

Evaluation of cardiopulmonary function and respiratory health symptoms of adults residing or working near landfill site in Lagos state

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ABSTRACT

Background/Objective: Emissions of poisonous gases and air pollution from landfill sites negatively impact the body systems especially the cardiopulmonary system of individuals living close to them resulting in various medical conditions. This study evaluated and compared the cardiopulmonary functions and respiratory health symptoms of adults residing/working near a landfill site with those in a non-landfill community in Lagos State.

Method: Two hundred and fifty-nine adults (134 male and 125 female) were recruited for this study through a multi-stage random sampling technique. One hundred and fifty-two of them were adults residing or working near Olusosun-Ojota-Oregun landfill site and 107 were the age and gender matched adults residing in Ikorodu far from a landfill site. Their cardiopulmonary function parameters were assessed using a digital blood pressure monitor (Omron M6, Japan) to obtain the blood pressure and heart rate values while spirometer was used to obtain pulmonary parameter values. Their respiratory health symptoms were evaluated using the Medical Research Council Questionnaire. Their demographic and physical characteristics were also collected. Data was analyzed using SPSS version 22. Statistical analysis was at 95% confidence interval and the level of statistical significance was set at p less than 0.05.

Results: Participants who reside or work near landfill site had significantly lower Forced expiratory volume in one second (FEV₁) (p=0.025), Peak expiratory flow rate (PEFR) (p=0.011) and FEV₁/FVC ratio (P=0.013) than the participants who reside far from the landfill site. They also had a significantly higher Systolic blood pressure (SBP) (p=0.01) than the participants who reside far from the landfill site. There was a significant difference in the presence of increased chest tightness (p=0.003) between the participants who reside or work near landfill site and those who do not. Participants who have resided near landfill site for more than 10 years had significantly lower Forced vital capacity (FVC) (p=0.044) than those who have resided for less than 10 years. Presence of increased chest

tightness was significantly associated ($p=0.038$) with the duration of exposure to landfill site.

Conclusion: This study established that individuals who reside/work near landfill sites are at higher risks of having compromised cardiopulmonary functions which may worsen with increased duration of stay. It is therefore recommended that there should be public awareness campaign on the hazards of residing or working near a landfill site and the Government should enact policies that will prevent people from erecting buildings for residential or commercial purposes near a landfill site.

Keywords: Cardiopulmonary functions, Respiratory Health symptoms, Landfill site

INTRODUCTION

Solid waste management requires consideration of health, environmental, social and economic factors for its sustainability.¹ A holistic approach integrating all of these factors should be in place to achieving the sustainable development goals (SDG). Of major concern to the public is the existence of landfills' pollution and their health-related effects.¹ In order to achieve a safe environment by 2030, access to adequate, safe and affordable solid waste collection services and discontinuity of uncontrolled dumping and open burning must be enacted.²

Waste management is the process of generating, collecting, processing, transporting and disposing solid wastes.³ This is vital for both environmental and public health. Landfill sites are areas of land where solid wastes are disposed either directly on the ground or in a dug hole.^{4,5} They are also known as dumping site or rubbish dump. Wastes that are not being recycled are usually dumped in these sites and it is the oldest form of waste disposal. Waste disposal is distressful and causes possible health hazards for people

living around the sites, particularly those sites where poisonous wastes are dumped.⁶ Emission of poisonous acidic gases like nitrogen dioxide, sulphur dioxide and halides are dangerous to the respiratory health.^{7,8}

Waste management has been closely associated with biological hazards.⁹ Landfill sites are usually associated with pungent odours, bioaerosol emissions, volatile organic compounds, and contamination of surface and groundwater with dissolved residues.^{4,5} The decomposition of waste materials in landfill sites; vehicle exhaust fumes and weather conditions result to the formation of bioaerosols and biological agents such as fungi, bacteria and volatile compounds like endotoxins, β (1-3)-glucans and mycotoxins.¹⁰ Exposure to bioaerosols has been implicated in various respiratory health diseases which can provoke inflammation of the airways.⁹ Studies have shown that occupational risk of waste handlers and landfill workers are high when compared to others.^{11,12} Cancer has been reported by houses located close to landfill sites.¹³ Previous studies reported serious health risks with landfill handlers

due to their close proximity to the biological agents over time.^{11,12,14} Aweto *et al*¹⁵ reported that the cardiovascular parameters of children living in oil-spilled and gas-flared community in Niger-Delta were significantly higher while their pulmonary functions were lower when compared to those in rural-riverine community in Lagos State.

