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Assessment of Risks of Cardiovascular Diseases among Leprosy Patients Settlement at Ossiomo-Ogan Rehabilitation Center, Edo State, Nigeria

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Abstract

Background/Aim: Quality of life is reduced in people living with leprosy as a result of its impact on human activities. Lipid profile means pattern of lipids in the blood, which is routinely done to assess cardiovascular risk. The aim of this study is to assess the risk of cardiovascular diseases among the leprosy patients settlement at Ossiomo-Ogan, Edo state. **Method:** Blood samples were collected from a total number of one hundred and eight (108) (57 leprosy patients and 51 controls) subjects. The lipid profiles of the participants were determined using standard methods. **Results:** Significantly ($p < 0.001$) higher mean serum levels of total cholesterol, triglycerides, HDL and LDL in leprosy patients compared with the healthy controls were obtained. There is significant positive correlation between artherogenic index and levels of total cholesterol ($r = 0.663$; $p < 0.001$); triglyceride ($r = 0.901$; $p < 0.001$); HDL ($r = 0.284$; $p = 0.003$); and LDL ($r = 0.626$; $p < 0.001$) in leprosy patients. However, all the control subjects and 54 (94.7%) of the leprosy patients had low cardiovascular disease risk, while 3 (2.8%) indicated moderate CVD risk. None of the participants had high risk of developing cardiovascular disease. **Con-**

clusion: In this study, lipid profile levels of leprosy patients significantly increased despite moderate level of BMI. This study also showed significant positive correlation between the anthrogenic index of plasma and all the lipid profile. Many of the leprosy patients are not conscious of their diet which was tilted towards heavy carbohydrate and fatty meals. None of the participants is at high risk of cardiovascular diseases but the risk may increase with further elevation of the lipid profiles. Efforts should be made by all stakeholders to improve on the awareness of leprosy disease and encourage the sufferers to live decent lives.

Keywords

Leprosy, Cholesterol, Triglycerides, HDL, LDL, Edo State

1. Introduction

Leprosy or Hansen's disease is a chronic debilitating disease caused by *Mycobacterium leprae* that affects the skin, peripheral nerves, mucosa of the upper respiratory tract, and the eyes causing progressive and permanent disabilities if not treated [1]. Although leprosy was eliminated as a public health problem (*i.e.* a disease burden of <1 case per 10,000 persons) globally in the year 2000, leprosy still remains a global public health issue [2]. Each year about 200 - 300 thousand people are diagnosed of leprosy and about 2 - 3 million people are disabled because of it [3]. Official figures from 150 countries from six World Health Organisation (WHO) regions show that globally 7,607,837 persons are infected with leprosy [4]. A global registered prevalence of 192,713 cases was reported in 2017, an increase by 20,765 cases over that in 2016, and 210,671 new cases were detected in the same year [5]. In the African region, leprosy prevalence rates have dropped from 57,516 cases in 2000 to 33,690 in 2010, this represents a 42% decrease. A leprosy-induced irreversible disability currently affects about one million people in the region. The most vulnerable and high-risk populations are living in poor rural areas in the Democratic Republic of the Congo, Ethiopia, Madagascar, Mozambique, Nigeria and Tanzania.

In Nigeria a registered prevalence of 3234 cases was reported in 2015 and 2892 new cases were detected in the same year [6]. With this, Nigeria ranked third among African countries with the highest burden of the disease [7]. However in 2017, prevalence of 11,230 cases was reported and 2447 new cases detected, with a total of 195,875 persons infected with leprosy in the country; making Nigeria first among African countries with the highest burden of the disease in 2017 [5]. Nigeria Center for Disease Control (NCDC) moreover maintains that over 3500 people are diagnosed with leprosy yearly in the country with about 25% of victims having some degree of disability [8].

According to Gupta *et al.* [9], the study of lipid metabolism in leprosy is important since lipid plays a central role in the pathology of the disease, and cholesterol dynamics in macrophages may influence the occurrence of cardiovascu-

lar diseases and suggested that lipids might also play an important role as an etiological agent of the vascular abnormalities observed in leprosy. At the end of the 20th century, greater attention started to be paid to total cholesterol and high-density lipoprotein cholesterol (HDL-c) due to their important associations with the prevention or development of cardiovascular diseases (CVDs) [10].

