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Health Conditions of Landfills Workers, Lagos State, Nigeria

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Abstract

This study investigated health conditions of landfills workers in Lagos State, Nigeria. The adverse effects of different management practices particularly from landfills are enormous with such concerns on health conditions of workers prompted the interest of this paper. The objective was to identify the causative agents associated with diseases occurring amongst landfill workers and to evaluate its potential health issues including psychological effects, diseases, and accidents of solid waste on humans while also identifying types of sicknesses amongst workers at Landfill Sites in Lagos State. The research design adopted was a survey descriptive method. Convenience sampling technique was employed to select 336 respondents using questionnaire which was structured on a 2-6-point Likert Scale. The Cronbach's alpha reliability coefficients for the constructs ranged between 0.727 and 0.930. The response rate was 75.5% and data were analyzed using descriptive and inferential statistics. Data gathered were analyzed with the aid of Statistical Package for the Social Sciences (SPSS) via Pearson Product Moment Correlation (PPMC). The result obtained indicate a significant and positive relationship between causative agents associated with diseases and landfill workers in Lagos State. Results also showed a positive correlation between potential health effects and landfill workers in Lagos State. It further showed that the levels of heavy metals in the soil were within acceptable limit relative to World Health Organization's standard. It is also noted that people living and doing business in the landfill were at risk from diseases. Microbial organisms such as *E. coli*, *Salmonella* Sp, *Klebsiella* Sp, *Staphylococcus aureus* and *Pseudomonas* Sp were also isolated. Provision of solid waste workers with Personal Protective Equipment (PPE), restriction of access to landfill sites, and review of existing laws to ensure compliance are strongly recommended.

Keywords: Health Conditions, Landfill Workers, Causative Agents, Solid Waste, Sickness/Disease

Introduction

The issue of health conditions of landfill workers is one that has been discussed by many authors and scholars with various perspectives on the subject, most coming at it from different sides than the others (Grant, 2013; Niekerk & Wegmann, 2019, Ojelowo & Wahab 2017). Health conditions of landfill workers are therefore a cause for concern globally. This concern is linked with man's struggling to meet his basic needs as the essence of existence

and development of human society (Singh, Chokhandre, Salve, & Rajak, 2020). To satisfy these needs, man exploits the natural environment in many ways, such as (i) agriculture, (ii) industrialization, (iii) energy generation, etc., and these have severe impact on the environment resulting in environmental degradation and attendant health effect on man.

Human population has increased significantly; this has led to tremendous generation of solid waste (International Labour Organization [ILO], 2019; Isemekhai, 2016). In developed countries, the amount of waste generated is very high compared to developing countries while the developed countries have better and efficient management systems, which may be resulted from awareness, enlightenment, more money, good legislature and technology to manage their wastes. However, developing countries does not have such capacity (Rotich, Zhao & Dong, 2005). The generation of waste, its collection, processing, transportation and disposal is of great importance for public health and environmental reasons. Waste is anything discarded by an individual, household or organization. Waste has no economic or physical value to the generator. As a result, waste is a complex mixture of different substances for example: plastic, metals, papers, food items, etc., (Oyeniyi, 2011). Landfill is a method of solid waste disposal and generally known for its common features for being exposed directly to the atmosphere or covered improperly with solid layer and without proper bottom line support (United Nations, 2014).

In Lagos State, the dumpsites are commonly used as disposal option to manage solid waste for long time. At the initial time of locating dumpsite in the Lagos metropolis, they were located far from residential areas, but due to accelerated population, urbanization and industrialization, people now live and work in landfill's vicinity. The open dumpsites are sources of environmental pollution and public health concern. The Lagos State since 1961 set up the Lagos State Waste Disposal Board, which it changed to the Lagos State Waste Management Authority (LAWMA) in 1992. It is observed that the waste disposal board suffered inefficiency, mal-administration, lack of funds and ineffective implementation of government policies.

