



## Relationship between ABO Blood Groups and Lipid Profile Level in Healthy Adult Residents in Port Harcourt Metropolis, Nigeria

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**ABSTRACT:** A multitude of risk factors are responsible for development of cardiovascular diseases (CVDs) and association of cardiovascular disease risk factors with the ABO blood antigens is increasingly being reported. Thus, this study was designed to investigate the relationship between ABO blood groups and lipoprotein profiles of apparently 150 healthy adult patients attending Braithwaite Memorial Specialist Hospital, Port Harcourt, Nigeria following due consent to participate in the study. The serum TC, HDL-C, LDL-C and VLDL-C levels were determined by standard methods. ABO blood grouping was carried out by standard tile technique. Results show that the mean of the TC and LDL-C of most of the subjects in all the blood groups appeared desirable (< 5.81 mmol/L and < 3.37 mmol/L) respectively in both males and females. HDL-C was deficient in all blood groups both in males and females while the triglycerides level in the subjects was desirable (< 2.83 mmol/L). While significant variation ( $p < 0.05$ ) was observed between the means of the blood groups in the females, no such variation was seen the males. Strong positive correlations were observed between the lipoproteins in blood group B, AB and O females. As a result of the fact the rate of prevalence of CVD in our population is increasing, it is recommended that diagnosis, management and treatment of CVD in Nigeria should take into consideration the blood group status of the subjects.

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**Key Words:** Lipoproteins, Blood groups, cardiovascular diseases, triglycerides

After the discovery of ABO blood groups (Lansteiner, 1900), several studies have reported that the occurrence of some diseases can be correlated with blood group types e.g. carcinoma of stomach (Aird et al., 1953), cardiometabolic diseases (Edgren et al., 2010), peptic ulcer (Risch et al., 2013), and upper urinary tract cancer (Gates et al., 2011). Several reports have also suggested an association of the ABO blood groups with the risk of developing severe manifestation of atherosclerosis (Meade et al., 1994). However, Saha, et al. (1973) and Nydegger et al. (2003) found that the O and B blood groups are predominant in patients with myocardial infarction and may play a role in the pathogenesis of myocardial infarction.

Stakishaitis et al. (2002) reported that the rate of prevalence of coronary atherosclerosis in Lithuanian women may be related to their B blood group type. Mitchell (1977) had earlier reported that higher rates of cardiovascular mortality in towns in Britain occurs among people with a higher prevalence of blood group "O". Mortality resulting from cardiovascular diseases was therefore suggested to be more in subjects with blood group "O" and the geographic variation in cardiovascular diseases was also attributed to the differences in the distribution of blood group "O" in different parts of Britain. Other studies also indicate that ABO blood group might influence plasma lipid levels (Wong et al., 1992). Lack of investigations examining the association between ABO blood groups and CVD in Nigeria especially adult residents of River state extraction in the face of established prevalence of cardiovascular

disease risk factors amongst citizens of the state was recognized as an important lacuna to be filled. Thus, this study was designed to investigate the relationship between ABO blood groups and lipoprotein profiles of adult residents in Rivers state.

### MATERIALS AND METHODS

**Subject Characteristics:** The subjects were patients selected from those attending routine clinic at Braithwaite Memorial Specialist Hospital, Port Harcourt. Ethical clearance for the study was approved by the Local Ethics Committee of the Braithwaite Memorial Specialist Hospital and the subjects willingly consented to participate in the study after due explanation of the purpose of the study was done.

**Collection of Blood Specimen:** 5 ml of blood samples were collected from patients, 1 ml blood was immediately put into EDTA bottle and the remaining 4 ml of blood was put in a plain bottle and both were labeled, capped and the EDTA sample was gently mixed with the anticoagulant and used for the blood groups determination while samples in the plain bottles were allowed to clot before centrifuging for five minutes at 6000 revolutions/minute and the serum were separated immediately into plain sterile sample bottles with Pasteur pipette and frozen in the refrigerator at  $-4^{\circ}\text{C}$  for (1-14) days. Lipid profile analyses were done within this period.

