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Assessment of Blood Gas Pattern amongst Artisanal Refinery Operators in Rivers State, Nigeria

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Abstract

Some identified setbacks of the legitimate and illegitimate explorations/exploitations of crude oil and its derivatives in the Niger Delta are degraded environment, weak economy, and deteriorating health of the populace. Therefore, the current study evaluated the effect of artisanal refinery operation on respiratory blood gases and renal functions of its workers in Rivers State. As a cross-sectional investigation with sparse population, the multistage sampling technique (including purposive and snowball tools) was adopted to recruit 203 (including 120 operators of artisanal refinery—OAR-actively exposed and 83 non-OAR- actively exposed) willing and apparently healthy male and female adult subjects. Following receipt of ethical approval and consent, five milliliter of blood was taken from each subject from their antecubital vein after sterilizing the portion of the cubital fossa. The sample was then put into plain sample bottle and centrifuged to recover serum. Thereafter, the automated blood gas analyzer was used to measure the arterial blood gases of the subjects. The result showed marked ($P<0.05$) reductions in the partial pressure of oxygen (P_{O2}) and oxygen saturation (S_{O2}) levels in artisanal refinery operators (actively exposed) when compared to that of the passively-exposed subjects. Again, there were marked ($P<0.05$) elevations in the plasma pH and bicarbonate ions (HCO^-_3) levels in the actively exposed subjects compared to their passively-exposed counterparts. In conclusion, there could be adverse impact on respiratory blood gases and incidences of metabolic alkalosis over chronic exposures to the OAR activities.

Keywords: Artisanal Refinery, Niger Delta, Degraded Environment, Blood Gases.

INTRODUCTION

The exploration and exploitation of crude oil in our country has been on for over six decades now (Okotie, 2018 Okorobia and Olali, 2018) and these have largely contributed to the economy and development of the country but this is not without its attendant adverse effects on the health and socio-economic life of host communities (Elum *et al*., 2016; Adeola *et al*., 2022). Such impacts have always been linked to the occurrence of accidental oil spills during the oil exploration and transportation activities, gas flaring, fire outbreaks at exploration sites as well as illegal oil bunkering activities (Odalonu, 2015).

During refining, crude oil is heated in a furnace and transferred into a distillation tower where its components are separated by boiling point (Alfke *et al*., 2000; Olsen, 2014). These components are converted into finished products (gasoline, diesel, asphalt, solvents, etc) by heating, pressure or a catalyst (Achaw *et al*., 2021). The refining of crude oil by artisanal petroleum refiners in the Niger Delta has been said to produce quantum of crude brands of gasoline, kerosene, and diesel (Onuh *et al*., 2021; Richard *et al*., 2023). Unlike in the ideal form of crude oil refining, where the refining processes go on in an enclosed chamber, thereby minimizing environmental, work and health hazards, the artisanal crude oil refining process begins with storing crude oil in metallic drums, heating those drums openly until they reach the boiling point, and finally allowing those drums to cool and condense (Wauquier, 1995; Goodnews and Wordu, 2019). Several studies have suggested that the environmental condition within which this artisanal refining activity is carried out, coupled with the various gases emitted during the processes of artisanal refining constitute adverse health risks (dangers to haematologic, hepatic, respiratory, renal, and neurologic functions). Of the artisanal workers (actively exposed) and people living around these sites (passively exposed) (Nriagu *et al*., 2016; Onakpohor *et al*., 2019).

The release of toxic fumes and chemicals from the sites of artisanal refinery can be a great source of pollution via the air, water, and land and this can collective result in variety of harmful health effects (Palinkas, 2012; Orisakwe, 2021). Further, burning biomass fuels has been linked in some studies to ocular irritations and impairment of respiratory function (Vivan *et al*., 2012; Ephraim-Emmanuel *et al*., 2023). Surprisingly, aside from speculations, evaluations of the actual health impacts on direct operators of these artisanal refineries are very scarce or almost non-existent. Thus, the need for the current study; which assessed the blood gas pattern amongst artisanal refinery operators in Rivers State, Nigeria.

MATERIALS AND METHODS

Research Design

The present study adopted a cross-sectional survey approach in recruiting the Artisanal Refinery Operators in Rivers State with multistage sampling techniques.

Study Area

The study was conducted in across Rivers State including Port Harcourt and its Metropolis, Rivers State, Nigeria. The city of Port Harcourt is the capital and largest city in Rivers State, Nigeria (WPR, 2022). It is the 5th most populous city in Nigeria after Lagos, Kano, Ibadan and Benin (WPR, 2022). It lies along the Bonny River and is located in the Niger Delta. As of 2016, the Port Harcourt urban area had an estimated population of 1,865,000 inhabitants, up from 1,382,592 as of 2006. The population of the metropolitan area of Port Harcourt is almost twice its urban area population with a 2021 United Nations estimate of 3,171,076 (WPR, 2021).

