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Prevalence and Atherogenic Index of Plasma as a Predictor of Cardiometabolic Syndrome amongst Road Transport Workers in Owerri

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Authors' contributions

This work was carried out in collaboration between all authors. Author CCO designed the study, carried out site visits, computational aspects, wrote the protocol and the first draft of the manuscript. Author ILN served as main supervisor of the study, performed the data analysis, modelling, confirmed the accuracy of the results and documentation. Author EIA provided guidance on literature review and data collection. All authors read and approved the final manuscript.

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ABSTRACT

Cardiometabolic Syndrome is a constellation of cardiovascular risk factors which include diabetes, hypertension, obesity, dyslipidaemia amongst others. This study was designed to determine the prevalence and predictors of cardiometaboic syndrome among road transport workers. The Study was a work – site based cross sectional study carried out on one hundred and twenty (120) workers at Imo Transport Corporation, Owerri. The Questionnaires were designed to address the background information of the respondents with respect to gender, age, job title, departments and address. The respondents were anthropometrically examined. The prevalence was calculated as a ratio and reported in percentage. Principal Component Analysis (PCA) and Multinomial Probit Regression Model were employed to determine the degree of relationship between the Atherogenic Index of Plasma (AIP) and cardiometabolic parameters and their order of importance. The

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prevalence of cardiometabolic syndrome was found to be 19.17%. AIP was shown to be statistically significant and positively correlated with waist circumference (WC) and body mass index (BMI). Atherogenic Index of Plasma (AIP) was shown to be a principal dominant predictor of cardiometabolic syndrome. AIP as a calculated factor can be used in the clinical setting for assessing cardiometabolic syndrome beyond the routinely done lipid profile.

Keywords: Prevalence; atherogenic index of plasma; cardiometabolic syndrome; predictors; principal component analysis.

1. INTRODUCTION

There is a global increase in the prevalence of non-communicable diseases. This growth is felt more in the developing countries of the world [1]. These days in sub-Saharan Africa, non-communicable diseases are projected to surpass communicable diseases, whereas it used to be the other way [2]. The trend is that there is a rise in both non-communicable and communicable diseases. This presents a double burden in the developing countries, a condition termed epidemiological transition [2,3].

Cardiometabolic Syndrome is a constellation of cardiovascular risk factors like hypertension, central adiposity, dyslipidaemia, type 2 diabetes [4]. Other risk factors include insulin resistance, sedentary lifestyle, consumption of calorie-dense foods and smoking [5]. Information concerning the prevalence and risk factors of cardiometabolic syndrome among sub-Saharan Africa is sparse, as most studies have been conducted in North America, Europe and Asia [6,7]. To the best of our knowledge, no study has systematically evaluated the prevalence of cardiometabolic syndrome in Owerri, Nigeria. The prevalence of cardiometabolic syndrome was determined according to the International Diabetes Federation definition.

Atherogenic Index of Plasma (AIP) is the logarithmically transformed ratio of molar concentration of Triglycerides (TG) to the High Density Lipoprotein cholesterol (HDLc) [8]. AIP is gaining prominence as a screening tool for dyslipidaemia. It has been used for diagnosis and prognosis of cardiovascular diseases. A strong correlation of AIP with lipoprotein particle size and this may explain its high predictive value [9]. It has been shown that AIP is a stronger marker to predict the risk of atherosclerosis and coronary heart disease [10]. It is also recognised as a useful surrogate for insulin resistance [11]. Several reports have shown cardiovascular diseases are independently associated with dyslipidaemia among Nigerians [12]. There is need to investigate the lipid patterns and Atherogenic Index of Plasma among populations with cardiometabolic syndrome in Nigeria.

2. METHODOLOGY

2.1 Study Area

Owerri is the capital of Imo State of Nigeria. It is situated at latitude 5.4891° N, longitude 7.0176° E. Owerri is mainly inhabited by Igbos, one of the major tribes in Nigeria. There are pockets of other ethnic groups in Owerri. The Otamiri and Nworie Rivers surround Owerri by the east and south respectively [13]. The study area houses the Imo Transport Corporation (ITC) which is the study population with respect to this research. It is located at Plot 16 - 28, MCC-Uratta Road, Owerri. ITC is among the largest and oldest transportation Corporation and maintains a web of network in the country. They maintain excellent services, time conscious and have regards for safety. They operate Shuttle Services within and outside the State and offer Sports events, corporate transportation, Local tours, Staff and school bus shuttle services.

ITC was a government owned Transport Corporation that was recently concessioned to a Private Partner known as Global Ginika Services Limited. It is believed that this Public – Private Partnership will create more jobs for the people of Imo State.

2.2 Study Design

This Study was a work – site based cross sectional study carried out on one hundred and twenty (120) workers at Imo Transport Corporation, Owerri. These workers included drivers, bus conductors, receptionists, security men, cashiers, accountants and traffic orderlies. The Corporation's registers were used to determine the population/sampling frame.

