EFFECTS OF STRUCTURED AND UNSTRUCTURED PHYSICAL ACTIVITIES ON BIOCHEMICAL INDICES, DISEASES RISK SCORES AND COST OF CARE OF OVERWEIGHT AND OBESE ADULTS

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DEDICATION

This work is dedicated to the almighty God- the owner of knowledge, my loving wife-Maureen Abara-Aliyu and all those that contributed to the success of this work.

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ABSTRACT

Overweight and obesity are global problems associated with a myriad of non-communicable diseases. Physical Activity (PA) is known to have positive effects on some Biochemical Indices (BI) of overweight and obese adults. However, studies comparing the effects of structured and unstructured PAs on BI, Disease Risk Scores (DRS) and Cost of Care (CoC) of overweight and obese adults in Nigeria are sparse. This study was conducted to compare the effects of structured and unstructured PA on BI, DRS and CoC of overweight and obese adults.

Forty-nine overweight and obese adults participated in a12-week randomised clinical trial. They were recruited from Gwagwalada Area Council of the Federal Capital Territory, Abuja; and randomly assigned into Structured PA Group [SPAG] (n=25) and Unstructured PA Group [UPAG] (n=24). Intervention consisted of thrice a week flexibility, resistance and aerobic exercises using the Healthy Active Living and Obesity Research Group's protocol for SPAG. Participants in UPAG underwent daily self-paced walking activity monitored with a pedometer. High-Density Lipoprotein (HDL, mmol/L), Low-Density Lipoprotein (LDL, mmol/L), Total Cholesterol (TC, mmol/L), Triglycerides (mmol/L), Fasting Blood Glucose (FBG, mmol/L), Glycated Haemoglobin (HbA1c, %), Aspartate Amino Transferase (AST, IU/L) and Alanine Amino Transferase (ALT, IU/L); DRS [Framingham Risk Scores (FRS) for cardiovascular disease, Finnish Diabetes Risk Scores (FINDRISC) for diabetes, Hypertension Risk Score (HRS) for hypertension] and cost of obesity for CoC (₦) were measured at baseline, 6th (except HbA1c) and 12th week using standard procedures, instruments and outcome measures. Data were analysed using Repeated Measure ANOVA, paired sample t-test and independent t-test at $\alpha_{0.05}$.

Participants in SPAG (43.48±6.85 years) and UPAG (44.88±7.54 years) were comparable in age. Baseline variables of SPAG and UPAG for BI [HDL=1.13;1.23, LDL=4.28;3.74, TC=5.11;5.05, Triglyceride=1.54;1.54, FBG=6.80;6.60, HbA1c=4.7;4.9, AST=11.04;11.46, ALT=8.00;7.75], DRS [FRS=8.12;8.04, FINDRISC=13.16;14.00, HRS=12.20;12.08] and CoC=135,200.00;179,266.67, respectively, were also comparable. At the 12th week, all the BI were not significantly different from the baseline in the two groups except HDL (1.13±0.31,1.24±0.29; 1.23±0.35,1.41±0.28), which increased significantly in both groups and AST (11.04±1.34,9.84±0.94;11.46±1.62,10.67±1.05), which decreased significantly in both groups. All the DRS were not significantly different between SPAG and UPAG at the 12th week. There was a significant reduction in CoC at the 12th week in SPAG (66,822.00±38,822.65) than UPAG (135,712.50 ±75,752.39). Within group comparison for SPAG showed that cardiovascular disease (8.12±3.95; 5.48±3.63), diabetes (13.16±2.34; 7.88±2.73) and hypertension (12.20±3.30; 7.16±2.36) risk scores were significantly reduced at the 12th week. Similarly, within-group comparison for UPAG showed that cardiovascular disease (8.04±3.91; 5.54±3.27), diabetes (14.00±2.21; 9.00±2.86) and hypertension (12.08±3.09; 7.33±2.01) risk scores were significantly reduced across the study periods. The CoC within SPAG at baseline (135,200.00±50,372.48) was significantly reduced (66,822.00±38,822.65) across the study periods, but the reduction in CoC within UPAG was not significant.

Structured and unstructured physical activity reduced the risk of developing cardiovascular diseases, diabetes and hypertension and impacted positively on selected biochemical indices of overweight and obese adults. However, structured physical activity was superior to unstructured physical activity in reducing the cost of care in overweight and obese adults.