Study Population

The target population comprised of all illegal bunkering/artisanal refining sites in Port Harcourt Metropolis, Rivers State. In all a total of one hundred and twenty (120) artisanal refinery operators were recruited into the research with 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 adopted was a multistage approach which included purposive and snowball sampling techniques for the OAR/actively exposed subjects.

Simple random frame of ten (10) subjects per strata (to allow equal chances of surveying the subjects) of 15 different locations of artisanal refinery were surveyed across Rivers State. A total of 120 of the exposed subjects were successfully recruited for the study. Similarly, a total eighty three (83) unexposed (control) subjects who resides at least 30 kilometers away from any artisanal refinery location.

Thus, a total of 203 male and female (both exposed and unexposed) subjects were recruited for the study across Rivers State.

Method of Data Collection/Instrumentation

Data collection included both qualitative and quantitative methods. Quantitative data was presented in numerical values and from which statistical inferences from the study subjects were made. Qualitative data used non-numerical data such as observations and interviews.

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).

Arterial Blood Gases

The arterial blood gas determination by the present study used the Automated Arterial blood gas analyzer (as reported by Gonzalez and Waddell, 2016; Castro *et al*., 2019).

Procedure for collection, transportation and analysis of arterial blood gases was done in accordance to the Procedures for the Collection of Arterial Blood Specimens; Approved Standard— Fourth Edition by clinical and laboratory standard institute (formerly NCCLS) (Blonshine, 2004).

Statistical Analysis

The quantitative data got from the current 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 one-way analysis of variance (ANOVA) and thereafter Post-Hoc multiple comparison test. 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) and frequencies/percentages accordingly.

Ethical Clearance

Ethical clearance was sought from ethical committee of Rivers State University. Written informed consent was sought from the workers of the artisanal refineries before their inclusion into the study. This was done after the procedures involved, risks and benefits of the study were diligently explained to each participant. Participation in the study was voluntary. Anonymity was maintained by using research numbers rather than names. Data obtained were held in confidence in line with ethical principles.

RESULTS

Table 1: General changes in Arterial Blood Gases of operators of artisanal refineries (OAR) and passively-exposed subjects.

S/N	Parameters	Study Groups	
		Control (n=83)	OAR (n=120)
	PO_2 (mmHg)	89.37 ± 9.38	86.19 ± 9.37
	PCO_2 (mmHg)	41.48 ± 3.01	40.30 ± 3.04
	pH	7.32 ± 0.05	7.37 ± 0.05
	HCO_3 (mmol/L)	24.26 ± 1.75	25.10 ± 1.86
	SPO_2 (%)	98.41 ± 1.2	97.40 ± 0.57 [a]

Values are expressed as Mean ± Standard Deviation (SD); [a] Significant at P<0.05 when compared to control (or passively-exposed) subjects. Control (passively exposed subjects) (n=83); OAR (actively exposed subjects) (n=120).

Table 2: Gender Based Changes in Arterial Blood Gases of operators of artisanal refineries (OAR) and passively-exposed subjects

S/N	Parameters	Control (n=83)		OAR (n=120)	
		Male (n=24)	Female (n=58)	Male (n=79)	Female (n=41)
	PO_2 (mmHg)	95.13 ± 2.98	86.88 ± 10.10 [a]	87.62 ± 7.83 [a]	84.04 ± 11.05 [a]
	PCO_2 (mmHg)	41.67 ± 2.95	41.40 ± 3.06	40.42 ± 2.97	40.11 ± 3.17
	pH	7.32 ± 0.05	7.32 ± 0.05	7.37 ± 0.05 [a, b]	7.37 ± 0.06 [a, b]
	HCO_3 (mmol/L)	24.25 ± 2.07	24.27 ± 1.60	25.09 ± 1.96	25.11 ± 1.73
	SPO_2 (%)	98.20 ± 1.89	98.50 ± 0.73	97.39 ± 0.54 [a, b]	97.41 ± 0.61 [a, b]

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

Table 1 shows the general changes in Arterial Blood Gases (ABG) of operators of artisanal refineries (OAR) and passively-exposed subjects.

There were decreases in the levels of partial pressure of oxygen (P_{O2}) and oxygen saturation (SP_{O2}) of the OAR subjects when compared to those of the control group; but of these, only that of the SPO_2 was statistically significant (P<0.05).

Considering the changes in Arterial Blood Gases of operators of artisanal refineries (OAR) and passively-exposed subjects on gender bases (as seen on Table 5), P_{O2} was seen to be markedly reduced in the male and female OAR subjects when compared to their passively-exposed counterparts.

The pH levels were found to be significantly (p<0.05) high in the male and female OAR subjects when compared to those of the passively-exposed control subjects.

Further, the SPO_2 levels in the male and female OAR subjects were equally significantly (P<0.05) decreased when compared to those of the passively-exposed subjects.

