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Albumin and Lipid Profiles Following Treadmill Exercise among Student Volunteers of Nnamdi Azikiwe University, Nnewi, Nigeria

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Abstract

The albumin and lipid profile changes following treadmill exercise were assessed among 160 apparently healthy student volunteers made up of 80 males and 80 females within the age bracket of 18 - 30 years, the physically active age group within the universities. The anthropometric indices (weight, height and BMI) of the subjects were taken using reference/standard methods. The blood pressures and pulse rate, then albumin and lipid profiles were also taken before and after exercise. The participants ran on a treadmill and their physical conditions were assessed using the Bruce protocol. Immediate post-exercise blood samples were again analyzed in the laboratory. There were significant increases (P < 0.05) in the after-exercise systolic BP, pulse rate and serum albumin, while marked decrease in diastolic BP was recorded (P < 0.05). Following exercise, total cholesterol and Low Density Lipoprotein reduced significantly (P < 0.01) in both sexes while High Density Lipoprotein increased markedly in males (P < 0.01) but not significantly increased in females (P > 0.5). There were gender variations in response to the treadmill exercise. Some of these findings indicate the expected functional alterations in the life of the students and there is a need to recommend the adoption of regular moderate exercise pattern to the students. These can bring about positive changes in their serum lipid and albumin profiles for better health in the face of stressful academic life.

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Keywords

Exercise, Albumin, Lipid Profile, Students, Nigeria

1. Introduction

During exercise, stored energy is converted into mechanical and heat forms. Three groups of exercises are identified: 1) Aerobic exercises, such as walking and running on treadmill, work on increasing cardiovascular endurance [1]. 2) Anaerobic exercises, such as weight lifting, increase short term muscle strength [2]. Flexibility exercises, such as stretching, improve the range of motion of muscles and joints [3]. Regular work out boosts the immune system and helps prevent chronic non-communicable diseases such as coronary heart disease, type 2 diabetes mellitus, over weight and obesity [4] [5]. Physical exercise improves mental alertness; prevents moodiness, enhances positive self-esteem and augments an individual's body image and self-worth [6]. Moderate physical activity positively affects calcium and bone metabolism by enhancing bone mineralization and checking urinary calcium loss. Conversely, physical inactivity leads to demineralization of bones with attendant increase in urinary calcium loss [7] [8]. Both human and animal studies have suggested that endurance exercise enhanced intestinal calcium absorption even though the underlying mechanism has remained controversial. What is known is that physical activity constitutes a pivotal requirement for maintaining and probably enhancing bone mass in human beings [9] [10].

Furthermore, physical activities increase blood levels of liver enzymes: alanine aminotransferase (ALT) and aspartate aminotransferase (AST) [11]. Some studies have also found that vigorous, short term exercise led to more pronounced serum enzyme activities than low or moderate but prolonged physical exercises, and the level of enzyme activity positively correlated with the intensity of muscle soreness [11] [12]. Exercise has also been found to increase bone alkaline phosphates isoforms in blood [12] [13], but on the other hand, it decreases blood glucose in peripheral tissues and can cause epinephrine to be released [14]. Furthermore, exercise plays a vital role in regulating insulin within the body. This is because exercise, by lowering blood glucose levels prevents the release of insulin from the pancreas [15]. Studies have also shown that total blood cholesterol levels are lowered with high-intensity aerobic exercise compared to low aerobic physical activity [16] [17]. Also endurance exercise has been found to lower triglyceride concentration especially among individuals who have raised initial pre-exercise levels [16]. Vigorous exercise raises high density lipoprotein a good kind of lipoprotein that actually helps cholesterol from the blood [16]. Decreases in total blood cholesterol and low density lipoprotein have been found in both men and women who undergo intense exercise [18].

Physical exercise is an integral component of the daily activity of most physically active individuals especially university students who go through the hustles and bustles of campus life epitomized by hectic academic and extra-curricular activities. Students in the study environment are daily involved in stressful life style resulting from not so conducive learning environment. Several research have shown that physical exercise can contribute to several long-term and short-term metabolic, physiological and hemodynamic changes which can impact either positively or negatively on the health of the exercising subjects [18]-[21]. In the light of this, are the students showing the expected physiological and metabolic responses following moderate exercise?

Therefore, this study has been designed to assess the immediate or short-term effects of moderate treadmill work out on not only the blood pressure but most importantly, the albumin and lipid profiles of apparently healthy students. Findings from this study in combination with the results from similar researches will hopefully constitute a veritable pool of evidence that can justify the use of physical exercise to assess the physical state of the students and to improve their health in our institutions of higher learning.