Keywords: Aerobic exercise, Disease risk factors, Non-communicable diseases

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LIST OF ABBREVIATIONS

ALT- Alanine amino transaminase enzyme

AST- Aspartate amino transaminase enzyme

BMI- Body mass index

CRF- Cardiorespiratory fitness

CVD- Cardiovascular Disease

FBG- Fasting blood glucose

FINDRISC- Finnish Diabetes risk score

FRS- Framingham risk score

Hb1Ac- Glycated haemoglobin

HDL- High density lipoprotein

HRS- Hypertension risk score

LDL- Low density lipoprotein

METs- Metabolic equivalent

NCD- Non communicable disease

PA- Physical activity

SPAG- Structured physical activity group

TC- Total cholesterol

TG- Triglycerides

UPAG- Unstructured physical activity group

WC- Waist circumference

WHR- Waist-hip ratio

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Overweight and obesity are significant public health challenges of the twenty first century (Barness et al., 2007). They are two of the most prevalent preventable causes of death globally, affecting an estimated 300 million people, and their prevalence is increasing across populations (World Health Organization [WHO], 2018). According to a systematic review conducted by Poobalan and Aucott (2016), the prevalence of obesity among young people in developing nations is on the increase. In the year 2014 alone, the World Health Organisation (WHO) reported that more than 1.9 billion individuals were overweight, with more than 600 million of them classified as obese (WHO, 2016). Commodre – Mensah, et al. (2014) also reported a prevalence of overweight/obesity ranging from 4% to 49% in Nigeria. Approximately two-thirds of the overweight or obesity prevalence is attributable to urban, professional, high socioeconomic Nigerian adults (Akarolo – Anthony et al., 2014).

Ekpenyong and Akpan (2013), reported that the most significant determinants of overweight and obesity in Nigeria are being female, married, physical inactivity, presence of a positive familial history, residing in an urban area, and being older than 40 years. Dankyau et al. (2016), stated that obesity and overweight have become significant preventable global public health challenges in the twenty-first century. Ford et al. (2017) reported that a progressing increase in the prevalence of overweight and obesity in countries that are known to be low- and middle-income has a negative effect on the overall health profile of persons in these countries.

Energy imbalance between calories consumed and caloric expenditure is the primary cause of obesity (Dankyau et al., 2016). In simpler terms, obesity and overweight is caused by the consumption of high-fat, high-carbohydrate, and energy-dense foods in conjunction with low levels of physical activity. According to Dankyau et al. 2016, when people take in food containing very large caloric contents such as food high in complex carbohydrate and these excess carbohydrates are not expended, it leads to being overweight or obese.

Overweight and obesity are associated with musculoskeletal disorders and Non-Communicable Diseases (NCDs) such as Cardiovascular-Diseases (CVDs), cancers, stroke, diabetes, hypertension, depression, and chronic respiratory disease (Dankyau et al., 2016). According to a 2018 WHO report, noncommunicable diseases accounted for approximately 71% of all projected deaths worldwide, or an anticipated 41 million of the 57 million deaths globally (WHO, 2018). It was also stated that majority of these fatalities (about 80%) happen in low to middle-income countries (WHO, 2018). In a separate report, the WHO estimated that various nations will incur significant economic losses due to NCDs. For example, it was estimated that Nigeria will lose approximately 8 billion US dollars due to NCDs between the years 2005-2015 (WHO,2005). Mortalities from communicable diseases, maternal or perinatal-related issues, and malnutrition are projected to decline during the same time period (WHO, 2005). A simulated model published in the Lancet by Wang et al. (2011) forecasted that there would be 11 million more obese adults in the United Kingdom by 2030, with a combined increase of up to £2 billion per year in the cost of treating associated diseases.

Lack of physical activity over time, has been recognized as a key contributor to the high rates of overweight, obesity and other non-communicable diseases (Kruger et al., 2007). Kesaniemi et al. (2001), reported that increased levels of physical activity are associated with the prevention of weight gain over time. Moreover, the WHO (2010) has reported that certain randomised controlled trials that lasted for 12 months have indicated that aerobic exercise executed at a dosage of a minimum of 150 minutes/week is linked with approximately 1-3% weight loss.

