similar to what [31, 32] used to address likely problems. While Afon [31] used the analysis to determine importance of some selected infrastructure in Asaba and resident’s level of satisfaction of “baro” boys' operations in Lagos, respectively, Adeniyi [32] adopted the technique to determine level of satisfaction of rural women to healthcare facilities. To arrive at the WGI, the summation of solid-waste value (SWV) was first computed. The SWV for each waste component is obtained through the summation of the product of the number of responses for each rating to a component and respective weight value. The mathematically expression is as follows:

$$SWV = \sum_{i=1}^{5} X_i Y_i,$$

where SWV is the total weight value; $X_i =$ number of respondents to rating $i; Y_i =$ the weight assigned a value ($i = 1, 2, 3, 4, 5$).

The WGI to each waste component is computed by dividing the SWV by the summation of the product of the number of responses for each rating to a component and respective weight value. The mathematically expression is

$$WGI = \frac{SWV}{\sum_{i=1}^{5} X_i Y_i},$$

where WGI the waste generation index, for waste component $i$ and $X_i$ as defined previously.

The closer the WGI to 5, the higher the quantity the waste component is perceived to be generated. Summarized in Table 3 is the solid waste generated (SWG) and rate of generation determined by WGI before and during COVID-19 lockdown and during lockdown periods. Also shown in the tables is the average WGI denoted by WGI for each period. This is obtained by the summation of the WGI of all waste components and dividing by the number of the identified components ($n = 8$). Thus, the mean waste generation index before lockdown denoted by WGI is 0.69; during pandemic lockdown, denoted by WGI, 0.75. From these figures, it is concluded that the quantity of waste generation in each of the two periods in the city under investigation was significantly difference. The quantity generated during the lockdown period was higher than what was generated before.

Further analysis indicates that the six waste components of the eight identified have positive deviation about the WGI before the lockdown. These waste components are: leaf (0.4), glass (0.4), rag (0.2), nylon/plastic (0.1), and food waste (0.1). Implication of this is that the rate at which these waste components were generated is higher during the period. Waste components with negative deviation about WGI are infectious (0.65) and metal (0.61). Similarly, waste component with positive deviation about WGI during the lockdown is glass (0.39), leaf (0.44), rag (0.2), nylon/polythene (0.1), food waste (0.1), and paper (0.08). However, infectious waste component and metal recorded low generation during the period. It could be

| Waste type          | Before the lockdown period |          |          |          | During the lockdown period |          |          |          |
|---------------------|----------------------------|----------|----------|----------|----------------------------|----------|----------|----------|
|                     | SWV | $x_c$ | $(x_c - \bar{x})$ | $(x_c - \bar{x})^2$ | SWV | $x_c$ | $(x_c - \bar{x})$ | $(x_c - \bar{x})^2$ |
| Nylon/plastic       | 83  | 0.79  | 0.1       | 0.01     | 128 | 1.22 | 0.47       | 0.2209     |
| Food waste          | 83  | 0.79  | 0.1       | 0.01     | 128 | 1.22 | 0.47       | 0.2209     |
| Paper               | 81  | 0.77  | 0.08      | 0.0064   | 93  | 0.89 | 0.14       | 0.0196     |
| Rag                 | 93  | 0.89  | 0.2       | 0.04     | 77  | 0.73 | −0.02      | 0.04       |
| Infectious          | 4   | 0.04  | −0.65     | 1.3      | 28  | 0.27 | −0.48      | 0.96       |
| Metal               | 8   | 0.08  | −0.61     | 1.22     | 0   | 0    | −0.75      | 1.5        |
| Glass/bottle        | 113 | 1.08  | 0.39      | 0.1521   | 87  | 0.83 | 0.08      | 0.0064     |
| Leaf                | 119 | 1.13  | 0.44      | 0.1936   | 85  | 0.81 | 0.06      | 0.0036     |
| Total               | 5.57| 2.9321| 5.97      | 2.9714   |

$X_c = WGI_c$ (waste generation index before COVID-19 lockdown), $X_e = SWV_e$ (waste generation index during COVID-19 lockdown)

$\sum p = 105$
established in this study that solid-waste components generated before lockdown caused by corona virus pandemic and during the lockdown period show significant variation. The quantity produced during the lockdown was higher by the mean waste generated index computed. It could also be inferred from the study that waste components with high volume during the two periods are either recyclable or nonrecyclable.

**Preventive measure puts in place against COVID-19**

Having considered the level of awareness of respondents about the deadly disease and components of waste perceived to be generated in the study area, the study made a further investigation on the preventive measures put in place by waste contractors for the safety of waste collectors before and during the lockdown in question. This was achieved with the investigation of preventive materials provided for the purpose. Protective Material Value (PMV) for each material used as protection against hazard was obtained. These materials include boot, engineering glove, surgical glove, nose cover, and face mask. It was obtained through the summation of the product of the number of responses for each rating to a component and respective weight value. This is expressed mathematically as

\[
PMV = \sum_{i=1}^{5} X_i Y_i,
\]

where PMV is the total weight value; \(X_i\) = number of respondents to rating \(i\); \(Y_i\) = the weight assigned a value \((i = 1, 2, 3, 4, 5)\).

