

## Assessment of Cardiac Status of Postmenopausal Women in Nnewi Metropolis, Anambra State, Nigeria.

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**Abstract:** This study investigated the cardiac status of postmenopausal women in Nnewi Metropolis, Anambra State, Nigeria. A total of 120 subjects comprising of 60 apparently healthy postmenopausal and premenopausal women (control) aged between 50 to 70 years and 20 to 30 years respectively were recruited for the study. Their blood pressure readings and body mass index (BMI) were obtained, whereas their demographic data and health status were obtained using a well-structured questionnaire. Thereafter, 5mls of blood sample was collected from the subjects into plain container and used for the estimation of biochemical parameters (LDH, Total CK, and CK-MB levels) respectively using standard laboratory methods. Data obtained were subjected to statistical analysis using student *t*-test and Pearson *r* correlation. The results showed that the mean serum activities of LDH ( $147.02 \pm 15.25$  Vs  $90.92 \pm 8.55 \mu/L$ ) and Total-CK ( $60.08 \pm 12.34$  Vs  $12.34 \pm 9.34 \mu/L$ ) were significantly increased in postmenopausal women than in the control subjects ( $P < 0.05$ ), whereas, the mean serum activity of CK-MB did not differ significantly in postmenopausal women when compared with the control subjects ( $P > 0.05$ ). Interestingly, the mean BMI did not differ significantly in both subjects ( $P > 0.05$ ) whereas, significant increases in the mean SBP ( $136.95 \pm 10.55$  Vs  $108.67 \pm 10.88$ ) and DBP ( $93.58 \pm 8.49$  Vs  $80.33 \pm 7.2$  mmHg) were observed in postmenopausal women than in the control subjects ( $P < 0.05$ ). These findings may suggest that the incidence of coronary heart disease may be associated with menopause. Therefore, lifestyle modifications should be incorporated into the daily lives of menopausal women and risk factors for cardiovascular diseases should be treated and controlled.

**Keywords:** Menopause, Postmenopausal Women, Lactate dehydrogenase, Total creatine kinase, Creatine kinase – MB, Body mass index, Systolic blood pressure, Diastolic blood pressure, Nnewi Metropolis.

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### I. Introduction

Menopause is a natural transition encompassing not only the biological changes but also the social and cultural changes associated with the aging process [1]. It usually occurs sometime between 40 and 60 years and marks the end of the reproductive phase of a women's life [2]. The median age for the final menstrual period is about 51 years, when the ovarian follicular reserve and indeed oestrogen production is significantly reduced [3]. While most women traverse the menopausal transition with little difficulty, others may undergo significant stress. And with increasing age, emerging physical health problems can cause significant changes in the woman's lifestyle, leading to social withdrawal, avoidance and curtailment of physical activity [4]. Menopause refers to the permanent cessation of menstruation due to loss of ovarian follicular activity. It results in a decrease in estrogen secretion that is responsible for most of the features seen in menopausal women. Natural menopause is recognized after 12 months of amenorrhea that is not associated with a pathologic cause. The global burden of cardiovascular diseases (CVD) is rapidly increasing. CVD is the leading cause of death in women around the world. More than 450,000 women succumb to heart disease annually, and 250,000 die of coronary artery disease [5]. Estrogen deficiency has been linked to the rapid increase in cardiovascular disease in women who have undergone natural or surgical menopause [6]. Cardiovascular disease risk increases after the menopause which

