



## LIPID PROFILES IN SERUM SAMPLES OF SOME NIGERIAN MALE SUBJECTS

EMMANUEL ILESANMI ADEYEYE<sup>1</sup> AND IDOWU OLUWADARE<sup>2</sup><sup>1</sup>Department of Chemistry, University of Ado Ekiti, PMB 5363, Ado-Ekiti, Nigeria<sup>2</sup>Institute of Public Analysts of Nigeria, 443, Herbert Macaulay Way, Yaba. PMB 1001, Oshodi, Lagos

EMMANUEL ILESANMI ADEYEYE

Department of Chemistry, University of Ado Ekiti, PMB 5363, Ado-Ekiti, Nigeria

**ABSTRACT**

Excessive levels of cholesterol in blood circulation are strongly associated with progression of atherosclerosis. While the measurement of total cholesterol (TC) low-density lipoprotein cholesterol (LDL-C) and high-density lipoprotein cholesterol (HDL-C) are recommended in current cardiovascular screening algorithms, recent guidelines have emphasized the importance of non-high density lipoprotein cholesterol (non-HDL-C) as a predictor of cardiovascular risk, while others have strongly advocated the use of specific lipid ratios of TC to HDL cholesterol. This study examined clinical utility of atherogenic dyslipidemia, metabolic syndrome, non-HDL cholesterol and the lipid ratios (TC to HDL cholesterol, LDL to HDL cholesterol, TG to HDL cholesterol, non-HDL to HDL cholesterol) as an individual marker of cardiovascular events. Characterisation of the study subjects was given. The analyses of the biochemical parameters were done using Reflotron® System. The TC, HDL and TG (total glyceride) were measured directly. LDL-C was estimated using the Friedewald formula:  $[TC] - [total\ HDL-C] - 20\ \% \ of\ the\ TG = estimated\ LDL-C$  based on the fact that TC is the sum of HDL, LDL and VLDL. The VLDL was estimated as one-fifth of TG. This formula was used to estimate LDL-C and VLDL-C in the samples. For the purpose of therapeutic decision-making, the followings were calculated: LDL-C/HDL-C, non-HDL-C/HDL-C, TG/HDL-C and TC/HDL-C ratios for the subjects. The results of the blood analyses revealed the total cholesterol (TC), total glyceride (TG) and the amounts of cholesterol in the various lipoproteins-high density lipoprotein-cholesterol (HDL-C), non-HDL-C, low density lipoprotein-cholesterol (LDL-C) and very low density lipoprotein-cholesterol (VLDL-C). 25 subjects were involved in the study. All TG levels < 200 mg/dl; all TC levels > 200 mg/dl; for HDL-C, 4 subjects (16 %) had values  $\leq 35$ mg/dl; in LDL-C, all values > 130 mg/dl. For therapeutic decision – making, non- HDL-C/HDL-C, TC/HDL-C, TG/HDL-C and LDL-C/HDL-C were calculated. In TC/HDL-C, only one subject (4 %) had value of  $\leq 3.4$  and in LDL-C/HDL-C, 22 subjects (88 %) had values < 5.0. Hence, non-HDL,TC, HDL-C, LDL-C, TC/HDL-C and to a lesser extent LDL-C/HDL-C could contribute to increased atherosclerotic heart disease such as hypercholesterolemia and/or low HDL cholesterolemia in the subjects. All the results were matched for age and sex. This report showed that significantly different results existed in TC and HDL-C (group II); VLDL-C and TG (group III) and LDL-C/HDL-C (group III); TG/HDL-C (group IV). All TG levels were < 200 mg/dl, all TC levels > 200 mg/dl; all levels in LDL-C were > 130 mg/dl and in LDL-C/HDL-C 88 % subjects had values < 5.0. Hence, TC, HDL-C, LDL-C, TC/HDL-C and to lesser extend LDL-C/HDL-C could contribute to increased risk of atherosclerotic heart disease and familial hyperlipoproteinemia.



## KEYWORDS

Male serum, lipid profile, therapeutic decision – making, Nigeria.

## INTRODUCTION

Cholesterol is the principal sterol synthesized by animals. Since cholesterol is essential for life, it is primarily synthesized *de novo* within the body. However excessive levels of cholesterol in blood circulation are strongly associated with progression of atherosclerosis. For an adult, typical total body cholesterol synthesis is about 1 gram per day (less if dietary intake is high) and total body cholesterol content is about 35 g. Average dietary intake in western societies is 0.2-0.3 g. Cholesterol is excreted by the liver via the bile into the digestive tract. Typically about 50 % of the excreted cholesterol is reabsorbed by the small intestine back into the blood stream <sup>1</sup>.

Since cholesterol is insoluble in blood, it is transported in the circulatory system within lipoproteins, complex spherical particles which have an exterior composed of amphiphilic (a molecule that has both hydrophilic and hydrophobic parts) proteins and lipids whose outward-facing surfaces are water-soluble and inward-facing surfaces are lipid-soluble, triglycerides and cholesterol esters are carried normally. Phospholipids and cholesterol, being amphiphathic, are transported in the surface monolayer of the lipoprotein particle.

In addition to providing a soluble means for transporting cholesterol through the blood, lipoproteins have cell-targeting signals which direct the lipids they carry to certain tissues. For this reason, there are many types of lipoproteins within the blood, generally called in order of increasing density: chylomicrons, very low density lipoprotein (VLDL), intermediate density lipoprotein (IDL), low density lipoprotein (LDL), and high density lipoprotein (HDL). However, the different lipoproteins contain apolipoproteins which serve as ligands for specific receptors on cell membranes. In this way, the lipoprotein

particles are molecular addresses that determine the start and endpoints for cholesterol transport <sup>2</sup>.

