GREENER JOURNALS

Greener Journal of Human Physiology and Anatomy

ISSN: 2354-2314

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Research Article

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ABSTRACT

The study aimed to determine the impact of solid waste exposure on Cardio-Pulmonary parameters of municipal solid waste workers in Port Harcourt, Nigeria. A total of 314 randomly selected apparently healthy males comprising 169 test and 145 control subjects Participants in the study. Their weight and height were measured and BMI calculated. Also, their systolic blood pressure, diastolic blood pressure, pulse rate, Peak Expiratory Flow Rate (PEFR) and respiratory rates were measured. Results show a significant increase in the systolic and diastolic blood pressures, pulse rate as well as a decrease in peak expiratory flow rate of the test subjects when compared with the control subjects. The effects were found to depend on the duration of exposure as well as on the body mass index (BMI) of the test subjects. We conclude that prolong exposure to solid waste impact negatively on the cardiovascular and lung functions and therefore could predispose to cardiovascular and or respiratory diseases.

Keywords: Solid waste, Cardiovascular, Lung function, Blood pressure, Peak expiratory flow rate, Port Harcourt.

INTRODUCTION

Since the dawn of civilization, industries have been established to meet various human needs. In sub-Saharan Africa, especially in Nigeria, the rapid urbanization and population growth has led to the generation of enormous quantities of solid waste which are often discarded by open dumping especially in urban cities. Environmental pollution is a worldwide phenomenon. It is progressively increasing as solid waste generation increases. This constitutes a major source of environmental and health hazard.

Man's activity encapsulates the totality of deriving benefits from raw materials while creating left over complexities. The nature of these complexities have been tied to factors as civilization, improved living standards, economic and cultural attributes of man in his environment (Akinola and Salami 2001). Complexity in waste is also increasing with biodegradable waste currently accounting for over 50%. This amounts to an annual average of about 50milion tons per annum of waste burden on the nation with less than 10% waste management capacity (Ossai, 2006).

Solid wastes, also referred as municipal solid waste (MSW), could be defined as non-liquid and nongaseous products of daily human activities, which are discarded by the public, and regarded as being useless. It could take the forms of household garbage, commercial refuse, construction and demolition debris, dead animals, abandoned vehicles, sludge, hazardous waste (paints, chemicals, light bulbs, fluorescent tubes, spray cans, fertilizer and containers), toxic waste (pesticide, herbicides, fungicides) radioactive wastes and medical waste (Cointreau, 1982; Leton and Omotosho, 2004); they are susceptible to burning and exposure to scavengers.

MSW are mainly biodegradable and non-biodegradable substances mostly papers and putrescible organic matter, with the chemical constituents nitrogen, phosphorus and potassium contents ranging between 0.5 to 0.7%, 0.5 to 0.8% and 0.5 to 0.8% respectively and toxicity characteristics include heavy metals, pesticides, insecticides and Leachates (UNEP-IETC, 1996).

Port Harcourt, a city located in the Niger delta region, South-South of Nigeria is among the fastest growing cities in the Nigeria (Onibokun and Kumuyi, 1996) and is faced with the problem of increased solid waste generation. The wastes generation in Port Harcourt was projected at about 210,934, 304,477 and 352,853 tonnes per annum in

1982, 1990 and 2000 respectively; with an estimated solid waste generation rate of 1.25 kg per person per day (Ayotamuno and Gobo, 2004). Evacuation of these wastes therefore poses a serious burden for the evacuation workers who are daily exposed to the gases (green house gases such as methane, carbon monoxide and carbon dioxide), chemicals and obnoxious odours emanating due to decomposition and degradation of these solid wastes at the collection and dump sites. Linn et al (1999) observed that the potential mechanisms for particulate matter-associated changes in blood pressure include an increase in sympathetic tone and/or the modulation of basal systemic vascular tone.

Previous studies have implicated occupational exposure to environmental pollutants on the incidence of respiratory and cardiovascular disorders (Jinadu and Malomo, 1986; Alakija *et al.*, 1990; Ige and Onadeko, 2000; Okojie *et al.*, 2003; Okwari *et al.*, 2005). Ubilla et al (2008) observed that a BMI of <20 and >30 are negatively associated with lung functions.