**Biochemical determinations:** Determination of serum total cholesterol:

The enzymatic procedure for total cholesterol determination in serum based upon the Trinder (1969) method as modified by the Centers for Disease Control and Prevention was used. The method is popularly known as the enzymatic endpoint method. Cholesterol esterases (CHE) hydrolyze the cholesterol esters into free cholesterol. Cholesterol oxidase (CHOD) oxidizes the cholesterol into cholest-4-en-3-one and hydrogen peroxide. Hydrogen peroxide reacts with a mixture of 4-aminoantipyrine and phenol in the presence of peroxidase enzyme (POD) and converts the reactants into a red quinone dye. The absorbance of the quinoneimine is directly proportional to the cholesterol concentration when measured at 520nm.

*Determination of serum high density lipoprotein - cholesterol :* The method of Lopes-Virella *et al.* (1977) for the determination of high-density cholesterol in serum was employed. Low density lipoproteins and very low density lipoproteins (LDL and VLDL) and chylomicron fractions are precipitated quantitatively by the addition of phosphotungstic acid in the presence of magnesium ions. After centrifugation, the cholesterol concentration in the HDL (high density lipoprotein) fraction, which remains in the supernatant, is determined at 520nm.

*Determination of serum low density lipoprotein cholesterol:* The Friedewald *et al.* (1972) equation was used to calculate the LDL-cholesterol in mmol/L. LDL-cholesterol in plasma was calculated, using the result obtained from estimation of total cholesterol.

*Enzymatic Determination of serum triglycerides:* The colorimetric method of Tietz (1995) was employed. Lipase hydrolyses triglycerides sequentially to di & monoglycerides and finally to glycerol. Glycerol kinase (GK) using ATP as phosphate source converts glycerol liberated to glycerol-3-phosphate (G-3-Phosphate). Glycerol-3-phosphate oxidase (GPO) oxidizes Glycerol-3-phosphate and forms dihydroxy acetone phosphate and hydrogen peroxide. Peroxidase (POD) uses the hydrogen peroxide formed, to oxidize 4-aminoantipyrine and TOOS (N-ethyl-N-sulphohydroxy propyl-m-toluidine) to a purple coloured complex. The absorbance of the coloured complex is measured at 520 nm and is proportional to triglyceride concentration in the sample

*ABO blood grouping:* ABO and Rh blood groupings were carried out by standard tile techniques (Lewis *et al.*, 2001) with appropriate positive and negative controls using one drop of whole blood mixed with one drop of appropriate antisera and rocked gently for agglutination. Quality monoclonal blood grouping reagents manufactured by Rapid Labs Limited, United Kingdom were used.

*Statistical analysis:* The results were statistically analyzed using the Statistical Package for Social Sciences (SPSS) version 21. Data values are given as mean, standard deviation, percentages and correlation coefficients. Comparison between test carried out in the different blood groups according to the male and female populations respectively were made using single factor analysis (ANOVA) and results were considered significant at  $p < 0.05$ .

**RESULTS AND DISCUSSION**

Results were obtained from 150 subjects for determination of biochemical risk factors of cardiovascular diseases, among the various blood group of both female and male populations. The age range for the male subjects was 17-88 years while that for the female population was 25-76 years. The demographic distribution of the blood groups in the subjects is shown in table 1.

**Table 1:** Demographic Distribution of the Blood Group Antigens in the Population

Sex	Blood group A	Blood group B	Blood group AB	Blood group O	Total
Male	12 (8%)	10 (6.67%)	3 (2%)	36 (24%)	61 (40.67%)
Female	24 (16%)	14 (9.33%)	3 (2%)	48 (32%)	89 (53.33%)
<b>Total</b>	36 (24%)	24 (16%)	6 (4%)	84 (56%)	150 (100%)