The PMI to each protective material is obtained by dividing the PMV by the summation of the respondents to each of the five ratings of a component. This is expressed mathematically as

\[
PMI = \frac{PMV}{\sum_{i=1}^{5} X_i Y_i},
\]

where PMI the protective material index, for material \(i\) and \(X_i\) as defined previously.

The closer the PMI to 5, the higher the rate of usage of the material is perceived to be used. Summarized in Table 4 is the PMI before and during COVID-19 and pandemic periods. Also shown in the tables is the average PMI denoted by \(\text{PMI}_a\) for each period. This is obtained by summing up the PMI of all materials and dividing by the number of the materials \(n = 6\). Thus, the mean protective material index before pandemic denoted by \(\text{PMI}_a\) is 2.9; during pandemic, denoted by \(\text{PMI}_e\) 3.58. From these figures, it is concluded that the level of use of the protective material is high during the lockdown period which was significantly different.

The study further showed that four protective materials have positive deviation about \(\bar{y}_a\) before the lockdown, while five are in this category during the lockdown period. Boot, engineering glove, surgical glove, and nose mask are the materials with positive deviation before the pandemic periods. These four protective materials and addition of over-all have positive deviation about \(\bar{y}_e\) during the period of pandemic. On the other hand, over-all \((-2.72)\) and face mask \((-2.91)\) have negative deviation about \(\bar{y}_a\) before the advent of the pandemic. Only face mask recorded negative deviation about \(\bar{y}_a\) during the period of the lockdown. It indicates that two important protective materials which were considered very important as protective guards against the pandemic were the most not available or neglected by solid-waste collectors before the lockdown which could be attributed to lack of sensitivity. However, face mask which was the only protective material not either supplied or neglected by the workers during the lockdown period was the basic that was made compulsory for general public that could reduce the spread of the dreaded disease.

Further investigation showed that waste contractors provide protective materials only once throughout the staying

| Table 4 Preventive materials used before and during the pandemic |
|-----------|
| **Protective materials** | **Before pandemic** | **During pandemic** |
| | PMV | \(y_a\) | \((y_a-\bar{y}_a)^2\) | **PMV** | \(y_e\) | \((y_e-\bar{y}_e)^2\) |
| Boot | 470 | 4.48 | 1.57 | 2.4649 | 466 | 4.44 | 0.85 | 1.3885 |
| Engineering glove | 470 | 4.48 | 1.57 | 2.4649 | 431 | 4.10 | 0.51 | 0.2601 |
| Surgical glove | 455 | 4.33 | 1.42 | 2.0164 | 431 | 4.10 | 0.51 | 0.2601 |
| Nose mask | 415 | 3.95 | 1.04 | 1.0816 | 431 | 4.10 | 0.51 | 0.2601 |
| Over all | 20 | 0.19 | -2.72 | 5.44 | 397 | 3.78 | 0.19 | 0.0361 |
| Face mask | 0 | 0 | -2.91 | 5.82 | 106 | 1.01 | -2.58 | 0.3364 |
| Total | 17.43 | 21.53 |

\(y_a = \text{PMI}_a\) (protective material index before COVID-19 lockdown), \(y_e = \text{PMI}_e\) (protective material index during COVID-19 lockdown)

\(\sum p = 105\)
of a worker at the job. Replacement of worn-out materials is the responsibility of each worker. It is also established that no insurance protection was provided for waste collectors for their exposure to environmental hazards. Awareness about insurance against hazards due to nature of their job is even alien to almost all of the workers, Contractors are mostly concerned with provision of vehicles and waste collection tools targeted mainly smooth running of the business.

**Device used to transfer waste into waste disposal vehicle**

Also important for the safety of waste collectors is material used to transfer waste into disposal vehicles. Essence of this is to assess how enabling is the condition provided to the collectors by their employers. As presented in Table 5, the study shows that perforated traditional basket is the most important waste transfer device use by the respondents to upload waste into vehicle. It accounts for 58.1% of the devices used to transfer waste. This device is made of local palm fronts. It has no part where it can be handled. Attempt to empty its contents is difficult and over sometime rots away. Perforated nature of the device makes it not suitable and constitutes threat to the health of collectors especially when the waste contains contaminated products and the water content is high. Another material use by waste collectors to transfer waste into waste van is plastics which accounts for 27.6% of the materials used. This material is fragile and it is easily breakup when contents in it is too heavy. Thus, subjected the collectors into danger of minor accidents. Head pan is the other device used by the waste collectors to transfer waste into waste disposal vehicles. This device is made of iron material more durable than basket and plastic, though not suitable for the task involved in waste loading. It accounts for 14.3% of the device used in for transfer of waste into disposal vehicles. It could be established that these devices are crude and not designed in a way to protect the health of solid-waste collector, since it was not made for such function. It could delay the work involved and could also cause fatigue on the part of the waste collectors. These crude devices used are below the standard used in developed nations which requires more energy compared to the devices used in developed countries [24]. This might be one of the responsible factors for third world inability to meet up with global standard on the issue of solid-waste management. In developed nation, more sophisticated equipments are used for waste transfer at transfer station purposely designated for such without much energy demand from collectors [30].