While the measurement of total cholesterol (TC), low-density lipoprotein (LDL) cholesterol, and high-density lipoprotein (HDL) cholesterol are recommended in most current cardiovascular screening algorithms <sup>3</sup>, recent guidelines have emphasized the importance of non- high density lipoprotein (non-HDL) cholesterol as a predictor of cardiovascular risk <sup>4</sup>, while others have strongly advocated the use of specific lipid ratios such as TC to HDL cholesterol, LDL to HDL cholesterol <sup>5, 6, 7</sup>. The aim of the present study is to focus the clinical utility of atherogenic dyslipidemia, metabolic syndrome, non-HDL cholesterol and the lipid ratios (TC to HDL cholesterol, LDL to HDL cholesterol, TG to HDL cholesterol, non-HDL to HDL cholesterol) as an individual marker of cardiovascular events. Also reported were the age ranges in groups of the subjects (males). This type of work will assist in knowing the level of susceptibility of those subjects to cardiovascular diseases and other blood related diseases and how to minimize or eliminate them.

The total number of subjects included in this study was 25, all registered for a medical test at the Nigerian National Petroleum Corporation, Warri, Delta State, Nigeria between April and May, 2008. At the time of the test, all subjects responded to a standardized questionnaire covering many personal details (such as smoking habit, alcohol intake, physical activity, food habit, etc.) organized by trained interviewers. Only male subjects were reported with age range of 16-81 years.



## MATERIALS AND METHODS

### **Characterisation of the study subjects:**

According to NCEP ATP III standard guidelines<sup>4</sup>, hypercholesterolemia and hypertriglyceridemia were defined as TC and TG levels of > 200 mg/dl and >150 mg/dl, respectively. Low-HDL cholesterolemia was defined as HDL cholesterol level of <40 mg/dl. LDL hypercholesterolemia was defined as >100 mg/dl. Atherogenic dyslipidemia was defined as having hypercholesterolemia, hypertriglyceridemia, and/or low HDL cholesterolemia. According to the NCEP criteria, an individual may be diagnosed to have metabolic syndrome if he or she has three or more of the following: obesity, hypertriglyceridemia, low-HDL cholesterolemia, hypertension and diabetes.

### **Biochemical parameters and analyses:**

Reflotron® System was used for these analyses. Reflotron® plus is a compact reflectance photometer for fully automatic evaluation of Reflotron® Tests. The instrument takes charge of all functions such as heating, automatic calibration, test execution and evaluation and calculation of results. Reflotron® Tests have reagent strips for specific testing of important clinical-chemistry parameters directly from whole blood, plasma or serum. The direct use of whole blood is made possible through an integrated plasma separation pad. Reflotron® plus is a product of Bio-Stat Diagnostic Systems, Pepper Road, Hazel Grove, Strockport, Cheshire SK7 5BW. The instrument has information on test principle and wavelength for each test and measuring ranges. Fasting blood samples were used and obtained by venipuncture.

Most testing methods do not actually measure LDL in blood. For cost reasons, LDL values have long been estimated using the Friedewald formula (or a variant)<sup>1</sup>: [total cholesterol]-[total HDL] - 20 % of the triglyceride value = estimated LDL-C. Or:  $LDL-C = [total\ cholesterol - (HDL-C + Triglyceride/5)]$ <sup>8</sup>. This

formula cannot be used, however, if blood triglycerides are > 400 mg/dl<sup>8</sup>. The basis of this formula is that TC is defined as the sum of HDL, LDL and VLDL. Ordinarily just the TC, HDL and TG are actually measured. The VLDL is estimated as one – fifth of the triglycerides. This formula was used to estimate LDL-C and VLDL-C in the samples. The term LDL-C (and HDL-C, VLDL-C) is used when expressing the blood concentration since it is the cholesterol content of these lipoproteins that is actually measured. The reference standard for expressing blood lipid concentrations also generally refers to the serum concentration. This is what remains after blood clots, and is then centrifuged to remove all red and white blood cells and clotting factors. Although blood cholesterol is a common term, the value actually refers to the concentration in the serum portion of the blood<sup>8</sup>. Hence, these determinations were actually in the serum. Non-HDL cholesterol was measured as TC-HDL cholesterol.

**Statistical analyses:** For the purpose of therapeutic decision-making, the followings were calculated: LDL-C/HDL-C, non-HDL-C/HDL-C, TG/HDL-C and TC/HDL-C ratios for the subjects. Also calculated were the variance ratio – 5 percent points for distribution of F within subjects of the same age group and the same parameter of non-HDL-C/HDL-C, TG/HDL-C, TC/HDL-C, LDL-C/HDL-C, TC, TG, LDL-C, HDL-C and VLDL-C to find if differences were significant<sup>9</sup>. Also calculated were the grand mean, standard deviation and coefficient of variation in percent.

**Ethics:** The Ethics Committee of the Nigerian National Petroleum Corporation Hospital approved the study. This was one of the reasons the subjects had to complete the questionnaire.