may be related to metabolic and hormonal changes [7]. Menopause is a risk factor for (CVD) because estrogen withdrawal has a detrimental effect on cardiovascular function and metabolism. The decrease in the levels of sex steroid hormones during menopause causes a number of structural, physiological and biochemical changes that alter the general health status of the menopausal woman which includes an increase in adiposity, which is a risk factor for developing insulin resistance, dyslipidaemia, breast cancer, hypertension and cardiovascular diseases [8]. Traditional cardiovascular disease risk factors includes changes in body fat distribution from a gynoid to an android pattern, reduced glucose tolerance, abnormal plasma lipids, increased blood pressure, increased sympathetic tone, endothelial dysfunction and vascular inflammation. Moreover, cardiovascular risks are poorly managed in women, especially during the menopausal transition when susceptibility to cardiovascular events increases [9]. Creatine kinase is also known as Adenosine-5-triphosphate, creatine phosphotransferase, creatine phosphokinase, phosphocreatine phosphokinase and creatineN –phosphotransferase. It catalyzes the reversible transfer of a phosphoryl group from ATP to creatine, producing phosphocreatine and adenosine diphosphate [10]. Creatine kinase is a highly conserved enzyme of 40 kDa, with its sequence being ~60% identical across all species and isoforms [11]. It is a member of the phosphagen kinase family of guanidino kinases (ATP-guanidino-phosphotransferases) [11]. There are four major CK isozymes, two are cytosolic and two are mitochondrial. The two tissue-specific (muscle or brain) cytosolic CKs exist as homo-dimers (CK-MM and CK-BB) under physiological conditions but hetero-dimers (CK-MB) composed of muscle (M) or brain (B) monomers have also been identified. There are, therefore, three different isoenzymes: CK-MM, CK-BB and CK-MB. Creatine kinase plays a pivotal role in the transport of high-energy phosphate (HEP) groups from mitochondria to myofibrils in contracting muscle [12]. While mitochondrial creatine kinase is directly involved in formation of phosphocreatine from mitochondrial adenosine triphosphate, cytosolic CK regenerates adenosine triphosphate from adenosine diphosphate, using phosphocreatine [13]. Lactate dehydrogenase (LDH) is a tetrameric enzyme, belonging to the 2-hydroxy acid oxidoreductase family that catalyzes the interconversion of pyruvate to lactate and nicotinamide adenine dinucleotide NADH to NAD<sup>+</sup>. NADH and lactate-NAD<sup>+</sup> are critical for anaerobic respiration as it can recycle NAD<sup>+</sup> for the continuation of glycolysis [14]. The reaction involves the transfer of a hydride ion from NADH to the C2 carbon of pyruvate [15]. Both skeletal and cardiac muscles avidly oxidize lactate as a fuel, accounting for ≤60% of the energy supply in the myocardium. Two major isoforms of LDH, namely LDHA (LDHM or LDH5) and LDHB (LDHH or LDH1), exist in mammalian cells, with the A form favoring the transformation of pyruvate to lactate and the B form favoring the backward conversion [16]. Menopause is associated with physiological and biochemical changes that alter the overall health of women which may include hyperlipidemia, hypertension and cardiovascular diseases. The decrease in estrogen during menopause leads to increase in plasma lipid. This study may be of utmost relevance in assessing the levels and activities of some cardiac markers in menopausal women.

## **II. Literature Survey**

### **2.1 Cardiovascular disease (CVD)**

This is a class of diseases that involve the heart or blood vessels [17]. Cardiovascular disease includes coronary artery diseases (CAD) such as angina and myocardial infarction (commonly known as a heart attack). Other CVDs include stroke, heart failure, hypertensive heart disease, rheumatic heart disease, cardiomyopathy, heart arrhythmia, congenital heart disease, valvular heart disease, carditis, aortic aneurysms, peripheral artery disease, thromboembolic disease, and venous thrombosis. [17]. There are many risk factors for heart diseases: age, gender, tobacco use, physical inactivity, excessive alcohol consumption, unhealthy diet, obesity, genetic predisposition and family history of cardiovascular disease, hypertension, diabetes mellitus, hyperlipidemia, psychosocial factors, poverty and low educational status, and air pollution. [18], [19]. While the individual contribution of each risk factor varies between different communities or ethnic groups the overall contribution of these risk factors is very consistent [20]. Some of these risk factors, such as age, gender or family history/genetic predisposition, are immutable; however, many important cardiovascular risk factors are modifiable by lifestyle change, social change, drug treatment for example prevention of hypertension, hyperlipidemia, and diabetes [21]. People with obesity are at increased risk of atherosclerosis of the coronary arteries [22].