Similar studies on municipal waste workers, especially in Port Harcourt is scanty. This study therefore, aimed at assessing some cardiovascular and lung function indices of solid waste evacuation workers in Port Harcourt, South-South, Nigeria.

MATERIALS AND METHODS

Study Area: This study was carried out in Port Harcourt, South-South Nigeria.

Selection of subjects: A total of 314 randomly selected apparently healthy adult male subjects comprising 169 test subjects (from solid waste evacuation workers), and 145 control subjects (from non solid waste workers) all of similar social status and biometric distribution were involved in the study. Subjects known to suffer from any cardiovascular or respiratory disorder as well as those less than six months in the job were excluded from the study; while those who met the inclusion criteria were enlisted for the study after giving their informed consent.

Date Collection: The study adopted the direct administration of questionnaire. Respondents voluntarily filled and returned the questionnaires given to them. Their heights (m) and weights (kg) were measured as described in previous studies (Adienbo et al, 2012). Their peak expiratory flow rates (PEFR) were measured using Wright's peak flow meter (Joffa et al, 2013). Briefly, each subject was instructed to perform maximum expiratory effort after inhaling to lung capacity. Three readings of PEFR were taken in standing position. The respiratory rates of the subjects were also determined. A digital blood pressure monitor was used to measure the blood pressure. The arm band of the monitor was tied around the left arm of the subject just above the median cubital fossa. The monitor measured the systolic blood pressure, diastolic blood pressure and pulse rate. The body mass index (BMI) for each subject was calculated from the following formula: BMI= weight (Kg) / square of the height (m^2).

Statistical Analysis: The data generated were subjected to statistical analysis using SPSS version 17. Statistical comparisons of measured variables between the groups were carried out using students' T-test or one way analysis of variance (ANOVA) with Turkey-k for multiple comparison. Values of $P<0.05$ were considered statistically significant. Results were presented in tables as Mean ± SEM, and as percentages.

RESULTS

The anthropometric and Cardio-Pulmonary parameters of the subjects in the population studied are as presented in table 1. It shows that there was no significant difference ($p>0.05$) in the age and BMI of the test subjects, when compared with the control subjects in spite of the significantly higher ($p<0.05$) weight and height of the test subjects, respectively, as compared with the control subjects. The cardiovascular functions parameters such as systolic blood pressure (SBP), diastolic blood pressure (DBP) and pulse rate (PR), presented in table1, were all observed to significantly ($p<0.05$) increase in the test subjects, when compared with their respective control subjects. The pulmonary parameters (table1) however, show an opposite trend to the cardiovascular, with the observation of a significant ($p<0.05$) decrease in the peak expiratory flow rate (PEFR) of the test subjects as compared to the control, although the respiratory rate (RR) does not show any difference between the test and control group subjects.

TABLE 1: Anthropometric and Cardio-Pulmonary parameters of subjects in the population studied.

PARAMETERS	CONTROL (n=145)	TEST (n=169)	TOTAL POPULATION (n=314)
AGE (Years)	28.42 ±5.11	30.87±7.65	29.65 ± 7.106
WEIGHT (Gram)	69.28±9.53	66.40±12.40*	67.73 ±11.25
HEIGHT (Meter)	1.71±0.09	1.65±0.10**	1.68± 1.07
BMI (kgm^{-2})	23.70±3.61	24.53±4.57	24.15± 4.17
SBP (mmHg)	124.95±12.77	134.04±19.48**	129.84 17.306
DBP (mmHg)	76.50±17.69	81.20±11.54*	79.03 ±14.866
PR (beat/min)	73.21±9.72	78.42±11.45**	76.02±10.99
PEFR (L/min)	428.08±109.94	271.09±10.03**	343.32±13.47
RR (c/min)	20.52±2.27	20.61±1.81	20.55±2.13

MEAN±SD; *P<0.05; **P<0.01

The relationship between the duration of exposure to the solid wastes by the test subjects and the observed changes in their Cardio-Pulmonary parameters is shown in table 2. There was a progressive exposure-duration-dependent significant (p<0.05) increase in the SBP, DBP and PR of the test subjects, compared to the control subjects. The PEFR, on the other hand, showed significant (p<0.05) duration dependent progressive decrease among subjects exposed for <3 years, 3-10 years and >10 years respectively, when compared to the control group subjects. There was no change in the respiratory rate among subjects in the different exposure duration groups.