Cardiorespiratory health is crucial in maintaining good health and living long healthy life. Affection of the respiratory health poses danger to human life and shortens the lifespan of the individual.¹⁶ Individuals living close to landfill sites may suffer from medical conditions such as asthma, lacerations, diarrhea, abdominal pain, reoccurring upper respiratory tract infections, cholera, malaria, cough, skin irritation, bronchoconstriction, dyspnoea and nasalaryngeal irritations which are common in asthmatic individuals.^{7,14,17,18} In addition, continuous exposure to chemicals and inhalation of toxic fumes may impact negatively on the cardiovascular system causing loss of elasticity of the blood vessels, congenital heart defects as well as causing severe conditions such as leukemia, central nervous system defects, oral defects and low birth weight.¹⁹ It has been advocated that more investigations are still required on the health hazards associated with residing or working around landfill sites in developing countries. For instance, Gumedé and Savage²⁰ stated that the health-related hazards as result of residing near landfill sites have not been thoroughly investigated or documented in developing countries. Hence, this study evaluated and compared the

cardiopulmonary functions and respiratory health symptoms of adults residing or working near a landfill site with those in a non-landfill community in Lagos State.

Methods:

A total of two hundred and fifty-nine (259) participants were recruited into this study through a multi-stage random sampling technique. There are 20 Local Government Areas (LGAs) in Lagos State and three LGAs have landfills while 17 LGAs do not have. Out of the three LGAs with landfills, random selection was done to select the exposed group using the fish bowl technique where each of the three LGAs were written on three pieces of paper respectively, then squeezed and placed in a bowl. One of the squeezed pieces of paper was later picked after being mixed together and Olusosun, Oregun-Ojota, Lagos was selected. The same process was done for the 17 LGAs and Ikorodu was selected for the non-exposed group. A cohort of adults residing or working in the two LGAs was recruited using systematic sampling technique in which one in five houses was selected. One hundred and fifty two (152) of them (80 males and 72 females) were residing or working near landfill site at Olusosun Landfill, Oregun-Ojota Lagos State while 107 age and gender-matched individuals were recruited from Ikorodu, Lagos State. The adult participants were residing or working within 2km radius from Olusosun, Oregun-Ojota, Lagos (Using Google Map). This was based on a previous study by Njoku *et al*.¹³ Excluded from this study were cigarette smokers or tobacco users, individuals with history of tuberculosis or other chronic respiratory

diseases like asthma and individuals who have had a recent major surgery (recent thoracoabdominal surgery etc) for less than one year from the time of this study. The research design was cross sectional analytical survey.

Ethical approval was obtained prior to the study from the Health Research and Ethics Committee of the College of Medicine, University of Lagos (CMUL) Idi-Araba, Lagos (Assigned No: CMUL/HREC/05/21/850).

Procedure for Data Collection

A letter of introduction was obtained from the Department of Physiotherapy, University of Lagos which was presented to the Chairman of the Community Development Association (CDA) of Olusosun, Oregun-Ojota, Lagos State. The aim and objectives of the study were carefully explained to the participants including the details of the research procedure. Written informed consent was obtained from each of the participants.

Socio-demographic characteristics were obtained from the participants and documented. This was followed by obtaining information on how long they have been residing or working in the area. The weight and height of the participants were measured using the weighing scale (ZT-150-WT, USA) and the height meter (Seca 213, Germany) respectively. This was followed by the measurements of the cardiopulmonary parameters - SBP, Diastolic blood pressure (DBP), Heart rate

(HR), Mean arterial pressure (MAP), FVC, FEV₁, FEV₁/FVC, PEFR after which the respiratory symptoms questionnaire was administered. A digital blood pressure monitor (Omron M6, Japan) was used to obtain the blood pressure and heart rate values while a spirometer (Contec Spirometer; model SP10W, USA) was used to obtain pulmonary parameter (FVC, FEV₁ and PEFR) values. Statistical Package for Social Sciences (SPSS Inc., Chicago, Illinois, USA) 22.0 version for Windows package programme was used for data analysis. Statistical analysis was at 95% confidence interval and the level of statistical significance was set at p less than 0.05.

