International Journal of Medical Science and Clinical Invention 10(4): 6661-6669, 2023
DOI:10.18535/ijmsci/v10i4.04
https://valleyinternational.net/index.php/ijmsci

Research Article,

Effects of Exposure to Cement Particles on Selected Respiratory and Cardiovascular Parameters among Cement Depot Workers in Delta State, South-South, Nigeria

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Abstract:

The incidence of occupational disease such as diseases of the cardiopulmonary system, arising from exposure to cement is increasing throughout the world. Hence this study is aimed at evaluating the effect of exposure to cement particles on selected cardiovascular and respiratory parameters of cement depot workers in Delta State, Nigeria. Comparative cross-sectional study design was adopted for this study. Three hundred (300) participants were used to carry out this research. Two hundred exposed workers that have been working in the cement depot for 0 - 10 years and one hundred (100) people as unexposed group as control who are matched with socio-economic class with workers from the cement depot (exposed group). Data collected were age, height, weight, blood pressure (mmHg), pulse rate, oxygen saturation rate (percentage), peak expiratory flow rate (meter) and inspiratory reserve volume (meter). The parameters collected were analyzed statistically using SPSS software. The result showed that for workers with >5 years of exposure, there was a significant increase in systolic blood pressure (140.29 ± 8.42), diastolic blood pressure (97.45 ± 4.03), expiration rate (357.21 ± 369.05) and inspiration rate (1392.3 ± 421.23), and a significant decrease in pulse rate (53.69 ± 2.213) and SPO_2 (89.08 ± 3.012) of cement workers when compared to the control group (cement workers) ($p<0.05$). For worker with 0 – 5 years of exposure, There was a significant increase in systolic blood pressure (144.2 ± 10.8), diastolic blood pressure (82.25 ± 6.14), expiration rate (243.60 ± 30.60) and inspiration rate (235.0 ± 63.9), and a significant decrease in pulse rate (77.7 ± 7.44) and SPO_2 (92.5 ± 8.2) of cement workers when compared to the control group (cement workers) ($p<0.05$). The findings of these study shows that exposure to cement dust has deleterious effect on cardiopulmonary parameters.

Keywords: exposure, cement particles, respiratory, cardiovascular parameters, cement depot workers

Introduction:

Environmental and occupational pollution has always been a major cause of morbidity and mortality. The incidence of occupational disease is constantly increasing throughout the world, especially in developing countries due to the lack of proper quality control documentation and the practical approach towards this

mammoth problem. This is also the case with diabetic mellitus, a metabolic disorder that has continue to attract public concern in developing countries as a result of increased incidents following urbanization and social life changes.[1-5] Cement industry is one of the largest manufacturing industries and its workers are exposed to dust at various manufacturing and production processes.[6] It consists of 60-67% calcium oxide (lime), 17-25% silicon oxide, 3-5% aluminium oxide, with some amount of iron oxide, chromium, lead, potassium, sodium, sulphur, mercury, antimony, cadmium, zinc, manganese and magnesium oxide. The aerodynamic diameter of cement dust particles is within the respirable extent, consequently occupational exposure to cement dust can cause numerous health hazards including the onset of acute or chronic respiratory diseases and respiratory function deficits.[7] Air pollution from cement manufacturing is becoming an environmental problem worldwide.[8]

Exposure to cement dust may occur at most stages of the manufacturing process, and higher dust concentrations have been reported in the crusher and packing sections than in other sections.[9] Cement production is invariably a dusty operation resulting in the exposure of factory workers to cement dust. Several clinical and epidemiological studies have shown an increased incidence of impairment of respiratory and a prevalence of respiratory symptoms among cement production workers. This study will be useful to cement depot workers, which will enlighten them on the dangers of exposure to cement dust on a daily basis. It will also be useful to encourage public health policy on the safety of cement depot workers and those residing close to such depots.