The analysis of mean  $\pm$ SD concentration of total cholesterol (TC), low density lipoprotein (LDL), high density lipoprotein (HDL), triglycerides and very low density lipoprotein (VLDL) in the male subjects by blood groups is shown in table 2. The table shows that the mean  $\pm$ SD of total cholesterol was  $5.01 \pm 1.63$  mmol/L in blood group A,  $5.70 \pm 1.00$  mmol/L in blood group B,  $4.86 \pm 1.52$  mmol/L in group O and  $5.48 \pm 1.62$  mmol/l in blood group AB subjects. The mean  $\pm$  SD

of triglycerides of blood group A, blood group B, AB and blood group O subjects were  $1.08 \pm 0.74$ mmol/L,  $1.28 \pm 0.64$  mmol/L,  $0.99 \pm 0.36$  mmol/L and  $1.25 \pm 0.40$  mmol/L respectively. The table also shows that blood group A male subjects had mean  $\pm$  SD of HDL-C of  $0.69 \pm 0.25$ mmol/l, blood group B had  $0.67 \pm 0.17$ mmol/L, blood group O had  $0.69 \pm 0.28$ mmol/L and  $0.79 \pm 0.22$ mmol/L for blood group AB. The mean  $\pm$ SD of LDL in blood group A, group B, group O and group AB subjects were  $3.84 \pm 1.73$  mmol/L,  $3.85 \pm 0.88$  mmol/L,  $3.61 \pm 1.41$  mmol/L and  $4.24 \pm 1.37$  mmol/L respectively. The mean  $\pm$ SD of VLDL in blood group A subjects was  $0.49 \pm 0.34$  mmol/L; in blood group B subjects it was  $0.58 \pm 0.29$  mmol/L,  $0.57 \pm 0.18$  mmol/L for blood group O subjects while

0.45± 0.16 mmol/L is the VLDL value in group AB subjects. . Comparison of the means of the lipoproteins among the blood groups did not show significant difference (p>0.05)

**Table 2:** Mean ±SD of TC, TG, LDL, HDL and VLDL, in male subjects by blood groups

Blood Groups	TG <sup>d</sup> (mmol/L)	TC <sup>a</sup> (mmol/L)	HDL <sup>b</sup> (mmol/L)	LDL <sup>c</sup> (mmol/L)	VLDL (mmol/L)
Group A	1.08±0.74	5.01±1.63	0.69±0.25	3.84±1.73	0.49±0.34
Group B	1.28±0.64	5.70±1.00	0.67±0.17	3.85±0.88	0.58±0.29
Group O	1.25±0.40	4.86±1.52	0.69±0.28	3.61±1.41	0.57±0.18
Group AB	0.99±0.36	5.48±1.62	0.79±0.22	4.24±1.37	0.45±0.16
F-value	0.7107	0.3368	0.5426	0.4024	0.7107
p-value	0.550	0.868	0.921	0.751	0.552

**Table 2a:** ANOVA table of comparison of means of TG amongst the blood groups in males

	SS	df	MS
Treatment (between columns)	0.5624	3	0.1872
Residual (within colons)	15.83	60	0.2638
Total	16.39	63	

**Table 2b:** ANOVA table of comparison of means of total cholest. amongst the blood groups in males

	SS	df	MS
Treatment (between columns)	2.216	3	0.7388
Residual (within colons)	131.6	60	2.194
Total	133.8	63	

**Table 2c:** ANOVA table of comparison of means of HDL-C among the blood groups in males

	SS	df	MS
Treatment (between columns)	0.1031	3	0.03438
Residual (within colons)	3.802	60	0.06337
Total	3.905	63	

**Table 2d:** ANOVA table of comparison of means LDL-C among the blood groups in males

	SS	df	MS
Treatment (between columns)	2.398	3	0.7992
Residual (within colons)	119.2	60	1.986
Total	121.6	63	

**Table 2e:** ANOVA table of comparison of means of VLDL-C among the blood groups in males

	SS	df	MS
Treatment (between columns)	0.16662	3	0.038774
Residual (within colons)	3.270	60	0.05451
Total	3.387	63	

The analysis of mean ±SD of total cholesterol (TC), triglycerides (TG), high density lipoprotein (HDL), low density lipoprotein (LDL) and very low density lipoprotein (VLDL) of the female subjects by their blood groups is shown in Table 3. The analysis of the mean ±SD of TC was 6.25 ±1.69 mmol/L for blood group A, 5.40 ±1.15 mmol/L for blood group B, 5.20 ± 1.11 mmol/L for blood group O and 5.48 ± 1.62 mmol/L for group AB. The mean ±SD of triglyceride is 1.15±0.46 mmol/L for blood group A, 1.49 ± 0.61mmol/L for group B, 1.16 ± 0.47 mmol/L for group O and 0.99 ± 0.36 mmol/L for blood group AB.