The WHO Global recommendations on physical activity for health, states that physical activity includes transportation (walking or cycling), household duties, recreation, games, sports or prearranged exercise within the context of daily, family or community activities

(WHO, 2011). The WHO has also emphasised that physical activity should not be confused with sport; therefore, physical activity has been defined as any bodily movement that is produced by the skeletal muscles (WHO, 2011). These may include sports, exercise and other activities such as playing, walking doing household duties or tending to garden (WHO,2011; WHO, 2018). Physical activity can be differentiated into mild, moderate and vigorous intensity. Mild intensity exercises include slow walking, light household chores, stretches and yoga. Examples of moderate intensity physical activity are; brisk walking, dance and domestic chores, while vigorous intensity physical activity are activities such as, running, cycling very fast and swimming very fast (WHO, 2011)

Esculcas and Mota (2002) categorised physical activity programmes into either structured or unstructured. Structured (formal) physical activities are referred to as “sportive’’ activities that are guided, coordinated or conducted by a trainer, sports authority or other specialist of physical activities. In contrast, unstructured (informal) physical activities refer to “non-guided sporting activities”, that are typically characterised by sole/double activities of little to modest intensity (such as walking, car washing, lawn mowing, gardening etc) (Esculcas and Mota, 2002). Structured physical activities include sports and instructional programmes in gymnastics, aerobics, dance, swimming and bicycling (Fahey et al., 2002). While unstructured physical activities are unguided activities such as active play, doing domestic chores and engaging in physically demanding work (Fahey et al., 2002). Structured exercises are activities designed with a specific objective in mind, typically to enhance cardiovascular fitness, strength, flexibility, or balance and agility. It may include aerobic, resistance, endurance, or cardiovascular exercise (Cleveland Clinic, 2017).

Morris et al. (2007) and Haycox (2009) explained health economics as the use of economic theories, representations, and practical systems to the analysis of informed decision-making in healthcare to ensure maximum value for any money spent on health services, as well as the medical efficacy and cost effectiveness of such services. Lewis et al. (2010) reported that public and private sector organisations are under considerable pressure to spend money on health services prudently. Lewis et al. (2010) elaborated that, due to limited health resources, there was increasing pressure to justify spending on all aspects of healthcare in the health sector, particularly preventive programmes. This has necessitated providing evidence of cost efficacy to justify the use, funding, or continued funding of specific public health initiatives.

In addition, economic evaluation is increasingly used to inform decisions regarding the allocation of scarce health funding resources for healthcare (Truman and Anokye, 2012). Economic evaluation is used to determine how the introduction of a new intervention affects the utilisation of healthcare resources (Fatoye, 2015).Economic evaluation includes Cost-benefit analysis (CBA) which access health benefits in monetary values; Cost-effectiveness analysis (CEA) which is used to determine health effects in normal units; Cost-utility analysis (CUA) measures consequences in health units such as the quality adjusted life years (QALY); the Cost-minimization analysis (CMA) likens dual interventions proven to be identical; and Cost-consequences analysis (CCA) used to describe the variance in clinical, resource use and cost outcomes in different interventions (Fatoye, 2015). Economic evaluation is crucial because it helps healthcare providers make better, more informed decisions regarding intervention selection in relation to available resources.

Beneath the auspices of health technology appraisal, the majority of efforts utilising pecuniary evaluations in the health sector have focussed on the use of economic techniques to ground-breaking treatments and therapeutic knowledge (Truman and Anokye, 2012 Nonetheless, additional research into the affordability of healthcare treatment procedures utilising well-being behaviour approaches is required (Trueman and Anokye, 2012). Cost of care could be evaluated using a cost-benefit analysis in which costs and outcomes are quantified in financial terms (Rome, 2014). This analysis also provides the opportunity to compare health care sector benefits with those of other industries (Drummond et al., 2005).

Biochemical indices of entail the measurement of chemical substances in the blood, which is known to correlate with an individual's level of physical activity (Hitosugi et al., 2004). Biochemical indices are essential for assessing internal organ functions, measuring electrolytes, and determining the levels of circulatory enzymes (Hitosugi et al., 2004). Numerous investigations, with each of them providing information on the state of one or more organs, may be included in the assessment. The presence of a disease may be indicated by an abnormal test result (Jamieson, 2005). Serum comprises of enzymes, protein-rich fluid, lipids substances, glucose materials and in-between products of metabolism. These serum components are derived from various organs, including the liver, kidney, and pancreas, and their measurement can provide insight into the functions of these organs (Reiss et al., 2008). Some of the investigations done in biochemical indices of human medical research include High Density Lipoprotein, (HDL), Low Density Lipoprotein (LDL), urea, creatinine, uric acid, glucose, HaemoglobinA1c(HbA1c), (Reiss et al., 2008), Aspartate Amino Transferase (AST) and Alanine Amino Transferase (ALT) (Zhang et al., 2004).

