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Research Article
Air Quality and Health of Cement Dealers in OBIO/Akpor Local Government Area of Rivers State, Nigeria

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Abstract

Background and Objective: The quality of air that it breathe plays a crucial role on the state of health of any individual and how well that individual will be in the long run. The need for a clean air ignited the need for this study. The study objectives includes to assess the indoor air quality of cement shops in the study area, determine if the air quality of the cement dealers shop in the area vary with WHO standards, identify the ailments associated with the cement dealers in the area and examine the impact of cement dust exposure on health of the cement dealers. **Materials and Methods:** Quasi-experimental and cross sectional research designs were used in carrying out the study, field measurements for air quality parameters such as SO_2, NO_2, CO, CH_4, NH_3, PM2.5 and PM10 was done using standard equipments. Copies of questionnaires were also distributed amongst the cement dealers to ascertain ailments associated with the cement dealers in the area as to examine the impact of cement dust exposure on health. **Results:** All the pollutants examined were found to be within the World Health Organization permissible limit apart from CO and PM 10 which are above the permissible levels in all the sampled cement shops. Statistically, the study reported that there is no statistically significant variation in air quality of the cement shops with WHO standards for air quality and that there is a statistically significant impact of cement dust exposure on health of cement dealers. **Conclusion:** It was therefore recommended that, there is need for a comprehensive check up for all cement dealers as to reduce the risk of developing terminal ailments and that air quality monitoring for every level of occupation should be encouraged as a way of ensuring a safe working environment devoid of risk.

Key words: Air quality, health risk, health, cement, cement dealers, air pollution

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The damaging effect of contact with properties of cement dust on human organs has long been known and was first reported in 1700[1]. The cement industry is one of the most basic industries involved in the development of a country. This is because the industry plays very active role in the production of building materials globally[2]. Due to the high demand for this product in the Nigerian market, factories who are involved in production of cement have as well increased each passing year to meet the demand and this have given rise to an increase in the use and production of cement in Nigeria in recent times. Amidst the role in building and development, the cement industries have contributed in large quantity in the pollution of the air especially in the places of their production and other neighboring areas, this have brought about diverse impacts on health and the natural environment. According to Bada *et al.*[3], the cement industry is one of the oldest and the most important industries in Nigeria's developing economy as well as one of the greatest environmental polluter.

Cement industry have been identified as one of the most striving industry in the area of manufacturing, due to the nature of its production the workers are eventually exposed to particles of dust at every stage of the production process.

Particle size analysis of cement dust shows that it is within sizes that can be taken in the air as breath and this could pose severe consequences on the individual arising from occupational exposure to cement dust. This scenario has been noted to bring about different health hazards that are responsible for several diseases connected to respiration in the human system[4]. The main environmental issues associated with cement production are emissions to air and energy use. Exposure to cement dust for a short period may not cause serious problem, however prolonged exposure can cause serious irreversible damage to plants and animals[5].

In a study on air quality and health of persons around cement factory in Onne, it was revealed that the exposure of people to cement dust have very much deleterious effects in their systems. Cement dust as reported contains some molecules which have far reaching health implication amongst which are 60-67% calcium oxide, 17-25 silicon oxide (SiO_2) and 3-5% aluminium (Al) oxide with some amount of iron oxide, chromium (Cr), potassium, sodium, sulphur and magnesium oxide, this is as reported by Richard *et al.*[6] and Gbadebo and Bankole[7]. It has also been reported that exposure to cement dust that contains aluminum (Al), iron (Fe), calcium (Ca) and silicon (Si) have brought about dis-functioning of lungs in persons who have been exposed to cement dust[8]. Several studies have been done[9-13], which revealed the effect of cement mainly around areas of production but there are limited evidences of the impact on transit and the end users of which the dealers are a part. Therefore, this study is poised to investigate the apparent impacts of cement pollution on the health of cement dealers in relation to air quality parameters in the dealers shop.

MATERIALS AND METHODS

Study area: This study was conducted in the month of April, 2019 in Ogbogoro, Rumualogu and Rumuosi communities in Obio/Akpor Local Government Area of Rivers state, Nigeria. The area is located within the tropics and therefore experiences significantly rainfall and less period of dryness. The communities are well drained, this is as a result of its location very close to the New Calabar river and other tributaries to the river which also support in draining water from the area. The soils of the area are very fertile, although there is a very low use of the soil in terms of agriculture due to low farming activities.

Sampling procedure: The sample population for the study was achieved through a total census of cement dealers in the selected (Table 1).