Cardiovascular diseases (CVD) are the leading cause of death and disability worldwide. Together they resulted in 17.9 million deaths in 2015 up from 12.3 million in 1990 and represented 31% of all global deaths in 2016 [4]. Majority of cardiovascular disease results from complications of atherosclerosis, and an important initiating event for atherosclerosis may well be the oxidation of low-density lipoprotein (LDL) and the transport of oxidized low density lipoprotein (Ox-LDL) across the endothelium into the artery wall [11]. Dyslipidaemia, hyperglycaemia, and insufficient physical activity are cardiovascular risk factors that have been associated with leprosy [12] [13].

In spite of the global interest in cardiovascular disease and its role in the aetiology of many diseases, very few studies on these have been conducted among people affected by leprosy. There is also dearth of information regarding the link between leprosy and the risk of cardiovascular disease in Africans in general and in Nigerians in particular, hence the need for this study. The purpose of this study therefore, was to assess the cardiovascular disease risk factors in leprosy patients to see if there are any deleterious changes on these markers.

2. Materials and Methods

2.1. Study Location

The study was conducted at the Daughter of Charity Rehabilitation Centre, Ossiomo-Ogan, in Orhionmwon Local Government Area of Edo State, Nigeria between September 2020 and March 2021. The center is situated at the outskirt of the village where all the leprosy patients are housed for rehabilitation. The people of the village are predominantly farmers, but some of the residents still engage in petty trading. The rehabilitation camp is some kilometers away from the main village, probably to prevent the villagers from coming in contact with the infected persons. The camp is secured and all the activities surrounding the rehabilitation of the infected persons are done within the camp.

2.2. Study Design and Subject Selection

This is a case control study design. The study subjects include both male and female leprosy subjects (n, 57) and male and female controls who have not been affected by leprosy or living with leprosy patients (n, 51). The leprosy subjects included those undergoing treatments and those that were newly diagnosed. The controls however were recruited from the healthy population within the village. Excluded from this study were those who were not diagnosed with leprosy and those leprosy patients that have been certified free of the disease. The personal consent of individual participants was sought after explaining the purpose of the research. A structured

questionnaire was administered to every participant of this study.

2.3. Sample Size Method

The sample size for the study was determined using the formula for comparison between two groups when endpoint is quantitative data: $n = 2SD^2\left(Z_\alpha + Z_\beta\right)^2 \big/ d^2$ [14]. Where: n = the sample size (respondents that were interviewed); SD = 0.19 (standard deviation from mean artherogenic index of leprosy patients from a previous study [15]); Z_α = 1.96 (Z score corresponding to 95% confidence interval); Z_β = 0.84 (Z score corresponding to 80% confidence interval); d = 0.10 (the margin error that was accepted in this study).

$$\text{Applying the formula, } n = \frac{2SD^2\left(Z_\alpha + Z_\beta\right)^2}{d^2}$$

$$n = \frac{2(0.19)^2 \times (1.96 + 0.84)^2}{(0.10)^2} = \frac{0.072 \times 7.84}{0.01} = \frac{0.57}{0.01} = 57$$

$$n = 42 + 2$$

2.4. Questionnaire/Ethical Approval

An interviewer-administered, pre-tested and structured questionnaire was used to collect data from the patients. The questionnaire consisted of questions designed to elicit details about their personal data, age, sex, occupation, marital status, medications, alcohol consumption, smoking habit, duration of the disease, diet, physical activity/exercise, as well as history of underlying diseases. The Ethical committee of the Ministry of Health, Edo State and leaders of the centre approved this study (File number: HA – 737/48; Date of approval: 25th September, 2020). The head of the center was also informed of the nature of the study and his permission was sought and obtained before the commencement of the study.