### **2.2.2 Pathophysiology of cardiovascular disease**

The major cause of cardiovascular disease is atherosclerosis. Atherosclerosis is a degenerative process of the major human elastic and muscular arteries. Atherosclerosis represents a hardening of the arteries, which involves in particular atheromatous plaque formation consisting of lipid accumulations, smooth-muscle and inflammatory cells, connective tissue fibers, and calcium deposits, an asymmetric focal thickening of the intima [23]. Atheromas are initiated by the retention of low-density lipoprotein (LDL) and other lipoproteins in the subendothelial matrix. This is supported by permeability changes of the endothelium triggered by haemodynamic forces acting on the endothelial cell surface. Trapped LDL becomes oxidized as a result of

interactions with reactive oxygen species. As a consequence of these endothelial cells in close proximity to oxidized LDL produce pro-inflammatory molecules and anti-atherogenic substances such as nitric oxide are down regulated. Following this, monocytes invade the vessel wall where they develop into foam cells through uptake of oxidized LDL. [24]. Collections of such cells can be seen in autopsy specimens as 'fatty streaks'. Further disease progression leads to an intermediate lesion consisting of layers of macrophages and smooth muscle cells. Infiltrating T-cells are also present in atherosclerotic lesions [25]. A fibrous plaque develops when extracellular lipid deposits increase and smooth muscle cells and extracellular matrix accumulates in the intima resulting in a fibrous cap. This pathological structure is defined as a plaque, which can be stable or unstable [23]. Stable plaques are rich in extracellular matrix and smooth muscle cells which usually overlay a core of lipid and necrotic debris. An unstable plaque, however has a very thin fibrous cap as a result of matrix degradation by various proteinases and an inhibition of de novo matrix secretion. As a result unstable plaques are prone to rupture and thrombus formation. Other features of an unstable plaque are a necrotic and sometimes calcified core, and an increased number of inflammatory cells with an accumulation of foam and mast cells at the margin of the plaque, also called the shoulder area [26]. Atherosclerosis can affect the vessel lumen in different ways. Continuing growth of smooth muscle cells can lead to extensive coronary artery stenosis. In contrast, unstable plaques can cause myocardial infarction without obstruction of the coronary lumen prior to rupture, "Positive remodeling"- a process by which the vessel diameter increases, allows a vessel wall plaque load of 40% to evolve before it affects the cross-sectional luminal area. Therefore smaller plaques are not detectable by coronary angiography. Similar processes can even lead to coronary ectasia, a dilatation of the artery lumen [25].