TABLE 2: Effect of duration of exposure to solid wastes on the Cardio-Pulmonary parameters of refuse workers

PARAMETERS	Duration of exposure (years)			
	CONTROL (n=145)	<3 YRS (n=112)	3-10 YRS (n=42)	>10 YRS (n=15)
SBP (mmHg)	124.95±12.77	131.71±18.05**	138.31±14.24**	139.53±13.53**
DBP(mmHg)	76.50±11.69	80.12±9.29	82.95±15.55*	84.33±13.29*
PR (beat/min)	73.21±9.72	78.70±11.54**	78.17±9.39**	79.87±10.34**
PEFR (L/min)	428.08±79.94	274.13±79.88**	271.95±86.52**	246.00±80.07**
RR (c/min)	20.52±2.27	20.12±1.51	21.19±1.66	22.00±3.03

MEAN±SD; *: Statistically Significant (P<0.05); **: (P<0.01).

The cardiovascular and pulmonary parameters of test subjects were analysed based on their body mass index (BMI) (table 3). Those with BMI <18.5 (under weight), 25-29.9 (overweight) and >30 (obese) groups were each compared with the normal weight subjects (BMI 18.5-24.9). it was observed that the obese test subjects have significantly (p<0.05) increased SBP and PR respectively with a significantly (p<0.05) decreased PEFR when compared with the normal weight (BMI 18.5-24.9) subjects. There was no significant (p>0.05) difference in the DBP and RR between the obese and test subjects. The overweight subjects, on the other hand, have significant (p<0.05) increase in the SBP only; without any difference in the DBP, PR, PEFR and RR respectively, when compared with the normal subjects. There was also an observed significant (p<0.05) decrease in the PEFR in the underweight test subjects when compared with the normal weight test subjects.

TABLE 3: Relationship between Body Mass Index (BMI) and Cardio-Pulmonary parameters of test subjects

PARAMETERS	Body Mass Index (kgm^{-2})			
	<18.5 (n=7)	18.5-24.9 (n=106)	25-29.9 (n=37)	≥ 30 (n=19)
SBP (mmHg)	130.38±12.73	126.36±16.43	135.21±14.62**	138.38±22.39**
DBP(mmHg)	80.13±7.77	77.74±16.77	80.98±11.01	81.86±11.68
PR (beat/min)	75.25±15.89	75.70±10.24	74.39±11.19	80.95±11.02*
PEFR (L/min)	279.75±89.06*	355.61±103.26	348.62±105.53	296.92±97.65*
RR (c/min)	21.00±2.16	20.51±2.09	20.76±2.44	20.11±1.66

MEAN±SD; *: Statistically Significant (P<0.05); **: (P<0.01).

DISCUSSION

The significant increase in systolic blood pressure (SBP) and diastolic blood pressure (DBP) observed among the urban solid waste workers may be due to the prolonged daily inhalation of particulate matter, carbon dioxide and other chemicals emitted from the solid wastes. Inhalation of particulate matter PM decreases the oxygen tension (PO_2) as well as an increase in sympathetic tone and/or the modulation of basal systemic vascular tone (Linn et al 1999); while carbon dioxide inhalation increases blood H^+ concentration (Decreased P^H level). These lead to stimulation of the vasomotor centres resulting in increase in the blood pressures, as observed in this study. This result is in agreement with the work of Gong *et al*. (2003), who reported an increase in the systolic blood pressure in healthy subjects on exposure to particulate matter (PM); and also with the report of Jessup et al (2009) who observed an increase in systolic dysfunction due to exposure to toxins and pharmacological agents which cause intracellular damage and oxidative stress. Also, some of these inhaled chemicals and gases may possess vasoconstrictor effects, thus increasing the total peripheral resistance (TPR) and hence increase the blood pressure. This may be the cause of the significant increase observed in diastolic blood pressure, similar to the result obtained by Urch *et al*. (2005), who observed an increase in DBP of about 6mmHg in subjects exposed to particulate matter and chemicals.