2.2.1 Inclusion criteria

The Criteria included workers of Imo Transport Corporation, Owerri who were 18 years and

above. They had given informed written consent for the study.

2.2.2 Exclusion criteria

Excluded from this study were Imo Transport Corporation, Owerri workers who had physical deformities affecting the spine and/or deformities that could not stand for height and weight the anthropometric measurements. Pregnant women were also excluded from the study.

2.3 Sample Size Estimation

The sample size was determined using the prevalence formula:

$$N = \frac{Z^2 P(1-P)}{T^2} \quad (1)$$

Where N represents the sample size, T = tolerance error (0.05); P = prevalence from a previous study [14]; and; Z= 1.96, is the level of significance (standard normal deviate) which corresponds to 95% confidence level.

Substituting the applicable parameters to Equation (1) yields:

$$N = \frac{1.96^2 X\ 0.075\ (1-0.075)}{0.05^2} = 106.6\ (\approx 107).$$

The sample size was calculated as 107 with attrition rate of 12% which gave a total of 120 respondents.

2.4 Sample Techniques

Stratified method was used to obtain a representative sample based on the inclusion criteria. Each department in the Corporation was regarded as a stratum. The frame was divided into seperate departments in the organisation which formed the strata. Each stratum was sampled as an independent sub-population, out of which individual respondents were randomly selected [15]. Finally, all the sets of respondents from different departments constitute the required sample.

2.5 Methods of Data Collection

2.5.1 Training of research assistants

Ten Healthcare professionals were engaged, trained and certified competent for the purpose of this study. Each Assistant had a defined and dedicated job description. This involved registration, questionnaire administration, anthropometric measurements, clinical measurements and laboratory estimations, respectively.

2.5.2 Questionnaire

The Questionnaires were designed to address the background information of the respondents with respect to gender, age, job title, departments and addresses.

2.5.3 Physical (anthropometric) measurements

The physical measurements undertaken were height (H), weight (W) and waist circumference (WC). The Body Mass Index (BMI) was calculated as weight per metre square. The weight was measured in kilograms with workers standing bare feet in their minimal clothing using weighing scale by Mettler Toleds Switzerland and measured to the nearest kilograms. The weighing scale was calibrated every morning before use with a 10 kg Standard weight and the zero mark was checked after each measurement. The Height was measured with the respondent being bare-footed and without head-gear or cap stood against the wall with the heels, gluteus and occiput touching the wall where the measuring tape was fixed. A pointer was placed firmly against the scale and the measurement read off on the scale in metres to the nearest centimetres.

The waist circumference was measured using a flexible tape and placing it at midway between the upper border of the iliac crest and the lower border of the coastal margin. The reading was taken when the tape was snug but did not compress the skin at the workers' exhalation [16].

2.5.4 Clinical measurements

The blood pressure was measured using the auscultatory method with Standard mercury in glass Accuson® Sphygmomanometer and Stethoscope. This was in accordance with the JNC VII guidelines [17].

2.5.5 Laboratory estimations

The Laboratory estimations carried out were the fasting lipid profile which represents the lipid parameters of Total Cholesterol (TC) and Triglycerides (TG) which were assayed using the enzymatic colourimetric method of Friedewal and

others [18]. The High Density Lipoprotein (HDL) was assayed after precipitation with phosphotungstate and magnesium ions [19]. Glucose was estimated using the Glucose oxidase/Peroxidase method [3,20,21].

2.6 Method of Data Analysis

The data generated were entered into the Microsoft Excel 2016 and transported into XLSTAT 2016, which is an instinctive statistical software that integrates seamlessly into Microsoft Excel. The prevalence was calculated as a ratio and reported in percentage. The Principal Component Analysis was applied in determining the degree of relationship between the AIP and cardiometabolic parameters. The Principal Component Analysis reduced the outcome (dependent variables) on a set of variables (the independent variables) without losing information on the process. The XLSTAT was adopted by subjecting 8 independent variables $x_1 - x_8$ (WC, BMI, AGE, PP, MABP, FBS, DBP, SBP) to PCA to identity, the most weighted parameters otherwise known as principal components or factors which gave the information that described the majority of the data set after data reduction. Verimax rotation was performed on these extracted factors to improve the interpretation of the plot as it increased the absolute values. Furthermore, Logistic Probit Regression Analysis was then employed to develop models with regard to the outcome from the application of PCA (see Equations 3 -5).

2.7 Operational Definition

The authors defined Cardiometabolic Syndrome according to the International Diabetes Federation Criteria: Any person was considered to have cardiometabolic syndrome in the presence of WC $\geq 102\ cm$ for men and 88 cm for women plus any two or more of the following: Systolic and/or diastolic blood pressure ≥ 130/85 mmHg and/or hypertension on treatment. Fasting blood glucose ≥ 100 mg/dl and/or diabetes mellitus on treatment, Triglyceride level ≥ 150 mg/dl and/or hypertriglyceridaemia on treatment and high density lipoprotein cholesterol (HDLc) < 40 mg/dl for men or > 50 mg/dl for women and/or dyslipidaemia on treatment [4,22].