2.5. Blood Collection and Analysis

Five milliliters of fasting blood was collected and dispensed into a plain container. The non anticoagulated blood was allowed to clot, spun at 1500 rpm for 10 minutes and the supernatant serum was separated into sterile tubes. The serum was stored at −20˚C for up to 2 weeks prior to analysis. Analysis for cholesterol, triglycerides, high density lipoprotein, were done spectrophotometrically using commercially purchased reagents from Fortres company, while low density lipoprotein value was calculated using Friedewald formula [16].

2.6. Tobacco, Diet and Other Lifestyle Factors

Average daily diet intakes of the patients were noted and registered. We did not bother to document current caffeine consumption as it sounded strange to most of the participants. It never formed sizeable part of their diet and few of them who took caffeine, did so occasionally, but could not really accurately keep records. We assessed the alcohol intake and smoking history by recording types

of alcohol they consumed as well as number of sticks of cigarette smoked daily. The participants were also asked if they do take vitamin supplements.

2.7. Measurement of Anthropometric Indices and Blood Pressure

Each participant's weight (in kilograms) and height (in metres) were measured. A weighing balance was utilized to measure weight in kilograms and a stadiometer was used to measure height in meters. Body mass index (BMI) was calculated as the ratio of the weight to the square of height (kg/m^2). Normal range for BMI is 18 - 25 kg/m^2. Obesity was defined as BMI ≥ 30 kg/m^2.

2.8. Data Analysis

Data were expressed as mean ± standard deviation for continuous data and percentages for categorical variables. Comparative analysis between variables was done using independent sample t-test. Correlation tests involving two variables were done using the Pearson's bivariate correlation test. The relative risk of developing cardiovascular diseases based on arthrogenic index and was determined using logistic regression test. Test of significance was set at $p < 0.05$. All statistics were done using SPSS/IBM Software (version 20).

3. Results

Table 1 shows the demographics, lifestyle and clinical characteristics of the study population. A total of 108 subjects were recruited for this study including 51 uninfected controls, 57 patients living with leprosy. The mean age of the participants was 59.84 years (ranging from 22 to 96 years) with a SD of ±10.78 years. The healthy control indicated significantly higher mean weight (62.80 ± 10.40 kg) compared with the leprosy patients (57.19 ± 10.50 kg). On the other hand, the leprosy patients indicated significantly greater age (63.64 ± 16.19 years vs. 53.64 ± 9.80 years) and SBP (136.17 ± 19.96 vs. 125.90 ± 11.92 mmHg) compared with the control. No significant differences were observed in mean height, BMI and DBP between the two groups. Majority of the control, 39.2% were of age group 50 - 59 years; while most of the leprosy patients, 59.6% were of the age group ≥ 60 years. A greater percentage of the participants were females (control, 62.7%; leprosy patients, 50.9%). All (100%) of the control subjects and 66.7% of the leprosy patients were married. Majority of the control, (47.1%) were employed, while most of the leprosy patients (45.6%) were retirees. Regarding their smoking and drinking habits, most of the participants were non-smokers (control, 90.2; leprosy, 87.7%) and non-alcoholics (control, 86.3%; leprosy, 73.3%). It is noteworthy that 7.8% of the controls were moderate smokers; 7.0% of the leprosy patients were mild smokers, while 5.3% were heavy smokers. Similarly, 9.8% of the controls were mild drinkers and 3.9% were moderate drinkers; 17.5% of the leprosy patients were mild drinkers, while 7.0% were heavy drinkers. Majority of the participants (control, 64.7%; leprosy patients, 66.7%) do not engage in any exercise. Eighty two percent of the control and eighty percent of

Table 1. Demographics, lifestyles and clinical characteristics of the study population.