The significant increase ($P<0.01$) observed in the pulse rate (index for heart rate) of the solid waste workers may be attributed to a possible haemodynamic instability resulting from exposure to chemicals and heavy physical work load. The inhaled particulate matter decreases the blood oxygen tension (PO_2) which the body responds by increasing the heart rate in order to sustain adequate oxygen delivery to tissues. This was observed as an increase in pulse rate. This is similar with the findings of Devlin et al., (2003) who reported that acute particulate matter exposure is capable of increasing Heart Rate Variability (HRV).

The significant increase ($P<0.01$) in SBP observed in over weight and obese subjects may be as a result of abnormal adipose tissue accumulation associated with these BMI classes. This may lead to peripheral vasoconstriction which results in increase in blood pressure. This is in agreement with the work of Ubilla et al (2008) who reported that the abnormal presence of adipocytes leads to an increase in blood pressure in individuals. This may also explain the significant increase in pulse rate observed among obese test subjects.

Peak expiratory flow rate (PEFR) is one of the important and simple respiratory function tests. It is used in dictating bronchial asthma and other obstructive airway diseases (Corre and Rothstein, 1985, Plymat an Bunn, 1985), as well as in the early diagnosis of occupational lung diseases (Tiwari et al, 1998; Osim, EE 1998). The significant decrease in PEFR observed in urban solid waste workers may be due to inhalations of gaseous chemicals, obnoxious odours, and deposition of dust and inspirable particulate matter along the respiratory tract. These cause inflammatory changes which leads to increased airway resistance thereby bringing about the remodeling of the airway and consequently lung dysfunction (Iyawe and Ebomoyi, 2005). The exposure-dependent decrease in the PEFR observed in the test groups when compared with the control may be due to the direct inhalation of a larger and progressively accumulating volume of obnoxious gaseous chemicals and particulate matter deposits in the lungs with associated inflammatory changes, as well as physically impeding the normal lung function (Ihekwaba et al, 2009). This is in agreement with the earlier reports that environmental factors such as exposure to air pollutants adversely affect lung function (Ihekwaba et al, 2009; Leonardi *et al*., 2000, Ovuakporaye, et al 2012; Stvendsen *et al*., 2007; Gauderman *et al*., 2007).

CONCLUSION

The study has established that prolong exposure to solid waste impact negatively on the cardiovascular and lung functions by increasing the systolic blood pressure, diastolic blood pressure and pulse rate as well as decreasing the peak expiratory flow rates. These effects are exposure duration dependent and worse in obese condition. Urban solid waste evacuation workers are therefore predisposed to developing cardiovascular and lung diseases. Protective devices should therefore be used by all solid waste evacuation workers. The outcome of this study has provided additional basis for the formulation and implementation of policies for addressing the adverse effect of solid waste exposure in developing countries, especially in Nigeria. However, further studies on the characterization and chemical analysis of the gaseous and particulate matter emitted by these wastes is recommended

REFERENCES

Adienbo, O.M., Hart, V.O. and Oyeyemi, W.A. 2012. High Prevalence of Obesity among Indigenous Residents of a Nigerian Ethnic Group: The Kalabaris in the Niger Delta Region of South-South Nigeria. Greener Journal of Medical Sciences. Vol. 2 (6), pp. 152-156.

Akinola. S. & Salami. R. 2001. “An Assessment of the Effectiveness of Private Sector Participation Initiatives In Solid Waste Management in Mushin Local Government Area, Lagos State”. Nigerian Journal of Social and Educational Research. A Publication of the Nigerian Association of Social and Educational Research, University of Ado-Ekiti.Canback Dangel. Retrieved 2008-08-20.