## RESULTS

Table 1 shows the Total Cholesterol (TC), High Density Lipoprotein – Cholesterol (HDL-C), Low Density Lipoprotein – Cholesterol (LDL-C), Very Low Density Lipoprotein – Cholesterol (VLDL-C), non-High Density Lipoprotein – Cholesterol and Total Glyceride (TG) for age group of 11- 20 years. Two subjects were in this group. The TC range was 213 – 218 mg/dl with a mean of  $215.5 \pm 3.54$  mg/dl and a coefficient of variation percent (CV %) of 1.64. The HDL-C showed a variation of 34.3 – 40.1 mg/dl with a mean of  $37.2 \pm 4.10$  mg/dl and higher CV % of 11.0. The LDL-C range was 154.9-165.62 mg/dl,

mean of  $160.26 \pm 7.58$  mg/dl and CV % of 4.73 which was less than the CV % of HDL-C. The VLDL-C range was 18.0-18.08 mg/dl, mean of  $18.04 \pm 0.06$  mg/dl and CV % of 0.31. The TG range was 90.0-90.4 mg/dl with a mean of  $90.2 \pm 0.28$  mg/dl and CV % of 0.31 which was similar to the CV % of VLDL-C. The non – HDL-C range was 172.9-183.7 mg/dl, mean of  $178.3 \pm 7.64$  mg/dl and CV % of 4.28 which was close to the CV % of LDL-C. Table 2 depicts the TC/HDL-C, non-HDL-C/HDL-C, TG/HDL-C and LDL-C/HDL-C ratios. The range of values was 5.31-6.36 with a mean of  $5.84 \pm 0.74$  and CV % of 12.7 for TC/HDL-C, the LDL-C had a range of

**Table 1**

**Lipids (mg/dl) in some Nigerian male serum samples (11-20 years age group), total number (n) = 2**

Statistics	Age (years)	TC	HDL-C	LDL-C	VLDL-C	TG	Non-HDL-C
	16	213	40.1	154.9	18.0	90.0	172.9
	19	218	34.3	165.62	18.08	90.4	183.7
Mean	17.5	215.5	37.2	160.26	18.04	90.2	178.3
SD	2.12	3.54	4.10	7.58	0.06	0.28	7.64
CV %	12.1	1.64	11.0	4.73	0.31	0.31	4.28

TC = total cholesterol; HDL-C = high density lipoprotein cholesterol; LDL-C = low density lipoprotein cholesterol; VLDL-C = very low density lipoprotein cholesterol; TG = total triglyceride; SD = standard deviation; CV % = coefficient of variation percent.

**Table 2**

**Ratio of values of TC/HDL-C and LDL-C/HDL-C in some Nigerian male serum samples (11-20 years age group), n = 2**

Statistics	Age	Non-HDL-C/HDL-C	TC/HDL-C	LDL-C/HDL-C	TG/HDL-C
	16	4.31	5.31	3.86	2.24
	19	5.36	6.36	4.83	2.64
Mean	17.5	4.84	5.84	4.35	2.25
SD	2.12	0.74	0.74	0.69	0.014
CV %	12.1	15.4	12.7	15.8	0.63



**Table 3**  
**Lipids (mg/dl) in some Nigerian male serum samples (21 -30 years age group), n = 8**

Statistics	Age	TC*	HDL-C*	LDL-C	VLDL-C	TG	Non-HDL-C
	21	222	45.5	159.42	17.08	85.4	176.5
	23	212	40.0	154.92	17.08	85.4	172
	24	228	38.1	170.46	19.44	97.2	189.9
	25	218	32.1	168.54	17.36	86.9	185.9
	27	231	38.5	173.36	19.14	95.7	192.9
	27	247	76.4	151.52	19.08	95.4	170.6
	28	210	43.4	161.32	15.28	76.4	166.6
	30	212	38.1	155.48	18.42	92.1	173.9
Mean	25.6	222.5	44.0	161.88	17.86	89.3	178.5
SD	2.92	12.5	13.7	8.04	1.42	7.08	9.65
CV %	11.4	5.63	31.1	4.97	7.94	7.93	5.41

- Results significantly different among column members at  $\alpha = 0.05$

3.86-4.83 with a mean of  $4.35 \pm 0.69$  and CV % of 15.8, non-HDL-C/HDL-C had values of 4.31-5.36 with a mean of  $4.84 \pm 0.74$  and CV % of 15.4 whilst TG/HDL-C had a range of 2.24-2.64 with a mean of  $2.25 \pm 0.014$  and CV % of 0.63 which was the lowest in the group.

In Table 3, parameter values of subjects of age group 21-30 years are shown. For TC, the range was 210-247 mg/dl with a mean of  $222.5 \pm 12.5$  mg/dl and CV % of 5.63. HDL-C range was 32.1-76.4 mg/dl and a mean of  $44.0 \pm 13.7$  mg/dl and a higher CV % of 31.1. The LDL-C had a range value of 151.52-173.36 mg/dl and a mean of  $161.88 \pm 8.04$  mg/dl with CV % of 4.97. VLDL-C had range value of 15.28-19.44 mg/dl and a mean of  $17.86 \pm 1.42$  mg/dl with CV

% of 7.94. TG showed a range of 76.4-97.2 mg/dl, mean of  $89.3 \pm 7.08$  mg/dl and CV % of 7.93. Non-HDL-C had a range of 166.6-192.5 mg/dl with a mean of  $178.5 \pm 9.65$  mg/dl and CV % of 5.41. Table 4 shows the ratios of TC/HDL-C, LDL-C/HDL-C, non-HDL-C/HDL-C and TG/HDL-C. The range of values in TC/HDL was 3.23-6.79, mean of  $5.32 \pm 1.06$  mg/dl and CV % of 20.0. Non-HDL-C/HDL-C had a range of 2.23-5.00 with a mean of  $4.32 \pm 1.06$  and CV % of 24.6, TG/HDL-C had values of 1.25-2.71 and mean of  $2.15 \pm 0.49$  and CV % of 22.9 whilst LDL-C/HDL-C ranged from 1.98-5.25, mean of  $3.92 \pm 0.96$  and CV % of 24.4.