Although not statistically significant (P>0.05), the bicarbonate ion (HCO^-_3) was seen to be raised in the male and female OAR subjects when compared to those of the control group.

DISCUSSION OF FINDINGS

Screening arterial blood gases can help healthcare providers interpret conditions that affect the respiratory system, circulatory system and metabolic processes (Professional, 2023). Acute elevations in the outdoor air pollution levels have been known to trigger immediate or shortly delayed remarkable alterations in arterial blood pressure (Li *et al*., 2018). Of course, one major source of air or environmental pollution in our environment is the artisanal refinery operation (Onakpohor *et al*., 2020); so, one can be sure of the possible significant impact of such pollution on the artisanal refinery operators and marketers of its products. The present study assessed the possible alterations in arterial blood gases and renal markers in operators and product marketers of artisanal refineries (OAR) in Rivers State and presented same below.

According to the WHO, (2017), a significant portion of the burden of chronic diseases is attributable to certain occupational dangers, such as injury, noise, carcinogenic agents, airborne particles, and ergonomic concerns: back pain, 16% hearing loss, 13% chronic obstructive pulmonary disease, 11% asthma, 8% injuries, and 9% lung disease patients. In line with this submission, it is obvious that the OAR exposed subjects of the present study may most likely be predisposed to several health conditions as they age on their job. Unquestionably, such health condition may remain unnoticed in a young population but could be quite adverse in older age of the subjects. It is thus suggestive that aside from earlier identified regional stimulated challenges facing the youths, another effect of environmental injustice in our region may be predisposal of our younger labour force to several chronic health conditions due to unsafe means of livelihood.

Changes in Partial Pressure of Oxygen (PO_2), Partial Pressure of Carbon dioxide (P_{CO2}) and Oxygen saturation (SO_2) in Artisanal Refinery Workers in Rivers State.

The present study recorded marked reductions in the partial pressures of oxygen and oxygen saturation level in the OAR subjects when compared to those of passively-exposed subjects.

According to Collins *et al*., (2015), the delivery of oxygen by arterial blood to the tissues of the body has a number of critical determinants including blood oxygen concentration (content), saturation (S_{O2}) and partial pressure, haemoglobin concentration and cardiac output, including its distribution.

Oxygen is essential for normal aerobic metabolism in mammals (MacIntyre, 2014). Tissue hypoxemia (low levels of oxygen in the blood) may result to symptoms like headache, difficulty breathing, rapid heart rate, etc. (Professional, 2023). In severe cases, hypoxemia has been said to interfere with normal heart and brain function (Lavie, 2015).

Furthermore, the human body is an efficient living system that has evolved systems to maintain oxygen levels at an appropriate level to meet metabolic needs while preventing noticeably low or high oxygen pressure (Ortiz-Prado *et al*., 2019; Berman, 2022). It's crucial to comprehend the significance of the primary components impacting oxygen availability, such as the gradient of oxygen pressure between normal and hypoxic situations (Ortiz-Prado *et al*., 2019). Large-scale hydrocarbon extraction may cause environmental pollution that lowers the partial pressure of oxygen in the alveolar space. This lower partial pressure of oxygen in the blood is then due to a decreased diffusion gradient (Berman, 2022).

When the brain does not receive enough oxygen, cerebral hypoxia ensues. For effective functioning, the brain requires a steady supply of nutrients and oxygen (Berman, 2022).

Reduced oxygen partial pressure can significantly influence the optimal function of brain cells and potentially cause brain injury, just as brain cells die when oxygen is not there. Other times, even when adequate blood enters the brain, as when someone breathes in smoke or carbon monoxide, it can still occur. Patients who suffer from cerebral hypoxia-induced brain damage can benefit from treatments. However, no one is able to revive brain cells that have already died or heal brain damage (Berman, 2022).

Thus, from the above finding of the current study, it can be deduced that chronic exposure to the artisanal refinery operations may be significant risk factors to possible myriad of metabolic/respiratory pathologic conditions and gradual brain damage over time. It can therefore be submitted here that, direct exposure to the artisanal refinery operations could impact on the health and quality of life of the individual.

CONCLUSION

To the best of the researchers' knowledge, for the first time in our environment, the present study found relatively significant reductions in the partial pressure of oxygen (P_{O2}) and oxygen saturation (SO_2) levels in artisanal refinery operators thus indicating a possible adverse impact on respiratory blood gases which may in turn adversely affect cellular metabolism.

There were comparatively marked elevations in the plasma pH and bicarbonate ions (HCO^-_3) levels; which is a possible indication to metabolic alkalosis and could be via volume depletion secondary to chronic dehydration from exposure to hyperthermia.

The changes in partial pressure of oxygen (P_{O2}) and oxygen saturation (S_{O2}) in artisanal refinery workers in Rivers State, the present study recorded marked reductions in the partial pressures of oxygen and oxygen saturation level in the OAR subjects when compared to those of passively-exposed subjects.

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