RESULTS

One hundred and thirty-four (51.7%) out of the 259 participants were males while 125 (48.3%) were females (Figure 1). Among the participants residing or working near landfill sites, 72 (47.4%) were females while 80 (52.6%) were males. The mean age and the details of physical status of the participants are as shown on Table 1. The mean weight, height and body mass index (BMI) of the participants residing or working near landfill site were 68.18±14.76kg, 1.64±0.07m and 25.23±5.06kg/m² respectively. There was no significant difference in age and physical characteristics of the participants residing or working in the two different communities.

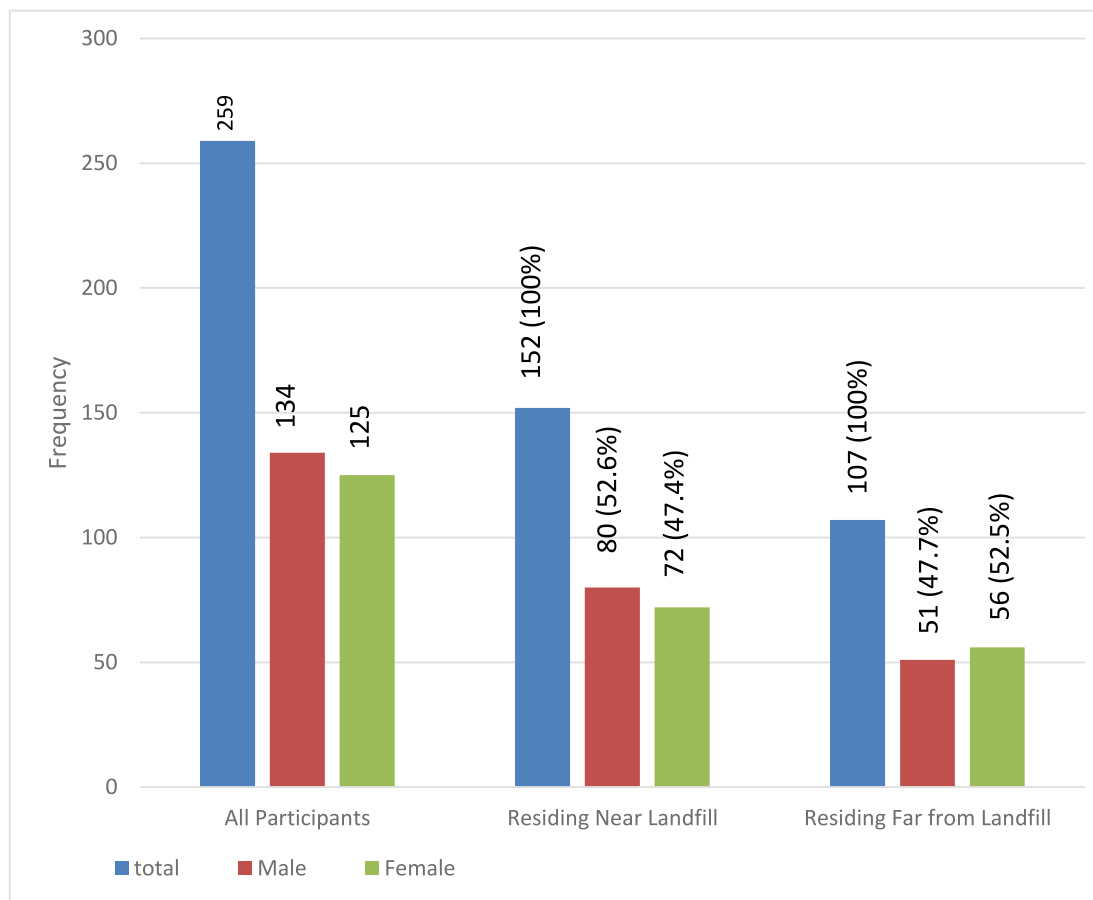


Figure 1: Gender distribution of the participants

Table 1: Demographic Characteristics of Participants

Variables	Residing or Working near Landfill Mean±SD	Residing or Working far from Landfill Mean±SD	t-value	p-value
Age (years)	35.42±11.98	33.11±10.46	1.608	0.109
Weight (kg)	68.18±14.76	67.14±10.76	0.624	0.533
Height (m)	1.64±0.07	1.62±0.09	1.414	0.159
BMI (kg/m ²)	25.23±5.06	25.60±5.24	-0.570	0.569
Duration of living in place of residence (years)	15.80±9.69	14.49±7.93	1.158	0.248

Key

SD: Standard Deviation

BMI: Body Mass Index

m: metre

Kg: Kilogramme

Kg/m: Kilogramme/metre

T-test: Independent t test

Cardiopulmonary Parameters of the Participants

For the cardiovascular parameters, the mean SBP for the participants residing or working near landfill site was 120.40 ± 17.39 mmHg and that of the participants residing or working far from landfill site was 113.32 ± 14.23 mmHg. Their DBP was 76.89 ± 12.07 mmHg and 79.49 ± 12.30 mmHg respectively (Table 2).