**Table 4**

**Ratio of values of TC/HDL-C and LDL-C/HDL-C in some Nigerian male serum samples (21-30 years age group), n = 8**

Statistics	Age	Non-HDL-C/HDL-C	TC/HDL-C	LDL-C/HDL-C	TG/HDL-C
	21	3.88	4.88	3.50	1.88
	23	4.30	5.30	3.87	2.14
	24	4.98	5.98	4.47	2.55
	25	5.78	6.79	5.25	2.71
	27	5.00	6.00	4.50	2.49
	27	2.23	3.23	1.98	1.25
	28	3.84	4.84	3.72	1.76
	30	4.56	5.56	4.08	2.42
Mean	25.6	4.32	5.32	3.92	2.15
SD	2.92	1.06	1.06	0.96	0.49
CV %	11.4	24.6	20.0	24.4	22.9

Table 5 shows the values of the TC, HDL-C, LDL-C, VLDL-C, non-HDL-C and TG in the serum of age group 31-40 years. The TC range was 201-244 mg/dl with a mean of 221±17.5 mg/dl and low CV % of 7.91. HDL-C had a range of 20.0-65.7 mg/dl with a mean of 43.5±17.6 mg/dl, with a CV % of 40.6 which was much higher than in TC. The range in LDL-C was 156.18-162.98 mg/dl and a mean of 159.78±2.46

mg/dl and a much lower CV % of 1.54. The VLDL-C had a range of 16.42 – 19.38 mg/dl with a mean of 18.16±1.23 mg/dl and a CV % of 6.76. The TG had a range of 82.1-96.9 mg/dl with a mean of 90.8±6.13 mg/dl and CV % low and similar to the value in VLDL-C. Non- HDL-C had a range of 172.6-181.0 mg/dl with a mean of 177.9±3.16 mg/dl and CV % of 1.78.

**Table 5**

**Lipids (mg/dl) in some Nigerian male serum samples (31-40 years age group), n = 5**

Statistics	Age	TC	HDL-C	LDL-C	VLDL-C*	TG*	Non-HDL-C
	31	218	38.8	159.92	19.28	96.4	179.2
	32	210	37.4	156.18	16.42	82.1	172.6
	36	234	55.4	159.22	19.38	96.9	178.6
	38	201	20.0	162.98	18.02	90.1	181.0
	40	244	65.7	160.62	17.68	88.4	178.3
Mean	35.4	221	43.5	159.78	18.16	90.8	177.9
SD	3.85	17.5	17.6	2.46	1.23	6.13	3.16
CV %	10.9	7.91	40.6	1.54	6.76	6.76	1.78

Results significantly different among members of the column at  $\alpha = 0.05$ .

Both TC/HDL-C, non-HDL-C/HDL-C, LDL-C/HDL-C and TG/HDL-C for age group 31-40 years are shown in Table 6. TC/HDL-C had a range of 3.71-10.1, mean of 5.85±2.52 and CV

% of 43.1. Range of LDL-C/HDL-C was 2.44-8.15, mean of 4.35±2.26 and CV % of 51.8. Range for non-HDL-C/HDL-C was 2.71-9.05 with mean of 4.84±2.50 and CV % of 51.6



whilst TG/HDL-C had values of 1.35-4.51 with a mean of  $2.46 \pm 1.23$  and CV % of 49.9.

Table 7 contains the TC, HDL-C, non-HDL-C, LDL-C, VLDL-C and TG of age group 41-50 years. TC range was 218 – 238 mg/dl, mean of  $227 \pm 9.00$  mg/dl and a CV % of 3.96. HDL-C range was 31.1-66.1 mg/dl, mean of  $49.5 \pm 15.1$  mg/dl and CV % of 30.5. For LDL-C, range was 152.82-169.22 mg/dl, mean of  $161.01 \pm 6.95$  mg/dl and CV % of 4.32. VLDL-C had a range of 14.94-18.06 mg/dl, mean of

$16.64 \pm 1.20$  mg/dl and a CV % value of 7.19. TG range was 74.7-90.3 mg/dl, mean of  $83.2 \pm 5.98$  mg/dl and CV % of 7.19. The non-HDL-C had range values of 169.9-186.9 mg/dl with a mean of  $177.7 \pm 6.56$  mg/dl and a CV % 3.70 which was the lowest in the group. Table 8 depicts the TC/HDL-C, non-HDL-C/HDL-C, TG/HDL-C and LDL-C/HDL-C in the 41-50 years age bracket. Range of TC/HDL-C was 3.57-7.01, mean of  $4.93 \pm 1.38$  and CV % of 28.0 whilst range

**Table 6**

**Ratio of values of TC/HDL-C and LDL-C/HDL-C in some Nigerian male serum samples (31-40 years age group), n = 5**

Statistics	Age	Non-HDL-C/HDL-C	TC/HDL-C	LDL-C/HDL*	TG/HDL-C
	31	4.62	5.62	4.12	2.48
	32	4.61	5.61	4.18	2.20
	36	3.22	4.22	2.87	1.75
	38	9.05	10.1	8.15	4.51
	40	2.71	3.71	2.44	1.35
Mean	35.4	4.84	5.85	4.35	2.46
SD	3.85	2.50	2.52	2.26	1.23
CV %	10.9	51.6	43.1	51.8	49.9

\*Results significantly different among members of column at  $\alpha = 0.05$ .

in LDL-C/HDL-C was 2.31-5.44 and a mean of  $3.57 \pm 1.27$  with a CV % of 35.4. Non-HDL-C/HDL-C had a range of 2.57-6.01 with a mean of  $3.93 \pm 1.38$  and CV % of 35.1, TG/HDL-C had a range of 1.29-2.84 with a mean of  $1.82 \pm 0.60$  and CV % of 32.7.