Alakija, W., V.I. Iyawe, L.N. Jarikre and J.C. Chiwuzie, 1990. Ventilatory function of workers at Okpella cement factory in Nigeria. West Afr. J. Med., 9(3): 187-191.

Ayotamuno, J M. and Gobo, A E. 2004. "Municipal solid waste management in Port Harcourt, Nigeria: Obstacles and prospects", Management of Environmental Quality: An International Journal, Vol. 15 Iss: 4, pp.389 - 398

Castillejos, M., D.R. Gold, A.I. Damokosh, P. Serrano, G. Allen and W.F. McDonnell. 1995. Acute effects of ozone on the pulmonary function of exercising schoolchildren from Mexico City. Am. J. Respir. Crit. Care Med., 152(5): 1501-1507.

Castillejos, M., D.R. Gold, D. Dockery, T. Tosteson, T. Baum and F.E. Speizer, 1992. Effects of ambient ozone on respiratory function and symptoms in Mexico City schoolchildren. Am. Rev. Respir. Dis., 145(2): 276-282.

Corre KA, Rothstein RJ. 1985. Assessing severity of adult asthma and need for hospitalization. Ann-Emerg-Med. 14 (1): 45-52.

Cointreau, S. 1982. *Environmental Management of Urban Solid Wastes in Developing Countries: A Project Guide*. Washington, DC: Urban Development Department, World Bank.

Devlin, R.B., A.J. Ghio, H. Kehrl, G. Sanders and W. Cascio. 2003. Elderly humans exposed to concentrated air pollution particles have decreased heart rate variability. Eur. Respir. J. Suppl., 40: 76-80.

Gauderman, W.J., C.F. Gilliland, H. Vora, E. Avol, D. Stram, R. McConnell, D. Thomas, F. Lurmann, H.G. Margolis, E.B. Rappaport, K. Berhane and J.M. Peters. 2007. Association between air pollution and lung function growth in Southern California children. Am. J. Respir. Crit. Care Med., 162: 1383-1390.

Gong, H., W.S. Linn, C. Sioutas, S.L. Terrell, K.W. Clark, K.R. Anderson and L.L. Terrell. 2003. Controlled exposures of healthy and asthmatic volunteers to concentrated ambient fine particles in Los Angeles. Inhal. Toxicol., 15: 305-325.

Ige, O.M. and O.B. Onadeko, (2000): Respiratory symptoms and ventilatory function of the sawmillers in Ibadan, Nigeria. Afr. J. Med. Med. Sci., 29(2): 101-104.

Ihekwaba, A.E. Nwafor, A and Adienbo, O.M. 2009. Lung function indices in primary and secondary sawmill workers in Port Harcourt, Nigeria. *Afr. J. of Appl. Zool. & Environ. Biol. Vol. 11: 101 – 105*

Iyawe, V.I. and Ebomoyi, M.I. 2005. Current developments in the physiology and management of asthma. Nig. J. Physiol. Sci. 20: 19–29.

Jessup .M, 2009: focused update ACCF/AHR guidelines for the diagnosis and management of heart failure in Adults, circulations.

Jinadu, M.K, Malomo, M.O. 1986: Investigation into occupational health problems of bakery workers in Ile-Ife, Nigeria. Nig. Med. Practitioner 12 (3): 39-41.

Joffa Paul Kwaku Price, Nwafor Arthur and **Adienbo Ologhaguo Macstephen** 2013. Correlation Between Body Mass Index and Peak Expiratory Flow Rate of an Indigenous Nigerian Population in the Niger Delta Region. *Research Journal of Recent Sciences.* Vol. 2(2), 28-32.

Johnson BL 1999. Impact of hazardous waste on human health. US: CRC Press.

Kuschener, W.G. and P. Stark, 2003. Occupational toxicant exposures have an important role in many cases of lung diseases seen in worker. Occupational Lung Disease. Part 1, Identifying work related asthma and other disorders. Postgrad Med., 113(4): 70-78.

Leonardi, G.S., D. Houthuijs, P.A. Steerenberg, T. Fletcher and B. Amstrong, 2000: Immune biomarks in relation to exposure to parti ulate matter: A cross-sectional survey in 17 cities of central Europe. Inhal. Toxicol., 12: 1-14.