Meo *et al.*[10] investigated the effect of duration of exposure to cement dust on respiratory function of non-smoking cement mill workers. They reported that there was significant reduction in the mean values of Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), Peak Expiratory Flow (PEF) and Maximal Voluntary Ventilation in cement mill workers who had been working in the cement industry for more than 10 years compared to their matched un-exposed group. However, this study investigated the effect of exposure to cement particles/dust on some cardiovascular and respiratory parameters of cement depot workers in Delta State, South-South, Nigeria by specifically determining the effect of exposure to cement particles on blood pressure, the peak expiratory flow rate, the peak inspiratory flow rate, the oxygen saturation rate (SPO_2), the pulse rate and the inspiratory reserve volume of cement depot workers.

Materials

Digital sphygmomanometer, Manual sphygmomanometer, Pulse oximeter, Peak flow meter and Incentive spirometer

Methodology:

Study area: Delta State is a Nigerian state in the South-South geopolitical zone, having a population of about 5.6 million people in 2016 (Ebewore, 2020). The state has an area of around 18,050 km2 (6,970 sq mi), with more than 60% of that area being land. According to Ebewore (2020), the state is positioned roughly between 5°00' and 6°45' E and 5°00' and 6°30' N. Edo State, Anambra, Bayelsa State, and the Bight of Benin form its northern, eastern, southern, and southern borders, respectively. The state is home to several large, unique ethnic groups, including the Urhobos, who inhabit the delta central senatorial district; the Ukwuani, Ika, and Aniocha-Oshimili who inhabit the delta north senatorial district; and the Isokos, Ijaws, and Itsekiris who inhabit the delta south senatorial district. The twin cities of Warri and Uvwie serve as the state's economic hub, while Asaba, the state capital, is situated along the River Niger on the state's northeastern edge (Ebewore, 2020). There are several cement depots dispersed across the three senatorial districts to accommodate the rising demand for construction and development in the state.

Study Design and Population: Comparative cross-sectional study design was employed in this study. The study comprised of all the cement depot workers in Delta State, South-south, Nigeria between the age of 18 to 60 years old

Sample Size and Sampling Technique

Three hundred (300) participants were used to carry out this research. Two hundred (200) exposed workers that have been working in the cement depot for 0-> 10 years (100 workers each with 0-5 years and greater than 5

years exposure to cement particles), and one hundred (100) people as unexposed group (control group) who were matched with socio economic class with workers from the cement depots (exposed group). The study employed the multistage sampling technique to recruit participants. The selected cement depot includes Dangote cement depot Police station road Abraka, Dangote cement depot close to Eku junction Eku, Dangote cement depot at Otokutu off DSC Express way, Dangote cement depot before orhuworun bridge Udu and Dangote cement depot along PTI road by Uti junction in Warri. Simple random sampling technique was used in the last stage of the multistage sampling technique to select the study participants from the selected cement depots in Delta State.

Methods of Data Collection

Digital Blood Pressure and Pulse rate Measurement: Blood pressure and pulse rate were measured by placing the cuff of the digital sphygmomanometer on the forearm of each participant, the circumference of the cuff was properly sized to at least eighty percent of the circumference upper arm, the cuff was rounded on the upper arm of each participant with the cuff's edge one inch above the antecubital fossa, the digital sphygmomanometer was put on and it began to take readings of the blood pressure and pulse rate of the participant. After the readings were taken, it was displayed on the screen of the sphygmomanometer and the values for systolic pressure, diastolic pressure and pulse rate were recorded.

Oxygen Saturation Rate Measurement: The oxygen saturation rate was measured by placing the participant's index finger in the pulse oximeter, then waiting for at least one minute for the reading to show and stabilize, the value was recorded after the result was stable.

Peak Expiratory Flow Rate Measurement: The participants were asked to stand of straight, the red marker of the peak flow meter was at the bottom of the meter. Each participant took a deep breath by filling their lings, the mouth piece of the meter was placed in the mouth of each participant. They also closed their lips on the peak flow meter's mouthpiece, air was blown out as hard and fast as possible in a single blow, the number by the red marker on the meter was written down. The red marker was put back at the bottom of the meter, and the measurement was repeated three times and the highest of the three readings was recorded.

Inspiratory Reserve Volume Measurement: The participants were asked to put the mouthpiece of the incentive spirometer in their mouth and close their lips tightly around it, inhale slowly and deeply through the mouthpiece to raise the indicator, when they could not inhale again, the value at where they stopped was recorded.