Creating a better environment should not be left in the hands of the government alone. Communities should be involved in the process of formulation and implementation of proposals and policies of the physical development of their areas. This process involves the mobilization of both men and material resources to improve the quality of their environment. This process is described by Oyesiku (1998) as an active process, in which the person in question takes part in the contribution and implementation of decisions for the fact that the government alone cannot provide the needs of the people.

LAWMA is responsible to collect and manage solid waste from individual residents. The authority has designated staff to handle the waste management activities. Waste management therefore is the organized and systematic channeling of waste through pathways to ensure that they are disposed of with attention to acceptable public health and environmental safeguards (Niekerk & Wegmann, 2019; Oyeniyi, 2011). However, proper management cannot be achieved without a well-designed waste management plan.

Landfill is also prone to the activities of scavengers. Interestingly, an open landfill attracts flies, vermin and other insects that serve as disease vectors that considerably affect people's health. Individuals who stay close to the landfill vicinity especially waste workers, scavengers who often come in contact with dumped waste are prone to develop health disorders (Ojelowo & Wahab, 2017).

For individuals to live in an environment that is void of pollutant, that will cause health problems such as diarrhea, dysentery, pneumonia, eye irritation, malaria, cholera etc. we have to efficiently manage the waste generated in our environment. There is need for the environment to be healthy if we need a healthy population. Environmental health may be defined as the provision and control of all those factors in people's physical water supply, efficient and effective sanitary waste disposal, access to good housing; food hygiene, vector control and personal hygiene are necessary for a healthy environment. The immediate environment where people live and work, greatly affects their health (Environmental and Social Safeguards Audit, 2015). This study therefore examined health conditions of landfills workers, Lagos State, Nigeria.

Statement of the Problem

The amount of waste generated is in an increasing trend with time due to urbanization, industrialization and increase population. Population residing and particularly those working within the landfills are exposed to environmental health risks (Singh, *et al.*, 2020). This is due to emission of toxic gases and air pollutants (landfill gas containing methane, carbon dioxide, hydrogen sulphide and other contaminants including volatile organic compounds bioaerosols and particulate matter) or to contaminated soil and water (Singh, *et al.*, 2020). Across the cities, it is the urban poor that suffer most from the life-threatening conditions stemming from deficient solid waste management (Schenck, Blaauw, Viljoen, & Swart, 2019).

Wastes are disposed of to prevent or control hazardous consequences on the human environment. However, landfill workers are constantly in contact with waste from various collection points. These workers are therefore constantly at risk of contracting disease agents or pathogens. There is need to determine and know the health and environmental problems associated with solid waste management.

Nonetheless, quite a lot of studies have been carried out on the concept of “waste or its management”, for instance, Niekerk and Wegmann (2019), Ojolowo and Wahab (2017), Cole (2015), Oyeniyi (2011) and World Health Organization (2011) and etc. However, not much has been written on the issues relating to “and health conditions” (Singh, *et al.*, 20-2020; Ezirim & Agbo, 2018, Martine, 2010). In the same vein, extant literatures on landfill workers include Fielder, Poon, Palmer and Coleman, (2000), Longe and Balogun (2010) and Eludoyin and Oyeku (2010) etc. Notwithstanding, the findings of these scholars, and the problem associated with the subject matter areas has not been concretely addressed. This has created a gap-in-knowledge which this study intends to fill.

Objectives of the Study

The primary aim of this paper is to investigate health conditions of landfill workers in Lagos State, Nigeria. Other specific objectives include:

- (i) To investigate the causative agents associated with diseases occurring among landfill workers in Lagos State;
- (ii) Identify the types of sicknesses among landfill workers using soil and leachate samples.
- (iii) To evaluate the potential health issues on landfill workers in Lagos State.

Research Hypotheses

This paper tested the following null hypotheses.

- H₀₁:** There is no significant relationship between causative agents associated with diseases and landfill workers in Lagos State.
- H₀₂:** Soil and leachates samples do not determine types of sicknesses affecting workers at landfill site located at Isheri-LASU Road in Ikotun-Igando, Lagos State.
- H₀₃:** There is no significant relationship between potential health effects on landfill workers in Lagos State.