In prevention and health promotion interventions, screening methods and disease risk scores assessments are frequently used as instruments for determining the efficacies of interventions as well as for selecting participants and determining their health status (Jansen and de Bont, 2010). Assessments of disease risk scores quantify health hazards and/or the state of the health of persons, i.e., they identify 'at-risk' personalities and provide insight into what necessary behavioural lifestyle adjustments that these individuals need to adopt to better their health. In a review of community preventive services by Soler et al. (2010), it was found that some of the leading major health conditions, such as cardiovascular diseases, cancers, strokes, aneurysms, chronic respiratory diseases, diabetes, angina pectoris, and myocardial infarction, are potentially responsive to health interventions if potential causes of risks such as smoking tobacco products, poor nutrition, absence of physical activity, high adiposity are eliminated or reduced.

Stuck et al. (2002) also reported that the increasing demand for well-being and public care services in European countries have become significant societal challenge in the 21st century. Moreover, they opined that devising measures and methods for cost-effective disease prevention through disease risk assessments would go a long way towards alleviating the financial burden and obstacles associated with providing healthcare services.

Physical activities, such as aerobic training, have been shown to induce biochemical responses. According to McKeever (2004), aerobic training reduces body obesity while maintaining a constant total energy expenditure and total energy intake. According to Panagiotakos et al. (2003) and Huet al. (2008), regular exercise is associated with beneficial serum lipids and lipoproteins in various populations. In routine visits to the physician in the hospitals in Nigeria, obese and overweight adults are usually asked for some routine biochemical indices investigations such as HDL, LDL, triglycerides (TG), total cholesterol (TC), Fasting blood glucose (FBG), HBA1c, AST and ALT as these tests are associated with obesity and overweight.

Since exercise has been shown to have positive effects on some of those biochemical indices, it will therefore be of scientific relevance to examine the comparative effects in relation with disease risk scores and cost of care, of structured and unstructured physical activity among adults with overweight and obesity in a Nigerian setting as there are no known data concerning this. This study therefore investigated selected disease risk scores, biochemical indices and the cost of care on structured and unstructured physical activities among overweight and obese adults.

1.2 Statement of the Problem

Adults who are obese and overweight have turned out to be a significant global scourge (Hammond and Levine, 2010). In addition, they are associated with several chronic disorders including cardiovascular diseases, depression, elevated blood pressure, increased sugar levels in the blood, atherosclerosis, stroke and some type of certain malignancies (Van Gaal et al., 2006; Dandona et al., 2004; Wolk et al., 2001). Furthermore**,** economic impact of obesity and overweight is significant and is associated with direct and indirect medical spending (Chukwuonye et al., 2013; Hammond & Levine, 2010; Yach et al., 2006). Additionally, individuals who are obese or overweight tend to be less productive, engaged in work absenteeism, and are likely to require extended hospital stay (Gates et al., 2008; Zizza et al., 2004).

In Nigeria, a developing country, there are no documented estimates from the existing literatures on the burden of overweight/obesity in relationship with death and disease costs. However, there is a possibility that these expenses may amount to quite a lot of billions of Naira in a year, in view of the high prevalence rates reported in earlier studies (Chukwuonye et al.,2013; Adedoyin et al., 2009; Siminialayi et al., 2008; Wahab et al., 2007;). Moreover, the healthcare delivery system in Nigeria tends to focus more on the treatment of diseases rather than adopting preventive measures.

The knowledge of disease risk scores could contribute to healthy behaviours or lifestyle changes that could reduce health risks or disease burden. Therefore, there is a need to get more people to be sufficiently physically active, as a way of promoting their health. Unfortunately, ensuring that people are sufficiently physically active is known to be affected by several barriers such as lack of time, exercise preference, i.e., supervised/unsupervised activities, affordability of the means of exercise, motivation, facilities and consistency and incorrect exercise habit/misconceptions (Adeniyi et al., 2014). A significant proportion of individuals usually adopt and readily participate in one form of unstructured physical activity or the other, such as jogging, brisk walking, swimming and recreational activities, probably due to increasing awareness. However, there is a need for a scientific study to answer key questions bordering on the comparative efficacies of such unstructured physical activities as against the well-regimented structured modes of physical activity with particular reference to their likely roles in moderating the costs, biochemical indices and health risk scores of the participants. Therefore, this study compared the effect of structured and unstructured physical activity on selected biochemical indices, health risk scores and cost of care among Nigerian adults with overweight and obesity.

This study thus, set out to find out the difference in the biochemical indices, disease risk scores and cost of care of adults with overweight and obesity between the participants in the structured and unstructured physical activities group after 12 weeks of participating in physical activity.