**Discussion**

The motive of any solid-waste management is to prevent health hazards that may befall the generators as well as the public in general. There is no doubt that without human efforts to put into action the management strategies of different categories of solid waste generated, its adverse implications would be dangerous. Responsibility of collection of solid waste for proper management in most urban areas has been taken up by commercial waste collectors under the supervision of government agency. As important as the health of the generators of solid waste awaiting collection, so also the safety of the health of these categories of people who collect our waste especially during epidemic or pandemic in the society. One of such pandemics events that is particularly attached to hygiene and sanity is corona virus which forced almost if not all of the countries of the world to impose stay at home order tagged lockdown. Though many activities were locked down, generation of solid and its management is one of very few activities that was not possible to be locked down. This paper investigates the protection measures put in place for the safety of urban solid-waste collection workers who are the receivers and managers of waste generated during a period when touching, hugging, hand shaking of each other’s hand, as well as using hand to cover sneezing and coughing were not encouraged.

The study established that majority of the people engaged in the waste collection activities are male youth and young adult who are still in their active ages. On like [31] which founds that urban waste collectors in Lagos, Nigeria comprised mostly single able men by marital status couple with low educational background, the current study established that most of the people are married with majority having minimum of secondary school certificate. Average monthly income of the majority is below global poverty line of $1.90 set by the World Bank. It could be affirmed that despite the relevance of solid-waste management as a social inclusion and mean of economy sustainability according to [5–7], the importance of the service rendered by waste collectors in the area is not supported with suitable socio-economic attributes.

It could be established that despite the low socio-economic characteristic of the waste collectors, they are adequately aware that the virus is associated with insanitary.

**Table 5** Devices used to transfer waste into the waste disposal vehicle

Source: author field research, 2020

| Devices                   | Frequency | Percentage (%) |
|---------------------------|-----------|----------------|
| Head pan                  | 15        | 14.3           |
| Perforated traditional basket | 61        | 58.1           |
| Plastics                  | 29        | 27.6           |
| Total                     | 105       | 100            |
Major sources of awareness are mass media (radio and television). This study corroborates [25] that enough awareness campaign was given to dreaded COVID-19 pandemic, which indicates that awareness got to the general public of which urban solid-waste collectors are inclusive. Similarly, the study showed that there is increase in the quantity of solid waste generated during the lockdown caused by corona virus as against to before advents of the disease. Result of waste generation index computed indicates this. Finding substantiates the studies of others such as [13–15, 24] which discovered more quantity of solid waste generated during the pandemic period than before the advent of the disease. It was further showed that components of solid waste generated during the two periods were similar. However, there is increased in quantity of plastic component of waste which might be the result of single-use practice that was encourage for caution against possible spread of the disease. The finding affirms results obtained by [19, 20] in similar studies.

In the same vein, it was also established that adequate protective materials were not provided for the worker operate in waste collection. These materials only supplies once when a worker joined the operation and replacement of worn-out ones is the responsibility of the workers instead of employer. The study is in uphold submission of [25] that adequate safety guard was not provided for waste collectors during the outbreak of COVID-19 pandemic. This assertion could be justified with the crude materials used for transfer of collected solid waste into vehicles corroborates [26] in a comparative study of waste management between developed and developing countries.

**Conclusion**

The study showed that standard of living of solid-waste collectors was poor when view from socio-economic perspective. Though, majority of the respondents are male with minimum educational qualification, they earned less than $1.90 per day which is the global poverty line despite the hazards involves in their job. Protective materials are not adequately provided for the workers against their exposure to dirtiness despite the dreaded Coronal virus pandemic and the fact that waste collectors have adequate information about the disease. It is also discovered that material used as provided by waste contractors for transfer of collected solid waste into disposal vehicles are crude and could not stand the global standard.

In view of the above, the study recommends that government should put relevant policies in place to regulate the minimum income of a worker of such kind of job requiring energy and expose to environmental hazards should be paid. This could be preventive in nature reducing cost than amount expended on medical treatment of environment-related diseases. There is also the need to establish standard requirements for the issuance of license to waste contractors. This requirement so stipulated should be under the control of regulatory body, accompany with authority to regulate performance of these firms at a regular duration. Minimum equipment and welfare of workers must be incorporated into the duties of this body. It is also essential to be included in such policies, and insurance of the concern workers. The study also recommends that constitution of committee on such epidemic or pandemic in the future should incorporate experts of waste management and other services that render unforeseen daily services which could not be locked down even in the occurrence of emergency. Observation of such stand would be of assistance in taking care of such activities during decision-making on issues of environmental concern.

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