### **2.2.3 Menopause and Cardiovascular Disease**

Coronary heart disease (CHD) accounts for the majority of CVD deaths in women and disproportionately affects racial and ethnic minorities. In the past, the number of CVD related deaths was strikingly higher in men when compared to women. Since 1984, the gap between male and female deaths attributed to CVD has narrowed dramatically. The reasons for this gender discrepancy are not well understood; however, studies have suggested that the clinical presentation of CVD in women differs from that of men. A large proportion of deaths attributable to CVD occur in women with no previous symptoms [27] making early detection in women particularly challenging. Risk factors suggested to be specific to development of CVD in women include dyslipidemia, inflammation, and insulin resistance [28]. During menopausal transition stage, levels of endogenous sex hormones such as estrogen decrease. The lack of estrogen is thought to be related to unfavorable changes in cardiovascular risk factors. In many women, CVD risk factors, including dyslipidemia, hypertension, abdominal adiposity, and insulin resistance begin to develop during the menopausal transition [29]. These changes have been suggested to explain the increase in development of CVD in older, postmenopausal women. One consequence of estrogen loss at menopause is an increase in centralized or intraabdominal fat. Higher intra-abdominal fat has been identified as an important CVD risk factor, independent of overall obesity due in part to its role in the development of dyslipidemia, inflammation, and insulin resistance [29]. Furthermore, centralized adiposity is associated with a greater risk for type 2 diabetes, higher triglyceride levels, and greater number of atherogenic, small, dense LDL particles. Alterations in lipid metabolism caused by the excess in intra-abdominal fat are thought to contribute to the increase in CVD development in postmenopausal women. It has been suggested that excess intra-abdominal fat is associated with an increase in insulin resistance, free fatty acid (FFA) levels, and decreased adiponectin (an adipocyte-derived peptide). These factors contribute to the increased secretion of apolipoprotein B (apo B) containing particles, which subsequently lead to high triglyceride levels, as well as an increase in hepatic lipase activity (liver enzyme). The increase in hepatic lipase activity results in a preponderance of small, dense LDL particles, which are thought to be atherogenic, and a reduction in larger, anti-atherogenic HDL particles [29]. The increase in intra-abdominal fat is also associated with increased levels of inflammatory markers, including C-reactive protein (CRP). Increased CRP levels have been shown to be a strong predictor of future cardiovascular events. Centralized adiposity is also directly related to insulin resistance and compensatory hyperinsulinemia, independent of total body fat [30]. The adverse changes to cardiovascular risk factors among postmenopausal women, such as the development of dyslipidemia, are demonstrated in results published from the Healthy Women Study (HWS) and the results suggested that premenopause was associated with increase in LDL cholesterol, triglycerides, and body mass index, while postmenopause was associated with increase in systolic blood pressure, pulse pressure, and fasting glucose [31].

### **2.2.4 Risk factors for Cardiovascular Disease in postmenopausal women**

The current concept of CVD implies that its process is initiated by risk factors such as dyslipidaemia, hypertension, diabetes, smoking and obesity. These factors lead to oxidative and mechanical stress, endothelial dysfunction, inflammatory processes and ultimately vascular remodeling. The occurrence of these factors marks

the beginning of the atherosclerotic process, and continues to be present throughout the cardiovascular continuum [32]. It has been demonstrated oxidized LDL in fetal aorta walls of hypercholesterolaemic mothers; suggesting atherosclerosis represents a lifelong process [33].

#### **2.2.4.1 Hypertension**

Pathologically raised blood pressure, also known as hypertension, is an established risk factor for all clinical manifestations of atherosclerosis. Hypertension is defined as persistent blood pressure equal or above 140 mmHg in systole and/or 90 mmHg in diastole. Hypertension leads to a two to four fold increase in cardiovascular events in comparison to a normotensive person of the same age group. An elevated blood pressure is associated with the development of CAD in a continuously graded manner, without a critical threshold. Mortality in CVD doubles with each 20 mmHg systolic or 10 mmHg diastolic blood pressures (DBP) rise and this extends in the normal blood pressure range. For instance, in comparison to values below 130/85 mmHg, the combination of SBP 130-139 mmHg and DBP 85-89 mmHg are associated with a 1.6 and 2.5 fold hazard of CVD in menopausal women [34].

#### **2.2.4.2 Diabetes**

Type 1 and type 2 diabetes mellitus are characterised by hyperglycaemia. Other features of diabetes mellitus type 2 are hyperinsulinaemia and an excess of free fatty acids resulting from genetic and environmental factors. Type 1 diabetes mellitus is an autoimmune disease and comprises 90% of those with diabetes and atherosclerosis. The link between elevated blood glucose levels and increased mortality and morbidity from vascular disease is well established. According to Coutinho et al., a fasting glucose level of 6.1 mmol/l in comparison to 4.2 mmol/l was associated with a relative cardiovascular disease risk [35]. The direct effect of hyperglycaemia on the vasculature is only partially understood, however hyperglycaemia directly impairs endothelial function. Interestingly, high glucose levels augment protein kinase C dependent endothelial nitric oxide synthase gene and protein expression. Yet this upregulation also leads to an increase in superoxide anions, which react with nitric oxide, suggesting an inactivation of nitric oxide by superoxide anions, which then leads to a production of further reactive oxygen species. Furthermore, protein kinase C activation by hyperglycaemia leads to cyclooxygenase 2 production. This is associated with an increase in thromboxane A<sub>2</sub> and a reduction of prostacycline [36]. In summary, hyperglycaemia induces endothelial dysfunction and oxidative stress.