1.3 Aim of the study

The aim of the study was to investigate the baseline, 6^{th} week and 12^{th} week values of biochemical indices, disease risk scores and cost of care of adults with overweight and obesity following each of structured and unstructured PA, and also investigate the effects of 12-week structured and unstructured PA on biochemical indices, diseases risk scores and cost of care of adults with overweight and obesity in Gwagwalada Area Council of the Federal Capital, Abuja, Nigeria.

1.4 Objectives of the Study

The objectives of the study were to:

(i) Compare the effects of participating in 12-week structured and unstructured PA on biochemical indices of adults with overweight and obesity.

(ii) Compare the effects of participating in 12-week structured and unstructured PA on diseases risk scores of adults with overweight and obesity.

2 Compare the effects of participating in 12-week structured and unstructured PA on cost of care of adults with overweight and obesity.

3 Compare the effects of participating in PA within the structured and unstructured groups at baseline, 6-weeks and 12-weeks on biochemical indices of adults with overweight and obesity.

4 Compare the effects of participating in PA within the structured and unstructured groups at baseline, 6-weeks and 12-weeks on disease risk scores of adults with overweight and obesity.

5 Compare the effects of participating in PA within the structured and unstructured groups at baseline, 6-weeks and 12-weeks on cost of care of adults with overweight and obesity.

5.5 Hypotheses

5.5.1 Major Hypotheses

(i) There will be no significant differences among the baseline, 6th week and 12th week values of biochemical indices, disease risk scores and cost of care following each of structured and unstructured PA among adults with overweight and obesity.

(ii) There will be no significant differences in the effects of 12-week structured and unstructured PA programmes on biochemical indices, disease risk scores and cost of care in overweight and obese adults.

5.5.2 Sub-Hypotheses

I. There will be no significant difference among the baseline, 6th week and 12th week cost of care following structured physical activity among adults with overweight and obesity.

II. There will be no significant difference among the baseline, 6th week and 12th week serum total cholesterol following structured physical activity among adults with overweight and obesity

III. There will be no significant difference among the baseline, 6th week and 12th week serum high density lipoprotein following structured physical activity among adults with overweight and obesity.

IV. There will be no significant difference among the baseline, 6th week and 12th week serum low density lipoprotein following structured physical activity among adults with overweight and obesity.

V. There will be no significant difference among the baseline, 6th week and 12th week serum triglycerides following structured physical activity among adults with overweight and obesity.

VI. There will be no significant difference among the baseline, 6th week and 12th week serum fasting blood glucose following structured physical activity among adults with overweight and obesity.

VII. There will be no significant difference between the baseline and 12th week HbA1c following structured physical activity among adults with overweight and obesity.

VIII. There will be no significant difference among the baseline, 6^{th} week and 12^{th} week serum AST following structured physical activity among adults with overweight and obesity.

IX. There will be no significant difference among the baseline, 6^{th} week and 12^{th} week serum ALT following structured physical activity among adults with overweight and obesity.

X. There will be no significant difference among the baseline, 6^{th} week and 12^{th} week cardiovascular disease risk score following structured physical activity among adults with overweight and obesity.

XI. There will be no significant difference among the baseline, 6^{th} week and 12^{th} week diabetes risk score following structured physical activity among adults with overweight and obesity.

XII. There will be no significant difference among the baseline, 6^{th} week and 12^{th} week hypertension risk score following structured physical activity among adults with overweight and obesity.

XIII. There will be no significant difference among the baseline, 6^{th} week and 12^{th} week cost of care following unstructured physical activity among adults with overweight and obesity.

XIV. There will be no significant difference among the baseline, 6^{th} week and 12^{th} week serum total cholesterol following unstructured physical activity among adults with overweight and obesity.

XV. There will be no significant difference among the baseline, 6^{th} week and 12^{th} week serum high density lipoprotein following unstructured physical activity among adults with overweight and obesity.

XVI. There will be no significant difference among the baseline, 6^{th} week and 12^{th} week serum low density lipoprotein following unstructured physical activity among adults with overweight and obesity.

XVII. There will be no significant difference among the baseline, 6^{th} week and 12^{th} week serum triglycerides following unstructured physical activity among adults with overweight and obesity.

XVIII. There will be no significant difference among the baseline, 6^{th} week and 12^{th} week serum fasting blood glucose following unstructured physical activity among adults with overweight and obesity.