Parameters measured	Low range	Normal range	High range
Systolic blood pressure	<90mmHg	90-120mmHg	>140mmHg
Diastolic blood pressure	<60mmHg	60-80mmHg	>90mmHg
Pulse rate	<60b/m	60-100b/min	>100b/min
Oxygen saturation rate	<90%	95%-100%	>100% (rare)
Peak expiratory flow rate	<400l/min	400-700l/min	----
Inspiratory reserve volume	<1900ml	1900-3300ml	>3500ml (not dangerous)

Selection Criteria:

Inclusion Criteria: The sample consists of apparently healthy looking workers from the study area mentioned earlier from age 18 and above in Delta state.

Exclusion Criteria: Asthmatic patients, workers younger than 18, workers not in Delta state and workers with previous medical history of cardiopulmonary diseases and other comorbidity were excluded from the research.

Data Analysis

Data were entered and analyzed statistically using SPSS software (Version 23, IBM). Statistical significance was established at P-value < 0.05

Ethical Clearance

Ethical approval was obtained from the ethical review committee of the faculty of Basic Medical Sciences, Delta State University, Abraka. A written informed consent was obtained from all the study participants before they were included in the study.

Results:

According to the length of exposure to the cement business (0–5 and greater than 5 years), the results are reported. Age, height, and weight were the matching variables in statistical comparisons for both groups, and as a result, the statistical validity of this information is not examined.

Effect of cement particles on blood pressure, expiration rate, inspiration rate and SPO_2 of control and workers with greater than 5 years of exposure

Table 1: Showing the Mean ± SD of the blood pressure, expiration rate, inspiration rate and SPO_2 of control and workers with greater than 5 years of exposure

Parameters	Control group	Experimental group (>5 years)
Systolic blood pressure (mmHg)	122.3 ± 9.46^{a}	140.29 ± 8.42^{ab}
Diastolic blood pressure (mmHg)	73.4 ± 3.39^{a}	97.45 ± 4.03^{ab}
Pulse rate (beat/min)	80.5 ± 9.65^{a}	53.69 ± 2.213^{ab}
Expiration rate (ud/mm)	72.78 ± 4.18	357.21 ± 369.05^{ab}
Inspiration rate (ud/mm)	273.8 ± 81.4^{a}	1392.3 ± 421.23^{ab}
SPO_2	95.25 ± 4.68^{a}	89.08 ± 3.012^{ab}

Values are expressed in Mean ± Standard, n=200. Values not sharing the same superscript in the same row differ significantly ($p<0.05$). Values sharing the same superscript in the same row are statistically significant ($p<0.05$)

Table 1 shows comparison between the cardiopulmonary parameters of the experimental groups (>5 years of exposure of cement workers) and the control groups, the non-cement workers. There was a significant increase in systolic blood pressure, diastolic blood pressure, expiration rate and inspiration rate, and a significant decrease in pulse rate and SPO_2 of cement workers when compared to the control group (cement workers) ($p<0.05$).