2. Methodology

One hundred and sixty (80 male and 80 Female) apparently healthy student volunteers without any known contra-indicating medical condition and with in the youthful age bracket of 18 to 30 were recruited to participate in the study. The volunteers were selected first because they were able to scale through a maximum exertion test and second because they were found to possess resting blood pressure range of 90/60 to 130/85 mmHg. The participants were interviewed to determine those who had a history of implicating cardiovascular condition, peripheral vascular or respiratory diseases and orthopaedic or musculoskeletal lesions. Before exercise, all the necessary parameters and data were measured and collected from the participants. These included blood pressure, pulse rate, weight and height measurements. Blood samples were also collected pre-exercise from the antecubital vein to measure serum lipid and albumin levels. The blood samples were collected into serum separator tubes and allowed to clot at room temperature for approximately one hour then centrifuged at 2500 RPM for 10 minutes to separate the serum. The samples were then analyzed for lipid profile. Then each participant embarked on a sub-maximal work out on a treadmill for 30 minutes. The post-exercise blood pressure and pulse rates were recorded within 30 seconds of the exercise. Blood samples were also taken and subjected to laboratory analyses as was done at the pre-exercise stage. Analysis of data was carried out using the Statistical Package for Social Sciences (SPSS) version 17 for windows. Results were presented as summary statistics such as mean and standard deviation. Also, appropriate statistical test of significance (z-test) was performed to evaluate differences between pre- and post-exercise values on one hand and gender differences on the other setting the significance level at $P < 0.05$.

Table 1 shows 30-minute Workout Schedule for the participants.

3. Results and Tables

Table 2 shows that male students were significantly taller and heavier than their female counterparts ($P < 0.01$) respectively. There were however no marked differences in their Body Mass Indices (BMI) and mean ages ($P > 0.5$) respectively.

In **Table 3**, the mean systolic blood pressure (MSBP) and mean diastolic blood pressure (MDBP) of the male students did not differ significantly from that of the females before exercise ($P > 0.05$) respectively. However, after exercise, the MSBP of the males became significantly higher than that of the females even though both increased with exercise ($P < 0.01$).

The MDBP of both sexes showed marginal increase following exercise but the difference between male and female MDBP was not statistically significant ($P > 0.7$). Before exercise, pulse rate was appreciably lower in males than females ($P < 0.01$) However, after exercise, pulse rate increased in both sexes but remained significantly lower in males than females ($P < 0.02$). Also the pack cell volume (PCV) was very significantly higher in males than females ($P < 0.001$) in the same manner that duration of exercise (endurance) was markedly higher in males than females ($P < 0.01$).

Table 4 shows that mean cholesterol level for the female students was significantly lower than for male subjects before exercise ($P < 0.01$). Following exercise however, both mean cholesterol levels decreased but the pre-exercise exercise significant difference in mean cholesterol levels between the two sexes became insignificant following exercise ($P > 0.05$). The mean triglyceride level before exercise between female and male subjects shows no significant difference ($P > 0.05$). However, while exercise tended to increase mean triglyceride level in females, there was a reduction in this parameter among males leading to a significantly higher mean triglycerides in females than males following exercise ($P < 0.01$). For low density lipoprotein (LDL) before exercise, males had significantly higher mean LDL than females before exercise ($P < 0.01$). However, following exercise, there was a slight increase in mean LDL in the males and slight reduction in the females making the significant difference in the parameter between the two sexes after exercise to be more pronounced ($P < 0.01$).

Table 1. Workout schedule for the study participants.

Time (Minutes)	What to do	Speed estimate (MPH)
0 - 2	Walk at an easy pace	3.0
2 - 4	Walk briskly	3.6 - 4.5
4 - 6	Turn left, bend knees slightly, and quickly step to the right with right foot then bring left foot towards it. Continue for one minute, then repeat in opposite direction	3.5 - 3.7
6 - 8	Walk backwards grasping rails for balance if needed	3.5 - 3.7
8 - 26	Jog	5.7 - 6.7
26 - 30	Walk at an easy pace	3.0

Table 2. Demographic information of subjects (mean + SD).