Literature Review

An extensive literature review is herein conducted to determine the status of academic thought on the subject-matter areas that are considered to be critical to this study. The review processes and corresponding findings are then reported and presented with regards to causative agents associated with diseases occurring among landfill workers; the potential health effects on landfill workers and types of sicknesses among landfill workers using soil samples.

The causative agents associated with diseases among landfill workers usually refers to the biological pathogen that also causes a disease including parasite, virus, fungus as well as bacterium (Wikipedia, 2020). This could also be described as a toxin or otherwise known as toxic chemical which causes illness. According to International Labour Organization (2019), the negative impacts of toxins found in waste are not just limited to workers, but can also

have detrimental impacts on human health in general (ILO, 2019). Humans are exposed via ingestion, inhalation or dermal contact. Workers working in the waste management sector are a particularly vulnerable group, as they are prone to absorbing toxic substances rapidly adults. The concentration of copper, lead, zinc and tin is almost higher in places like major markets in Lagos (including Oshodi market, Balogun market, Alaba International market amongst others) when compared to typical background levels. Since their bodies are still developing, some people are much more vulnerable to health risks and irreversible damage from exposure to hazardous materials. Some individuals' hand-to-mouth behaviour puts them at high risk in areas with soil and dust contaminated with lead. Exposure to lead could cause intellectual impairment (Osibanjo, 2015).

Waste generally poses a threat not just to workers involved in the waste value chain, but also to individuals living in cities very close to the landfill areas including Igando-Solous sites. A comparative study on the environmental and health impacts of waste in China and Nigeria observed significant DNA damage to populations that were exposed to the processing of waste (Alabi, 2012; Environmental Justice Atlas, 2017).

Specific health outcomes that have been examined in epidemiological studies of the health effects of landfill sites include as submitted by (a) congenital malformations, (b) birth weight, prematurity and child growth, (c) cancers, (d) symptoms of illness (Staines, Crowley, Bruen, & O'Connor, 2019). Most of the studies on human health close to landfill sites have used a very non-specific model of exposure. Usually proximity to the site has been used as a proxy for exposure, presumably working on a model of simple radial diffusion of unspecified contaminants from the site.

As the likely routes of exposure are more structured than this, such studies have fundamental weaknesses. There must be an exposure pathway from a source in order for an agent released into the environment to ultimately effect human health (Ezirim & Agbo, 2018). The potential exposure pathways are water, air, soil and locally produced food and so exposures to the local population could be ingestion, inhalation or through the skin (trans-dermal) (Zheng & Wang, 1999). Some exposure of the wider population might occur through eating food produced near the landfill site. A description of exposure for a particular route should include the concentration, and the duration of contact. For example, landfill leachate might enter local groundwater and surface water but people are only exposed if the waters are used for drinking, producing or preparing food or for recreational purposes.

Landfill operations, especially those of poorly run sites, can lead to the emission of unpleasant odours. The health effects of this do not seem to be well established. In the literature, odour for instance is commonly referred to as a 'nuisance', with the implication that it is not a serious issue, and hence, not a priority for betterment (Ogungbuyi, 2016). Noise from traffic from site operations is another potential health issue. A great deal of published work on airport noise exists, but like odour, this issue has not been well explored in the waste management and health literature. Emissions from landfills do not always lead to human exposure. Exposure can only arise if individuals come into contact with the harmful agents in emissions. Contact can be by breathing, skin contact or eating or drinking food or water contaminated with the substance. If there is no contact there can be no toxicity.

Landfill sites contain many different potentially toxic substances. Potential and actual hazardous emissions from these sites have caused concern to both local populations and regulatory bodies. This has resulted in numerous studies examining different potential adverse effects. These studies indicate that residence near certain specific sites is associated with risks to health.

Although a great number of studies have been carried out, evidence of a causal relationship between specific health outcomes and landfill exposures is still inconclusive. Methodological difficulties make determination of cause and effect very difficult. Difficulties in assessing and categorising exposure, and difficulties in controlling for other confounding factors, limit the ability of such studies to detect these adverse effects.

