

Evaluation of Alterations in Basic Cardiac Functions in Operators of Artisanal Refineries in Rivers State, Nigeria

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Abstract

Original Research Article

The impact of numerous artisanal refineries on the populace in Niger Delta region has been a great source of mainly health, economic and environmental concerns. Thus, the present study comparatively assessed the alterations of basic cardiac functions that may be associated with the operation of artisanal refineries (OAR) in Rivers State of Nigeria. This cross-sectional survey used 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 electrocardiographic (ECG) machine, the basic ECG 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 indicated significantly ($P < 0.05$) elevated heart rates in the OAR-exposed subjects when compared to their non-OAR-exposed counterparts. Amongst the various ECG features, the exposed subjects predominantly presented with left atrial enlargement (LAE) (male exposed=57% and female exposed =46.3%) as against none in the unexposed group. And there was no significant association of the incidences of Abnormal/clinical ECG Features between the actively exposed (OAR operators) and passively exposed (residents in same city who are non-OAR operators) subjects. In conclusion, the operation of artisanal refineries in our locale may potentially predispose its operators to significant elevation of heart rate and incidences of abnormal ECG features.

Keywords: Artisanal Refineries, Niger Delta Region, Electrocardiographic (ECG), Basic Cardiac Functions.

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INTRODUCTION

Petroleum refining is known to emit solid, liquid, and gaseous wastes into the environment (Ogbuagu *et al.*, 2011). In fact, polynuclear aromatic hydrocarbons (PAH) are the most frequent of the principal hydrocarbons detected in crude oil mixtures and have been reported to be huge component of oil pollutants (Ogbuagu *et al.*, 2011; Varjani *et al.*, 2018).

Similarly, PAHs are said to constitute a serious concern due to their potency in the stimulation of mutagenic/carcinogenic conditions, and bioaccumulation in organs/tissues due to their lipophilic nature (Clergé *et al.*, 2019; Tiwari *et al.*, 2011). Individuals who are frequently exposed to PAH and

other associated components may suffer long-term respiratory, cardiovascular and chromosomal defects (Rodriguez-Trigo *et al.*, 2010).

No doubts, the activities of the artisanal refineries in Rivers State, vis a vis Niger Delta Region of Nigeria, have been sufficiently linked to several bedeviling effects on the general health of the population and the environment; especially with the release of smoke/soot pollution which constitutes air, soil and water pollutions (Akpan and Bassey, 2020; Omisakin, 2022). Of course, such pollutants are known to pose detrimental impacts on health, which include impaired cardiovascular and pulmonary function, irritation of the sensory organs, amongst others (Richard *et al.*, 2023).

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Quite a lot of speculations have been made about the possible health impact of the activities of these operations of artisanal refineries (OAR) (John and Nnadozie, 2021; Bello and Nwaeke, 2022) but not many have directly evaluated the possible actual health effect of these actions on especially subjects.

Thus, the current study evaluated the alterations of basic cardiac functions in operators of artisanal refineries (OAR) (actively exposed subjects in Rivers State of Nigeria).

MATERIALS AND METHODS

Research Design

This study used the cross-sectional survey method in engaging the artisanal refinery operators in Rivers State with multistage sampling techniques.

Study Area

The current study was done in Rivers State and the focus was on Port Harcourt and the surrounding upland and riverine communities of the state. 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. In 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 main population of the current study was the operators of the scattered artisanal refining sites in the study area. Up to 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

In view of the peculiarity 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.

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

So, a total of 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 were presented from which statistical inferences were made.

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).

Heart Rate and ECG Measurement

The auscultatory method of blood pressure measurement with mercury sphygmomanometer and stethoscope (Ogedegbe and Pickering, 2010) were used to determine the systolic and diastolic blood pressures and heart rates. The Cardiovit AT-2+ model standard resting 12 – lead ECG with paper velocity of 25mm/sec and standardized at 0.1mv/mm and reclining bed and power source The method as reported by Tamuno-Opubo *et al.*, (2023) was adopted for the ECG setup and recordings.