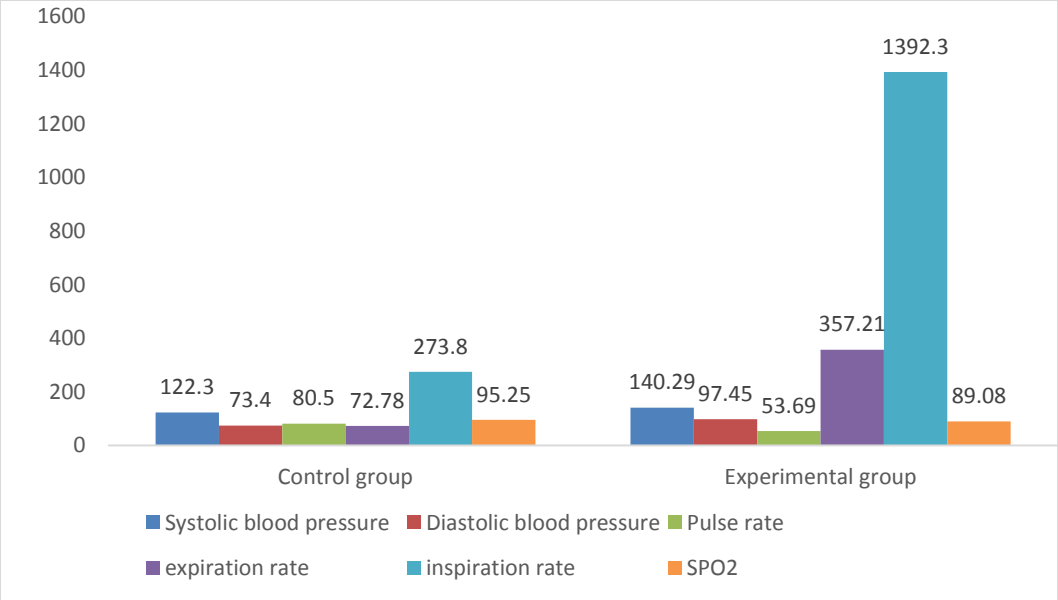


Figure 1: Comparison between the cardiopulmonary parameters of control group and experimental group group (> 5 years).

From Figure 1 above, it was observed that there was a significant difference between the control group and experimental group across all parameters studied. There was a significant increase in expiration rate and inspiration rate when compared with the control group.

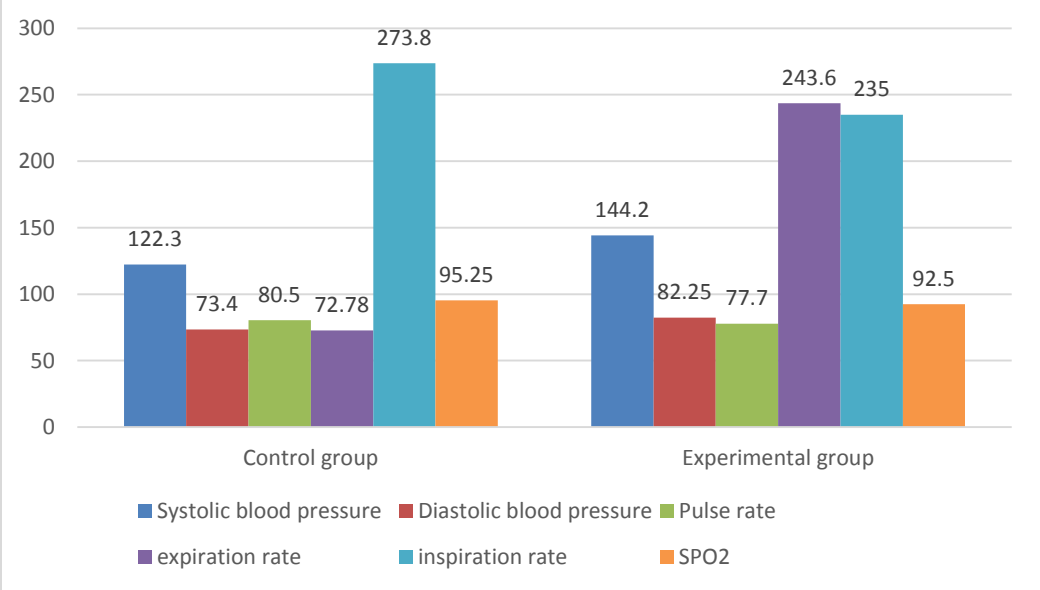
Effect of cement particles on blood pressure, expiration rate, inspiration rate and SPO_2 of control and workers with 0 -5 years of exposure

Table 2 shows comparison between the cardiopulmonary parameters of the experimental groups (0-5 years of exposure of cement workers) and the control groups, the non-cement workers. There was a significant increase in systolic blood pressure, diastolic blood pressure, expiration rate and inspiration rate, and a significant decrease in pulse rate and SPO_2 of cement workers when compared to the control group (cement workers) ($p<0.05$).