Many studies of symptoms conducted in communities living near landfill sites rely on self-reported symptoms. The knowledge of and concern about possible exposure to hazards present in the landfill may introduce some bias into the results of these studies. When compared to populations living further away from such sites, individuals in proximity to landfills may be more likely to recall minor complaints and symptoms, which they may attribute to landfill exposures.

Currently, there is unsatisfactory evidence to demonstrate a clear link between potential health effect, for example in the form of cancer and exposure to landfill. Excesses of bladder, lung, leukemia and stomach cancer have been reported in some studies and not in others (Schenck, Blaauw, Viljoen & Swart, 2019). The association between adverse birth outcomes such as low birth weight and birth defects is more compelling, but as yet cannot be described as causal. Further studies are required. In particular, examination of specific types of defects, which may be related to exposure to specific environmental agents may serve to clarify these questions (Staines, *et al.*, 2019). Reports of increased risk of respiratory, skin and gastrointestinal illnesses are based mainly on self-reported symptoms. Although this evidence must not be dismissed, consideration should be given to the strong possibility of bias and the influence of fears and worry related to the waste sites.

Much of the existing work relates to older landfills, which would have been managed poorly by modern standards, or specifically to hazardous waste landfills. It seems likely that the health effects of workers at landfills, run in strict accordance with standard operating procedures (Kumar, Bathma, Dixit & Parashau, 2020).

Materials and Methods

The paper employed the use of descriptive survey design to investigate health conditions of landfill workers, Lagos State, Nigeria. The study was conducted using Solus 2 and 3 in Lagos State. The landfill was opened by Lagos State Government to receive wastes from Alimosho and its environs. The site is located at Isheri-Lasu Road in Ikotun-Igando Local Government Development Area with a size of about 10.2 hectares. It lies approximately between longitude 3°13'30" E to 3°17'15" E and Latitude 6°28'N to 6°42'N.

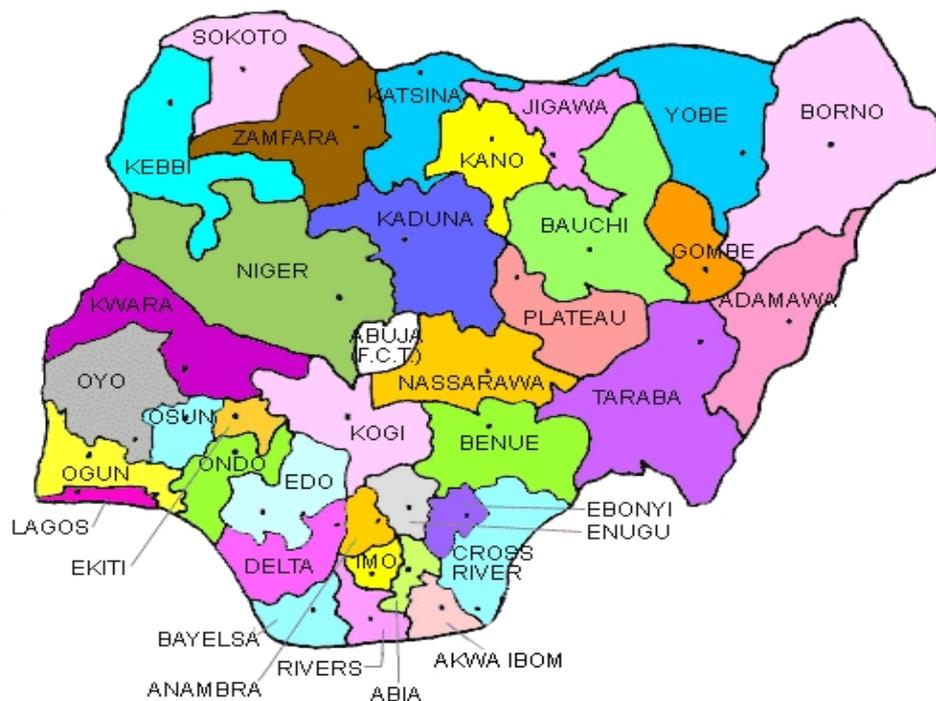


Figure 1: Map of Nigeria showing Lagos State and other States.