For the pulmonary parameters, the mean FEV₁ of participants residing or working near landfill site was 1.47 ± 0.77 l, while that of participants living far from landfill site was 1.69 ± 0.74 l. The mean PEF_R was

2.05 ± 1.20 l/min for participants residing or working near landfill site while it was 2.50 ± 1.66 l/min for participants residing or working far from landfill site.

The comparison of the cardiovascular and pulmonary function variables of the participants residing or working near and far from landfill site shows that there was significant difference in the SBP ($p=0.01$) while all other cardiovascular parameters were not significantly different. There were significant differences in all the pulmonary parameters ($p<0.05$) except in the FVC ($p=0.810$).

Table 2: Cardiopulmonary Status of the Participants

Variables	Residing or Working near Landfill Mean $\pm$ SD	Residing or Working far from Landfill Mean $\pm$ SD	t-value	p-value
SBP (mmHg)	120.40 $\pm$ 17.39	113.32 $\pm$ 14.23	3.474	0.01*
DBP (mmHg)	76.89 $\pm$ 12.07	79.49 $\pm$ 12.30	-1.691	0.092
HR (bpm)	76.50 $\pm$ 11.39	75.67 $\pm$ 9.46	0.616	0.538
MAP (mmHg)	91.62 $\pm$ 13.24	90.76 $\pm$ 12.10	0.531	0.596
FVC (litres)	2.50 $\pm$ 1.39	2.46 $\pm$ 1.09	0.241	0.810
FEV ₁ (litres)	1.47 $\pm$ 0.77	1.69 $\pm$ 0.74	-2.247	0.025*
FEV ₁ /FVC (%)	0.64 $\pm$ 23.28	0.71 $\pm$ 0.19	-2.509	0.013*
PEFR (l/min)	2.05 $\pm$ 1.20	2.50 $\pm$ 1.66	-2.549	0.011*

*Level of Significance set at $p<0.05$

Key:

mmHg: milimetre of Mercury

bpm: beat per minute

l/min: litre/min

t-test: Independent t test

Respiratory Health Symptoms of the Participants

Of the participants residing or working near landfill site, 42 (27.6%) had recurrent coughing and 42 (27.6%) reported

excessive production of sputum while among the participants residing or working far from landfill site, 23 (21.5%) had recurrent coughing and 23 (21.5%)

reported excessive production of sputum (Table 3).

There was no significant association between the place of residence of the

participants (either near or far from landfill sites) and other respiratory symptoms except the presence of chest tightness ($p=0.003$) in the participants (Table 3).

Table 3: Association between Place of Residence and Respiratory Health Symptoms of the Participants

		Participants residing or working near landfill site (n=152)	Participants residing or working far from landfill site (n=107)	X ²	p value
Recurrent Cough	Yes	42 (27.6%)	23 (21.5%)	1.258	0.262
	No	110 (72.4%)	84 (78.5%)		
Excessive production of Sputum	Yes	42 (27.6%)	23 (21.5%)	1.258	0.262
	No	110 (72.4%)	84 (78.5%)		
Shortness of Breath	Yes	34 (22.4%)	23 (21.5%)	0.028	0.867
	No	118 (77.6%)	84 (78.5%)		
Excessive Wheezing	Yes	22 (14.5%)	18 (16.8%)	0.265	0.607
	No	130 (85.5%)	89 (83.2%)		
Increased Chest tightness	Yes	11 (7.2%)	21 (19.6%)	8.901	0.003*
	No	141 (92.8%)	86 (80.4%)		

*Level of Significance set at $p<0.05$

Key:

X²: Chi square test

Duration of Exposure to landfill site and the comparison between their corresponding cardiopulmonary parameters

Among the participants residing or working near landfill site, 53 (34.9%) had lived or worked in the area for less than 10 years while 99 (65.1%) had lived or worked in the area for greater than 10 years (Figure 2).