The mean concentration of HDL was 0.72mmol/l for blood group A, 0.73mmol/l for blood group B, 0.74mmol/l for group O and 0.79mmol/l for blood group AB. The mean concentration of LDL for blood group A and group B was 4.81mmol/l and 4.00mmol/l while for blood group O and blood group AB, it was 3.90mmol/l and 4.24mmol/l respectively. The mean concentration of VLDL for blood group A, group B, group O and group AB were 0.69mmol/l, 0.68mmol/l, 0.53mmol/l and 0.45mmol/l respectively. Significant variation (p<0.05) was observed between the means of triglycerides, total cholesterol, low density cholesterol and very low density lipoprotein cholesterol in the blood groups while no significant difference (p>0.05) was noticed in the mean of high density cholesterol between the blood groups. Turkey's multiple comparison test of the means of lipoproteins showed significant variation between triglycerides of blood group O and triglycerides of blood group A (q=4.097), total cholesterol of blood group A and total cholesterol of blood group O (q=4.390) and low density lipoproteins of blood group A and low density lipoprotein of blood group O (q=4.350). The correlation of the lipoproteins of the blood groups shows that VLDL-C is strongly correlated positively with triglycerides for blood groups B, AB and O (r=1.00) except in blood A where no correlation was observed. Positive correlations were also observed between triglycerides and total cholesterol in males (r=0.55) and females (r=0.56) with blood group B and blood group AB (r=0.84). Total cholesterol and low density lipoprotein cholesterol correlated positively in males with blood group B (r=0.91), females with blood group B (r=0.56), female with blood group O (r=0.87) and subjects with blood group AB (r=0.99). Results further shows strong positive correlations between total cholesterol and high

density lipoprotein in females with blood group O (r=0.50), and subjects of blood group AB (r=0.62) (table 4 and 5). Significantly, most of the lipoproteins were positively strongly correlated in the the subjects with AB blood group (table 4).

**Table 3:** Mean ±SD of TC, TG, LDL, HDL and VLDL, in female subjects by blood groups

Blood Groups	TG (mmol/L)	TC (mmol/L)	HDL (mmol/L)	LDL (mmol/L)	VLDL (mmol/L)
Group A	1.51±0.48	6.25±1.69	0.72±0.22	4.81±1.64	0.69±0.22
Group B	1.49±0.61	5.40±1.15	0.73±0.24	4.00±1.04	0.68±0.28
Group O	1.16±0.47	5.20±1.11	0.74±0.21	3.90±0.88	0.53±0.21
Group AB	0.99±0.36	5.48±1.62	0.79±0.22	4.24±1.37	0.45±0.16
F-value	4.334	3.259	0.2970	3.280	4.334
p-value	0.007	0.025	0.948	0.025	0.0067

**Table 3a:** ANOVA table of comparison of means triglycerides among the blood groups in males

	SS	df	MS
Treatment (between columns)	3.168	3	1.056
Residual (within colons)	21.44	88	0.2437
Total	24.61	91	

**Table 3b:** ANOVA table of comparison of means triglycerides among the blood groups in males

	SS	df	MS
Treatment (between columns)	17.37	3	5.790
Residual (within colons)	156.3	88	1.776
Total	173.7	91	

**Table 3c:** ANOVA table of comparison of means HDL-C among the blood groups in males

	SS	df	MS
Treatment (between columns)	0.04417	3	0.01472
Residual (within colons)	4.362	88	0.04957
Total	4.407	91	

**Table 3d:** ANOVA table of comparison of means LDL-C among the blood groups in males

	SS	df	MS
Treatment (between columns)	13.87	3	4.623
Residual (within colons)	124.0	88	1.409
Total	137.9	91	

**Table 3e:** ANOVA table of comparison of means VLDL-C among the blood groups in males

	SS	df	MS
Treatment (between columns)	0.6546	3	0.2182
Residual (within colons)	4.431	88	0.05035
Total	5.085	91	

**Table 4:** Correlation coefficients of lipoproteins among the AB blood group

Lipoproteins	*AB Blood group (r)
TG vs TC	0.84
TG vs HDL	0.64
TG vs LDL	0.77
TG vs VLDL	1.00
TC vs HDL	0.62
TC vs LDL	0.99
TC vs VLDL	0.85
HDL vs LDL	0.50
HDL vs VLDL	0.67
LDL vs VLDL	0.78

\*The subjects in this blood group were combined.