Mean demographic variables	Females N = 80	Males N = 80	Z-Value	P-Value
MHEIGHT (M) ± SD	1.66 ± 0.07	1.73 ± 0.08	4.36	<0.01*
MWEIGHT (Kg) ± SD	66.67 ± 7.60	72.80 ± 10.16	3.65	<0.01*
MBMI (kg/M^2) ± SD	24.13 ± 2.50	24.35 ± 2.27	0.76	>0.5
MAGE (Yrs) ± SD	21.00 ± 1.49	21.30 ± 1.44	0.94	>0.5

Table 3. Mean blood pressure and pulse rate before and after exercise.

Mean Variables	Females N = 80	Males N = 80	Z-Value	P-Value
MSBPB (mmHg) ± SD	124.07 ± 5.09	125.70 ± 6.56	1.86	>0.05
MDBPB ± SD	82.27 ± 6.23	80.47 ± 6.80	1.69	>0.05
MSBPA ± SD	138.13 ± 7.02	142.93 ± 8.58	3.87	<0.01*
MDBPA ± SD	67.07 ± 5.21	66.63 ± 8.46	0.239	>0.7
MPULSE B ± SD	85.57 ± 14.66	74.90 ± 13.41	3.91	<0.01*
MPULSE A ± SD	107.93 ± 11.90	100.50 ± 12.79	3.43	<0.02*
MPCV ± SD	0.35 ± 0.05	0.42 ± 0.05	6.26	<0.001*

Table 4. Mean lipid and albumin levels before and after exercise among the subjects.

Mean variables	Female N = 80	Male N = 80	Z-Value	P-Value
MCHOL B ± SD	4.51 ± 0.31	4.68 ± 0.23	2.326	<0.01*
MCHOL A ± SD	4.24 ± 0.30	4.39 ± 0.30	1.926	>0.05
MTGB ± SD	0.84 ± 0.13	1.05 ± 1.07	1.74	>0.05
MTGA ± SD	0.97 ± 0.86	0.79 ± 0.11	6.954	<0.01*
MLDL B ± SD	2.88 ± 0.40	3.23 ± 0.52	4.172	<0.01*
MLDL A ± SD	2.87 ± 0.35	3.27 ± 0.20	5.330	<0.01*
MHDL B ± SD	1.20 ± 0.19	1.04 ± 0.07	4.431	<0.01*
MHDL A ± SD	1.23 ± 0.18	4.40 ± 10.27	2.14	<0.05*
MALB B ± SD	31.70 ± 2.84	32.78 ± 3.08	1.308	>0.2
MALB A ± SD	35.23 ± 2.80	36.20 ± 3.45	1.192	>0.1

In addition, the mean high density lipoprotein (HDL) level before exercise was significantly higher in females than males ($P < 0.01$). This increased in both sexes following exercise, but this time the males recorded significantly higher mean HDL than females ($P < 0.05$). Also there were no significant differences in albumin levels between the males and females before and after exercise; ($P > 0.2$) and ($P > 0.1$) respectively.

In **Table 5**, among the females, mean cholesterol level was significantly decreased following exercise ($P < 0.01$) in contrast to the triglyceride level which increased among them after exercise, though not statistically significant ($P > 0.05$). For mean LDL, the female subjects recorded no significant reduction following exercise ($P > 0.4$). The same picture was applicable for mean HDL which increased during exercise among the females even though the increase was not statistically significant ($P > 0.5$). However, the albumin level among the females increased significantly following exercise ($P < 0.001$).

Table 6 shows the variation of the parameters among the male subjects following exercise. The cholesterol level after exercise was significantly lower than the level before exercise ($P < 0.001$) while triglyceride level after exercise also showed significant reduction when compared with the pre-exercise value ($P < 0.05$). Conversely, the slight increase in mean LDL level of the male subjects after exercise ($P > 0.1$) was not statistically significant even though the mean HDL level significantly increased post-exercise ($P < 0.005$). Similarly, mean albumin also showed a significant increase following exercise ($P < 0.001$).

4. Discussion

All the participants are medical students of same age group. Even though the boys are taller and heavier than the girls, the BMI of the two groups do not differ significantly from each other. This result is in agreement with

Table 5. Lipid profile and albumin level pre- and post-exercise for female subjects.

Mean variables	Pre-exercise N = 80	Post-exercise N = 80	Z-Value	P-Value
MCHOL ± SD	4.51 ± 0.31	4.24 ± 0.30	7.29	<0.01*
MTG ± SD	0.84 ± 0.13	0.97 ± 0.86	1.83	>0.05
MLDL ± SD	2.88 ± 0.40	2.87 ± 0.35	0.53	>0.4
MHDL ± SD	1.20 ± 0.19	1.23 ± 0.18	1.03	>0.5
MALB ± SD	1.24 ± 0.19	31.70 ± 2.84	18.99	<0.001*

Table 6. Lipid profile and albumin level pre- and post-exercise among male subjects.