Figure 2: Map of Lagos State

The population of the study comprised of all landfill workers at Igando, Lagos State. These categories were targeted because they are in the best position to provide the required information on causative agents associated with diseases, prevention and controlling of diseases and accidents relating to landfill workers amongst others. Convenience sampling technique was used to select 336 out of 445 participants for the study based on availability, accessibility, convenience and willingness.

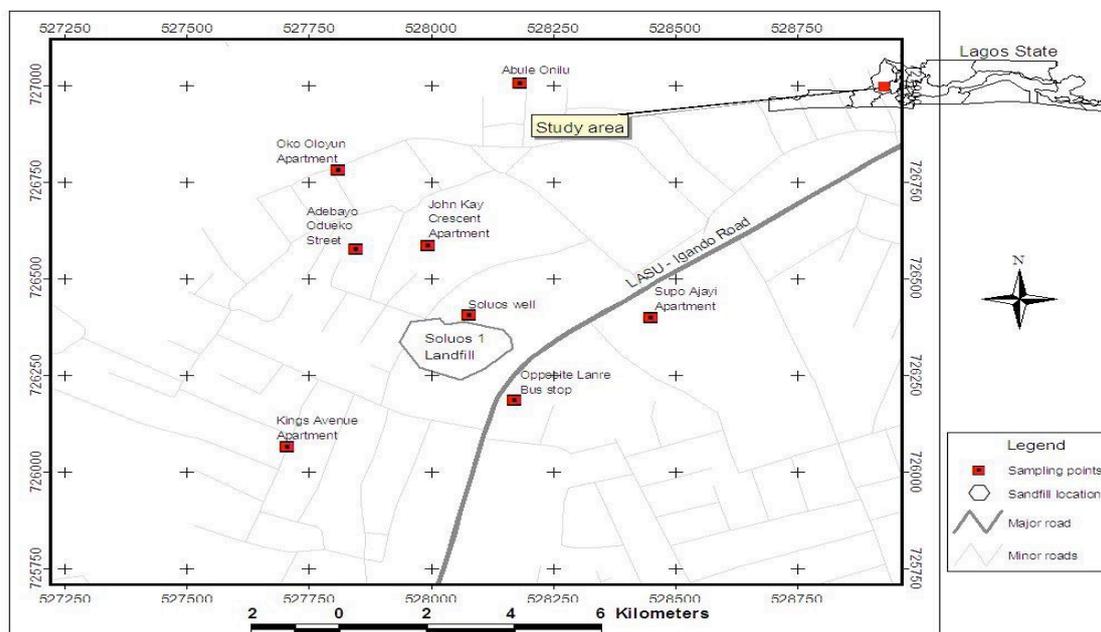


Figure 3: Map showing study area

The study was carried out by using both questionnaires and laboratory analysis of leachates and soil samples collected from the study landfill. The questionnaire was to obtain demographic and health information regarding landfill workers at the study site. The research instrument with the name “Health Condition and Landfill Workers Questionnaire” (HECOLAWQ) has three sections. Section A (personal information) has five items (including sex, position at work, age category, marital status, and level of education) and was used to collect general information about the participants’ demographic data. Section “B” has fourteen items, intended to elicit information on issues relating to health condition of landfill workers, while Section “C” requested the provision of any other related information that the respondents perceive to be relevant and useful on the subject. The items were structured on a 2-6-point Likert rating scale with response options. The instrument was subjected to face and content validity by

experts in Environmental Biology, Environment and Science Education, and Waste Management. They were to examine the instrument items for clarity and suitability for use in collecting data for the study. Observations and suggestions of these experts improved the instrument. The reliability test of the instrument was administered on 30 participants. Cronbach Alpha at 0.05 level of significance was computed for testing the internal reliability from the responses using Statistical Package for the Social Sciences (SPSS) and the reliability coefficient was 0.886 indicating that the instrument was reliable for the study. The result from the two tests showed some similarities thus attesting reliability of the instrument for this study. The instrument was administered during the visits to study areas, and 336 copies were retrieved from the initial 445 over a period of three weeks. This represented 75.5% return rate and were all found useful.