XIX. There will be no significant difference between the baseline and 12^{th} week serum HbA1c following unstructured physical activity among adults with overweight and obesity.

XX. There will be no significant difference among the baseline, 6^{th} week and 12^{th} week serum AST following unstructured physical activity among adults with overweight and obesity.

XXI. There will be no significant difference among the baseline, 6^{th} week and 12^{th} week serum ALT following unstructured physical activity among adults with overweight and obesity.

XXII. There will be no significant difference among the baseline, 6^{th} week and 12^{th} week cardiovascular disease risk score following unstructured physical activity among adults with overweight and obesity.

XXIII. There will be no significant difference among the baseline, 6^{th} week and 12^{th} week diabetes risk score following unstructured physical activity among adults with overweight and obesity.

XXIV. There will be no significant difference among the baseline, 6th week and 12th week hypertension risk score following unstructured physical activity among adults with overweight and obesity.

XXV. There will be no significant difference in the12thweek cost of care between the structured and unstructured physical activity groups among adults with overweight and obesity.

XXVI. There will be no significant difference in the12th week serum total cholesterol between the structured and unstructured physical activity groups among adults with overweight and obesity.

XXVII. There will be no significant difference in the 12th week serum high density lipoprotein between the structured and unstructured physical activity groups among adults with overweight and obesity.

XXVIII. There will be no significant difference in the 12th week serum low density lipoprotein between the structured and unstructured physical activity groups among adults with overweight and obesity.

XXIX. There will be no significant difference in the12th week serum triglycerides between the structured and unstructured physical activity groups among adults with overweight and obesity.

XXX. There will be no significant difference in the12th week serum fasting blood glucose between the structured and unstructured physical activity groups among adults with overweight and obesity.

XXXI. There will be no significant difference in the12th week serum HbA1c between the structured and unstructured physical activity groups among adults with overweight and obesity.

XXXII. There will be no significant difference in the12th week serum AST between the structured and unstructured physical activity groups among adults with overweight and obesity.

XXXIII. There will be no significant difference in the12th week serum ALT between the structured and unstructured physical activity groups among adults with overweight and obesity.

XXXIV. There will be no significant difference in the12th week cardiovascular disease risk score between the structured and unstructured physical activity groups among adults with overweight and obesity.

XXXV. There will be no significant difference in the12th week diabetes risk score between the structured and unstructured physical activity groups among adults with overweight and obesity.

XXXVI. There will be no significant difference in the 12th week hypertension risk score between the structured and unstructured physical activity groups among adults with overweight and obesity.

5.6 Delimitation of the Study

This study was delimited to:

1. Participants: overweight and obese adults recruited from Gwagwalada area council of the Federal capital territory, Abuja, Nigeria.
2. Assessment of the following clinical variables:
   i. Anthropometric parameter: weight and height (to calculate the Body Mass Index [BMI]) and waist circumference (WC).
   ii. Serum biochemical indices: TC, HDL, LDL and TG; FBG; HbA1c; Liver function test (AST and ALT).
3. Exercise programmes:
   a. Structured Physical activity group

    i. Aerobic exercises (using treadmill),
    ii. Resistance exercises (using dumbbells) and
    iii. Flexibility exercises
  b. Unstructured Physical activity group
    i. Walking
4. Cost of care: Cost-benefit Analysis (CBA).
5. Assessment of the following disease risk scores;
   i. Cardiovascular disease risk scores.
   ii. Diabetes risk scores.
   iii. Hypertension risk scores.
6. Instrumentation (questionnaires):
   a) The Cost of Overweight and Obesity Questionnaire adopted and modified from a questionnaire used to assess cost of juvenile idiopathic arthritis to assess the cost of care-Cost-Benefit Analysis (CBA).
   b) The Framingham Risk Score (FRS) questionnaire.
   c) The Finnish Diabetes Risk Score (FINDRISC) questionnaire.
   d) Hypertension Risk Score (HRS) questionnaire.

1.7 Limitations

1. Recall bias from respondents might possibly be a limitation as some of the instruments used were questionnaires
2. Only individual literate in English were considered in this study. Hence, the findings may not adequately apply to some demographics in the study area.

1.8 Significance of the Study

1. Findings from this research have shown that structured PA programmes has a cost advantage over unstructured PA programmes in reducing overweight and obesity in adults.
2. This study has shown that to prevent or reduce the health risk of developing cardiovascular disease, diabetes and hypertension in overweight and healthy

adults, both structured and unstructured PA programmes could be used as preventive measures in health promotion strategies.