The mean SBP and FVC of the participants that have resided for less than 10 years 118.42 ± 11.43 mmHg and 2.81 ± 1.49 l/min respectively while that of participants that have resided for more than 10 years were 121.46 ± 19.82 mmHg and 2.33 ± 1.32 l/min respectively (Table 4). There was

significant difference in the FVC ($p=0.044$) while all other cardiopulmonary parameters were not significantly different (Table 4).

Of the participants who have resided for less than 10 years, 17 (32.1%) had recurrent coughing and 11 (20.8%) reported shortness of breath while among the participants who have resided for more than 10 years, 25 (25.3%) had recurrent coughing and 23 (23.2%) reported shortness of breath (Table 5). There was no significant association between the respiratory health symptoms ($p>0.05$) except in the chest tightness ($p=0.038$) as shown on Table 5.

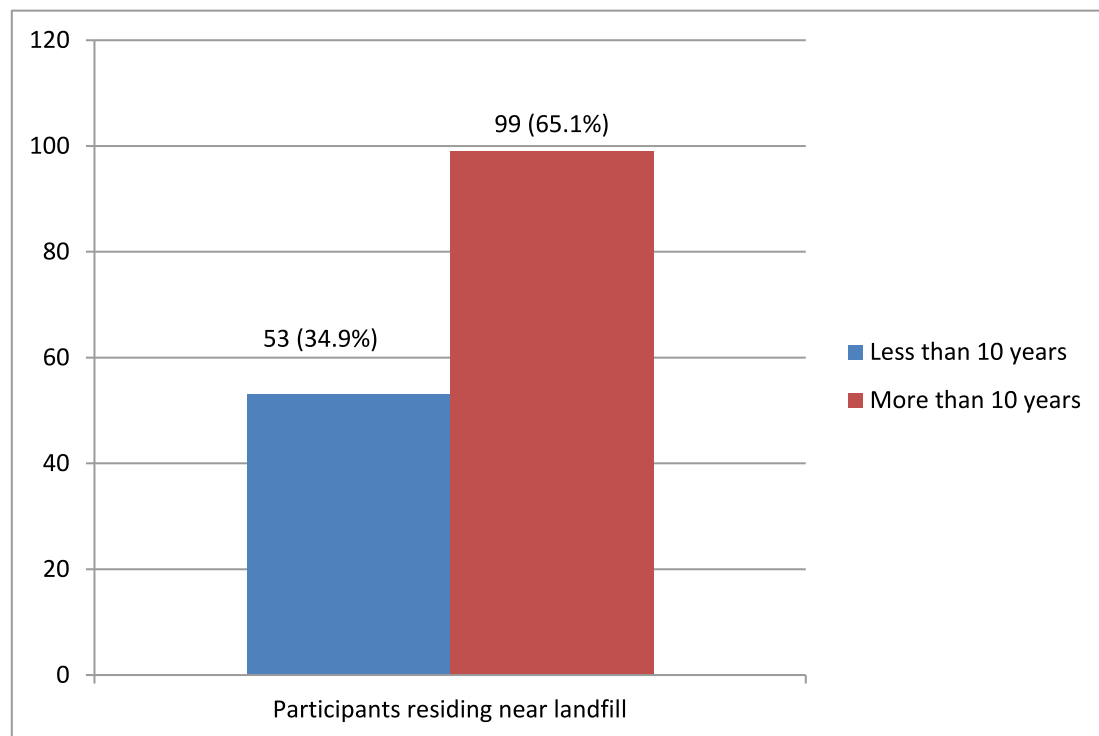


Figure 2: Duration of exposure

Table 4: Comparison of cardiopulmonary parameters among the different duration of Exposure to landfill site

Living/working near landfill (n=152)	Less than 10 years (n=53) Mean±SD	Greater than 10 yrs (N=99) Mean±SD	t-value	p-value
SBP (mmHg)	118.42±11.43	121.46±19.82	-1.031	0.304
DBP (mmHg)	75.06±8.87	77.87±13.42	-1.372	0.172
HR (bpm)	78.60± 9.79	75.37± 12.06	1.676	0.096
MAP (mmHg)	89.50±8.48	92.75±15.11	-1.443	0.151
FVC (litres)	2.81±1.49	2.33±1.32	2.029	0.044*
FEV ₁ (litres)	1.58±0.84	1.41±0.74	1.245	0.215
FEV ₁ /FVC (%)	0.61±0.24	0.69±0.22	1.028	0.306
PEFR (l/min)	2.18±1.30	1.97±1.14	-1.400	0.164