Also, soil samples were collected at two different locations in Solous 2 and 3 respectively. The soil samples were collected at 15cm deep with soil auger. The samples were labeled as follows: (a) Solous 2: S1 and S2; (b) Solous 3: S3 and S4.

Each sample was collected at 50m interval. The soil samples were sieved through 2mm sieve to remove stones and other coarse particles. 2g of the sieved soil was transferred to a conical flask of 100ml capacity and 20ml of conc. Hcl together with 20ml of conc. HNO₃ was added. The solution was heated at 120°C for 30 minutes. The solution was cooled to room temperature and diluted with deionized water to fill the flask. After settling overnight, samples were filtered through the Ashless filter paper into a 50ml volumetric flask. The digested sample was then analyzed for heavy metal by a flame type Atomic Absorption Spectrometer (AAS) model series (711047). This analysis was carried out with Lagos State Environment Protection Agency (LASEPA).

Leachate Samples: Leachate samples from 3 different locations in Solous 2 and 3 different locations in Solous 3, at a distance of 50 Metres apart were collected in a sterile bottle and taken to the laboratory. The samples were collected under sterile condition so as to minimize the possibility of introducing secondary bacteria contamination. The samples were labeled as follows:

Solous 2: First Extreme (E1), Second Extreme (E2). First Centre (C1).
Solous 3: Third Extreme (E3), Fourth Extreme (E4). Second Centre (C2).

The Leachate samples were flooded on MacConkey agar plate; duplicate of each plate was made. The plates were incubated at 37°C for 24 hours to 48 hours depending on the bacteria growth. Bacteria colonies were noted on different media and subcultures several times and a pure culture was obtained. Morphological and biological test for bacteria isolate were carried out to obtain the desired results.

Results

After careful and systematic analysis of the respondents' responses to the baseline research objectives, the following analyses are further carried out for the specific testing of the formulated research hypotheses and laboratory analysis. Pearson Correlation was used to test the first two hypotheses, while laboratory analysis was used to test the third hypothesis.

Hypothesis One:

H₀₁: There is no significant relationship between causative agents associated with diseases and landfill workers in Lagos State.

Table 1: Correlation analysis showing significant relationship between causative agents associated with diseases and landfill workers in Lagos State.

		Causative agents associated with diseases	Landfill workers in Lagos State
Causative agents associated with diseases	Pearson Correlation	1	.820**
	Sig. (2-tailed)		.000
	N	336	336
Landfill workers in Lagos State	Pearson Correlation	.820**	1
	Sig. (2-tailed)	.000	
	N	336	336

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Computer SPSS version 23.0 Output, Field Survey, 2020.

From the Table 1 above, the Pearson correlation coefficient between the independent variable and dependent variable is 0.820, indicating a significant positive relationship between causative agents associated with diseases and landfill workers in Lagos State. Therefore, we reject the null hypothesis and accept the alternate hypothesis.

Hypothesis Two:

H0₂: Soil and leachate samples do not determine types of sicknesses affecting workers at landfill site located at Isheri-LASU Road in Ikotun-Igando, Lagos State.

The study shows that 5 microbial organisms were isolated from different Leachate samples collected in different locations within the study site. These microbial organisms are:

E Coli, Salmonella Sp, Klebsiella Sp, Staphylococcus Gurena and Pseudomona Sp. Among the organisms isolated, E coli had the highest occurrence (35.3%) while staphylococcus aureus and salmonella sp had the lowest occurrence of 11.8% each. The detail of this occurrence is presented in table 2i.