The computation of the cardiovascular disease risk profile of the subjects based on the recommendations of the National Cholesterol Education Program, Adult Treatment Panel 111 of 2003 according to the blood groups using total cholesterol as the risk factor shows that risk in the males was highest in blood group A (33.33%) followed by blood group B (16.67%) while females of blood group AB exhibited highest risk profile (66.67%) followed by blood group A (54.17%) (table 6). When high density lipoprotein (HDL-C) was used to determine the CVD risk profile of the subjects by blood groups, the result revealed that the concentration of HDL-C in the subjects in all the blood groups was generally low resulting in very high risk profile in the range of 89.89% to 100% in both the males and female subjects for all blood groups (table 7)

The percentage categorization of the CVD risk profile of the blood groups in the male subjects using low density lipoprotein cholesterol (LDL-C) shows that the risk of CVD was highest in subjects of blood group A (41.67%), followed by blood group AB (33.33%), blood group O (30.56%) and blood group B (20.00%). In the females, the risk profile for CVD increased in the order of blood group AB (67.67%), blood group A (62.50%), blood group O (41.67%) and blood group B (35.71%) (table 8). The cardiovascular disease risk profile of the subjects in the all blood groups using triglycerides as the risk factor were within the desirable limits (< 2.83 mmol/L) except for 2.08% of blood group O females that showed moderate risk profile (table 9). The percentage risk level of the male and female subjects in the various blood group groups according to the cardiovascular risk risk factors (total cholesterol, high density lipoprotein cholesterol and low density lipoprotein cholesterol) is shown in figures 1 to 6.

**Table 5:** Correlation coefficients of lipoproteins among the blood groups in male and female subjects

Lipoproteins	Males			Females		
	Blood group A (r)	Blood group B (r)	Blood group O (r)	Blood group A (r)	Blood group B (r)	Blood group O (r)
TG vs LDL	0.98	-	-	-	-	-
TG vs TC	-	0.55	-	-	0.56	-
TG vs VLDL	-	1.00	1.00	-	1.00	1.00
TC vs LDL	-	0.91	-	-	0.56	0.87
TC vs VLDL	-	0.55	-	-	-	-
TC vs HDL	-	-	-	-	-	0.50

**Table 6:** Percentage categorization of CVD risk profile of the blood groups using total cholesterol level

Risk level (mmol/L)	Blood group A		Blood group B		Blood group AB		Blood group O	
	Male	Females	Males	Females	Males	Females	Males	Females
Desirable (<5.81)	58.32% (3.81)	29.17% (4.20)	50.00% (4.25)	57.14% (4.64)	66.67% (3.80)	0.00%	63.89% (3.94)	54.17% (4.48)
Moderate (5.81-6.18)	8.33% (5.32)	16.67% (5.85)	40.00% (5.75)	21.43% (5.68)	33.33% (5.63)	33.33% (5.02)	19.44% (5.70)	33.33% (5.65)
High (≥6.22)	33.33% (7.02)	54.17% (7.45)	10.00% (6.99)	21.43% (7.17)	0.00%	66.67% (7.33)	16.67% (7.40)	12.50% (7.15)

**Table 7:** Percentage categorization of CVD risk profile of the blood groups using high density lipoprotein level

Risk level (mmol/L)	Blood group A		Blood group B		Blood group AB		Blood group O	
	Male	Females	Males	Females	Males	Females	Males	Females
Desirable (≥1.55)	0.00%	4.17% (1.55)	0.00%	0.00%	0.00%	0.00%	2.78% (1.74)	0.00%
Moderate (1.02-1.50)	8.33% (1.33)	0.00%	0.00%	7.14% (1.22)	0.00%	0.00%	8.33% (1.16)	8.33% (1.28)
High (<1.02)	91.67% (0.64)	95.83% (0.69)	100.00% (0.67)	92.86% (0.69)	100.00% (0.64)	100.00% (0.93)	88.89% (0.61)	91.67% (0.69)