Arising from the table above, 21 cement dealers were sampled as the population for the study. The choice of 30% of the population is in agreement with Oyegun[14], who stated that 30% of a population can be used as sample size for a study. Air quality data was also collected purposively from three cement dealers shops one in each of the selected community. This was actually done in the cement dealer's chairperson's shop in each of the communities selected and at the time when cement were available in the shop, this was done to ascertain the air quality in shops and its implication on the dealers health. This research made use of the primary data sources which was mainly the collection of air quality measurements from the shops of sampled cement dealers in the study location alongside questionnaire which was used to illicit information with regards to the health status of selected cement dealers. For air quality of the area, the Portable Real-Time Monitoring Technique was used in ambient air (outdoor-breathing zone). Air samples were automatically analyzed for Nitrogen dioxides (NO_2), Oxides of carbon (CO), Sulphur dioxide (SO_2), Methane (CH_4), Ammonia (NH_3) and Particulate Matter (PM) content. Data collection for the gases was done with two Industrial Scientific's MX6 IBRID™ gas monitors. The gases were determined by the

instrument using different sensor technology and the other gases with the use of Electro-chemical sensor technology. For each of the gases measured, gas concentration readings were taken from the instrument's monitor.

Particulate Matter (PM) data was collected in the cement shops with Met One GT-321 for PM 2.5 and PM 10 and it is measured in micrograms per cubic meter. The sampler takes a total of 10 samples for each micron size after which it averages them to represent the result per micron size per location. The air quality was done for morning (7.00 am) and evening (4.00 pm), respectively within the month of April, 2018.

Statistical analysis: Tables were used in the presentation of the data collected for the study. The first study hypothesis which state that air quality of the cement shops vary with WHO standards for air quality was tested using the One Way Analysis of Variance (ANOVA), while the second hypothesis which states that cement dust exposure in the area has no impact on health of cement dealers was tested using the Chi-Square statistical tool.

RESULTS

The air quality data collected during the morning hour in three cement shops in the selected communities as reported in Table 2 showed that sulphur dioxide concentration was high in the cement shop at Rumualogu with a value of 220 μg m^{-3} and then in Rumuosi with a value of 80 μg m^{-3} and Ogbogoro which had the lowest value 40 μg m^{-3}. Nitrogen oxides report showed that the highest of its concentration was in the cement shop in Rumualogu with a value of 140 μg m^{-3}, this was followed by the cement shop located in Rumuosi with a value of 60 μg m^{-3} and lastly the cement shop in Ogbogoro with a value of 20 μg m^{-3}. Carbon monoxide concentration report showed that the CO value was also highest in the cement shop in Rumualogu accounting for more at 100 μg m^{-3}, thereafter cam the cement shop in Rumuosi accounting for 70 μg m^{-3} and lastly the cement shop in Ogbogoro accounting for 50 μg m^{-3}.

As reported by the study there was a much concentration of methane in the cement shop located in Rumuosi than the others as it accounted for 38% this was followed by the cement shop in Ogbogoro accounting for 14% of methane, the shop in Rumualogu accounted for least with a value of 11% methane.

Ammonia as reported had the highest value in the cement shop in Rumuosi accounting 70 μg m^{-3} this was followed by the cement shop in Ogbogoro accounting for 40 μg m^{-3} and then the cement shop in Rumualogu accounting for 20 μg m^{-3}. Particulate matter reports showed that PM 2.5 was highest in the cement shop in Rumualogu accounting for 22.7 μg m^{-3}, this followed by the cement shop in Ogbogoro accounting for 20.1 μg m^{-3} and then the cement shop in Rumuosi which accounted for 18.6 μg m^{-3}. Pm 10 as revealed a high concentration level in Rumualogu accounting for 91.5 μg m^{-3}, this was followed by that of Ogbogoro accounting for 87.2 μg m^{-3} and last the cement shop in Rumuosi which accounted for 79.3 μg m^{-3} concentration level. The air quality data collected during the evening h in three cement shops in the selected communities as shown on Table 3 reports that sulphur dioxide concentration was high in the cement shop at Rumuosi with a value of 100 μg m^{-3} and then in Ogbogoro with a value of 60 μg m^{-3} and Rumualogu which had the lowest value 20 μg m^{-3}. Nitrogen oxides report showed that the highest of its concentration was in the cement shop in Rumualogu with a value of 170 μg m^{-3}, this was followed by the cement shop located in Rumuosi with a value of 140 μg m^{-3} and lastly the cement shop in Ogbogoro with a value of 43 μg m^{-3}. Carbon monoxide concentration report showed that the CO value was also highest in the cement shop in Ogbogoro accounting for more at 480 μg m^{-3},