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 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 \pm standard error of mean (SEM) and frequencies/percentages accordingly.

Ethical Clearance

The ethical clearance for the study was sought and obtained 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. 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

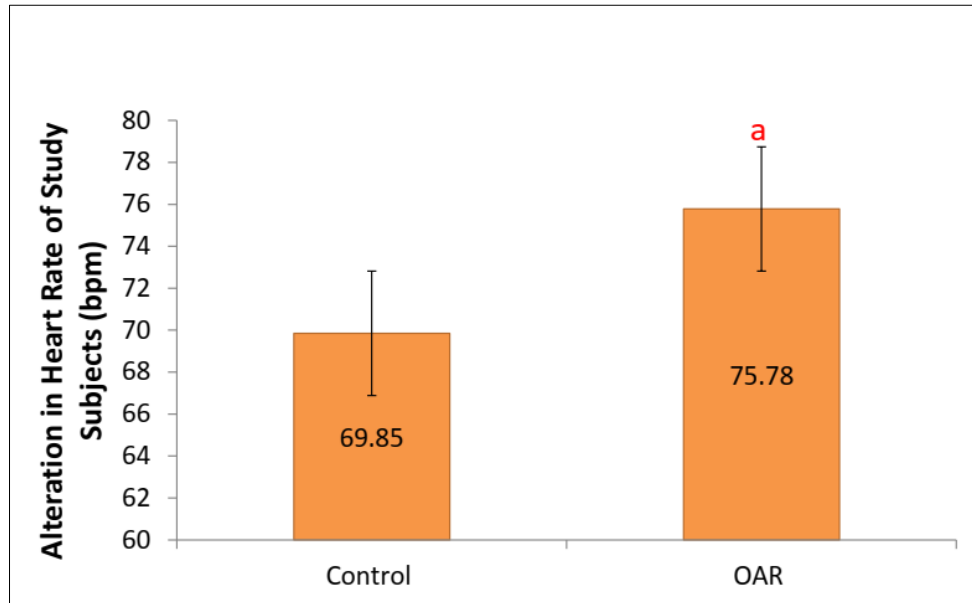


Figure 4.1: General changes in heart rates of operators of artisanal refineries (OAR) (actively exposed) and passively exposed control subjects (passively exposed)

The data on Figure 4.1 shows the general changes in heart rates of operators of artisanal refineries (OAR) (actively exposed) and passively exposed control subjects (passively exposed).

The mean heart rate (HR) of the OAR subjects (75.78 ± 13.59 bpm) were seen to be significantly ($P < 0.05$) higher when compared to that of the passively exposed control subjects (69.85 ± 7.62 bpm)

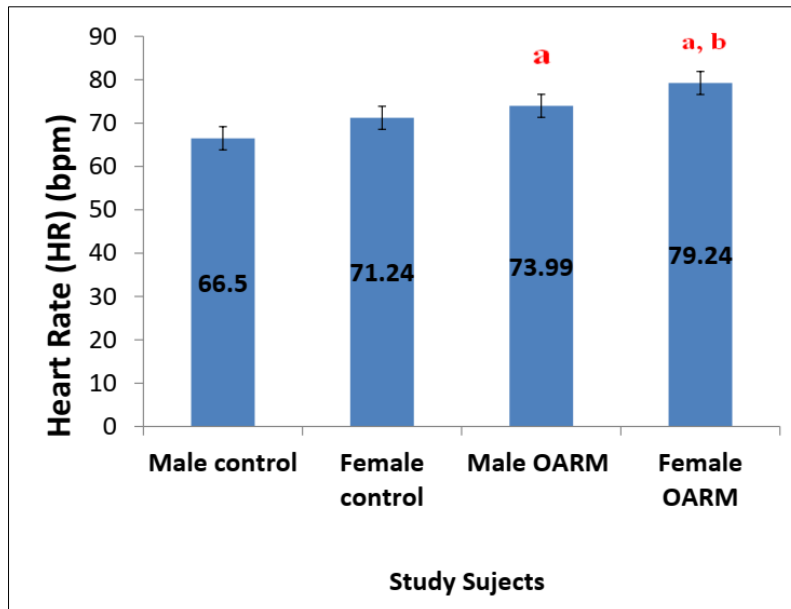


Figure 4.2: Gender Based Changes in Heart rates of operators of artisanal refineries (OAR) and passively exposed control subjects