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Demography distribution

One hundred and twenty (120) participants who scaled through the inclusion criteria and who gave their informed written consent were physically examined and subsequently, questionnaires were administered to them primarily to generate background information on gender, age, sex, job description and department (see Table 1). Also, Appendix-A, Table A1 presents the descriptive statistic of the participants' data with respect to Cardiovascular Parameters. The prevalence of cardiometabolic syndrome among ITC workers was determined to be 19.17% (see Equation 2).

The age distribution of the workers ranged from 25.0 to 64.0 years. Seventy-eight (78) respondents were males while forty-two (42) were females. The modal age group for this study was the age category of 35.0 – 44.0 years. This represents 32 and 21 male and female participants, respectively (see Table 1). The distribution of the measured variables ranged from 65-125 cm, 13.13-53.33, 10-401 mg/dl, 193-90 mmHg, 10-110 mmHg and -0.519-0.641 with respect to WC, BMI, FBS, SBP, DBP, and AIP, respectively (see Appendix –A, Table A1).

$$\text{Prevalence Rate} = \frac{\text{No. of Respondents with Cardiometabolic Risk}}{\text{Total No. of Respondents}} \times 100$$

$$= \frac{23}{120} \times 100 = 19.17 \qquad (2)$$

Table 1. Demographic information of ITC workers

Age Group (years)	Male		Female		Total No. of respondents in age group	Proportion of respondents in age group (%)
	No. of respondents	Proportion of respondents (%)	No. of respondents	Proportion of respondents (%)		
25 – 34	8	6.7	8	6.7	16	13.4
35 – 44	32	26.7	21	17.5	53	44.2
45 – 54	28	23.3	13	10.8	41	34.1
55 – 64	10	8.3	0	0.0	10	8.3
Total	78	65	42	35	120	100.0

3.1.2 Principal component analysis (PCA)

The review of the data on Appendix A with respect to AIP confirmed 23 respondents were at risk of cardiometabolic syndrome while 97 were not. The principle component analysis was therefore carried out for the 23 respondents at risk (data set-1) and the entire 120 respondents both at risk and non-risk (data set-2). To validate the application of PCA, the Kaiser-Meyer-Olkin (KMO) analysis was carried out on both sets of data (see Appendix-A, Table A2). Similarly, the normality test (Kolmogorov-Smirnov test) was carried out on both data sets for the purpose of selection of parametric or non-parametric regression option; the results are as presented in Appendix-A (Table A3). The application of PCA on the collected data sets-1 and 2 yielded the results / outputs (see Table 2 and scree plot, Fig. 1). Also, the biplot of the correlation of 23 respondents (data set-1) on the variables (x_1 – x_8) is as shown in Fig. 2. Table 3 presents the squared cosines of the variables after varimax rotation.

The output from the analyses of data sets-1 & 2 using PCA, generated six factors (F1 – F6). Factors -1 & 2 where extracted with respect to the eigenvalues and cumulative percentage variability of the cardiovascular parameters (see Table 2). Factors 1 and 2 cumulatively reflected 72.4% for data set-1 and 55.9% for data set-2 of the cardiovascular parameters (see Fig. 1 for data set-1). The 72.4% of extracted factors-1 & 2 for data set-1 is reasonably above average and thus, adequate for prediction of cardiovascular parameter (AIP). However, the 55.9% cumulative percentage variability for data set-2 is not adequate for sake of developing predictive model.

The results of varimax rotation on the extracted factors, D1 and D2 indicated 5 & 3 variables for D1 and D2 for 23 respondents at risk; and 3 & 5 variables for D1 and D2 for 120 respondents at risk and non-risk (see Table 3), respectively. Given Table 3, for data set-1, variable x_6 (pp), and x_5 (SBP) have relatively high contribution with respect to D1, while variable x_7 (DBP) has the highest contribution with respect to D2, followed by x_3 (FBS) and finally x_1(WC) as the least. The biplot (see Fig. 2) is a plot of the correlation of respondents on the cardiovascular variables. It can be seen from the biplot that most of the variables correlate positively with each other when reflected on the respondents.

3.1.3 Model development for atherogenic index of plasma (AIP)

Based on the results of the normality test in Appendix-A (Table A3) between data sets-1 & 2, it is apparent that for data set 1, the majority of the results indicated normal distribution. Thus, the parametric statistical approach was adopted for regression modelling. The regression modelling for AIP was carried out for both data sets-1 and 2 in order to compare their respective goodness of fits and appropriateness or otherwise of using data set-2 in preference to data set-1.