Mean variables	Pre-exercise N = 80	Post-exercise N = 80	Z-Value	P-Value
MCHOL ± SD	4.68 ± 0.23	4.39 ± 0.30	6.613	<0.001*
MTG ± SD	1.05 ± 1.07	0.79 ± 0.11	2.16	<0.05*
MLDL ± SD	3.23 ± 0.52	3.28 ± 0.20	0.76	>0.1
MHDL ± SD	1.04 ± 0.07	4.40 ± 10.27	2.92	<0.005*
MALB ± SD	32.70 ± 3.08	36.20 ± 3.45	10.147	<0.001*

what was found among their Western counterparts [22]. It is an indication that the students enjoy adequate nutrition and fairly similar socioeconomic conditions. This study has shown that the average BMI of male and female students fall within the normal range expected for their respective age groups [22] [23].

The outcome of exercise among the students especially as it pertains to the systolic blood pressure is that of increased post-exercise blood pressure, and this is quite similar and corroborated by previous multiple studies [14]. According to another study, normal subjects are expected to record systolic blood pressure rise of between 5 - 10 mmHg per metabolic equivalent of effort (MET). This figure is roughly comparable to the amount of energy expended in the resting state, and so for a middle-aged subject who can tolerate an average physical exertion, the systolic blood pressure can be expected to rise to at least 40 to 50 mmHg in course of the treadmill exercise [24]. The minimal reduction in the diastolic blood pressure recorded in this study has been principally attributed to the vasodilation of the arterial blood vessels in response to the exercise bouts, thus this expansion in size of the arterial lumen has the potential to decrease blood pressure during the diastolic phase [25].

Following exercise, the pulse rates increased in all the subjects irrespective of gender and this was because the heart pumped in more oxygenated blood in response to the increased demand by the body at this time. Since more energy is needed by the muscles, the heart quickly delivers more blood to the other parts of the body to replenish oxygen and nutrient stored. It then follows that the more rapidly the heart pumps blood, the faster the pulse rate [21]. The mean pulse rate was significantly higher in females than males both before and after exercise. Studies have shown that, among women, the sino-atrial node in their heart recovers faster after each heart beat and prepares the heart to beat again sooner than among men. This quicker beat, is noticeable in women as young as 5 years of age. It is then not surprising that the females not only exhibited higher frequency heart rates, but also possessed an overall more complex heart rate changes than their male counterparts [26]. Similarly, the finding of higher SBP post exercise is akin to what Deschenes *et al.* [27], reported about men exhibiting markedly more elevated SBP values than women when evaluated at both the 15^{th} minute and 30^{th} minute of cycling. However, another study was of the opinion that when statistical adjustments were made for resting Systolic BP, resting heart rate, duration of exercise, and BMI, these differences in heart rates between male and female subjects ceased to be significant. These study findings are therefore strong indications that gender may not be a significant predictor of SBP and HR outcomes following exercise in healthy young adults [28]. Furthermore the finding of a significant decrease in the duration of exercise in male than female is because the male has more endurance rate than the female [29].

The mean serum total cholesterol levels of both male and female subjects was significantly lower than their mean serum levels before the exercise. Martin *et al.* [30] in their study discovered that persons who enjoyed high aerobic fitness shad lower total cholesterol levels compared to those with low aerobic fitness. It has been reasonably demonstrated in our study that the work out on the treadmill lowered total cholesterol among the participants. Studies have shown that total cholesterol appears to have been significantly reduced in situations where the activities were more dynamic and vigorous in nature. On the other hand, endurance exercise tends to lower triglyceride concentration especially in individuals who showed initial raised pre-exercise levels. This finding has been ascribed to increases in levels of skeletal muscle and adipose tissue lipoprotein lipase activity which is a direct effect of the aerobic training [30].

Before exercise, females had significantly lower total serum cholesterol than the males, but following exercise, the males experienced greater reduction in serum level of this parameter than their female counterparts. Similarly, the males tended to achieve greater fall in mean serum triglycerides and higher rise in HDL than the females, following exercise. Conversely, the females achieved greater exercise benefit than the males by recording more pronounced decrease in LDL levels. But for the post-exercise variations in serum triglyceride levels, the other results are in agreement with the findings of another study which reported significantly higher HDL among male students than females in the physical and health education class [31]; and also recorded markedly lower LDL among females than males in the same study group [31] [32]. Some of the reasons for these gender differences in serum lipid levels post-exercise can be found in result of a study which compared the regression slopes of training-induced increase in HDL and TG in men and women and concluded that women may be more resistant to exercise-induced changes than men [31]. Moreover, another study found that in females, HDL levels were higher than in males between the ages of 10 - 50 years probably due to the effect of estrogen. HDL was similar in boys and girls until age of 13 years, after which values remained greater in girls. So HDL levels cannot increase by the continuous physical activities in females [33] No clear pattern of gender differences emerged for TG [32].