**Table 8:** Percentage categorization of CVD risk profile of the blood groups using low density cholesterol level

Risk level (mmol/L)	Blood group A		Blood group B		Blood group AB		Blood group O	
	Male	Females	Males	Females	Males	Females	Males	Females
Desirable (<3.37)	58.33% (2.55)	20.83% (2.65)	40.00% (2.91)	21.43% (2.78)	66.67% (2.96)	0.00%	55.56% (2.68)	20.83% (2.64)
Moderate (3.37-4.12)	0.00%	16.67% (3.53)	20.00% (4.04)	42.86% (3.74)	0.00%	33.33% (3.75)	13.88% (3.63)	37.50% (3.73)
High (≥4.14)	41.67% (5.65)	62.50% (5.88)	40.00% (4.71)	35.71% (5.03)	33.33% (4.25)	66.67% (5.86)	30.56% (5.28)	41.67% (4.68)

**Table 9:** Percentage categorization of CVD risk profile of the blood groups using triglycerides level

Risk level (mmol/L)	Blood group A		Blood group B		Blood group AB		Blood group O	
	Male	Females	Males	Females	Males	Females	Males	Females
Desirable (<2.83)	100.00% (1.08)	100% (1.51)	100.00% (1.28)	100.00% (1.49)	100.00% (0.83)	100.00% (1.16)	100.00% (1.25)	97.92% (1.11)
Moderate (2.83-5.65)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.08% (3.38)
High (>5.65)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

**Note:** The categorization of the risk levels was done based on the criteria of the National Cholesterol Education Programme, Adult Treatment Panel III, 2003. Number in parenthesis represents mean of parameters.

*Discussion:* In the last few decades, concerted efforts have been put into studies aimed at establishing a link between the ABO blood groups and the incidence of

cardiovascular diseases (Ketch et al., 2008; Kaur 2012). it has been severally reported that the relationship between ABO blood groups and the development of cardiovascular disease as reported in

various literatures is still very unclear (Alireza et al., 2006; Bianca et al., 2002). Hypercholesterolaemia is usually considered a cardiovascular risk which could predispose to the development of ischaemic heart disease (Grover et al., 1995). Apart from high levels of total cholesterol, low levels of high density lipoprotein cholesterol, elevated low density lipoprotein cholesterol level and high levels of triglycerides are also important and recognized risk factors of cardiovascular diseases (Grover et al., 1995).

The results obtained from the analysis of the lipoprotein levels in this study shows that the mean of the total cholesterol and low density lipoprotein cholesterol of most of the subjects in all the blood groups appeared desirable ( $< 5.81$  mmol/L and  $< 3.37$  mmol/L) respectively in both males and females. The triglycerides level in the subjects in the various blood groups was desirable ( $< 2.83$  mmol/L). When the total cholesterol was categorized into the various risk levels, the non O blood groups showed higher cardiovascular risk profile. Females of blood AB showed highest risk profile (66.67%) with total cholesterol, 100% risk profile with HDL-C and 66.67% with low density lipoprotein cholesterol. The triglycerides level in the population was within the desirable limit ( $< 2.83$  mmol/L). The males with AB blood group only showed moderate risk (33.33%) with total cholesterol, high risk (100%) with HDL-C and 33.33% with LDL-C. Anjum et al. (2017) reported that in a Saudi Arabian population, individuals of blood group AB showed highest cardiovascular risk with serum total cholesterol. This finding agrees with the observation made in this study particularly in the females. Also, in their findings, Meade et al. (1994) and Girgla et al. (2011) reported that ischaemic heart disease occurred more in subjects with blood group AB phenotype.