Variables	Control (n, 51) Mean ± SD or n (%)	Patients (n, 57) Mean ± SD or n (%)	Total (n, 108) Mean ± SD or n (%)
Weight (kg)	62.80 ± 10.40	57.17 ± 10.50	59.84 ± 10.78
Height (meters)	1.64 ± 0.15	1.61 ± 0.13	1.63 ± 0.14
BMI (kg/m^2)	23.88 ± 7.40	22.24 ± 5.03	23.01 ± 6.29
SBP (mmHg)	125.90 ± 11.92	136.17 ± 19.96	131.3 ± 17.36
DBP (mmHg)	77.07 ± 5.58	77.24 ± 7.66	77.16 ± 6.73
Age (years)	53.64 ± 9.80	63.64 ± 16.19	58.92 ± 14.40
<40	1 (2.0)	0 (0)	1 (0.9)
40 - 49	14 (27.5)	15 (26.3)	29 (26.9)
50 - 59	20 (39.2)	8 (14.0)	28 (25.9)
≥60	16 (31.4)	34 (59.6)	50 (46.3)
Duration of Disease (yrs)	-	29.17 ± 17.36	29.17 ± 17.36
Sex			
Males	19 (37.3)	28 (49.1)	47 (43.5)
Females	32 (62.7)	29 (50.9)	61 (56.5)
Marital Status			
Single	0 (0)	19 (33.3)	19 (17.6)
Married	51 (100)	38 (66.7)	89 (82.4)
Occupational Status			
Employed	24 (47.1)	4 (7.0)	28 (25.9)
Unemployed	15 (29.4)	21 (36.8)	36 (33.3)
Retired	10 (19.6)	26 (45.6)	36 (33.3)
Self Employed	2 (3.9)	6 (10.5)	8 (7.4)
Smoking Status			
Non-Smokers	46 (90.2)	50 (87.7)	96 (88.9)
Smokers	5 (9.8)	7 (12.3)	12 (11.1)
Alcoholic Status			
Non-Drinkers	44 (86.3)	42 (73.7)	86 (79.6)
Drinkers	7 (13.7)	15 (26.3)	22 (20.4)
Exercise Status			
Non-Exercisers	33 (64.7)	38 (66.7)	71 (65.7)
Exercisers	18 (35.3)	19 (33.3)	37 (34.3)

Continued

Conscious of Dietary Intake			
No	42 (82.4)	46 (80.7)	88 (81.5)
Yes	9 (17.6)	11 (19.3)	20 (18.5)
Medication			
No	48 (94.1)	40 (70.2)	88 (81.5)
Yes	3 (5.9)	17 (29.8)	20 (18.5)

Abbreviations: BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; *Significant difference between control and leprosy patients.

the leprosy patients were conscious of their dietary intakes. Most of the participants (control, 94.1%; leprosy patients, 70.2%) were not under any form of medication.

Table 2 shows the lipid profile and artherogenic index of the study population. The independent sample t-test shows that the leprosy patients indicated significantly ($p < 0.001$) higher mean serum levels of total cholesterol, triglycerides, HDL and LDL compared with the healthy controls. On the other hand, the mean artherogenic index was significantly greater among the controls compared with the leprosy patients.

Table 3 shows the relationship between the artherogenic indices of the leprosy patients and their lipid profiles. The bivariate correlation test indicated a significant positive correlation between artherogenic index and levels of total cholesterol ($r = 0.663$; $p < 0.001$); triglyceride ($r = 0.901$; $p < 0.001$); HDL ($r = 0.284$; $p = 0.003$); and LDL ($r = 0.626$; $p < 0.001$). These results indicated that an increase in the lipid profile of the leprosy patients will result to increase in their artherogenic index.

Table 4 shows the classifications of cardiovascular disease risk based on the artherogenic indices of the study population. Data shows that all the control subjects had low cardiovascular disease risk. On the other hand, 94.7% ($n = 54$) of the leprosy patients group indicated low CVD risk, while 2.8% ($n = 3$) indicated moderate CVD risk. It is noteworthy that none of the control or leprosy groups indicated high CVD risk. The Chi-square test indicated lack of significant ($p = 0.097$) variations in the level of CVD risk between the leprosy patients and the healthy controls. In other words, the leprosy patients were not at greater risk (OR, 0.514; CI, 0.42 - 0.62) of CVD compared with the controls.