Table 2i: The Occurrence of Bacteria isolated from the Leachate

Bacteria Isolate	E1	E2	E3	E4	C1	C2	No. of Isolate	Percentage Occurrence
E. coli	+	+	+	+	+	+	6	35.3%
Salmonella sp	-	+	-	+	-	-	2	11.8%
Klebsiella sp	-	-	+	+	+	-	3	17.6%
Staphylococcus aureus	+	+	-	-	-	-	2	11.8%
Pseudomonas sp	+	+	+	-	-	+	4	23.5%

E₁ E₂ and C₁ leachate samples from Solous 2

E₃ E₄ and C₁ leachate samples from Solous 3

Table 2ii: Soil Analysis for Heavy/Trace Metals Associated with study site

Trace/Heavy Metals	S1	S2	S3	S4	WHO Standard
Zinc	0.0654	0.2619	0.0313	0.4174	<1
Iron	3.8185	4.0265	4.1286	4.4391	5mg/kg
Lead	0.0464	0.8017	0.0364	0.3339	5.0mg/kg
Chromium	0.0332	0.0494	0.0418	0.0590	5.0mg/kg
Potassium	0.3609		0.0674	0.8514	725mg

S1, S2 soil samples collected from Solous 2

S3, S4 soil samples collected from Solous 3

Hypothesis Three:

H₀₃: *There is no significant relationship between potential health issues and landfill workers in Lagos State.*

Table 3: Correlation analysis showing significant relationship between potential health issues and landfill workers in Lagos State.

		Potential health issues (psychological effects, diseases, accidents in terms of solid waste)	landfill workers in Lagos State
Potential health effects (psychological effects, diseases, accidents in terms of solid waste)	Pearson Correlation Sig. (2-tailed)	1	.819** .000
	N	336	336
Landfill workers in Lagos State	Pearson Correlation Sig. (2-tailed)	.819** .000	1
	N	336	336

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Computer SPSS Version 23.0 Output, Field Survey, 2020.

From the Table 3 above, the Pearson correlation coefficient between health problems and productivity loss is 0.819, indicating a positive and strong correlation between potential health effects (psychological effects, diseases, accidents in terms of solid waste) and landfill workers in Lagos State. Therefore, we reject the null hypothesis and accept the alternate hypothesis.

Discussion of Findings

Overall, the following findings were made through this study:

There was a significant positive relationship between causative agents associated with diseases and landfill workers in Lagos State. This finding is supported with the submission of Ojolowo and Wahab (2017). The author is prone to the activities of scavengers. Interestingly, an open landfill attracts flies, vermin and other insects that serve as disease vectors that considerably affect people's health. Individuals who stay close to the landfill vicinity especially waste workers, scavengers who often come in contact with dumped waste are prone to develop health disorders.

Microbial infection is very common among people working in and around landfill sites. The high symptoms of disease expressed from the results shows that waste workers are highly prone to microbial infection. Symptoms such as diarrhea, headache, dizziness, fever, coughing and eye irritation are suggestive of pathogens. These symptoms correlate with the microbial organisms isolated, as recorded. For example: *E. coli*, *pseudomonas*, *salmonella*, spp, etc. This finding is in line with Ebere (2000). In comparing the incidences of disease symptoms among waste workers and the incidence of disease symptoms among waste workers family. It is also suggestive that there could be link of disease transmission from the waste workers to their family members. It is also of great importance that waste workers are prone to various degrees of injuries. From this finding, it shows that waste workers are more prone to cuts due to injuries from glass, sharp objects such as metals, syringe, blade, scalpels; these could also create health hazard to waste workers, this find is in line with Ajadike (2001). The work of waste collectors involved considerable heave lifting as well as other normal handling of containers, increasing the risk of muscular skeletal problems such as sprain, dislocation and fracture, this is in tandem with Gustavsson (1989).