Similarly, we observed that females (54.17%) and males (33.33%) of blood group A respectively ranked second in the development of CVD risk with total cholesterol. The CVD risk profile using HDL-C for the blood group A subjects was 91.67% and 95.83% in the male and female respectively while the risk profile for the blood group A subjects with LDL-C was also highest in the females (62.50%) than in the males (41.67%). This finding is in agreement with results obtained from several studies. In a study among British men, the incidence of heart diseases was reported to be higher in patients with blood group A (Whincup et al. 1990). Similar finding was also reported among Hungarian general population (Tarjan et al., 1995). Whincup et al. (1990) and Akhand et al. (2001) also reported that excess coronary artery disease has been observed in blood group A individuals while a deficit of incidence occurred in blood O individuals irrespective of the sex. Positive coronary angiography was reported to

be more frequent in blood group A individuals (Tarjan et al. 1995). Also, Skaik (2009) found that myocardial infarction was most common in blood group A (57%) patients in Gaza Strip of Palestine. These observations are, however, in contrast and conflicting with results that reported higher risk in individuals with blood group AB as reported above.

The blood group category in our study that ranked third in the development of cardiovascular risk with total cholesterol was blood group B females (21.43%) while 10.00% was noticed in the blood group B males. CVD risk was equally high with HDL-C as with other blood groups in the population studied. The CVD risk profile with LDL-C was, however, higher in males (40.00%) than in the females (35.71%). Nydegger et al. (2003) indicated that the ABO blood group B allele was an independent risk factor for myocardial infarction. In a study in Indian, Garg et al. (2012) further reported that there is a significant association between myocardial infarction and blood group B. Our observation did not reveal blood group B phenotype as the blood group most at risk of cardiovascular disease.

It is worthy to note that blood group O individuals in this study exhibited less cardiovascular risk profile with total cholesterol (16.67%) and (12.50%) and low density lipoprotein cholesterol (30.56%) and 41.67% in both males and females when compared with the other blood groups respectively. This observation is, however, inconsistent with the observation of Anvari and his colleagues (2009), and Mitchell (1977) who reported that towns with a higher prevalence of blood group O had higher rates of cardiovascular mortality, whereas Meade et al. (1994) reported significantly higher incidence of ischaemic heart disease in blood group AB as compared to those of B and A. Another contrast to the above observations was a systematic review and meta-analysis which documented that having a non-O blood group carries an approximately two-fold increased risk of venous thrombosis (Dentali et al., 2012).

Another striking observation made in this study was the discovery that though the triglycerides level in the various blood groups were within the desirable limits ( $< 2.83$  mmol/L), strong positive correlations were observed between the triglycerides level and other atherogenic lipoproteins in the male blood group B, female blood group B, and female blood group O subjects. This could account for the higher prevalence of cardiovascular risk in the females than the males in the population studied irrespective of the blood groups.

In this study, gender distribution of CVD risk was profoundly observed. It is possible that genetic variation and make up of the Nigerian population which differed profoundly from the western and

Asian populations where some of these studies were performed could have accounted for this disparity in sex distribution of risk profile in the blood groups. However, some authors reported that gender distribution have no significant association with blood groups in ischaemic heart disease in patients (Abdollahi et al. 2009; Lutfullah et al. 2010).

Despite the findings in this study, it is important to state that the results from some cohort studies show that the prevalence of cardiovascular disease in various blood groups was almost similar to that in controls and no significant association was found between ABO blood groups and cardiovascular disease. Sari et al. (2008) reported that the distribution of ABO blood groups in patients with myocardial infarction was quite similar to that in control group and that of general Turkish population, which supports the idea that ABO blood group might not be significantly associated with the development of cardiovascular disease.