Table 9 shows the TC, non-HDL-C, HDL-C, LDL-C, VLDL-C and TG levels in the bracket 51-60 years. TC range was 214-241 mg/dl, mean value of  $229 \pm 13.9$  mg/dl with a CV % of

6.06. HDL-C range was 36.4-60.0 mg/dl, mean of  $46.9 \pm 12.0$  mg/dl and a CV % 25.6. LDL-C range was 157.58 – 177.5 mg/dl, mean of  $166.37 \pm 10.2$  mg/dl and CV % of 6.11. In VLDL-C, range was 11.2-20.02 mg/dl, mean was  $16.06 \pm 4.48$  mg/dl and CV % of 27.9; TG range was 56.0 -100.1 mg/dl, mean value of  $80.3 \pm 22.4$  mg/dl and CV % of 27.9. Non-HDL-C values ranged from 177.6-188.7 mg/dl with a mean of

**Table 7*****Lipids (mg/dl) in some Nigerian male serum samples (41-50 years age group), n = 6***

Statistics	Age	TC	HDL-C	LDL-C	VLDL-C	TG	Non-HDL-C
	44	218	39.4	162.18	16.42	82.1	178.6
	45	218	31.1	169.22	17.68	88.4	186.9
	45	236	66.1	152.82	17.08	85.4	169.9
	48	231	55.6	159.72	15.68	78.4	175.4
	48	222	38.8	168.26	14.94	74.7	183.2
	50	238	66.1	153.84	18.06	90.3	171.9
Mean	46.7	227	49.5	161.01	16.64	83.2	177.7
SD	2.34	9.00	15.1	6.95	1.20	5.98	6.56
CV %	5.01	3.96	30.5	4.32	7.19	7.19	3.70

**Table 8*****Ratio of values of TC/HDL-C and LDL-C/HDL-C in some Nigerian male serum samples (41-50 years age group), n = 6***

Statistics	Age	Non-HDL-C/HDL-C	TC/HDL-C	LDL-C/HDL-C	TG/HDL-C
	44	4.53	5.53	4.12	2.08
	45	6.01	7.01	5.44	2.84
	45	2.57	3.57	2.31	1.29
	48	3.15	4.15	2.87	1.41
	48	4.72	5.72	4.34	1.93
	50	2.60	3.60	2.33	1.37
Mean	46.7	3.93	4.93	3.57	1.82
SD	2.34	1.38	1.38	1.27	0.60
CV %	5.01	35.1	28.0	35.4	32.7

**Table 9*****Lipids (mg/dl) in some Nigerian male serum samples (51-60 years age group), n = 3***

Statistics	Age	TC	HDL-C	LDL-C	VLDL-C	TG	Non-HDL-C
	52	241	60.0	164.04	16.96	84.8	181
	52	214	36.4	157.58	20.02	100.1	177.6
	52	233	44.3	177.5	11.2	56.0	188.7
Mean	52	229	46.9	166.37	16.06	80.3	182.4
SD	0.00	13.9	12.0	10.2	4.48	22.4	5.69
CV %	-	6.06	25.6	6.11	27.9	27.9	3.12



**Table 10****Ratio of values of TC/HDL-C and LDL-C/HDL-C in some Nigerian male serum samples (51-60 years age group), n = 3**

Statistics	Age	Non-HDL-C/HDL-C	TC/HDL-C	LDL-C/HDL-C	TG/HDL-C
	52	3.02	4.02	2.73	1.41
	52	4.88	5.88	4.33	2.75
	52	4.26	5.26	4.01	1.26
Mean	52	4.05	5.05	3.69	1.81
SD	0.00	0.95	0.95	0.85	0.82
CV %	-	23.4	18.8	22.9	45.4

**Table 11****Lipids (mg/dl) in some Nigerian male serum samples (81-90 years age group); TC/HDL-C and LDL-C /HDL-C; n = 1**

Age	TC	HDL-C	LDL-C	VLDL-C	TG	Non-HDL-C	TC/HDL-C	TG-C/HDL-C	LDL-C/HDL-C	Non- HDL-C/HDL-C
81	244	56.7	167.42	19.88	99.4	187.3	4.30	1.75	2.95	3.30

**Table 12(a)****Range variation of some parameters for the different age groups in their serum samples**

Age group	Age	TC	HDL-C	Non-HDL-C
11-20	16-19(3)	213-218 (5)	34.3-40.1 (5.8)	173-184 (10.8)
21-30	21-30(9)	210-247 (37)	32.1-75.4 (44.3)	167-193 (25.9)
31-40	31-40(9)	201-244 (43)	20.0-65.7 (45.7)	173-181 (8.4)
41-50	44-50(6)	218-238 (20)	31.1-66.1 (35)	170-187 (17.0)
51-60	52-52(0)	214-241 (27)	36.4-60.0 (23.6)	178-189 (11.1)

**Table 12 (b)****Range variation of some parameters for the different age groups in their serum samples**

Age group	Age	TG/HDL-C	LDL-C	VLDL-C	TG	Non-HDL-C/HDL-C
11-20	16-19(3)	2.24-2.26(0.02)	155-166(10.7)	18.0-18.1(0.08)	90.0-90.4 (0.4)	4.31-5.36 (1.05)
21-30	21-30(9)	1.25-2.71(1.46)	152-173(21.8)	15.3-19.4(4.16)	76.4-97.2 (20.8)	2.23-5.0 (2.77)
31-40	31-40(9)	1.35-4.51(3.16)	156-163(6.8)	16.4-19.4(2.96)	82.1-96.9(14.8)	2.71-9.05 (6.34)
41-50	44-50(6)	1.29-2.84(1.55)	153-169(16.4)	14.9-18.1(3.12)	74.7-90.3(15.6)	2.60-6.01 (3.41)
51-60	52-52(0)	1.26-2.75(1.49)	158-178(19.9)	11.2-20.0(8.82)	56.0-100(44.1)	3.02-4.88 (1.86)