#### **2.2.4.3 Obesity**

Due to changing ways of life in modern society and sedentary lifestyle, obesity has become a serious growing problem worldwide [37]. Obesity in women has been associated with a variety of factors, including genetic predisposition, social class, early age at menarche, lack of exercise, excessive alcohol consumption and diet low in fruits and vegetables. For most women obesity peaks during and after menopause in the fourth and fifth decade of life. These changes in body composition may be due to reduced levels of circulating estrogen, also an increase in the androgen-estrogen ratio is a likely factor for shifting fat distribution [38]. In the postmenopausal years, women develop a central pattern of fat distribution and an increased risk of developing CVD [39]. In a cross-sectional study by Gower et al., it was indicated that postmenopausal women had greater total body fat, central skinfolds, intra-abdominal fat and also higher plasma concentrations of total-C, LDL-C, and triglycerides than premenopausal women [39]. Obesity is measured with a Body Mass Index (BMI) which is calculated as weight in kilograms divided by the square of height in meters. Women with a BMI of 25 to 29.9 are considered overweight, while women with a BMI of 30 or more are considered obese [40]. Overweight and obesity result from an energy imbalance. This involves eating too many calories and not getting enough physical activity. Several studies [41], [42], [43], have supported the theory that increased physical activity reduces obesity and thus has beneficial effects on CVD risk factors. [44]. Patalay et al. concluded that exercise reduces plasma LDL-C and triglycerides in premenopausal women due to increased expression of the LDL receptors and lipoprotein lipase activity [45]. Ryan et al., suggested that fat deposition within mid-thigh muscle, represented by low-density lean tissue, is associated with increased risk factors for CVD in women [43]. Exercise and caloric restriction has shown to cause a decrease in body weight by 8%, total body fat by 15%, triacylglycerol concentration by 19% and glucose tolerance test by 10%. High density lipoprotein cholesterol levels were increased by 8%. They concluded that increased physical fitness and weight loss improve glucose and lipid profile thus reducing metabolic risk factors for CVD in obese postmenopausal women. Results from this study suggest that menopausal women can benefit from increasing physical activity and reducing weight and hence prevent CVD [43].

#### **2.2.4.4 Dyslipidaemia**

Lipid metabolism can be perturbed in different ways. In general dyslipidaemia is caused by an alteration in lipid function or increased levels compared to the physiologic state. These can be of genetic origin

such as in familial hypercholesterolaemia, diet related, part of disease complexes such as the metabolic syndrome, secondary to other disease like end stage renal failure or a mixture of these causes [45]. Besides the most common forms of dyslipidaemia, the elevation of total cholesterol and LDL cholesterol, several other forms predispose to premature cardiovascular disease. An example is the so-called atherogenic lipid triad. It consists of the combined increase of very low density lipoproteins, triglycerides and small dense low density lipoprotein particles in association with reduced high density lipoprotein particles [46]. Consequently the cardiovascular risk increases continuously the higher the cholesterol level becomes. A total cholesterol of 8 mmol/L and an LDL cholesterol of 6 mmol/L for instance places a patient at a high total risk of CVD in the absence of other risk factors. On the other hand, a 10% reduction in total cholesterol levels leads to a 25% reduction of coronary heart disease events over a 5 year period. Similarly an LDL cholesterol reduction of 1 mmol/L is followed by a 20% decrease of coronary heart disease [45].

