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Medicine

Evaluation of Lung Function and Body Mass Index Changes in Operators of Artisanal Refineries in Rivers State, Nigeria

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Abstract	Original Research Article

The influence of different artisanal refineries in the Niger Delta region is still a significant health, economic and environmental setback. Consequently, the present study comparatively examined the lung function and body mass index changes in operators of artisanal refineries (OAR) in Rivers State, Nigeria. This cross-sectional survey adopted a multi-stage sampling technique (including purposive and snowball tools) to recruit 203 (including 120 OAR-exposed and 83 non-OAR exposed) consenting and apparently healthy adult male and female subjects. With the use of the automated spirometer, the basic pulmonary function indices were recorded from the study subjects. Quantitative data obtained from the subjects were subjected to statistical analyses using the Statistical Package for Social Sciences (SPSS) version 21.0. The result showed that the male control subjects had raised levels of FVC, FEV1 and FEV1/FVC compared to those of the male OAR subjects; although, only those of FEV1 were significant (P<0.0.5). Notably, the FEV6 of the male OAR was markedly (P<0.05) elevated compared to that the male control. Again, the FEV1/FVC level in the female OAR group was found to be significantly (P<0.05) raised compared to their female control counterparts. In conclusion, the operators of artisanal refineries may thus be predisposed to some forms of restrictive respiratory disorders with time.
Keywords: Artisanal refineries operators; Niger Delta region; pulmonary function test; body mass index.

INTRODUCTION

Artisanal crude oil refining in the Niger Delta has been described to significantly exert adverse effects on respiratory health risks to the surrounding population (Ephraim-Emmanuel *et al.,* 2023; Eli *et al.,* 2025). The operation of artisanal refineries often relies on the use of rudimentary equipment to convert crude oil into several products (Richard *et al.,* 2023). In actual fact, unchecked refining operations are known to emit toxic pollutants, such as particulate matter and volatile organic compounds (VOCs), which have been found to contribute to a raised incidence of respiratory diseases like asthma, bronchitis, and chronic obstructive pulmonary disease (COPD) and even cardiovascular disorders (Ugbomeh *et al.,* 2020; Angaye *et al.,* 2024; Tamuno-Opubo *et al.,* 2024). Further, continuous exposure to even biomass combustion has been linked to an elevated incidence of respiratory symptoms, decreased lung function, and an increased likelihood of chronic obstructive pulmonary disease (da Silva *et al.,* 2012). Even though there is a reinforced impact, the loss in pulmonary function caused by such exposure is independent of smoking and is proportional to the duration and magnitude of the exposure (da Silva *et al.,* 2012).

Certainly, lung function, as assessed by pulmonary function tests (PFTs), is an important indicator of the health consequences of chronic smoke exposure (Guo *et al.,* 2018). On the other hand, overly high and low body mass index (BMIs) are linked to respiratory symptoms like cough, asthma, and dyspnea, as well as asthma and COPD (Sun *et al.,* 2024).

A close observation on earlier submissions on the health impact of artisanal refinery operation is on adjacent or non-artisanal refinery operators (Ikezam *et al.*, 2021; Richard *et al.*, 2023; Ephraim-Emmanuel *et al.*, 2024). It is thus, suggestive that the direct health impact on the artisanal refinery operators may be severer. Of course, long-term exposure to hazardous chemicals can lead to chronic illnesses like cancer and cardiovascular disease (Prüss-Ustün *et al.*, 201; Eli *et al.*, 2025). Consequently, the present study set out to examine lung function and body mass index changes in operators of artisanal refineries (OAR) in Rivers State, Nigeria.

MATERIALS AND METHODS

Research Design
The current investigation employed the cross-sectional survey method as well as multistage sampling techniques to engage artisanal refinery operators in Rivers State.

Study Area
The present research was conducted in Rivers State, with a focus on Port Harcourt and the surrounding upland and riverine communities of the state. Port Harcourt is the capital and largest city of Rivers State, Nigeria (WPR, 2022). This is Nigeria's fifth most populous city, behind Lagos, Kano, Ibadan, and Benin (WPR, 2022). It is situated in the Niger Delta, on the Bonny River. In 2016, the Port Harcourt urban area had an estimated population of 1,865,000, up from 1,382,592 in 2006. The Port Harcourt metropolitan area has nearly twice the population of the urban area, with a United Nations estimate of 3,171,076 in 2021 (WPR, 2021).

Study Population
The current study's primary population consisted of the operators of the scattered artisanal refining sites in the study area. The study included up to 120 artisanal refinery operators and 83 control subjects.