The soil analysis was carried out in order to determine the extent of contamination from the landfill, and verily, the associated hazardous substance such as heavy metals that could cause health and environmental problems to the waste workers. The quantity of trace/hazardous elements in Solous 2 and 3 are very close. When compared to standard, it is clear that the amount of trace elements in both landfills is within acceptable limit. The low level of hazardousness of the soil sample could also imply that the solid waste deposited on this landfill were not hazardous waste, this could be further subjected to future academic research. The low amount of hazardousness could also be traceable to leaching. The adverse potential impact of these heavy metal on the waste workers may be noticeable in the nearest future due to environmental persistence, bioaccumulation as reported by the U.S. Department for health and human services (1995).

It is also of importance that perception to wearing of protective gadgets is very low, 20.8% of the waste workers questioned uses one out of four protective equipment's. This could be attributed to low education or inability of employers to provide this equipment for them. The low usage of protective equipment by the waste workers agrees with Ajadike's assertion that the risk to solid waste workers in low income countries like Nigeria are expected to be much higher because workers protection is not required (Ajadike, 2001). Those that spend more time on the landfill are more prone to infection such as waste workers and scavengers.

There is was positive and strong correlation between potential health issues and landfill workers in Lagos State. No wonder existing literature is linked with man's struggling to meet his basic needs as the essence of existence and development of human society (Singh, Chokhandre, Salve, & Rajak, 2020). To satisfy these needs, man exploits the natural environment in many ways, such as (i) agriculture, (ii) industrialization, (iii) energy generation, etc., and these have severe impact on the environment resulting in environmental degradation and attendant health effect on man.

Conclusion

The purpose of this study was to investigate and present results relating to health conditions of landfill workers in Lagos State, Nigeria. In line with the statistical results obtained, it was concluded that a significant and positive relationship exist between causative agents associated with diseases and landfill workers in Lagos State. Results also showed a positive correlation between potential health issues and landfill workers in Lagos State, while leachate samples did determine types of bacteria affecting workers at landfill site in Lagos State. However, the levels of heavy metals in the soil were within acceptable limit relative to World Health Organization's standard.

There is need for the environment to be healthy and conducive if we need a healthy population. Human activities have had severe negative impact on the environment. Waste management involves the collection, transportation, storage, treatment of waste and the efficient management options of the final disposal sites; this has to take into consideration, activities that will minimize the health, environmental and aesthetic impact of solid waste. People working and doing businesses in the landfill sites are at great risk of contracting microbial organisms. Other negative health outcome such as cancers, infertility, etc. that results from trace elements would not be expected to occur until several years after exposure. It is therefore, clear that improved solid waste collection and disposal options would decrease the population exposed to risk.

Recommendations

Based on the finding of the study, the following recommendations were made:

- i. Educating and training on occupational and environmental health issues associated with solid waste management is key to safety of waste workers. Such training provision should include operational procedures for safe waste handling, accident response procedures, first aid and emergency evacuation procedures, hazardous material release response, fire control, self-hygienic tips, and emergency call numbers.
- ii. There is need of strict monitoring and control of hazardous waste coming to the landfill. Regular monitoring of the level of hazardous substances such as heavy metals should be done annually. This is important, in the sense that it will reduce and maintain the level of hazardous substances that would generate into environmental and health problems.

- iii. Vaccination of solid waste workers for hepatitis A and B, tetanus, diphtheria, polio, typhoid and rabies. A good medical surveillance, standard including baseline and follow-up medical examination. Routine survey of workers about job task performed and their physiological responses to their job task. Provision of clean drinking water and sanitation facilities. (a) Provision of solid waste workers with protective equipment: Protective equipment such as protective clothing, shoes/boots, gloves, eye glasses and helmets. This protective equipment will reduce the incidence of injuries and accidents also created with solid waste management; (b) Provision of data base of solid waste workers: This takes into consideration of record-keeping on incidents of diseases, injuries and death. It also includes the record keeping of personal data of waste workers; (c) Restriction of access to landfill sites: Such that only safety-trained personnel with protective gears are permitted. Animals, such as dogs, goats, pigs, rats, etc. should be restricted and controlled from getting into the landfills. This will reduce the incident of disease transmission; (d) Enabling Laws: The government should review and strengthen existing laws and regulations for efficient solid waste management and ensure strict compliance.

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