Table 2: Showing the Mean ± SD of the blood pressure, expiration rate, inspiration rate and SPO_2 of control and workers with 0 –5 years of exposure

Parameters	Control group	Experimental group (0-5 years)
Systolic blood pressure	122.3 ± 9.46^{a}	144.2 ± 10.8^{ab}
Diastolic blood pressure	73.4 ± 3.39^{a}	82.25 ± 6.14^{ab}
Pulse rate	80.5 ± 9.65^{a}	77.7 ± 7.44^{ab}
Expiration rate	72.78 ± 4.18	243.60 ± 30.60^{ab}
Inspiration rate	273.8 ± 81.4^{a}	235.0 ± 63.9^{ab}
SPO_2	95.25 ± 4.68^{a}	92.5 ± 8.2^{ab}

Values are expressed in Mean ± Standard, n=200. Values not sharing the same superscript in the same row differ significantly ($p<0.05$). Values sharing the same superscript in the same row are statistically significant ($p<0.05$)



Comparison between the cardiopulmonary parameters of control group and experimental group (0–5 years). From Figure 2 above, it was observed that there was a significant difference between the control group and experimental group across all parameters studied. There was a significant increase in expiration rate and decrease in inspiration rate when compared with the control group.

Effect of cement particles on Anthropometric, FVC, $FEF_{25–75\%,}$ FEV_1, FEV_1/FVC and MVV **of control and workers with less than five (0-5) years of exposure**

Table 3 highlights the FVC, FEF25-75%, FEV1, FEV1/FVC, and MVV differences between cement workers and their matched control group. FVC and MVV levels were much lower among cement depot workers who had been exposed for less than five years. There was no significant difference in the means of any other $FEF_{25-75\%}$, FEV1, or FEV1/FVC values between the groups.

Table 3: Showing the Mean ± SD of the Anthropometric, FVC, $FEF_{25–75\%}$, FEV_1, FEV_1/FVC and MVV value for cement workers with duration of exposure less than five years compared with their matched controls.

Parameters	Control group	Experimental group (0 - 5 years)	*P-value*
Age (years)	27.25 ± 2.23	28.51 ± 2.98	NS
Height (cm)	158.90 ± 1.43	160.10 ± 1.67	NS
Weight (kg)	65.20 ± 3.76	66.80 ± 2.38	NS
FVC (litres)	3.80 ± 0.11	4.10 ± 0.25	0.05
$FEF_{25–75\%}$ (litres/s)	4.61 ± 0.55	4.70 ± 0.60	NS
MVV (litres/min)	110.6 ± 10.06	139.4 ± 10.03	0.01
FEV_1 (litres)	3.01 ± 0.29	3.30 ± 0.26	NS
FEV_1/FVC (%)	98.62 ± 3.29	80.49 ± 3.74	NS

Values are expressed in Mean ± Standard, n=200. Values are presented as Mean ± SEM; N S = non-significant.

Effect of cement particles on Anthropometric, FVC, $FEF_{25–75\%}$, FEV_1, FEV_1/FVC and MVV of control and workers with greater than five (5-10) years of exposure

Cement depot workers exposed for more than 5 years had significantly lower FVC, FEV1, and MVV compared to their matched controls (Table 4). However, there was no significant difference in FEV1/FVC, PEF, or FEF25-75% between these workers and controls. There were no significant changes in age, height, or weight between the control and experimental groups.

Table 4: Showing the Mean ± SD of the Anthropometric, FVC, $FEF_{25–75\%}$, and MVV data for cement mill workers with duration of exposure for greater than 5 years compared with their matched controls.

Parameters	Control group	Experimental group (greater than 5 years)	*P-value*
Age (years)	30.24 ± 2.61	31.20 ± 3.05	NS
Height (cm)	172.21 ± 3.02	173.32 ± 3.16	NS
Weight (kg)	59.49 ± 2.51	62.00 ± 2.01	NS
FVC (litres)	4.42 ± 0.12	5.41 ± 1.21	0.001
$FEF_{25–75\%}$ (litres/s)	3.75 ± 0.25	3.77 ± 0.30	NS
MVV (litres/min)	101.22 ± 5.83	140.40 ± 5.52	0.001
FEV_1 (litres)	3.57 ± 0.12	4.35 ± 0.39	0.001
FEV_1/FVC (%)	80.77 ± 4.26	80.41 ± 2.88	NS

Values are expressed in Mean ± Standard, n=200. Values are presented as Mean ± SEM; NS = non-significant.