From the output of PCA, three logistic probit models were developed each for data sets-1 & 2 assuming the collected data type as ordinal at 95% confidence interval. AIP was assumed as the dependent variable (y) while WC, BMI, FBS, Age, PP, MABP, DBP, and SBP were assumed as independent variables representing x_1, x_2, x_3, x_4, x_5, x_6, x_7, and x_8, respectively (see Appendix-A, Table A1). The first model employed all the eight independent variables; second model five independent variables and third model three independent variables. All the variables in models-1 & 2 correspond to the extracted factor-1 (F1) after varimax rotation (see Table 3). The third model was developed using variables corresponding to extracted factor-2 (F2). Table 4 presents the summary of the regression analyses for data sets-1 & 2 with the respective resultant goodness of fits for each developed model (see Appendix B). Variable x_7 and x_8 were omitted in

Table 2. Summary result of principal component analysis

23 Respondents @ Risk						
	F1	**F2**	**F3**	**F4**	**F5**	**F6**
Eigenvalue	3.7009	2.0938	1.0573	0.5484	0.4379	0.1618
Variability (%)	46.2607	26.1721	13.2160	6.8552	5.4740	2.0220
Cumulative %	46.2607	72.4328	85.6487	92.5039	97.9780	100.0000
120 Respondents @ Risk/Non- risk						
	F1	**F2**	**F3**	**F4**	**F5**	**F6**
Eigenvalue	2.1378	1.2182	1.0513	0.7371	0.6771	0.1785
Variability (%)	35.6294	20.3040	17.5214	12.2854	11.2856	2.9742
Cumulative %	35.6294	55.9334	73.4549	85.7403	97.0258	100.0000

the model development for Model-1 due to multicolinearity between them (see Equation 3). The frequency distribution of Atherogenic Index of Plasma and the risk stratification among workers in ITC, are shown in Table 5.

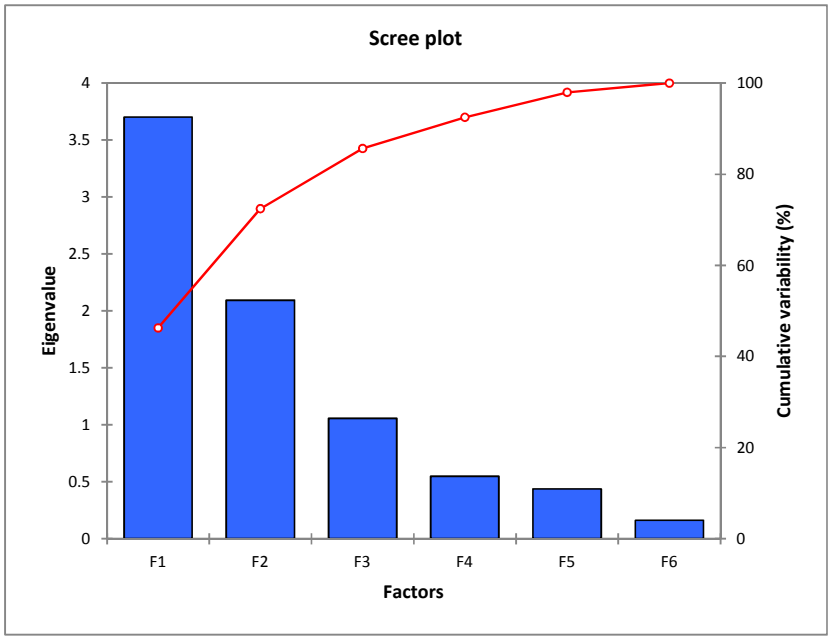

Fig. 1. Scree plot for factor extraction with respect to the 23 respondents @ risk