3. The outcome of this study has also shown that the effect of structured and unstructured PA programmes in preventing health risks in overweight and obese adults could be seen as early from the 6^{th} week of participation in PA up to the 12^{th} week.
4. The outcome of this study also revealed that structured PA has significant effect more than unstructured PA in improving some biochemical indices such as HDL and AST, whereas, both PA programmes have the same benefits on some other biochemical indices such as TC, LDL, TG, FBG and HbA1c. This knowledge could be applied in tailoring PA programme specifically for clients or patient's need individually.
5. This study is useful to exercise and other health care professionals aimed at prescribing exercises by making informed choices on whether to use structured or unstructured physical activities for their clients/patients.
6. The result of this study has further exposed the facts that the benefits of PA programmes for overweight and obese individuals can be observed from week 6 and further into week 12 of intervention.
7. This study has revealed that unstructured PA could be used by apparently healthy individuals in areas where health professionals are scarce or unavailable such as in the rural areas to prevent or reduce the danger of developing some diseases such as cardiovascular disease, diabetes and hypertension without the supervision of medical experts.
8. The study has shown that apparently healthy individuals in areas where there are scarce health professionals who prescribes and supervises exercise programmes such as in the rural settings, could engage in unstructured PA to improve some of their biochemical indices.
9. This study may also stimulate further research interest in the application of economic assessments in physical activities involvements in the area of promoting sound health.

10. This study has also added to existing information on the usefulness of physical activity in well-being to influence modifiable risk factors of some selected chronic diseased conditions.

1.9 Definition of operational terms

For the purpose of this study, overweight and obese adults are grouped and analysed as adults with BMI greater than 24.99 kg/m^2.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overweight and Obesity

The World Health Organisation (WHO, 2017) defined overweight and obesity as an aberrant or excessive fat accumulation that can be detrimental to well-being. One simple index of weight and height frequently used to classify overweight and obesity in adults is the BMI, defined as a person's weight in Kilograms divided by the square of his height in metres (kg/m2) (WHO, 2017). In adults, a BMI more than or equivalent to 25 kg/m^2 is overweight and a BMI larger than $30kg/m^2$, the individual is said to be obese (WHO, 2017).

The most commonly used classification devised by WHO in 1997 and published in 2000, 2004 and 2005 is displayed in Table 2.1 (WHO, 2017). Waist circumference (WC) has also been used to classify abnormal weights in adults. A WC above 102 cm for males and greater than 88cm for females (Grundy et al 2005) is excessive. Waist-hip ratio (WHR) > 1 for males and WHR> 0.8 for females (WHO, 2010) have also been used to define overweight and obesity.

Table 2.1: Adult's weight classification in BMI

Classification	BMI(Kg/m²)
Underweight	< 18.50
Normal weight	18-50 – 24.99
Pre-obese(overweight)	25.00 – 29.99
Obese class 1	30.00 – 34.99
Obese class 2	35.00 – 39.99
Obese class 3	$\geq$ 40.00

Source: WHO, 2017.

One in ten adults are either overweight or obese (Iwuala et al., 2015), making obesity and overweight a global issue. It is linked with a multitude of conditions, including cardiovascular disease, diabetes, hypertension, stroke, sleep apnea, osteoarthritis, depression, decreased quality of life, and numerous malignancies (Vucenik and Stains, 2012; Poirier et al., 2006; Carr and Friedman, 2005). Obesity and overweight are associated with enormous economic expenses (Finkelstein et al, 2009). The developing world, which continues to struggle with infectious diseases, is not exempted from this worldwide plague. This is due to changes in nutrition, decreased physical activity, and economic development (Rivera et al., 2002).

In some cultures, obesity is a representation of attractiveness and vitality. Some native practises such as "fattening a soon-to-be bride" rite have been reported in many parts of the world such as among the Massa man north of the Cameroon and Chad, in Tahiti, Nauru, Japanese Sumo wrestlers and the Annang tribe in the southern part Nigeria (Ekpenyong and Akpan, 2013; Samson-Akpan, et al., 2013; Ogunjimi et al., 2010; Enang, 2009; Hattori, 1995; de Garine and Koppert, 1991).

Okop et al. (2016) reported that obesity would affect more than 1.3 billion people worldwide by 2030, and because this has grave health implications, it should be viewed as a cause for alarm. An imbalance of energy between calories of food consumed and calories expended is the fundamental origin of overweight and obesity. Universally, an increase in the intake of high caloric-dense-carbohydrate foods has been on the increase; there has also been a rise in physical inactivity due to the high sedentary nature of many occupations, altering means of transportation, and budding suburbanisation, particularly in developing nations like Nigeria (WHO, 2017).