* Level of Significance set at p<0.05

Key:

mmHg: milimetre of Mercury

bpm: beat per minute

l/min: litre/min

t-test: Independent t test

Table 5: Association between Respiratory Health Symptoms and duration of exposure to landfill site

Living/working near landfill (n=152)		Less than 10 yrs (n=53)	Greater than 10 yrs (N=99)	X ²	p value
Recurrent Cough	Yes	17 (32.1%)	25 (25.3%)	0.804	0.370
	No	36 (67.9%)	74 (74.7%)		
Excessive production of Sputum	Yes	19 (35.8%)	23 (23.2%)	2.748	0.097
	No	34 (64.2%)	76 (76.8%)		
Shortness of Breath	Yes	11 (20.8%)	23 (23.2%)	0.122	0.727
	No	42 (79.2%)	76 (76.8%)		
Excessive Wheezing	Yes	11 (20.8%)	11 (11.1%)	2.593	0.107
	No	42 (79.2%)	88 (88.9%)		
Increased Chest tightness	Yes	7 (13.2%)	4 (4.0%)	4.321	0.038*
	No	46 (86.8%)	95 (96.0%)		

*Level of Significance set at $p < 0.05$

Key:

X²: Chi square test

DISCUSSION

This study evaluated and compared the cardiopulmonary functions and respiratory health symptoms of adults residing or working near a landfill site with the age and gender-matched apparently healthy individuals in a non-landfill community in Lagos State.

The observation that the participants residing or working near the landfill site had higher systolic blood pressure may be attributed to constant or long hours of inhalation of poisonous gases emanating from the decomposing wastes in the landfill site. According to Metin and Metin,¹⁹ continuous exposure to chemicals and inhalation of toxic fumes may impact negatively on the cardiovascular system causing loss of elasticity of the blood vessels as well as causing severe conditions such as leukemia, central nervous system defects, congenital heart defects, oral defects, low birth weight and chronic respiratory symptoms.

This study also found out that the PEF_R, FEV₁/FVC and FEV₁ were significantly lower in the landfill-exposed group compared to the unexposed. This suggests that exposure to landfill sites impairs lung function. Methane, a byproduct of wastes has the tendency to replace oxygen in the surrounding atmosphere and poses health hazards to individuals when inhaled in high concentration.^{21,22} Mataloni *et al*²³ reported that the people who reside within 5 km of a landfill site are exposed to the respiratory health risk as they are prone to lung cancer, hospitalizations for respiratory diseases, and in worst cases, death. Aweto *et al*¹⁵ also reported reduced lung function parameters among school children living in gas-flared community of Ogoni land in Rivers State, Nigeria.

The observation that there was a significant difference in the presence of increased chest tightness between the participants who reside or work near landfill site and those who do not as well

as between those who had resided or worked near the landfill site for less than ten years and more than ten years imply that chest tightness is associated with exposure to inhalation of harmful fumes from the wastes in landfill site which is also dependent on the duration of exposure. According to Larsson *et al*²⁴ and Shusterman²⁵, increased chest tightness could be as a result of air pollution in the environment which could act as an irritant to the airways and reduce full chest expansion. Al-Delaimy *et al*²⁶ and Fadhullah *et al*²⁷ suggested that exposure to outdoor environmental contaminants can cause a variety of respiratory symptoms such as breathing difficulties. Apart from duration of residence, proximity to the landfill site is also identified as an indicator of exposure and this is determined by measuring the distance from the houses to the landfill site.²³ These factors significantly produce respiratory symptoms.^{23,28}

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CONCLUSION

This study established that individuals who reside or work near landfill sites are at higher risks of having compromised cardiopulmonary functions which may worsen with increased duration of stay.

RECOMMENDATIONS

It is therefore recommended that;

1. There should be public awareness campaign on the hazards of residing or working near a landfill site.
2. The Government should enact policies that will prevent people from erecting buildings for residential or commercial purposes near a landfill site.
3. There should be public awareness programme to improve respiratory health of the residents near landfill site and efforts should be made at relocating them.
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