Values are expressed as Mean \pm Standard Deviation (SD); ^a Significant at $P < 0.05$ when compared to male control subjects (or passively exposed control

male) subjects; ^b Significant at $P < 0.05$ when compared to female control subjects (passively exposed control

female) subjects; ° Significant at P<0.05 when compared to male OAR subjects (exposed) subjects.

Figure 4.2 shows the outcome on the possible gender based changes in the heart rates of operators of artisanal refineries (OAR) and passively exposed control subjects.

Comparing the changes in heart rates (HR) on gender bases, both the male and female OAR subjects had significant (p<0.05) increases with respect to those of their respective gender who are control subjects. Similarly, the HR of the female OAR subjects had marked elevation when compared to that of the male control subjects. It is noteworthy that, both genders of the control subjects did not show any significant (P>0.05) variations in their HR values.

Table 1: Changes in Some ECG Parameters of operators of artisanal refineries (OAR) and passively exposed control subjects

ECG Changes	All Subjects n=202		Study Groups [Frequency (percent-%) of prevalence]			
			Control subjects (n=82)		OAR Subjects (n=120)	
	All Control Subjects (n=82)	All OAR Subjects (n=120)	Male (n=24)	Female (n=58)	Male (n=79)	Female (n=41)
Normal ECG	78(95.1)	28(23.3)	23(95.8)	55(94.8)	17(21.5)	11(26.8)
Left ventricular hypertrophy (LVH)	3(3.7)	-	1(4.2)	3(1.85)	-	-
Right ventricular hypertrophy (RVH)	1(1.2)	-	-	1(1.7)	-	-
Anterolateral myocardial ischaemia		8(6.7)	-	-	5(6.5)	3(7.3)
Anterior septal myocardial ischaemia		-	-	-	-	-
Left atrial enlargement		64(53.3)	-	-	45(57)	19(46.3)
Septal myocardial ischaemia		5(4.2)	-	-	3(3.8)	2(4.9)
Benign early repolarization		12(10)	-	-	9(11.4)	3(7.3)
Sinus tachycardia		5(4.2)	-	-	2(2.5)	3(7.3)
Sinus bradycardia		3(2.5)	-	-	3(3.8)	
Left axis deviation		2(1.7)	-	-	2(2.5)	

Source: Field Survey, 2023.

Table 2: Association of incidences of Abnormal/clinical ECG Features between operators of artisanal refineries (OAR) and passively exposed control subjects

S/No.	Variables	ECG Features		Chi-Square Test Outcome
		Normal [Frequency (%)]	Abnormal [Frequency (%)]	
1	Control Subjects	78(95.12)	4(4.88)	X ² = 2.180 ^a df=1 P=0.140
2	OAR Subjects	28(23.33)	92(76.67)	

Field survey, 2023

The data on Table 1 shows the changes in some ECG parameters of operators of artisanal refineries (OAR) and passively exposed control subjects.

Considering the qualitative analyses of the ECG parameters of the both groups of subjects (control and OAR), cumulatively, 95.1% of the control subjects had normal ECG features.

Only 4.2% of the male and 1.85% of the female amongst the control subjects presented with left ventricular hypertrophy (LVH), and 1.7% of the female control also had right ventricular hypertrophy (RVH). On the other hand, the male and female OAR subjects indicated varying incidence levels of anterolateral myocardial ischaemia; anterior septal myocardial ischaemia; left atrial enlargement septal myocardial

ischaemia; benign early repolarization; sinus tachycardia; sinus bradycardia and left axis deviation. Very predominant amongst the foregoing is left atrial enlargement (male OAR=57% and female OAR=46.3%).