#### **2.2.4.5 Hyperlipidemia**

Hyperlipidemia is an elevation of lipids in the bloodstream. It is one of the modifiable risk factors for coronary heart disease. Non-modifiable risk factors such as a strong family history may serve to justify more aggressive treatment. In the 1970s, Fredrickson et al. introduced a classification of the primary hyperlipidemias, based on lipoprotein ultracentrifugation and electrophoresis into; mixed hyperlipidemia which is defined as increase in total cholesterol and triglyceride level with or without decrease in HDL-cholesterol, hypertriglyceridemia which is characterized by high serum level triglycerides and also may be associated with high serum LDL-C or low HDL-C levels and hypercholesterolemia is defined as an increase in total cholesterol and low density lipoprotein cholesterol levels. Most patients who present with hyperlipidemia have a polygenic predisposition to raised blood lipids aggravated by dietary or lifestyle indiscretion. Diets rich in saturated fat tend to raise blood cholesterol levels, more specifically LDL-C, while high carbohydrate intake or excessive alcohol consumption may increase plasma (VLDL) and triglyceride concentrations [47]. Dietary manipulation in menopausal women should aim to reduce intake of red meat, and refined sugar while increasing the intake of vegetables, fruits. Other sources of protein such as fish should be encouraged, particularly oily fish such as mackerel, salmon or trout. The omega (n)-3 polyunsaturated fatty acid content of fish improves the lipid profile [48]. Docosahexaenoic acid, an n-3 fatty acid, is known to improve endothelial response of vascular system in familial hyperlipidemic patients [49]. Increased physical activity and attaining ideal body weight, improves glucose, blood pressure and lipid profiles [41].

## **II. Materials And Methods**

### **Study Site**

The participants for this study were recruited from some churches in Nnewi Metropolis, Anambra State, Nigeria.

### **Study Design**

This is a case-control study on the assessment of cardiac status of menopausal women. The study was conducted in Nnewi metropolis, Anambra State, Nigeria. Based on 3.96% prevalence rate of menopausal women in Nigeria (Nigeria Demographic Profile, 2016) and using the formula of Daniel (1999) for sample size calculation[50], a total of 120 participants was recruited for this study which comprises of randomly selected 60 apparently healthy menopausal women between the ages of 50 to 75 years and 60 apparently healthy premenopausal women between the age ranges of 20 to 30 years as control group. Structured questionnaire was included to obtain the demographic and anthropometric (height, weight, and BMI) data of the participants. Again, the blood pressure readings of the subjects were measured using standard method. Thereafter, five milliliters (5) ml of venous blood was collected aseptically from each of the subjects and dispensed into a plain container. The samples were allowed to clot, centrifugation was performed at 5,000 rpm for 5 minutes, and the serum was separated into another container and used for the laboratory analysis of biochemical parameters (Total creatine-kinase, Creatine-kinase-MB, and LDH). Total creatine-kinase was determined by Optimized IFCC Method as described by [51]; Creatine kinase –MB was determined using Immuno-inhibition Method as described by [51], whereas, Lactate dehydrogenase was assayed using SCE Method as described by [52].

### **Inclusion and Exclusion Criteria**

Apparently healthy menopausal women within the age range of 50 to 75 years who reported absence of menstruation for at least a year and apparently healthy premenopausal women within the age range of 20 to 30 years (as control group) were included for the study whereas, Adolescent female, Men, Children, Pregnant women, and Smokers were excluded from the study.

### **Ethical Approval And Informed Consent**

The ethical approval for this research was obtained from Nnamdi Azikiwe University Teaching Hospital ethics committee. Consent of the subjects was sought and obtained prior to study.

### **III. Statistical Analysis**

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 20. The test of significant differences between the two groups was calculated using the student's t- test with  $P < 0.05$  being the cut-off point of significance. Correlation of the parameters was determined using Pearson's correlation coefficient.