Table 1: Communities and population of cement dealers

Communities	Population	Sample population (30%)
Ogbogoro	23	7
Rumuosi	31	9
Rumualogu	16	5
Total	70	21

Field work (2018)

Table 2: Air quality results for cement shops in the morning

	Communities		
Parameters	Ogbogoro	Rumuosi	Rumualogu
SO_2 (μg m^{-3})	40	80.0	220.0
NO_2 (μg m^{-3})	20	60.0	140.0
CO (μg m^{-3})	50	70.0	100.0
CH_4 (%)	14	38.0	11.0
NH_3 (μg m^{-3})	40	70.0	20.0
Particulate matter			
PM 2.5 (μg m^{-3})	20.1	18.6	22.7
PM 10 (μg m^{-3})	87.2	79.3	91.5

Source: field work (2018)

Table 3: Air quality results for cement shops in the evening

Parameters	Ogbogoro	Rumuosi	Rumualogu
SO_2 (μg m^{-3})	60.0	100.0	20.0
NO_2 (μg m^{-3})	43.0	140.0	170.0
CO (μg m^{-3})	480.0	240.0	180.0
CH_4 (%)	30.0	27.0	30.0
NH_3 (μg m^{-3})	40.0	65.0	43.0
Particulate matter			
PM 2.5 μg m^{-3}	19.2	20.1	16.4
PM 10 μg m^{-3}	42.1	36.7	29.8

Field work (2018)

Table 4: Mean air quality value for cement shops in the selected communities

Parameters	Ogbogoro	Rumuosi	Rumualogu
SO_2 (μg m^{-3})	50.0	90.0	120.0
NO_2 (μg m^{-3})	30.0	100.0	160.0
CO (μg m^{-3})	280.0	160.0	140.0
CH_4 (%)	22.0	32.5	20.5
NH_3 (μg m^{-3})	40	67.5	31.5
Particulate matter			
PM 2.5 (μg m^{-3})	19.6	19.4	19.4
PM 10 (μg m^{-3})	64.7	58.0	60.7

Field work (2018)

thereafter came the cement shop in Rumuosi accounting for 240 μg m^{-3} and lastly the cement shop in Rumualogu accounting for 180 μg m^{-3}.

As reported by the study, concentration of methane was the same in the cement shop located in Ogbogoro and Rumualogu as they accounted for 3% each, this was followed by the cement shop in Rumuosi which accounted for 27% of methane. Ammonia as reported had the highest value in the cement shop in Rumuosi accounting for 65 μg m^{-3} this was followed by the cement shop in Rumualogu accounting for 43 μg m^{-3} and then the cement shop in Ogbogoro accounting for 40 μg m^{-3}

Particulate matter reports showed that PM 2.5, was highest in the cement shop in Rumuosi accounting for 20.1 μg m^{-3}, this followed by the cement shop in Ogbogoro accounting for 19.2 μg m^{-3} and then the cement shop in Rumualogu which accounted for 16.4 μg m^{-3}. PM10 as reported revealed a high concentration level in Ogbogoro accounting for 42.1 μg m^{-3}, this was followed by that of Rumuosi accounting for 36.7 μg m^{-3} and lastly the cement shop in Rumualogu which accounted for 29.8 μg m^{-3} concentration level.

Table 4 show the mean air quality value for cement shops in the selected communities. As reported it is observed that sulphur dioxide concentration was high in the cement shop at Rumualogu with a value of 120 μg m^{-3} and then in Rumuosi with a value of 90 μg m^{-3} and Ogbogoro which had the lowest value 50 μg m^{-3}. Nitrogen oxides report showed that the highest of its concentration was in the cement shop in Rumualogu with a value of 160 μg m^{-3}, this was followed by the cement shop located in Rumuosi with a value of 100 μg m^{-3} and lastly the cement shop in Ogbogoro with a value of 30 μg m^{-3}. Carbon monoxide concentration report showed that the CO value was also highest in the cement shop in Ogbogoro accounting for more at 280 μg m^{-3}, thereafter came the cement shop in Rumuosi accounting for 160 μg m^{-3} and lastly the cement shop in Rumualogu accounting for 140 μg m^{-3}.

As reported by the study concentration of methane was highest in Rumuosi with a value of 32.5%, this was followed by Ogbogoro which accounted for 22% methane concentration and lastly the cement shop located in Rumualogu as it accounted for 20.5%. Ammonia as reported had the highest value in the cement shop in Rumuosi accounting for 67.5 μg m^{-3} this was followed by the cement shop in Ogbogoro accounting for 40 μg m^{-3} and then the cement shop in Rumualogu accounting for 31.5 μg m^{-3}.