Discussion:

Chronic exposure to cement dust has been reported to lead to greater prevalence of various clinical conditions which includes both respiratory and cardiovascular systems involvement.[7] These conditions are consistently associated with the degree of exposure. Regular use of appropriate personal protective equipment, if available at the work site could protect the cement factory workers from adverse health effects. The main route of entry of cement dust particles in the body is the respiratory tract or the gastrointestinal tract or both by inhalation or swallowing. This has been identified as a skin irritant, which causes itching, skin allergy, boils, and burn.The result of this present study shows the effect of exposure of cement particle on the male workers. From the results obtained, it shows a significant ($p<0.05$) increase and decrease (Table 1) in systolic blood pressure, diastolic, purse rate, peak expiratory rate, inspiratory rate and SpO_2 among cement workers when compared to the control.

This study showed that there was a significant increase in systolic and diastolic blood pressure of cement factory workers in comparison to the control group. There is a possibility that once particulate matter are deposited in the lungs, pollutants may trigger an inflammatory response and induce oxidative stress through the generation of reactive oxygen species (ROS), the ultrafine particles can penetrate through the alveoli and cause injury to the cardiovascular system The ROS and pro-inflammatory cytokines released in the bloodstream to affect automatic cardiac control (heart rate, heart rate variability and cardiac contractility). The potential toxicity of cement dust particles may involve ROS formation, oxidative damage and inflammation and cause harm to the cardiovascular system.[11] This is in agreement with the work of Gong *et al*.[12], who observed that there is an increase in the systolic blood pressure in healthy subjects on exposure to PM 2.5. This is also related to the result obtained by Urch *et al*.[13], who observed a significant increase of about 6mmHg in subjects exposed to particulate matter.

In the present study, there were also observed significant increase in the expiration and inspiration rate of cement workers when compared with non-workers. This suggests that chronic cement dust exposure impairs lung function. It agrees with the findings of Alakija *et al.*[14] who first reported "Cement factory lung disease" in Nigeria and those of others elsewhere.[10, 15]

The findings of this study also showed that there were observed significant decrease in pulse rate and SPO_2 of cement factory workers in comparison with non-workers. Low blood oxygen saturation, or hypoxaemia, is an indicator of severe illness including pneumonia and sepsis, and has been identified as a predictor for morbidity and mortality in individuals with respiratory illness. [15, 16] This result is similar to the reports by Merenu *et al.*[17] who studied the effect of cement dust exposure on lung function among residents of Kalambaina Community in Sokoto State, Nigeria.

The results of the present study suggest that chronic exposure to cement dust has deleterious effect on the lungs. However the exact mechanism (s) by which it does this is unknown. For instance it is yet to be determined whether these effects are due directly to cement dust or mediated by a metabolic product of cement dust. It will be interesting to further investigate this.

In the present study, the workers were suffering from varied health problems, which was relatively more than the general population. It suggests the cement factory workers were exposed to the dust in the environment, with minimum or no protective equipment. The observed significant difference in the cardiopulmonary parameters of cement workers and non-workers, also, our result further suggests that chronic exposure to cement dust impairs lung function and this corroborate earlier report by Ovuakporaye *et al.*[18] that prolong exposure to gas impact on lung function. This finding is also in consonant with Ovuakporaye et al.[19-21] that prolong exposure to pollutants (gas flare) impact on cardiopulmonary parameters[22,23].

Our research discovered a duration response effect and discovered that long-term exposure to cement dust dramatically reduced lung function. Meo et al. [24] also found that the mean values for FVC, FEV1, and MVV were considerably lower in cement depot workers, implying a link between exposure duration and lung function measures. Cement mill workers showed considerably poorer FVC, FEV1, and PEF than unexposed patients, according to Al-Neaimi et al. [25]. Nordby et al. [26] found that when exposed to the greatest level of cement dust, FEV1 decreased with an exposure-response connection. FVC and FEV1 were considerably lower among cement production workers but not among controls, according to Zelke et al. [27]. According to Olerue [28] the lung function metrics FVC and FEV1 decreased with length of employment in the cement sector, but this was not statistically significant. Our findings reveal that the duration of occupational exposure to cement dust causes a significant decline in FVC and FEV1. Olerue's [28] selection criteria were minimal, which could explain the non-significant change in lung function measures.