### **IV. Result**

There were significant differences in the mean age ( $60.42 \pm 7.40$  years), systolic blood pressure ( $136.95 \pm 10.55$  mmHg) and diastolic blood pressure ( $93.58 \pm 8.49$  mmHg) when postmenopausal subjects were compared with the control group; age ( $22.63 \pm 3.12$  years), systolic blood pressure ( $108.67 \pm 10.88$  mmHg) and diastolic blood pressure ( $80.33 \pm 7.2$  mmHg) at  $P < 0.05$  respectively (see table 1). Between groups comparison showed that age, systolic blood pressure and diastolic blood pressure were significantly higher in postmenopausal women when compared with the control subjects ( $P < 0.05$ ). However, there was no significant difference in body mass index (BMI) in postmenopausal women ( $25.15 \pm 5.81$  kg/m<sup>2</sup>) when compared with the control subjects ( $24.56 \pm 4.81$  kg/m<sup>2</sup>) at  $P > 0.05$  (see table 1). Group comparison between menopausal subjects and the control group showed that the serum levels of Lactate dehydrogenase ( $147.02 \pm 15.25$  μ/L Vs  $90.92 \pm 8.55$  μ/L,  $p = 0.000$ ) and Total Creatine Kinase ( $60.08 \pm 12.34$  μ/L Vs  $12.34 \pm 9.34$  μ/L,  $p = 0.000$ ) were significantly increased in postmenopausal subjects when compared with the control subjects (see table 2). The mean serum level of Creatine kinase-MB ( $2.44 \pm 0.90$  μ/L) in menopausal women did not differ significantly when compared with the control subjects ( $2.19 \pm 0.82$  μ/L) at  $P > 0.05$  respectively (see table 2). In this study, there were no significant correlation observed in the parameters studied between the postmenopausal women and control subjects ( $P > 0.05$ ) (see table 3). Again, there were no significant correlation observed in the parameters studied in postmenopausal subjects ( $P > 0.05$ ) (see table 4), whereas, there was significant correlation seen in the parameters studied in the control subjects ( $P < 0.05$ ) (see table 5).

### **V. Discussion**

The global burden of cardiovascular diseases (CVD) is rapidly increasing. It is the leading cause of death in women around the world; with over 450,000 women succumbing to heart disease annually and 250,000 dying of coronary artery disease [5]. Menopause is a risk factor for cardiovascular diseases because estrogen withdrawal has a detrimental effect on cardiovascular function and metabolism. The decrease in the levels of sex steroid hormones during menopause causes a number of structural, physiological and biochemical changes that alter the general health status of the menopausal women which includes an increase in adiposity; which is a risk factor for developing insulin resistance, dyslipidaemia, breast cancer, hypertension and cardiovascular diseases [8]. Therefore, this study was designed to assess the cardiac status of postmenopausal women in Nnewi Metropolis, Anambra State, Nigeria. The present study showed that the mean serum activities of LDH, CK-T and CK-MB were significantly different between the studied groups. The mean serum activities of LDH ( $147.02 \pm 15.25$  μ/L;  $90.92 \pm 8.55$  μ/L) and CK-T ( $60.08 \pm 12.34$  μ/L;  $12.34 \pm 9.34$  μ/L) was observed to be significantly elevated in postmenopausal subjects than in the control subjects at  $P < 0.05$  respectively. This finding agrees with a study carried out by Demissie et al. [53], who reported that increase in serum activities of these enzymes may be due to hormonal influence of oestrogen on the cardiovascular system, which play a vital role in lipid metabolism mediated by estrogen receptor alpha and Beta (ER $\alpha$  and ER $\beta$ ). The lack of estrogen during menopause has been shown to increase a woman's risk for developing various acute and chronic diseases such as myocardial infarction and coronary heart disease [6]. From this study, it was observed that there was no significant difference in the mean serum CK-MB activity ( $2.44 \pm 0.90$  μ/L;  $2.19 \pm 0.82$  μ/L) in postmenopausal subjects when compared with the control subjects at  $P > 0.05$  respectively. This finding is in accordance with a study by Oluboyo et al. [54], who observed that there was no significant difference in the mean serum activity of CK-MB in postmenopausal and premenopausal women. Interestingly, in this study, there were no significant correlation observed in the parameters studied between both postmenopausal and control subjects.