**Table 12 (c)****Range of variation of some parameters for the different age groups in their serum samples**

Age group	Age	TG/HDL-C	TC/HDL-C	LDL-C/HDL-C	Non-HDL-C/HDL-C
11-20	16-19(3)	2.24-2.26(0.02)	5.31-6.36(1.05)	3.86-4.83(0.97)	4.31-5.36 (1.05)
21-30	21-30(9)	1.25-2.71(1.46)	3.23-6.79(3.56)	1.98-5.25(3.27)	2.23-5.0 (2.77)
31-40	31-40(9)	1.35-4.51(3.16)	3.71-10.1(6.39)	2.87-8.15(5.28)	2.71-9.05 (6.34)
41-50	44-50(6)	1.29-2.84(1.55)	3.57-7.01(3.44)	2.31-5.44(3.13)	2.60-6.01 (3.41)
51-60	52-52(0)	1.26-2.75(1.49)	4.02-5.88(1.86)	2.73-4.33(1.6)	3.02-4.88(1.86)

182.4±5.69 mg/dl and CV % of 3.12. Table 10 shows the non-HDL-C/HDL-C, TG/HDL-C, TC/HDL-C and LDL-C/HDL-C levels. Range in TC/HDL-C was 4.02-5.88, mean was 5.05±0.95 and CV % of 18.8 whereas range in LDL-C/HDL-C was 2.73-4.33, mean of 3.69±0.85 and CV % of 22.9. Non-HDL-C/HDL-C had values of 3.02-4.88 with a mean of 4.05±0.95 and CV % of 23.4 whilst TG/HDL-C were 1.26-2.75 with mean of 1.81±0.82 and CV % of 45.4. Table 11 contains all the determined

parameters for age group 81- 90 years with only one member (81 years old).

Tables 12 (a) and 12(b) show the summary of non-HDL-C, TC, HDL-C, LDL-C, VLDL-C and TG range variation in age groups 11-20, 21-30, 31-40, 41-50 and 51-60 whilst Table 12(c) shows their corresponding TG/HDL-C, non-HDL-C/HDL-C, TC/HDL-C and LDL-C/HDL-C. The results of the F-test distribution calculations are used for discussion in the relevant Tables; critical value was set at  $\alpha = 0.05$ .

## DISCUSSION

The age range group for the subjects was 11-81 years although no subject was in the age range of 61-80 years. All the results were matched for age and sex. The TC, HDL-C, non-HDL-C, LDL-C, VLDL-C and TG levels in the age 11-20 years showed the CV % of TC (1.64), HDL-C (11.0), non-HDL-C (4.28), LDL-C (4.73), VLDL-C (0.31) and TG (0.31) to be low or the values were very close (Table 1). No TC was lower than 200 mg/dl; the two subjects (Table 1) were in the borderline high (in the risk group) of 200-239 mg/dl. The present TC values were higher than the value reported (178 ±43.0 mg/dl) by Sowunmi *et al.*<sup>10</sup> but within the range (70-250 mg/dl) reported by Edozien<sup>11</sup>. Akinkugbe<sup>12</sup> reported 122 mg/dl for hypertensive and 131 mg/dl for non-hypertensive male subject of 19 years old. The HDL-C showed that one subject (50 %) had the

HDL-C level of ≤ 35 mg/dl which is an indication of risk. The level of 35 mg/dl set for women had been said to be too low for them<sup>13</sup>. According to NCEP ATP III standard<sup>4</sup>, anybody with HDL-C < 40 mg/dl will likely suffer from atherogenic dyslipidemia. The HDL-C levels in the present report were lower than the average level (54.0±9.4 mg/dl) reported by Sowunmi *et al.*<sup>10</sup>. The LDL-C in our subjects was not desirable in any subject because no value was < 130 mg/dl; in the borderline high of 130-159 mg/dl we had one subject whilst the other subject was in high risk of ≥ 160 mg/dl LDL-C level. The blood cholesterol linked to atherosclerosis risk is LDL-C; 46 % of its molecule is made up of cholesterol, etc.<sup>14</sup>. HDL also carries cholesterol, but raised HDL represent cholesterol returning from the arteries to the liver and thus indicates a reduced risk of atherosclerosis and heart attack. HDL includes 20 % of cholesterol in its molecule<sup>14</sup>. It has been confirmed that high blood



cholesterol carried in LDL correlates directly with heart disease, whereas high blood cholesterol in HDL correlates inversely with risk<sup>15</sup>. Our TG levels were all within the desirable level of < 200 mg/dl (90.0-90.4; 90.2±0.28 mg/dl); our mean value was close to Sowunmi *et al.*<sup>10</sup> with a mean value of 89 mg/dl. High TG alone normally does not indicate direct risk, but may reflect lipoprotein abnormalities associated with coronary heart disease (CHD). The risk of CHD increases as triglyceride levels increase (as VLDL-C also increases) in people with other risk factors. High TG also occurs in conditions such as kidney disease and diabetes, which suggest a high risk<sup>15</sup>. The VLDL has good relationship with the TG, hence their similarities in the CV % (0.31 in each case). VLDL has 8% cholesterol<sup>14</sup>. Non-HDL cholesterol is known to be a likely superior predictor of sub clinical atherosclerosis<sup>16</sup>.