It is our recommendation that to safeguard the health of workers and the host community, cement factory management should embark on safety training in work environment and conduct health education on hazards of exposure to cement dust, safety precautions and practices. There should be acquisition of effective protective gadgets and ensure compliance with their usage. Also, there is need for regular and periodic monitoring of cement dust level in and around the factory environment, and containment of dust emission by the use of dust filters.

References

[1] Ojieh AE, Ugorji AE, Ovuakporaye IS, Ewhre OL, Ossai NR. Comparative evaluation of hypoglycemic properties of raw and boiled Allium cepa in alloxan-Induced Diabetes mellitus rats. Pharmaceutical and Biosciences Journal. 2016 Jun 20:38-44.

[2] Chijiokwu EA, Nwangwa EK, Oyovwi MO, Naiho AO, Emojevwe V, Ohwin EP, Ehiwarior PA, Ojugbeli ET, Nwabuoku US, Oghenetega OB, Ogheneyoma OO. Intermittent fasting and exercise therapy abates STZ-induced diabetotoxicity in rats through modulation of adipocytokines hormone, oxidative glucose metabolic, and glycolytic pathway. Physiological Reports. 2022 Oct;10(20):e15279.

[3] Agbonifo-Chijiokwu E, Nwangwa KE, Oyovwi MO, Ben-Azu B, Naiho AO, Emojevwe V, Ohwin EP, Ehiwarior AP, Ojugbeli ET, Nwabuoku SU, Moke EG. Underlying biochemical effects of intermittent fasting, exercise and honey on streptozotocin-induced liver damage in rats. Journal of Diabetes & Metabolic Disorders. 2023 Jan 4:1-3.

[4] Chijiokwu EA, Nwangwa EK, Oyovwi MO, Ben-Azu B, Naiho AO, Moke EG, Emojevwe V, Ehiwarior PA, Nwabuoku US. Possible homeostatic, glucose uptake mechanisms and hepato-pancreatic histological effects of intermittent fasting, exercise, starvation, and honey in streptozotocin-induced diabetes in rats. Nutrire. 2023 Jun;48(1):1-4.

[5] Queen Eiza Bisi Ozegbe, **Oyovwi Mega Obukohwo,** Gideon Nimedia Aitokhuehi, Adesoji Adedipe Fasanmade, Lawrence Dayo Adedayo, and Onome Bright Oghenetega (2023). High dietary consumption of iodine induced thyroid cytotoxicity in diabetic intoxicated rats and oxidonitrergic stress in non-diabetic rats Songklanakarin J. Sci. Technol. 45 (1), 131–137.

[6] AbuDhaise BA, Rabi AZ, Al Zwairy MA, El Hader AF, El Qaderi S. Pulmonary manifestations in cement workers in Jordan. International journal of occupational medicine and environmental health. 1997 Jan 1;10(4):417-28.

[7] Adeyanju E, Okeke CA. Exposure effect to cement dust pollution: A mini review. SN Applied Sciences. 2019 Dec;1(12):1572.

[8] Priyanka R, Mishra RM, Sarita P. Quantifying the Cement Air Pollution related Human Health diseases in Maihar city, MP, India. Research Journal of Recent Sciences ISSN.;2277:2502.

[9] Mwaiselage J, Moen B, Bråtveit M. Acute respiratory health effects among cement factory workers in Tanzania: an evaluation of a simple health surveillance tool. International archives of occupational and environmental health. 2006 Jan;79:49-56.

[10] Meo SA, Al-Drees AM, Al Masri AA, Al Rouq F, Azeem MA. Effect of duration of exposure to cement dust on respiratory function of non-smoking cement mill workers. International journal of environmental research and public health. 2013 Jan;10(1):390-8.

[11] Emmanuel TF, Ibiam UA, Okaka AN, Alabi OJ. Effects of cement dust on the hematological parameters in Obajana cement factory workers. Eur Sci J. 2015;11(27):256-66.

[12] Burwell-Naney K, Wilson SM, Tarver SL, Svendsen E, Jiang C, Ogunsakin OA, Zhang H, Campbell D, Fraser-Rahim H. Baseline air quality assessment of goods movement activities before the Port of Charleston expansion: A community–university collaborative. Environmental Justice. 2017 Feb 1;10(1):1-0.