4. Discussion

Lipid profile means pattern of lipids in the blood, which is routinely done to assess a cardiovascular risk, usually involves the measurement/calculation of plasma levels of total cholesterol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, triglycerides and non-HDL cholesterol, although LDL-C measurement still plays a key role in the diagnosis, prediction and the

Table 2. Lipid profile and artherogenic index of the study population.

Variables	Control (n = 51)	Leprosy Patients (n = 57)	t-Statistics	p-Values
Total Cholesterol (mg/dl)	186.17 ± 19.33	224.12 ± 43.59	−5.73	<0.001
Triglycerides (mg/dl)	101.82 ± 10.87	133.89 ± 26.57	−8.03	<0.001
High Density Lipoprotein (mg/dl)	55.64 ± 4.47	59.40 ± 5.24	−3.98	<0.001
Low Density Lipoprotein (mg/dl)	109.62 ± 18.03	139.40 ± 36.89	−5.23	<0.001
Arthrogenic Index	−0.09 ± 0.04	−0.01 ± 0.06	−7.71	<0.001

Table 3. Relationship between the artherogenic indices of the leprosy patients and their lipid profiles.

Artherogenic Index vs.	Correlation Coefficient (r)	p-Value
Total Cholesterol	0.663	<0.001
Triglycerides	0.901	<0.001
High Density Lipoproteins	0.284	0.003
Low Density Lipoproteins	0.626	<0.001

Table 4. Classifications of cardiovascular disease risk based on the artherogenic indices of the study population.

CVD Risk Classifications	Control N (%)	Leprosy Patients N (%)	Total N (%)	X^2	p-Value	OR (CI)
Low Risk	51 (100)	54 (94.7)	105 (97.2)	2.76	0.097	0.514 (0.42 - 0.62)
Moderate Risk	0 (0)	3 (5.3)	3 (2.8)			
High Risk	0 (0)	0 (0)	0 (0)			

Abbreviations: OR, Odds Ratio; CI, Confidence Interval. Classification CVD based on artherogenic index: −0.3 to 0.1 for low risk, 0.1 to 0.24 for medium, and >0.24 for high risk [17].

monitoring of both the course and treatment of lipid disorders [18] [19] [20]. According to Gupta *et al.* [9] the study of lipid metabolism in leprosy is important since lipid plays a central role in the pathology of the disease. They also indicated that cholesterol dynamics in macrophage may influence the occurrence of cardiovascular diseases thus suggesting that lipids might also play an important role as an etiological agent of the vascular abnormalities observed in leprosy. The present study therefore aimed at determining the levels of lipid profiles in leprosy patients and correlating between the lipid profile and risk for cardiovascular diseases in these patients.

In this study, individuals aged 60 years and above constituted the highest percentage (59.6%) of patients with leprosy. A previous study has shown that individuals aged 50 - 60 years are mostly affected by leprosy [21], while another study by Reibel *et al.* [22] indicated that the age group 20 - 64 year is mostly affected. A greater percentage of the leprosy patients were females (50.9%) and this is in agreement with a previous study by Montnegro *et al.* [23]. In contrast, Salgado *et al.* [24] reported that males were more affected by leprosy than females. Lifestyles or habits such as cigarette smoking, alcohol consumption were all evaluated among the leprosy patients using oral questionnaire. Of the 57 leprosy patients that participated in this study, 26.3% (n, 15) indulged in alcohol consumption, while 12.3% (n, 7) were smokers. This outcome is in contrast with the study by White and Franco—Paredes [25] who observed a higher percentage of alcohol consumers (35.7%) and cigarette smokers (36.9%) among the leprosy patients.