The TC/HDL-C in Table 2 was greater than 3.4 (indicating risk for men) in the two subjects. This ratio has been found to be highly predictive of heart disease risk, more so than total blood cholesterol alone<sup>17</sup>. Also the LDL-C/HDL-C range of 3.86-4.83 was above the American standard value of 3.4 in the two subjects. Individuals with a LDL-C/HDL-C of 1.0 or TC/HDL-C of 3.4 are said to have about one half the heart disease risk of the average American<sup>18</sup>. The values of LDL-C/HDL-C were higher than 2.02±0.8 as reported by Sowunmi *et al.*<sup>10</sup>. TG/HDL-C values were lower than the TC/HDL-C values. High TG/HDL-C ratio is known to be as strong a lipid predictor of CHD as the widely used TC/HDL-C ratio<sup>16</sup>.

Table 3 contains the serum lipids in the ages 21-30 years range. The TC of this age range appeared to be generally higher in most cases than in the 11-20 years age range although we had a minimum value of 210 mg/dl lower than in 11-20 years range (213 mg/dl) and a maximum value of 247 mg/dl higher than the highest level of 218 mg/dl in the 11-20 years age range. No subject had a desirable level of <

200 mg/dl among the subjects; seven subjects (87.5 %) population were in borderline high of 200-239 mg/dl and only one subject (12.5 %) was in the high risk of ≥ 240 mg/dl TC. Akinkugbe<sup>12</sup> reported TC values of 117-182 mg/dl for hypertensive subjects and 131 -189 mg/dl for non – hypertensive subjects respectively with respective age range of 22-27 years male subjects. In the USA, the normal serum cholesterol in male subject of 20-24 years was 162.2±2.5 mg/dl<sup>19</sup>; this value was much lower than all the present results (Table 3). Our TC values in Table 3 were close with a low level of CV % of 5.63. In the HDL-C levels in Table 3, one subject would be at risk with HDL-C levels ≤ 35 mg/dl; this is about 12.5 % of the population of subjects. For male subjects of age range 20-24 years in the USA, the normal HDL-C level was 45.4±1.0 mg/dl. In our subjects, seven or 87.5 % of the population had HDL-C level above the critical level of 35 mg/dl. However, based on the NCEP ATP III<sup>4</sup>, four (50 %) subjects had HDL-C < 40 mg/dl. The values of HDL-C were more scattered than the values of TC as shown by their CV % (Table 3). However, both TC and HDL-C had F- calculated > F- table at  $\alpha = 0.05$  showing them to be significantly different within their columns. LDL-C levels in Table 3 showed that no subject value was within the desirable level of < 130 mg/dl<sup>20</sup>; but even greater than 100 mg/dl<sup>4</sup>; as at 1980 the range was between 151.52-173.36 mg/dl with a mean of 161.88 ±8.04 mg/dl although with a low level of CV % (4.97). The male normal LDL-C level of 20 – 24 years in the USA was 103.3 ± 2.4 mg/dl<sup>19</sup> which was much lower than our present report. In general, the higher the cholesterol (or, more specifically, the higher the LDL-C) the greater the risk of CHD. Research suggests that men with high cholesterol levels when they are young (mean age of 22 years) have a high risk of developing heart disease later in life<sup>15</sup>. Almost half of all deaths from CHD occur among men with blood cholesterol in the borderline – high range



[CCCC 1988]. In the age range of 20-24 years, the normal VLDL-C level is  $13.7 \pm 0.8$  mg/dl in the USA<sup>19</sup>; no subject was within this category; our subjects in 21-24 years age group had VLDL-C levels of 17.08-19.44 mg/dl. The TG in Table 3 was all within the desirable level of < 200 mg/dl<sup>20</sup> or even < 150 mg/dl<sup>4</sup> as also found in Table 1. The non-HDL-C values were also high with values of 166.6-192.5 mg/dl which is an aggregate measure that included the concentration of all lipoproteins currently believed to contribute to atherosclerosis.

The TC – to HDL-C had values of 3.23-6.79 (Table 4). All the values (except one, 12.5 %) were higher than the standard non risk value of 3.4 indicating the risk of CHD. In the case of LDL-C/HDL-C, seven (87.5 %) of the population had LDL-C/HDL-C less than the risk value of 5.0<sup>20</sup> whereas one subject would be highly susceptible to CHD. Both the non-HDL-C/HDL-C and TG/HDL-C appeared to be generally lower than in the 11-20 years age bracket.

Table 5 shows the lipid profile results for age group 31 – 40 years. The TC here had similar pattern of concentration as observed in the TC of Table 3 (21-30 years age group). The CV % was however lower than in Table 3 TC CV %. Akinkugbe<sup>12</sup> reported TC value of 92-201 mg/dl (hypertensive) and 123-214 mg/dl (non hypertensive) in 32-39 years old male subjects. These values were mostly lower than the present report. All our results were all outside the desirable level of < 200 mg/dl and one was still outside the borderline level of 200-239 mg/dl<sup>20</sup> making the subjects susceptible to CHD. The HDL-C levels of 20.0-65.7 mg/dl had one value of  $\leq 35$  mg/dl whereas four subjects or 80 % were outside the risk level. The LDL-C levels were all higher than the desirable level of < 130 mg/dl<sup>20</sup>, whereas two results were on the borderline high of 130-159 mg/dl and three in high risk level of  $\geq 160$  mg/dl<sup>2</sup>. The VLDL-C in Table 5 was 16.42-19.38 mg/dl and average of  $18.16 \pm 1.23$  mg/dl which was close to the mean value of  $17.86 \pm 1.42$  as observed for age group

21-30 years. The TG in Table 5 like the previous results was all lower than 200 mg/dl which meant they were all within the desirable level. The F-test results for VLDL-C and TG showed that F-calculated > F-table at  $\alpha = 0.05$ , hence, results were significantly different in the column. The non-HDL-C showed high values as in the previous Tables. The TC/HDL-C in Table 6 had all its values greater than 3.4 which meant that the subjects would be susceptible to CHD whereas subject with LDL-C/HDL-C value of 8.15 would have the problem of CHD but the others had LDL-C/HDL-C level less than 5.0. LDL-C/HDL-C showed significantly different relationship in Table 6. Non-HDL-C/HDL-C values showed significant differences among themselves. On a one-to-one comparison, every value of non-HDL-C/HDL-C was greater than its corresponding age value in LDL-C/HDL-C showing a very likely risk of CHD for all the members of the age group.