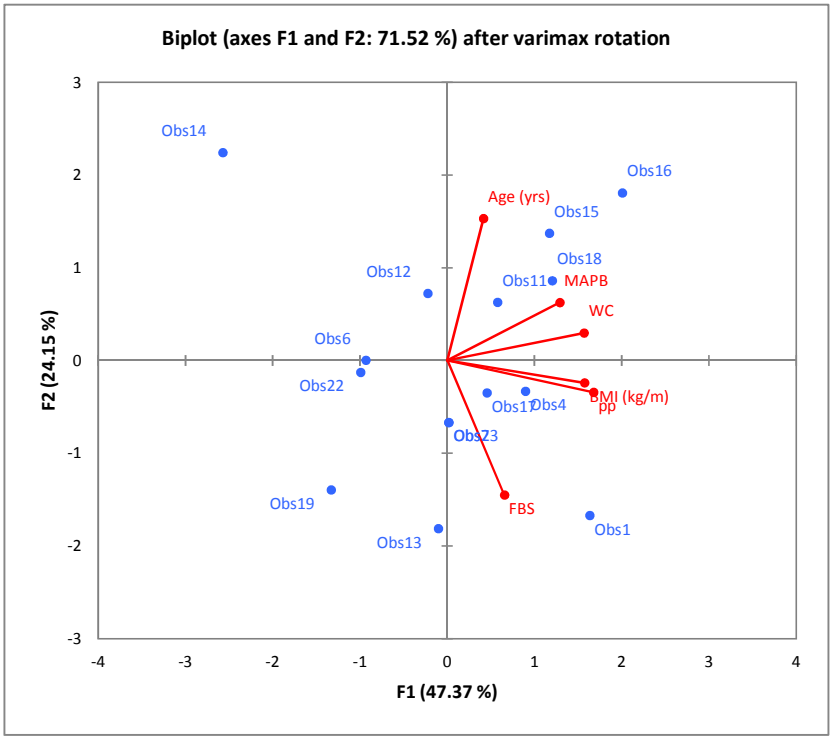

Fig. 2. Biplot of the correlation of 23 respondents on the variables

Table 3. Squared cosines of the variables after Varimax rotation

Parameters	23 Respondents @ Risk		120 Respondents @ Risk & Non-risk	
	±D1	±D2	±D1	±D2
x1 = WC	***0.5867**	0.0075	0.0819	***0.3821**
x2 = BMI (kg/m^2)	***0.6445**	0.0700	0.0383	***0.3765**
x3 = FBS	0.1516	***0.4177**	***0.0859**	0.0064
x4 = Age (yrs)	0.0187	***0.3611**	0.0027	***0.2055**
x5 = pp	***0.8890**	0.0110	0.0029	***0.7316**
x6 = MABP	***0.5118**	0.3799	***0.9014**	0.0579
x7 = DBP(mm/Hg)	0.0000	***0.8358**	***0.9014**	0.0351
x8 = SBP(mm/Hg)	***0.8697**	0.0396	0.3248	***0.4915**

*±D1 & D2 = Factor 1 & 2 After varimax rotation; * parameters selected by PCA*

Table 4. Summary of regression analyses

Model	Goodness of Fit, R^2 (%)		Modelled independent variable	Model parameter interpretation
	120 respondents @ risk & non-risk	23 respondents @ risk		
Model 1	68.83	73.11	x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8	WC, BMI, FBS, Age, PP, MABP, DBP, SBP.
Model 2	65.35	-	x_3, x_6, x_7	FBS, MABP, DBP .
	-	69.97	x_1, x_2, x_5, x_6, x_8	WC, BMI, PP, MABP, SBP.
Model 3	68.53	-	x_1, x_2, x_4, x_5, x_8	WC, BMI, Age, PP, SBP.
	-	66.29	x_3, x_4, x_7	FBS, Age, DBP.

Equations (3 – 5) are the developed models with respect to data set-1:

Model 1:

$$y = -0.0554x_1 + 0.214x_2 - 0.290x_3 - 0.387x_4 - 0.630x_5 + 0.485x_6 + 2.951 \quad (3)$$

Model 2:

$$y = -0.667x_1 + 0.249x_2 - 0.667x_5 + 0.487x_6 + 2.481 \quad (4)$$

Model 3:

$$y = 0.483x_3 - 0.521x_4 + 0.233x_7 + 1.851 \quad (5)$$

Table 5. Frequency distribution of Atherogenic Index of Plasma (AIP)

AIP Range	Frequency distribution		Percentage (%)	
	120 respondents @ Risk & Non-risk	23 respondents @ Risk	120 respondents @ Risk & Non-risk	23 respondents @ Risk
AIP < 0.11	7	2	6	9
AIP = 0.11 – 0.24	30	1	25	4
AIP > 0.24	83	20	69	87
Total	**120**	**23**	**100**	**100**

3.2 Regression of Principal Components

Kishore and others [23] used multivariate logistic regression analysis to demonstrate a strong association between age and hypertension. The models developed using logistic probit regression analysis yielded goodness fit of 64 – 65%. In this study, the three models developed each for data sets-1 & 2, the distributions of the goodness of fit were as follows: 73.1% for 8 variables, 69.97% for 5 variables and 66.29% for 3 variables for models 1-3 for data set-1. Also, we have 68.8% for 8 variables, 65.35% for 3 variables and 68.5 for 5 variables for models 1-3 for data set-2, respectively. The superiority of models-1 & 2 from data set-1 (23 respondents at risk) over the same models for data set-2 was established based on the corresponding goodness of fit. In other words models developed on applicable data set are to be preferred from a more general data. However, the goodness of fit of model-3 for data sets 1 & 2 were 66.29 for 3 variables and 68.53% for 5 variables, respectively. By reason of data economy, model-3 of data set-1 may be preferred to the same model of data set-2. In model development we seem to prefer models with few independent variables for sake of data availability to those with more independent variables.

From analysis of the results, it showed that WC, BMI, PP, MABP, and SBP have very high contribution or influence on AIP Thus, one could confidently make predictions of AIP using the five cardiometabolic parameters (WC, BMI, PP, MABP, and SBP). This is at variance with the study reported by Niroumand and others [24], in which they found a significant association between AIP and FBS. In another study, it was shown that hyperglycaemia and hypertension are contributory to the development of atherosclerosis [25]. From Table 5 the AIP risk stratification has been presented as AIP less than 0.11 to be of low risk, AIP greater than 0.11 to 0.24 to be of moderate risk and AIP greater than 0.24 to be of a high risk. Among the ITC workers 87% of them have a high risk of developing cardiometabolic syndrome. They carried a high value of AIP. Only 4% of the workers have a moderate risk of developing cardiometbolic syndrome. This was with respect to data set-1 (23 respondents at risk).