The present study indicated significantly higher mean serum levels of total cholesterol, triglycerides, HDL and LDL among the leprosy patients compared with the healthy controls. Our findings further indicated that the mean values for total cholesterol and LDL-c were above the normal healthy values. The HDL and triglyceride values for the leprosy patients, though higher than those of controls, fell within the normal, healthy range of these variables. The higher mean serum levels of total cholesterol observed among the leprosy patients compared with the healthy controls is in agreement with a previous study [26] carried out in the Southern Nigeria. In contrast, some workers including, Bassey *et al.* [15], Lemes *et al.* [27], Sheikh *et al.* [28], Nega *et al.* [29], Ghulam *et al.* [30] recorded lower total cholesterol among leprosy patients. Other studies [12] [31] have also reported normal values of serum total cholesterol. Regarding the normal, but higher levels of triglycerides observed in leprosy patients compared with controls, our finding concurs with that of Bassey *et al.* [15], but disagrees with the results of studies by Ghulam *et al.* [30] and Kumar *et al.* [32], which reported reduced triglyceride levels in leprosy patients. Also in agreement with our study are some studies which have also recorded normal triglycerides levels in leprosy patients [12] [31].

HDL-c levels were found to be normal, although higher mean concentrations were observed among leprosy patients compared with the control, agreed with those of Nwosu and Nwosu [26], Ghulam *et al.* [30] and Sheik *et al.* [28], that reported significantly higher level of HDLc in leprosy patients compared with controls. Silva *et al.* [12] and Fichelmann *et al.* [31] also reported normal values, while Bassey *et al.* [15] reported lower values in contrast with the present result. Futhermore, Our study which indicated higher level of LDL-c among leprosy patients was in contrast with some previous studies [9] [12] [33] that reported normal values. Also in disagreement with our result are Hariprasad *et al.* [34], Bassey *et al.* [15] and Bansal *et al.* [35] who indicated lower LDL–c in leprosy patients when compared with controls.

The exact mechanisms responsible for the elevation of the serum levels of total cholesterol and LDL-c among the leprosy patients are not clear. However, sedentary lifestyle with excessive dietary intake of total calories, saturated fat, cholesterol, and trans fats have been identified as most important causes of dyslipidemia [36]. In this study, majority (66.7%) of the leprosy patients lived a sedentary lifestyle. In addition, a greater percentage (80.7%) of the leprosy patients was not conscious of their dietary intakes, thus suggesting lack of a clear-cut feeding pattern among the leprosy patients. Interestingly, many of the patients confessed of indulging in unregulated, heavy carbohydrate and fat loaded meals, which is common in this part of the country. These may have accounted for the high levels of the lipid profiles observed among the leprosy patients. Moreover, it has been reported that the ability to synthesize different lipid moieties and their distribution to various body tissues through plasma may be altered in leprosy [37]. Furthermore, the invasion of the liver, the principal organ involved in the lipid metabolism, by lepra bacilli may alter the lipid metabolism in patients with leprosy [38].

The abnormal levels of total cholesterol and LDL-c among the leprosy patients are suggestive of dyslipidemic condition. Dyslipidemia is recognized as a prominent risk factor for cardiovascular diseases [39]. Anthrogenic index of plasma is a novel indicator of dyslipidemia and is strongly correlated to cardiovascular risk [17] [40]. In this study, we classified the risk of developing cardiovascular disease using the artherogenic index. Of the 57 leprosy patients, 54 (94.7%) indicated low CVD risk, while 3 (2.8%) indicated moderate CVD risk. It is noteworthy that none of the participants indicated high CVD risk. Furthermore, significant positive correlations were observed between the anthrogenic index of plasma and total cholesterol, triglyceride, LDL-c and HDL-c. These results indicate that an increase in the lipid profile of the leprosy patients will result to an increase in their anthrogenic index which may put them at risk of cardiovascular events. Our findings are in agreement with a previous study [41].

Limitations

This study was a cross-sectional study; therefore, it cannot be generalized for general population and no causal relationship can be established. We did not also assess the influences of social and environmental factors, hence the need to apply caution in the interpretation of the data.

5. Conclusion

In this study, lipid profile levels of leprosy patients significantly increased despite moderate level of BMI. This study also showed significant positive correlation between the anthrogenic index of plasma and all the lipid profile. Many of the leprosy patients are not conscious of their diet which was tilted towards heavy carbohydrate and fatty meals. None of the participants was at high risk of cardiovascular diseases but the risk may increase with further elevation of the lipid profiles. Efforts should be made by all stakeholders to improve on the aware-

ness of leprosy disease and encourage the sufferers to live decent lives.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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