In Table 7 (41-50 years) was depicted the lipid profile of age group subjects. It was observed that the TC, non-HDL-C and LDL-C values were on the high side compared with earlier results in Tables 1, 3 and 5 but the corresponding VLDL-C values were lower than in the Tables 1, 3 and 5. The TG followed the earlier patterns. The TC levels in Table 7 could lead to CHD, five (83.3%) subjects had HDL-C values higher than 35 mg/dl which suggested non-risk of CHD, however only three (50 %) subjects had HDL-C > 40 mg/dl; LDL-C range from 152.82-169.32 mg/dl with the range of risk of borderline high (130-159 mg/dl) and high risk of CHD with a value of  $\geq 160$  mg/dl. All the TG values were less than 200 mg/dl which is the desirable level. The normal average TC in an American man of age 40-44 years had been reported as  $205.2 \pm 1.9$  mg/dl which was lower than our present report. The normal HDL-C in the American man of age group 40-44 years had been put at  $44.3 \pm 0.6$ <sup>19</sup>, three results (50 %) HDL-C (Table 7) was better than the reference report. The LDL-C in the American



man of age group 40-44 years was  $135.6 \pm 1.6$  mg/dl which was lower than all our LDL-C levels. The VLDL-C in an American man (40-44 years age group) was  $25.5 \pm 1.2$  mg/dl which was higher than our results of 14.94-18.06 mg/dl. Most studies examining heart disease involve only men<sup>15</sup>. The significance of findings on LDL-C and HDL-C to women is less clear. Women younger than 45 years tend to have lower concentrations of LDL-C than men of the same age. This hypothesis appears reasonable because the 26 subjects (male and female) of age group 11-40 years compared showed that 16/26 (61.5 %) had LDL-C levels in women lower than men in the corresponding age levels (unpublished report). Women's blood cholesterols begin to exceed those of men between the age 45 and 55<sup>15</sup>. After age 55, the disparity in LDL-C becomes even greater. The TC/HDL-C and LDL-C/HDL-C for the age group 41-50 years are shown in Table 8. No TC/HDL-C levels were less than 3.4<sup>17</sup>. All the six subjects but one had LDL-C/HDL-C levels  $\leq 5.0$  which is the risk level<sup>20</sup>. The TG/HDL-C statistical result showed that significant differences existed in the values within the column.

The non-HDL-C, TC, HDL-C, LDL-C, VLDL-C and TG levels of ages 51-60 years are shown in Table 9. The HDL-C, VLDL-C and TG levels were mostly within the expected non risk levels whereas both TC and LDL-C were all above the risk levels. In the American man of age group 50-54 years: normal TC ( $213.2 \pm 1.9$  mg/dl), normal HDL-C ( $44.1 \pm 0.6$  mg/dl), normal VLDL-C ( $26.8 \pm 1.1$  mg/dl) and LDL-C ( $142.3 \pm 1.7$  mg/dl)<sup>19</sup>, these literature values were very close to the present report in this age group. It was reported that in women, at menopause, LDL-C tend to rise and HDL-C decline<sup>22</sup>. In Table 10, TC/HDL-C levels were all above 3.4 while all the values of LDL-C/HDL-C were all less than 5.0 (the risk level).

From the study of Glew *et al.*<sup>23</sup> on the lipid profiles and trans fatty acids in serum

phospholipids of semi-nomadic Fulani in northern Nigeria, it was observed as follows. The concentration of TC was higher in women than in men (156 vs 122 mg/dl,  $p < 0.001$ ). The same was true of the LDL-C concentration: women 95 mg/dl; men 73 mg/dl ( $p = 0.005$ ). Conversely, the female subjects had a higher serum HDL-C concentration (41 vs 32 mg/dl,  $p = 0.007$ ). The serum TG was slightly higher in women than in men (100 vs 91 mg/dl, difference not significant). Compared with our results for the males: both TC and LDL-C were generally higher in the present report whereas both TG and HDL-C were much better in the present report.

## CONCLUSIONS

Tables 12(a), 12(b) and 12(c) gave summaries of the range values with the range differences in brackets. Only ages 11-20, 21-30, 31-40, 41-50 and 51-60 had enough information for range calculation exercise.

In summary, this report showed that significantly different results existed in TC and HDL-C (Group II, 21-30 years); VLDL-C and TG (Group III, 31-40 years) and LDL-C/HDL-C (Group III, 31-40 years); TG/HDL-C (Group IV, 41-50 years). All TG levels were in desirable level of  $< 200$  mg/dl or  $< 150$  mg/dl; all TC levels were  $> 200$  mg/dl; for HDL-C, four subjects (16 %) had HDL-C  $\leq 35$  mg/dl spread among the ages (years) 11-20 (1), 21-30 (1), 31-40 (1), 41-50 (1); in LDL-C, all levels were  $> 130$  mg/dl; only one subject (4 %) TC/HDL-C had a risk free value of  $\leq 3.4$  in the age range of 21-30 years (1) and in LDL-C/HDL-C, 22 subjects (88 % cutting across the age group) had values  $< 5.0$ . Hence, TC, HDL-C, LDL-C, TC/HDL-C and to a lesser extend LDL-C/HDL-C could contribute to increased risk of atherosclerotic heart disease and familial hyperlipoproteinemia.



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