Particulate matter reports showed that PM 2.5 was highest in the cement shop in Ogbogoro accounting for 19.6 μg m^{-3}, while the cement shop in Rumuosi and Rumualogu accounted for 19.4 μg m^{-3} each. PM10 as reported revealed a high concentration level in Ogbogoro accounting for 64.7 μg m^{-3}, this was followed by that of Rumualogu accounting for 60.7 μg m^{-3} and lastly the cement shop in Rumuosi which accounted for 58 μg m^{-3} concentration level.

Table 5 shows the reports of air quality measurement in cement shops and the World Health Organization limits for air quality. From the report it is shown that sulphur dioxide in the three locations sampled are within acceptable limits. In the case of Nitrogen dioxide it is reported that in the three locations also sampled the measurements falls within acceptable WHO limits. The report of carbon monoxide in the three sampled locations was higher than the permissible level of 100 μg m^{-3}. This therefore, reported that the dealers may be exposed to carbon monoxide based illness as a result of long term exposure. The study further reported that ammonia concentration in the cement dealers shop reveals that the concentration of ammonia in all the shops in the three sample locations is within acceptable limits. Particulate matter as reported revealed that PM 2.5 in the cement dealers shops was within acceptable limits while in the case of PM10, the study reported that in all the cement dealers shop its concentration was above acceptable limits. From the reports generally, it is noted that air quality in the cement dealers shop is unhealthy and therefore there is a high tendency of health related challenges amongst the cement dealers.

Results on response to questionnaire: The Table 6 showed the illness suffered by cement dealers, from the analysis, 2 respondents representing (9.5%) of the respondents stated that malaria was a very common illness they have suffered, only one of the respondent representing (4.7%) of the total population stated that he had suffered typhoid, 5 (23.6%) respondents stated that cough and catarrh was another prevalent illness that they have suffered, skin/eye irritation as

Table 5: Air quality in cement shops and WHO standards

Parameters	Ogbogoro	Rumuosi	Rumualogu	WHO limit (μg m^{-3})
SO_2 (μg m^{-3})	50.0	90.0	120.0	500
NO_2 (μg m^{-3})	30.0	100.0	160.0	200
CO (μg m^{-3})	280.0	160.0	140.0	100
CH_4 (%)	22.0	32.5	20.5	-
NH_3 (μg m^{-3})	45.0	62.0	42.0	100
Particulate matter				
PM 2.5 (μg m^{-3})	19.6	19.4	19.4	25
PM 10 (μg m^{-3})	64.7	58.0	60.7	50

Source: Field work (2018), Source: WHO[15]

Table 6: Illness associated with air pollutants amongst the cement dealers

Response	Frequency	Percentage
Malaria	2	9.5
Typhoid	1	4.7
Cough and catarrh	5	23.8
Skin/Eye irritation	6	28.6
URTI	7	33.3
Total	21	100.0

Field work (2018)

Table 7: Awareness of cement dust effect on health

Response	Frequency	Percentage
Yes	18	85.7
No	3	14.3
Total	21	100.0

Field work (2018)

Table 8: Cement dust exposure impacts health of cement dealers

Response	Frequency	Percentage
Strongly agreed	14	66.7
Agreed	4	19.0
Strongly disagreed	2	9.5
Disagreed	1	4.8
Total	21	100.0

Field work (2018)

an option of prevalent illness amongst the cement dealers and was backed up by 6 respondents representing (28.6%), while 7 (33.3%) respondents of the total study population agreed that upper respiratory tract infection (URTI) was identified as the common illness suffered by cement dealers.

Table 7 showed the level of awareness of air pollution effects on cement dealers in the area, 18 respondents representing (85.7%) of the total study stated that they are aware of air pollution effect arising from air pollution while 3 respondents representing (14.3%) of the study population stated that they are not aware of any effect of air pollution in the area.

Furthermore, it was observed that 14 respondents representing (66.7%) strongly agreed that exposure to cement dust, impacts the health of cement dealers, 4 (19%) agreed, 2(9.5%) strongly disagreed and 1(4.8%) disagreed (Table 8).