Leton, TG; Omotosho, O 2004. Landfill operations in the Niger delta region of Nigeria. Engineering Geology 73(1-2): 171-177.

Linn WS, Gong H Jr, Clark KW, Anderson KR. 1999. Day-to-day particulate exposures and health changes in Los Angeles area residents with severe lung disease. *J Air Waste Manag Assoc.*;49:108 –115.

Okojie, O.H., E. Egbagbe and I. Kadiri. 2003. An epidemiological study of the health status of sawmill

Okwari, O.O., A.B. Antai, D.U. Owu, E.J. Peters and E.E. Osim, 2005: Lung function status of workers exposed to wood dust in timber markets in Calabar, Nigeria. Afr. J. Med. Med. Sc., 34: 141-145.

Onibokun, AG; Kumuyi, AJ. 1996. Urban poverty in Nigeria: towards sustainable strategies for its alleviation. Centre for African Settlement Studies and Development, Ibadan, Nigeria. CASSAD Monograph Series 10. pp. 1-2.

Osim EE, Musabayane CT, Mufunda J. 1998. Lung function of Zimbabwean farm workers exposed to flue curing and stacking of tobacco leaves. S-Afr-Med-J. Sep; 88 (9): 1127-31.

Ossai, R.M. (2006). Moving Solid Waste Management into the 21st century in Nigeria. Presented at the 6th National Council on Environment Meeting held at Katsina State Secretariat, Katsina.

Ovuakporaye, S.I; Aloamaka, C.P.; Ojieh, A.E.; Ejebe D.E. and Mordi, J.C. 2012 :Effect of Gas Flaring on Lung Function among Residents in Gas Flaring Community in Delta State, Nigeria; Research Journal of Environmental and Earth Sciences 4(5): 525-528.

Plymat KR, Bunn CI. 1985: Monitoring asthma with a Mini Wright Peak Flow Meter. Nurse-pract; 10(8):25-7, 47.

Pope, C.A., J.B. Muhlestein, H.T. May, D.G. Renlund, J.L. Anderson and B.D. Horne, 2006: Ischemic heart disease events triggered by short-term exposure to fine particulate air pollution. Circulation, 114:2443-2448.

Romieu, I., F. Meneses, S. Ruiz, J. Huerta, J.J. Sienra and M. White, 1997: Effects of intermittent ozone exposure on peak expiratory flow and respiratory symptoms among asthmatic children in Mexico City. Arch. Environ. Health, 52: 368-376.

Stvendsen, E.R., K.B. Yeatts, D. Peden, S. Orton, N.E. Alexis, J. Creason and R. Williams, 2007: Circulating neurophil CD14 expression and the inverse association of ambient particulate matter on lung function in children. Ann. Allergy. Asthma. Immunol., 99: 244-253.

Tiwari RR, Zodpey Sample Prescpiptions, Deshpande SG, Vasudeo ND 1998: Peak expiratory flow rate in handloom weavers. Indian-J-Physiol-pharmacol. Apr;42(2):266-70.

Ubilla, C.; Bustos, P; Amigo, H; Oyarzum; Rona RJ. 2008: Nutritional status, especially body mass index and blood pressure, from birth to adulthood and lung function in young adulthood. Ann of Hum Biol. 35(3): 322-333.

UNEP-IETC, 1996. International Source Book on Environmentally Sound Technologies for Municipal Solid Management. Osaka/Shiga, UNEP International Environmental Technology Centre.

Urch, B., F. Silverman, P. Corey, J.R. Brook, K.Z. Lukic, S. Rajagopalan and R.D. Brook, 2005. Acute blood pressure responses in healthy adults during controlled air pollution exposures. Environ. Health Perspect., 113: 1052-1055.

Ward, D.J., M.R. Miller, S. Walters, R.M. Harrison and J.G. Ayres, 1999: Impact of correcting peak flow for nonlinear errors on air pollutant effect estimates from a panel study. Eur. Resp. J., 15: 137-140.