### **VI. Conclusion**

The findings from this study showed that the mean serum activities of LDH and CK-T were significantly increased in postmenopausal subjects whereas; there was no significant difference in the mean serum activity of Creatine Kinase-MB in postmenopausal women when compared with the control subjects.

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**Table 1:** Comparison of mean  $\pm$  SD levels of Age, Systolic blood pressure (SBP), Diastolic blood pressure (DBP) and Body mass index (BMI) in Subjects Studied.

Groups	Age (years)	SBP (mmHg)	DBP (mmHg)	BMI (Kg/m <sup>2</sup> )
postmenopausal women (n= 60)	60.42 $\pm$ 7.40	136.95 $\pm$ 10.55	93.58 $\pm$ 8.49	25.15 $\pm$ 5.81
Control subjects (n= 60)	22.63 $\pm$ 3.12	108.67 $\pm$ 10.88	80.33 $\pm$ 7.21	24.56 $\pm$ 4.81
t- value	33.15	0.095	5.34	0.544
p- value	0.000 (<0.05)	0.000 (<0.05)	0.000 (<0.05)	(>0.05)

\*Statistical significance at p<0.05.

**Table 2:** Serum activities of Lactate dehydrogenase (LDH), Creatine kinase Total (CK-T) and Creatine kinase-MB in studied groups (mean  $\pm$  SD, n=60).

Groups	LDH ( $\mu$ /L)	CK- T ( $\mu$ /L)	CK- MB ( $\mu$ /L)
postmenopausal women (n= 60)	147.02 $\pm$ 15.25	60.08 $\pm$ 12.34	2.44 $\pm$ 0.90
Control subjects (n= 60)	90.92 $\pm$ 8.55	12.34 $\pm$ 9.34	2.19 $\pm$ 0.82
t- value	25.15	7.375	0.562
P- value	0.000 (< 0.05)	0.000 (< 0.05)	0.109 (> 0.05)

\*Statistical significance at p<0.05.

**Table 3:** Levels of association between parameters studied in menopausal subjects (1) and controls (2)

Parameters	Pearsons correlation Coefficient r	F-value	P-value
CK-MB <sub>1</sub> v CK-MB <sub>2</sub>	0.002	0.982	<0.05
SBP <sub>1</sub> v SBP <sub>2</sub>	0.039	0.766	<0.05
DBP <sub>1</sub> v DBP <sub>2</sub>	0.036	0.785	<0.05
Age <sub>1</sub> v Age <sub>2</sub>	0.010	0.942	<0.05

\*Statistical significance at p<0.05.

**Table 4:** Levels of association between parameters studied in postmenopausal subjects.

Parameters	Pearson's correlation coefficient r	F-value	P-value
CK-T v LDH	-0.030	0.816	<0.05
CK-T v Age	0.001	0.998	<0.05
CK-MB v LDH	0.024	0.857	<0.05
CK-MB v BMI	-0.010	0.939	<0.05
BMI v SBP	0.029	0.828	<0.05
BMI v DBP	0.043	0.747	<0.05

\*Statistical significance at p<0.05.

**Table 5:** Levels of association between parameters studied in control subjects

Parameters	Pearson's correlation Coefficient	F-value	P-value
CK-MB v SBP	0.034	0.791	<0.05
CK-MB v DBP	-0.022	0.866	<0.05
LDH v SBP	-0.036	0.786	<0.05
BMI v SBP	-0.045	0.732	<0.05

\*Statistical significance at p<0.05.

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