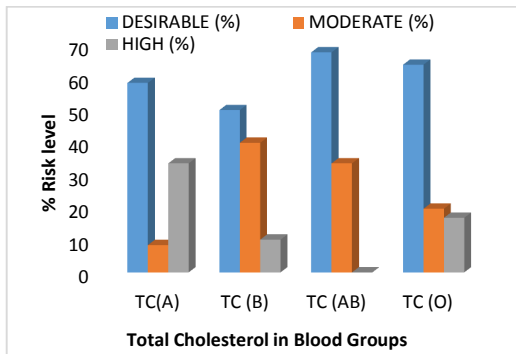


Fig.1: Percentage Risk Level of Male Subjects with TC amongst the Blood Groups

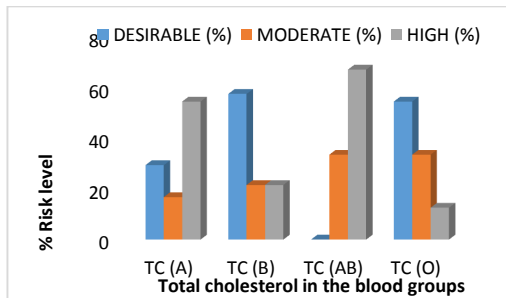


Fig.2: Percentage Risk Level of Female Subjects with TC amongst the Blood Groups

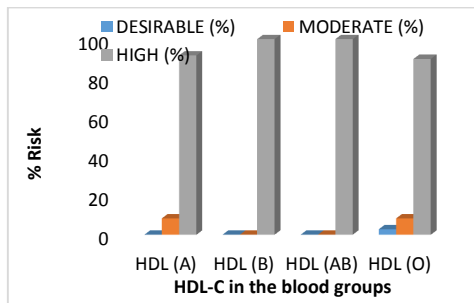


Fig. 3: Percentage Risk Level of Male Subjects with HDL-C amongst the Blood Groups

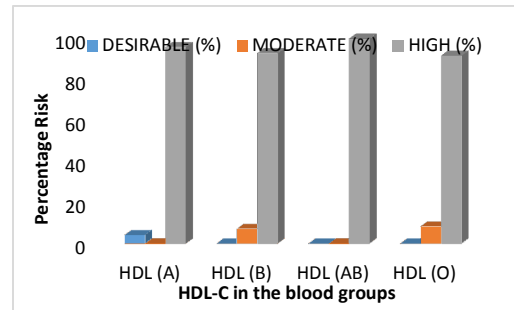


Fig. 4: Percentage Risk Level of Female Subjects with HDL-C Amongst Blood Groups

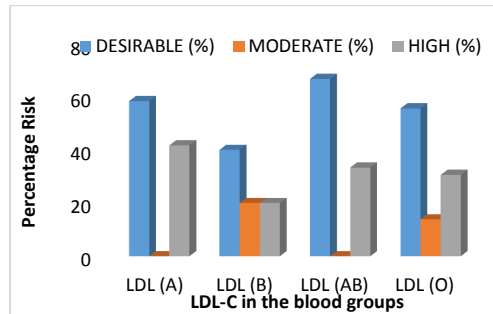


Fig. 5: Percentage Risk Level of Male Subjects with LDL-C amongst the Blood Groups

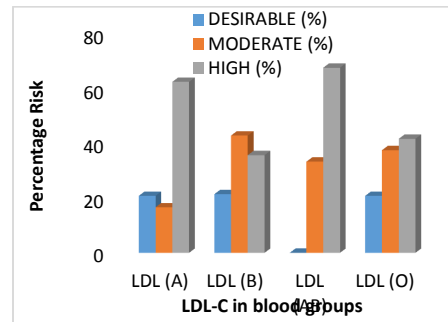


Fig. 6: Percentage Risk Level of Female Subjects with LDL-C amongst the Blood Groups

In conclusion, looking at the contradictory results from cross-sectional studies of various racial groups, it is obvious that the relationship between ABO blood groups and CVDs is still not clear signifying need for more research to draw a decisive conclusion. However, it is reiterated that this study reveals that the prevalence of CVD risk is highest in blood group AB, followed by blood group A, B and O respectively with the females exhibiting higher prevalence than the males in each blood group. The implication of this finding is that since lipid profile is a genetic component, family history may play an important role in the development and pathogenesis of cardiovascular disease risk factors. Similarly, because the prevalence of CVD is on the increase in worldwide and in Nigeria, it is our opinion that diagnosis, management and treatment of CVD in

Nigeria should take into consideration the blood group status of the subjects. Furthermore, a more elaborate study across Rivers State, Nigeria should be conducted to confirm the findings made in this study against the back drop that variation in demographic characteristics may affect the association of lipoprotein parameters with different blood groups.

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