More specifically, this study has shown that high-density lipoproteins (HDL) increased significantly in both sexes following exercise. This is in consonance with the findings of other studies that concentration of HDL tends to be high in subjects with very vigorous physical activity [34]. Appreciable evidence has accumulated that the serum level of HDL is inversely related to the development of coronary heart disease (CHD) [34], a pointer to the protective benefits of physical exercise against CHD. On the other hand, this study has demonstrated a slight increase in triglycerides and LDL following exercise in both sexes. These findings are worrisome even though the post exercise increases in these parameters are not statistically significant. Several epidemiologic surveys have shown that elevated levels of total cholesterol and LDL and triglycerides are associated with increased risk of CHD [35]. However, some other studies have discovered that subjects active at work or during leisure time tend to have lower serum cholesterol and triglyceride concentrations than those with a sedentary occupation or lifestyle, but the differences are not always evident when other factors known to affect serum lipids are controlled [34]. Thus despite the finding that mild-to-moderate physical activity lowers serum triglyceride and raises HDL cholesterol level in healthy, middle aged men, it is not clear whether the changes in serum lipid concentrations are directly attributable to physical exercise itself [34].

In this study, the mean serum albumin levels of both the male and female subjects after the exercise were significantly higher ($P < 0.05$) than their mean serum albumin levels before the exercise. The higher plasma albumin levels found in post-exercise subjects observed in this study is corroborative with findings from multiple previous studies [36]-[38]. This finding may result from haemo-concentration that occurred during the exercise as a result of increased sweating, increased body temperature or splenic contraction [38]. Total albumin is known to rise in response to prolonged exercise as it is essential in the mobilization of free fatty acids [39], a preferred fuel source during prolonged exercise [40]. In the present study, prolonged strenuous aerobic exercise may result in higher serum albumin levels. However, albumin concentration changes that occur after strenuous exercise need to be more fully understood.

5. Recommendation

Aerobics exercise is strongly recommended for students because it enables them engage in longer, more frequent and more rewarding activities that consume more energy when the individual is active. In recognition of sex/gender variations in the response to exercise most people will benefit from a moderate increase in endurance following aerobic exercise. Some individuals will even double their oxygen uptake, while others may never derive any benefit at all from the exercise. Consequently, it is recommended that students should experiment and try out the different types of physical activity, so as to place them in a position to determine what type really works for them and which one they really want to continue with.

6. Conclusion

The result of this study has revealed that physical exercise on treadmill has short-term effects on the metabolic, physiologic and hemodynamic functions of the exercising individuals. These short-term effects are beneficial health-wise and have the potential to optimally improve the health of all participating individuals in our university communities irrespective of their health status, and may subsequently help them achieve improved academic performance. Although there is considerable interindividual variability in the response to physical activity, and with the understanding that physical activity is not necessarily an easily modifiable behaviour, these results and others provide further evidence for and highlight the importance of some forms of exercise on plasma lipid profiles of university students.

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Key for Tables

MHEIGHT (M) = *mean height in meters*
MWEIGHT (Kg) = *mean weight in kilograms*
MBMI (kg/M^2 = *mean basal mass index in kilogram per meter square*
MAGE (Yrs) = *mean age in years*
MSBPB & MSBPA = *mean systolic BP before exercise and mean systolic BP after exercise*
MDBPB & MDBPA = *mean diastolic BP before exercise and mean diastolic BP after exercise*
MPULSE B & MPULSEA = *mean pulse rate before exercise and mean pulse rate after exercise*
MCHOLB & MCHOLA = *mean cholesterol before exercise and mean cholesterol after exercise*
MTGB & MTGA = *mean triglycerides before exercise and mean triglycerides after exercise*
MLDLB & MLDLA = *mean low density lipoprotein before exercise and mean LDL after exercise*
MHDLB & MHDLA = *mean high density lipoprotein before exercise and mean HDL after*
MALBB & MALBA = *mean albumin before exercise and mean albumin after exercise*