Hypotheses testing: The following hypotheses of the study were tested in this section:

- **Hypothesis one:** There is no statistically significant variation in air quality of the cement shops with WHO standards for air quality

The ANOVA revealed that calculated F-statistic value for the analysis is 0.68719 while the critical value is 3.098391. Therefore, since the calculated F-statistic value of 0.68719 is less than the critical value of 3.098391 at F_{23}^{3} degree of freedom, hence the null hypothesis H_0 of no significant variation is accepted and the alternate hypothesis H_1 is rejected. From the result the study has revealed that there is no statistically significant variation in air quality of the cement shops with WHO standards for air quality (Table 9).

- **Hypothesis two:** There is no statistically significant impact of cement dust exposure on health of cement dealers. This hypothesis is tested using the Chi-Square statistical tool (Table 10)

It analyzed that X^2 calculated value is 171.8 while the critical value at 1 degree of freedom and 95% significant level is 3.841.

Since the calculated chi-square statistic value of 171.8 is greater than the critical value of 3.841, this therefore implies that we reject the null hypothesis which states that there is no statistically significant impact of impact of cement dust exposure on health of cement dealers and accept the alternate hypothesis which states that there is a statistically significant impact of impact of cement dust exposure on health of cement dealers.

DISCUSSION

The study revealed the air quality of the identified cement shops under investigation, from the air quality assessment it was observed that all the parameters tested amongst which

Table 9: Result of ANOVA for variation in air quality of the cement shops with WHO standards for air quality

Source of variation	SS	Df	MS	F	p-value	F-crit
Between groups	26053.95	3	8684.649	0.68719	0.570385	3.098391
Within groups	252758.20	20	12637.910			
Total	278812.10	23				

Table 10: Chi-Square analysis for impact of cement dust on health of cement dealers

Response	Frequency	Percentage
Strongly agreed	14 (52.5)	66.7
Agreed	4 (52.5)	19.0
Strongly disagreed	2 (52.5)	9.5
Disagreed	1 (52.5)	4.8
Total	21	100.0

are SO_2, NO_2, CO, CH_4, NH_3, PM2.5 and PM10 were higher in the morning h than the evening h, this was due to the fact that the day was just beginning and activities of the day had no began hence, the air was at a state of rest.

The study also revealed that all the pollutants assessed were within the world health organization permissible limit apart from CO and PM 10 which were above the permissible levels in all the sample cement shops. The implication of these as reported by other studies on human health is that CO brings about headache, dizziness, vomiting and nausea. Exposure to high level of CO makes an individual unconscious and may bring about death, for the cement dealers who are exposed to CO concentration of a long period of time may cause heart diseases and other health related challenges. In the case of PM 10 it is reported that it include inhalable particles that are small enough to penetrate the thoracic region of the respiratory system. The health effects of inhalable due to exposure over both the short term (hours, days) and long term (months, years) are respiratory and cardiovascular morbidity, such as aggravation of asthma, respiratory symptoms and an increase in hospital admissions and that mortality from cardiovascular and respiratory diseases and from lung cancer[15].

On the ailments suffered by cement dealers, the study revealed that cough and catarrh which accounted for 23.8% of ailments, skin/eye irritation accounted for 28.6% of ailments and upper respiratory tract infections accounted for 33.3% of ailments suffered by cement dealers in the study area. This finding is in agreement with Mehraj and Bhat[2].

The study also reported that 85.7% of the cement dealers were aware of the effect of exposure to cement in the study area and that 66.7% of them strongly agreed that exposure to cement dust has significant impact on their health. Statistically, the study reported that there is no statistically significant variation in air quality of the cement shops with WHO standards for air quality and that there is a statistically significant impact of cement dust exposure on health of cement dealers. The implication of the study is that since every occupation has its associated dangers, there is therefore a need to curtail the continuous exposure to occupational related hazards for the sustenance of life.

CONCLUSION AND RECOMMENDATION

The continuous exposure of people to an unfriendly and unhealthy environment may bring about a drastic reduction in the productive capacity of the people and subsequent death. Better health is central to human happiness and well-being. However, the recommendations of the study states thus:

- There is need for a comprehensive check up for all cement dealers as to reduce the risk of developing terminal ailments
- Air quality monitoring for every level of occupation should be encouraged as a way of ensuring a safe working environment devoid of risk
- There is need for proper treatment of those infected by any form of the identified ailment so as to ensure that the health of the infected persons is fine

SIGNIFICANCE STATEMENT

The study discovered that the effect of exposure to cement is not only to cement factory workers nor people who reside in the areas close to the cement factory but that due to the toxic nature of cement has the capacity to affect any one who is in contact with it. Empirically, the study revealed that CO and PM 10 are above WHO permissible level. The study concluded that there is a statistically significant impact of impact of cement dust exposure on health of cement dealers.

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