Eligibility Criteria for Subject Selection
1. Individuals between the ages of 18 and 50 years
2. Individuals who have been working in artisanal refinery for six (6) months and above
3. Apparently healthy subjects

Exclusion Criteria
1. Individuals who were less than 18 years old and more than 50 years old
2. Individuals working in an artisanal refinery for less than 6 months
3. Individuals with obvious medical conditions

Sample Size Determination and Sampling Technique
Considering the uniqueness of the study population, the sampling technique available to the researchers was the multistage technique that included purposive and snowball samplings for especially the OAR/actively exposed subjects.

A simple random frame with ten (10) subjects per strata (to ensure equal chances of surveying the subjects) was used to survey 15 different artisanal refinery locations across Rivers State. Exactly 120 OAR-exposed subjects were successfully recruited for the study. Similarly, eighty-three (83%) of the passively exposed (control) subjects lived at least 30 kilometers from any artisanal refinery location. Therefore, 203 male and female (both actively exposed and passively exposed) subjects were recruited for the study drawn from across the state.

Method of Data Collection/Instrumentation
Quantitative data obtained from the study were subjected to statistical analyses.

Samples Collection and Processing
Blood specimen was obtained from the antecubital vein via venepuncture from the subjects after disinfecting the portion with swab (of cotton wool soaked in 70% methylated spirit). This was then dispensed into an SST vacuum tube and then centrifuged for 10 minutes at 1000 rpm. The serum was separated from the blood cells and transferred into plain sample bottle and then frozen at -20 °C in deep freezer until the time for analysis within three hours of collection (Lalongo and Bernardini, 2016).

Pulmonary function Test and Body Mass Index Determination
A lengthened meter rule and standiometer were used to determine the BMI. The classification of BMI as adopted by the present study was stipulated by the World Health Organization (WHO, 2021). The procedure for recording each subject's lung function parameters (Forced Vital Capacity (FVC), Forced Expiratory Volume in first second (FEV1), Forced Expiratory Ratio (FEV1/FVC %) and Peak Expiratory Flow (PEF)) using an electronic spirometer, were as reported by Wanger, (2011) and Ruppel & Enright, (2012).

Statistical Analysis
The numerical data from the study were subjected to statistical analyses using the Statistical Package for Social Sciences (SPSS) version 21.0. The level of statistical significance was determined using independent T- test tool. The p-values less than 0.05 were taken to be statistically significant. And the values were expressed as mean ± standard error of mean (SEM).

Ethical Clearance
The ethical approval for the study was got from the ethical committee of the Rivers State University. Written informed consent was sought from the workers of the artisanal refineries before their inclusion into the study. Participation in the study was voluntary. Anonymity was upheld by using research numbers rather

than names. Data got were kept in confidence in line with ethical principles.
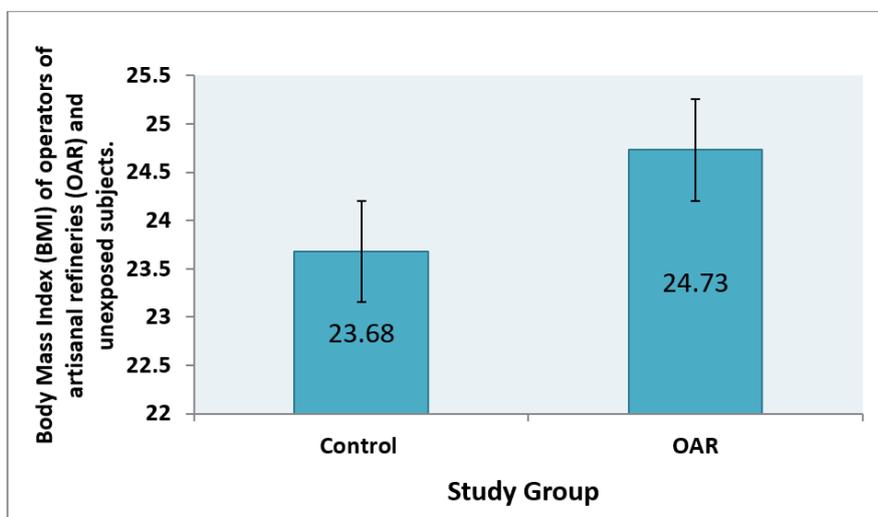
RESULTS

Figure 1: Body Mass Index (BMI) of operators of artisanal refineries (OAR) and unexposed subjects

Values are expressed as Mean ± Standard Deviation (SD); a Significant at P<0.05 when compared to control (or unexposed) subjects.

The data on Figure 1 shows the body mass index of the operators of artisanal refineries (OAR) and their unexposed counterparts. The mean BMI values (OAR= 24.73 ± 4.47 and control or unexposed= 23.68 ± 4.46) of the two groups did not vary significant (p>0.05) when compared.