This Study has demonstrated that Atherogenic Index of Plasma (AIP) correlates statistically and significantly with WC and BMI (Equation 4). According to Grundy and others [26], Bhardwaj and others [7] both WC and BMI are important components and determinants of cardiometabolic syndrome. Similarly, this study has shown that AIP is a strong predictor of cardiometabolic syndrome. This is in agreement with the study of Rexrode and others [27] and Arden and others [28] who reported the usefulness of WC as an indicator of truncal obesity which is associated with abnormal adiposity. This also, is a strong risk factor for cardiovascular morbidity and diabetes.

Furthermore, in a study carried out in a Qatar population, it was found that WC happened to be the best predictor of cardiometabolic syndrome. In another cross-sectional study which took place among Whites and African-Americans in the United States of America, WC was reported to be the most powerful anthropometric tool in predicting cardiometabolic syndrome [29]. This Study has also demonstrated that the prevalence of cardiometabolic syndrome in Owerri was 19.1%. Adediran and others [30] reported that the cardiometabolic syndrome was 12.1% in Lagos. In Ethiopia in a study carried out among working adults the prevalence of cardiometabolic syndrome was 17.9% [31].

3.3 Study Implications

Cardiometabolic Syndrome is a constellation of cardiovascular risk factors and it is no longer rare in sub-Sahara Africa. The prevalence is increasing and the trend is that it increases with age. Nigeria is not an exception, the prevalence as reported in Jos was as high as 63.6% [32]. This could be attributed to the adoption of western life style and departure from traditional African lifestyles.

In situations where other lipid parameters like TG and HDLc appear normal, the use of AIP may be of diagnostic value [33]. Many clinicians are now using AIP as significant predictor of atherosclerosis [34]. There is also the advantage of using AIP when other sub-fractions appear normal or elevated. The risk stratification of AIP into low, moderate and high risk helps in determining the appropriate intervention to be applied which could be physical activity, nutritional, pharmacological or surgical.

4. CONCLUSION

This study has established that the:

i) Prevalence of cardiometabolic syndrome in Owerri is 19.17%. AIP has shown to be

positively correlated with WC, BMI, PP, MABP and SBP with goodness of fit of 69.97%; and

ii) A set of predictive regression models for AIP have been developed for 3, 5 and 8 cardiometabolic parameters as independent variables.

5. RECOMMENDATIONS

The following recommendations were made as a result of this study:

i) There is need to introduce preventive strategies and interventional programmes in the workplace.
ii) This can be accomplished through the establishment of occupational health programmes that increase physical activities.
iii) Efforts should be made to reduce intake of calorie-dense foods. Whole grain cereals, fruits, vegetables and white meat should be taken. One must avoid the intake of sugar containing beverages and other simple sugars.

CONSENT AND ETHICAL CLEARANCE

Ethical approval was obtained from the Chairman of Research & Ethics Committee, Department of Health Services, Federal University of Technology, Owerri. All respondents gave their informed written consent for the study. All the information shared during the research were kept secret and protected by the law of confidentiality.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX A