[13] Liu L, Urch B, Poon R, Szyszkowicz M, Speck M, Gold DR, Wheeler AJ, Scott JA, Brook JR, Thorne PS, Silverman FS. Effects of ambient coarse, fine, and ultrafine particles and their biological constituents on systemic biomarkers: a controlled human exposure study. Environmental health perspectives. 2015 Jun;123(6):534-40.

[14] Alakija W, Iyawe VI, Jarikre LN, Chiwuzie JC. Ventilatory function of workers at Okpella cement factory in Nigeria. West African journal of medicine. 1990 Jul 1;9(3):187-92.

[15] Al-Neaimi YI, Gomes J, Lloyd OL. Respiratory illnesses and ventilatory function among workers at a cement factory in a rapidly developing country. Occupational Medicine. 2001 Sep 1;51(6):367-73.

[16] V

[17] Meo SA, Azeem MA, Ghori MG, Subhan MM. Lung function and surface electromyography of intercostal muscles in cement mill workers. International journal of occupational medicine and environmental health. 2002 Jan 1;15(3):279-87.

[18] Merenu IA, Mojiminiyi F, Njoku CN, Ibrahim M. The effect of chronic cement dust exposure on lung function of cement factory workers in Sokoto, Nigeria. African journal of biomedical research. 2007;10(2).

[19] Ovuakporaye S. Effect of prolong exposure to gas flaring on the mean peak expiratory flow rate of residents in gas flaring community in delta state Nigeria. Journal of Science and Multidisciplinary Research. 2012:16-21.

[20] Ovuakporaye S, John IC, Peter AC. Impact of gas flaring on cardiopulmonary parameters of residents in gas flaring communities in Niger Delta Nigeria. British Journal of Medicine and Medical research. 2016 Jan 1;15(6).

[21] Ovuakporaye SI, Enaohwo MT, Odigie OM, Igweh JC. A Comparative Study on Cardiopulmonary Markers in Gas-Flaring Communities Southsouth nigeria. J Pulm Respir Med. 2019;9(1):10-4172.

[22] Yang, C.Y., Huang, C.C., Chiu, H.F. and Chiu, J.F. (2016). Effects of occupational dust exposure on the respiratory health of Portland cement workers. *Journal of Toxicology and Environmental Health*, 49: 581–588.

[23] Rai, P., Mishra, R.M. and Parihar, S. (2013). Quantifying the Cement Air Pollution related Human Health diseases in Maihar city, MP, India,

[24] Meo SA, Al-Drees AM, Al Masri AA, Al Rouq F, Azeem MA. Effect of duration of exposure to cement dust on respiratory function of non-smoking cement mill workers. Int J Environ Res Public Health. 2013 Jan 16;10(1):390-8. doi: 10.3390/ijerph10010390. PMID: 23325026; PMCID: PMC3564149.

[25] Al-Neaimi YI, Gomes J, Lloyd OL. Respiratory illnesses and ventilatory function among workers at a cement factory in a rapidly developing country. Occupational Medicine. 2001 Sep 1;51(6):367-73.

[26] Nordby KC, Fell AK, Notø H, Eduard W, Skogstad M, Thomassen Y, Bergamaschi A, Kongerud J, Kjuus H. Exposure to thoracic dust, airway symptoms and lung function in cement production workers. European Respiratory Journal. 2011 Dec 1;38(6):1278-86.

[27] Zeleke ZK, Moen BE, Bråtveit M. Cement dust exposure and acute lung function: a cross shift study. BMC pulmonary medicine. 2010 Dec;10:1-8.

[28] Oleru UG. Pulmonary function and symptoms of Nigerian workers exposed to cement dust. Environmental research. 1984 Apr 1;33(2):379-85.

[29] Ebewore, Solomon Okeoghene (2020). "Rural Folks Perception of Suicide Drivers in rural communities of Delta State, Nigeria: Implications for Societal and Agricultural Security". *Open Agriculture*. **5** (1): 50–62. Doi:10.1515/opag-2020-0005. ISSN 2391-9531