Table 1: Changes in some lung function indices of operators of artisanal refineries and marketers (OAR) and unexposed subjects

S/N	Parameters	Control (n=83)		OAR (n=120)	
		Male (n=24)	Female (n=58)	Male (n=79)	Female (n=41)
1.	FVC (%)	3.75 ± 1.53	1.80 ± 0.06 [a]	3.25 ± 1.26 [b]	1.82 ± 0.92 [a, c]
2.	FEV1 (%)	4.08 ± 1.15	1.30 ± 0.05 [a]	3.07 ± 1.08 [a, b]	1.71 ± 0.75 [a, c]
3.	FEV6 (l/s)	1.74 ± 0.50	1.80 ± 0.06	3.25 ± 1.26 [a, b]	1.83 ± 0.92 [c]
4.	FEV1/FVC (%)	96.11 ± 15.57	72.31 ± 2.39 [a]	95.82 ± 9.00 [b]	96.17 ± 7.29 [b]

Values are expressed as Mean ± Standard Deviation (SD); a Significant at P<0.05 when compared to male control subjects (or unexposed male) subjects; b Significant at P<0.05 when compared to female control subjects (unexposed female) subjects; c Significant at P<0.05 when compared to male OAR subjects (exposed) subjects.

The changes in some lung function indices of operators of artisanal refineries and marketers (OAR) and unexposed subjects are displayed on Table 1. The values of FVC, FEV6 and FEV1/FVC of the female subjects of the both groups (control and OAR) were mainly seen to be significantly (P>0.05) reduced compared to the respective male counterparts. On the other hand, the male control subjects indicated raised levels of FVC, FEV1 and FEV1/FVC compared to those of the male OAR subjects; although, only those of FEV1 were significant (P<0.0.5). Notably, the FEV6 of the male OAR was markedly (P<0.05) elevated compared to that the male control. Again, the FEV1/FVC level in the female OAR group was found to be significantly (P<0.05) raised compared to their female control counterparts.

DISCUSSION

Quite a lot of speculations have been made about the possible health impact of the activities of these operators of artisanal refineries (OAR) (John and Nnadozie, 2021; Bello and Nwaeke, 2022) but not many have explored as to ascertain the possible direct health effect of these actions on for example, their handlers. Thus, the current study evaluate d the pulmonary functions and BMI changes in operators of artisanal refineries in Rivers State; some useful findings were recorded and discussed below.

The mean BMI value (OAR= 24.73 ± 4.47) was similar to an apparently healthy unexposed subjects (control or unexposed= 23.68 ± 4.46). There was no significant variation in the BMI of the both groups in the study. The inference here is that the OAR subjects may

not have any serious effect on their BMI. Although, People with lower BMI have been reported by a study to be more likely to develop chronic obstructive pulmonary disease (COPD) and have poorer lung function than those with higher BMI (Grigsby *et al.,* 2019). And Sun *et al.,* (2024) noted that, these findings reveal that the risk of small airway obstruction in lower weight individuals warrants further investigation, and that overbearing muscle wasting in such people may also have an impact on their prognosis of COPD.

The lung function indices evaluated include Forced vital capacity (FVC), Forced expiratory volume in one second (FEV_1), Forced expiratory volume in six seconds (FEV_6), the percentage of the FVC expired in one second (FEV_1/ FVC ratio). It was found that the values of FVC, FEV6 and FEV1/FVC of the female subjects of the both groups (control and OAR) were mainly significantly reduced compared to the respective male counterparts. On the other hand, the male control subjects indicated raised levels of FVC, FEV1 and FEV1/FVC compared to those of the male OAR subjects; although, only those of FEV1 were significant.

The evaluation of lung function indices using the spirometric technique helps establish a medical diagnosis when signs or symptoms of disease are evident; the technique is helpful in detecting airflow limitation thus enabling higher precision in the associated diagnosis (Al-Ashkar *et al.,* 2003). In a related opinion, to refine diesel, gasoline, and kerosene from crude oil, artisanal refining uses a simple process that uses a local distillery method and heat from an open fire. It is possible that continuous exposure to these conditions may be responsible for the recorded drop in lung function test the OAR subjects of the present study. This may be true because, smoke inhalation injury is generally linked to the inhalation of thermal or chemical irritants (Rehberg *et al.,* 2009). It is thus suggestive that the OAR's subjects, one, employ the use of standard personal protective equipment (PPE) to help reduce the impact of the hazardous conditions; two, engage in regular medical checks and possible early retirement from such highly hazardous jobs.

CONCLUSIONS
In conclusion, on the changes in some lung function indices of operators of artisanal refineries (OAR) and unexposed subjects: It is possible that continuous exposure to these conditions may be responsible for the recorded drop in lung function test for the OAR subjects of the present study. The values of FVC, FEV1, FEV6, and FEV1/FVC ratio of the exposed subjects had significant reductions compared to those of the unexposed subjects. The operators of artisanal refineries may thus be predisposed to some forms of restrictive respiratory disorders with time.

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