Similarly, the data on Table 2 shows the relationship of incidences of Abnormal/clinical ECG Features operators of artisanal refineries (OAR) and passively exposed control subjects.

The Chi-square test showed a non-significant (p=0.140) relationship in the pattern of incidences of abnormal ECG across the control and OAR subjects. Thus, indicating dissimilarity in the causative factors of the incidence rates of abnormal ECG across the subjects.

DISCUSSION

As was earlier mentioned, frequent and long-term exposure to polynuclear aromatic hydrocarbons (PAH) and its derivatives in our environment and workplaces could lead to multiple chronic conditions on, especially, the respiratory and cardiovascular, etc., systems (Rodriguez-Trigo *et al.*, 2010). Thus, the current study evaluated the possible alterations in basic cardiac functions in operators of artisanal refineries in Rivers State; some useful findings were recorded and discussed in the following paragraphs.

The present study recorded that both the male and female OAR subjects had significant ($p < 0.05$) increases in their heart rates with respect to those of their male control subjects. Of course, the heart rate is an important indicator of the efficiency and functionality of the heart (Arnold *et al.*, 2008); thus, even though the male and female OAR subjects fell within normal ranges (60 to 100bpm) (Avram *et al.*, 2019), it is also established that elevated resting heart rate could be associated with mortality across several general population studies (Jensen *et al.*, 2013). Reasonably, it could be deduced that the relatively raised heart rate may be somewhat connected to their workplace and routine hazards. Further in depth investigation in this direction may unravel better explanation to this manifestation in the study subjects.

The electrocardiography (ECG) is helpful in the diagnosis of numerous cardiac conditions, including prior infarction and active cardiac ischemia, as well as conduction abnormalities such as atrial fibrillation and life-threatening tachycardias (Rijnbeek *et al.*, 2001). Thus, the ECG recordings on the study participants revealed that the male and female OAR subjects indicated varying incidences of different ECG abnormalities. Very predominant amongst the foregoing is left atrial enlargement (LAE).

Left atrial size has prognostic implications, and studies reveal that LAE can independently predict the development of clinically significant cardiovascular diseases and heart failure (Bombelli *et al.*, 2014; Parajuli and Ahmed, 2022). Underlying pathologies leading to LAE must be explored in a timely fashion to avoid life fatal consequences. It is suggestive that operations of the OAR subjects predispose them to cardiovascular complications.

The Chi-square test showed a non-significant relationship in the pattern of incidences of abnormal ECG across the control and OAR subjects. Thus, indicating that passive exposure to artisanal refining pollutions may equally predispose subjects to some level of abnormal ECG features. This calls for further comparative investigations in this perspective between passively exposed (residents in same city where artisanal refining activities are carried out) and non-exposed

subjects (residents in cities distant from where artisanal refining activities are carried out).

CONCLUSIONS

Beyond speculations, the alterations on basic cardiac functions possibly impacted by the activities of artisanal refining have been explored by the present study and some notable findings made. The activities of artisanal refineries in our locale that have been frequently seen to release obviously harmful gases and particulate matters could be responsible for the recorded adversely altered cardiovascular functions in the subjects that were actively exposed in the present study.

The findings on the changes in the heart rates of operators of artisanal refineries (OAR) and passively exposed control subjects: Reasonably, it could be deduced that the relatively raised heart rate may be somewhat connected to their workplace and routine hazards.

On some changes on ECG parameters of operators of artisanal refineries (OAR) and passively exposed control subjects: Very predominant amongst the presentations of clinical ECG by the OAR subjects is the left atrial enlargement (LAE). As an independent predictor for the development of clinically significant cardiovascular diseases and heart failure, the LAE values suggests that operations of the OAR subjects predisposes them to cardiovascular complications.

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