Table A1. Cardiovascular parameters of ITC workers

No	AIP	WC	BMI (kg/m^2)	FBS	Age (yrs)	pp	MAPB	DBP(mm/Hg)	SBP(mm/Hg)
1	0.577	89	48.23	107	53	50	96.667	80	130
2	0.230	84	42.78	79	52	40	93.333	80	120
3*	**0.641**	**115**	**58.24**	**203**	**44**	**70**	**113.333**	**90**	**160**
4	0.301	90	44.12	10	50	50	76.667	60	110
5	0.125	84	41.67	146	40	40	83.333	70	110
6	0.215	103	53.53	108	39	50	86.667	70	120
7	0.509	96	50.31	76	29	30	80.000	70	100
8	0.036	88	40.74	83	35	10	83.333	80	90
9	0.274	80	34.36	104	40	50	86.667	70	120
10	0.239	80	39.08	94	50	50	96.667	80	130
11	0.273	74	35.32	70	62	20	96.667	90	110
12	0.306	92	46.01	108	50	40	73.333	60	100
13	0.158	87	44.91	108	58	40	93.333	80	120
14	0.306	72	28.75	102	32	40	83.333	70	110
15*	**0.493**	**99**	**44.67**	**134**	**51**	**50**	**106.667**	**90**	**140**
16*	**0.223**	**97**	**51.51**	**80**	**48**	**40**	**103.333**	**90**	**130**
17	0.374	94	48.57	107	45	50	86.667	70	120
18*	**0.567**	**118**	**63.16**	**91**	**37**	**50**	**106.667**	**90**	**140**
19*	**0.572**	**94**	**47.6**	**78**	**40**	**40**	**103.333**	**90**	**130**
20	0.301	89	43.29	80	53	50	106.667	90	140
21	0.166	86	40.85	401	43	70	113.333	90	160
22	0.301	97	52.87	113	36	50	106.667	90	140
23	0.260	104	52.25	100	48	30	100.000	90	120
24	0.000	96	50.31	76	29	30	80.000	70	100
25	0.232	91	43.07	79	40	40	73.333	60	100
26	0.225	77	38.82	88	47	40	81.333	68	108
27*	**0.454**	**94**	**47.85**	**100**	**47**	**10**	**93.333**	**90**	**100**
28	0.222	65	31.65	89	22	20	96.667	90	110
29	0.301	93	50	89	43	10	93.333	90	100
30*	**0.410**	**104**	**50.7**	**106**	**37**	**40**	**103.333**	**90**	**130**
31*	**0.020**	**96**	**48.05**	**99**	**48**	**40**	**103.333**	**90**	**130**
32	0.465	99	52.26	85	26	40	93.333	80	120
33	0.322	67	46.88	82	34	39	92.000	79	118
34	0.426	100	50	102	54	40	93.333	80	120
35*	**0.333**	**102**	**53.31**	**87**	**45**	**20**	**96.667**	**90**	**110**
36	0.223	71	31.17	73	30	10	93.333	90	100
37	0.488	118	63.16	91	37	50	106.667	90	140
38	0.230	89	40.12	62	62	40	93.333	80	120
39	0.129	85	38.69	102	42	30	90.000	80	110
40	0.143	92	46.86	77	38	40	73.333	60	100
41	0.149	85	39.49	85	60	30	90.000	80	110
42	0.227	82	37.11	78	49	50	106.667	90	140
43	0.301	75	42.33	85	45	40	83.333	70	110
44	0.224	79	35.54	96	38	30	90.000	80	110
45	0.283	84	44.94	84	27	20	86.667	80	100
46	0.260	96	48.07	75	43	70	113.333	90	160
47	0.435	89	47.02	85	64	130	53.333	10	140
48*	**0.462**	**102**	**55.28**	**105**	**40**	**20**	**96.667**	**90**	**110**
49	0.056	81	41.21	89	40	50	86.667	70	120
50	0.264	88	42.6	227	56	30	100.000	90	120
51	0.372	69	31.25	98	35	40	93.333	80	120
52	0.106	83	37.5	84	38	60	100.000	80	140
53	0.505	85	43.67	91	36	40	93.333	80	120
54*	**0.460**	**115**	**57.69**	**89**	**50**	**40**	**103.333**	**90**	**130**
55	0.176	75	36.84	91	35	40	73.333	60	100
56	0.250	85	36.18	69	37	40	73.333	60	100
57	0.497	91	49.4	90	33	40	83.333	70	110

No	AIP	WC	BMI (kg/m^2)	FBS	Age (yrs)	pp	MAPB	DBP(mm/Hg)	SBP(mm/Hg)
58	0.501	67	57.42	212	40	30	100.000	90	120
59	0.273	97	48.13	105	29	40	83.333	70	110
60	0.570	104	52.87	84	36	20	96.667	90	110
61*	**0.512**	**102**	**50.56**	**81**	**51**	**30**	**100.000**	**90**	**120**
62	0.499	88	35.29	97	56	50	86.667	70	120
63	0.255	97	41.04	75	52	108	121.000	85	193
64	0.213	91	49.4	90	33	40	83.333	70	110
65	0.140	99	56.73	83	50	50	106.667	90	140
66*	**0.452**	**96**	**43.45**	**143**	**30**	**50**	**106.667**	**90**	**140**
67	0.290	94	46.28	83	42	40	93.333	80	120
68	0.273	83	40.63	81	45	50	106.667	90	140
69	0.351	92	43.9	83	39	50	96.667	80	130
70	0.398	104	49.69	87	40	40	93.333	80	120
71	0.493	91	46.86	93	52	40	93.333	80	120
72	0.352	96	46.88	94	61	60	100.000	80	140
73*	**0.416**	**90**	**5.27**	**36**	**54**	**-26**	**101.333**	**110**	**84**
74*	**0.233**	**102**	**52.78**	**74**	**51**	**70**	**133.333**	**110**	**180**
75	0.305	96	50.31	76	29	30	80.000	70	100
76*	**0.591**	**119**	**67.28**	**62**	**56**	**80**	**126.667**	**100**	**180**
77*	**0.564**	**107**	**55.56**	**101**	**40**	**50**	**106.667**	**90**	**140**
78*	**0.499**	**125**	**61.25**	**90**	**52**	**50**	**106.667**	**90**	**140**
79	0.486	83	41.57	90	35	40	93.333	80	120
80	0.324	91	40.12	61	47	30	90.000	80	110
81	0.167	98	44.64	81	62	50	86.667	70	120
82	0.142	108	59.52	81	34	50	86.667	70	120
83	0.494	95	48.24	81	42	50	106.667	90	140
84	0.500	91	41.32	104	48	70	113.333	90	160
85	0.548	98	46.43	74	61	40	83.333	70	110
86	0.301	99	51.52	84	41	50	106.667	90	140
87	0.528	86	36.42	88	60	80	106.667	80	160
88	0.447	98	48.78	81	38	50	106.667	90	140
89	0.387	124	72.28	65	33	20	86.667	80	100
90	0.564	69	30	66	30	30	90.000	80	110
91	0.314	71	29.76	74	45	40	73.333	60	100
92	0.431	118	64.53	111	39	60	100.000	80	140
93	0.186	85	32.5	33	38	40	73.333	60	100
94	0.372	80	40	71	26	30	100.000	90	120
95	0.204	95	48.24	76	36	20	96.667	90	110
96	0.427	100	67.76	81	53	40	83.333	70	110
97	0.337	95	46.79	95	48	40	93.333	80	120
98	0.255	82	37.13	79	56	40	113.333	100	140
99	-0.477	70	36.67	127	38	20	86.667	80	100
100*	**-0.383**	**88**	**31.71**	**90**	**24**	**30**	**100.000**	**90**	**120**
101	-0.519	88	42.6	227	56	30	100.000	90	120
102	0.194	69	31.25	98	35	40	93.333	80	120
103	0.143	83	37.5	84	38	60	100.000	80	140
104	-0.454	85	43.67	91	36	40	93.333	80	120
105	0.018	91	41.32	104	48	70	113.333	90	160
106	0.374	98	46.43	74	61	40	83.333	70	110
107	0.567	99	51.52	84	41	50	106.667	90	140
108*	**0.572**	**94**	**48.57**	**107**	**45**	**50**	**86.667**	**70**	**120**
109	0.301	118	63.16	91	37	50	106.667	90	140
110	0.166	94	47.6	78	40	40	103.333	90	130
111	0.301	89	43.29	80	53	50	106.667	90	140
112	0.499	91	43.07	79	40	40	73.333	60	100
113	0.255	77	38.82	88	47	40	81.333	68	108
114	0.213	94	47.85	100	47	10	93.333	90	100
115	0.140	65	31.65	89	22	20	96.667	90	110
116*	**0.452**	**93**	**50**	**89**	**43**	**10**	**93.333**	**90**	**100**
117*	**0.460**	**104**	**50.7**	**106**	**37**	**40**	**103.333**	**90**	**130**
118	0.176	94	48.57	107	45	50	86.667	70	120

No	AIP	WC	BMI (kg/m^2)	FBS	Age (yrs)	pp	MAPB	DBP(mm/Hg)	SBP(mm/Hg)
119	0.250	118	63.16	91	37	50	106.667	90	140
120	0.497	98	46.43	74	61	40	83.333	70	110

** Respondents at Risk of Cardiometabolic Disorder; WC = Waist Circumference; FBS = Fasting Blood Sugar; DBP = Diastolic Blood Pressure; SBP = Systolic Blood Pressure; BMI= Body Mass Index; AIP = Antherogenic Index of Plasma*

Table A2. ‡KMO analyses

Parameters	23@ Risk	120@ Risk/Non- risk
WC	0.6557	0.6017
BMI (kg/m^2)	0.5247	0.6511
FBS	0.4511	0.4166
Age (yrs)	0.5982	0.4987
pp	0.5310	0.4971
MABP	0.4225	0.3187
KMO	0.5275	0.5075

‡Kaiser-Meyer-Olkin measure of sampling adequacy

Table A3. Summary of normality test on data of cardiometabolic parameter of respondents

Cardiometabolic parameters	Total respondents (120 No.)	Respondents at risk (23 No.)
y = AIP	Normal Distribution	Normal Distribution
x1 = WC	Normal Distribution	Normal Distribution
x2 = BMI	Normal Distribution	Normal Distribution
x3 = FBS	Not Normal Distribution	Normal Distribution
x4 = AGE	Normal Distribution	Normal Distribution
x5 = pp	Not Normal Distribution	Normal Distribution
x6 = MABP	Normal Distribution	Not Normal Distribution
x7 = DBP	Not Normal Distribution	Not Normal Distribution
x8 = SBP	Not Normal Distribution	Normal Distribution

APPENDIX B – Model Development

Table B1. Goodness of fit statistic (Variable y) – Data set-1

	Model-1	Model-2	Model-3
-2 Log(Likelihood)	120.5392	123.0827	125.8066
R^2(Cox and Snell)	0.7311	0.6997	0.6619
R^2(Nagelkerke)	0.7322	0.7007	0.6629
AIC	168.5392	167.0827	167.8066
SBC	195.7910	192.0636	191.6520
Iterations	6	7	6

Table B2. Goodness of fit statistic (Variable y) – Data set-2

	Model-1	Model-2	Model-3
-2 Log(Likelihood)	1032.6663	1033.7875	1045.3761
R^2(Cox and Snell)	0.6883	0.6853	0.6534
R^2(Nagelkerke)	0.6883	0.6854	0.6535
AIC	1224.6663	1223.7875	1231.3761
SBC	1492.2655	1488.5992	1490.6128
Iterations	6	6	6

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