Changes in nutritional and physical exercise patterns are often the upshot of environmental and societal deviations connected to development and the lack of presence of helpful strategies in sectors such as health, agronomy, transportation, urban planning, environment, food manufacturing and conservation, delivery, marketing, and education. According to WHO reports (2017), many developing nations are now confronting a "double burden" of disease (infectious diseases and a progressive rise in non-infectious disease risk factors such as been excessively overweight), especially in urban areas.

Overweight and obesity are preventable, as are their associated non-infectious diseases. This is accomplished primarily through changes in lifestyle, including dietary patterns involving the selection of healthy foods and regular physical activity. These are achieved when individuals restrict their caloric intake from dangerous fatty foods and excessive carbohydrates, increase eating of fruits, vegetables, legumes, whole grains, and nuts, and participate in regular physical activity (60 minutes per day for children and 150 minutes per week for adults) (WHO, 2017).

2.1.1 Prevalence of Obesity and Overweight

According to a fact document on obesity and overweight published in 2017 (WHO, 2017), globally, obesity has nearly increased in three-folds in the last four decades. The WHO reported that in 2016, approximately 2 billion grown-ups, 18 years and older, were having excess weight. Out of these figures, well above 650 million were diagnosed as being obese (WHO, 2017). The statistics on overweight and obesity are further broken down as follows: 39% of grown persons who were 18 years and above were said to be overweight in 2016, while 13% were reported as being obese (WHO, 2017). The report further showed that, more than 340 million children and young people between the ages of 5-19 were overweight or obese in 2016 (WHO, 2017). The WHO summarises these disturbing numbers as in total, almost 13% of the world's adult populace were diagnosed as being obese in 2016. All these alarming figures according to the WHO are due to the large increase in physical inactivity, sedentary lifestyles resulting from various types of occupation such as the "white collar job".

In the past, overweight/obesity was considered a disease of industrialised nations (Kolawole et al., 2011). However, a 10% prevalence rate has been reported in the West Africa sub-region, with urban women being three times more likely to be affected than men (Abubakari et al., 2008). Obesity in Nigeria with a high increased prevalence has been observed in the past decade, with a high rate recorded in the northern parts of the country with women seen to be significantly more affected than men, which has been attributed to a lack of physical exercise that may be as a result of culture; for example, women in the northern part of Nigeria are only permitted to be full-time housewives (Kolawole et al., 2011; Akpa and

Mato, 2008). It is estimated that 20-50 percent of the city population in Africa may either be overweight or obese (Sodjinou et al., 2008; Kamadjeu et al., 2006).

In a systematic evaluation of the prevalence of obesity and overweight in Nigerian adults, Chukwuonye et al. (2013) reported that overweight prevalence in Nigeria ranged from 20.3% to 35.1%, while the prevalence of obesity ranged between 8.1% to 22.2%. The lowest occurrence of overweight was found in Ile-Ife, Nigeria, at 20.3%, while the greatest prevalence of overweight was found in Ilorin, Nigeria, at 35.1%. For obesity, Chukwuonye et al. (2013) found in their study that Maiduguri had the least prevalence of obesity (8.1%), while Lagos had the uppermost prevalence (22.2%). They concluded their study by stating that these figures of persons in Nigeria who were reported as being overweight and obese has reached pandemic magnitudes due to sedentary lifestyles, physical inactivity, and the ingesting of foods with high calories. Thus, greater emphasis must be placed on combating these health disorders.

A cross-sectional study in the Nigerian city of Ile-Ife by Adedoyin and colleagues (2009) expressed the prevalence of obesity and overweight as 12.5% and 20.3%, respectively, and were greater among females than males. The study revealed a correlation between this prevalence and inactivity and sedentary lifestyles. A survey of adults aged between 18 years and older in two Local Government Areas of Kwara State, Nigeria, and discovered that 2.4% of males and 7.4% of females were found to be obese, respectively (Desalu et al.,2008).

A WHO survey data conducted in Nigeria in 2010, revealed a prevalence of overweight for men to be 26% with women having 37%, whereas obesity prevalence was found to be 3% in males and 8.1% in females (Ono et al., 2012). Ono and co also reported an increase in prevalence of obesity as 47% in men and 39% in women, from 2002-2010, in Nigeria. In a study carried out by Olatunbosun et al. (2011) in Ibadan, Nigeria, they found out a prevalence rate for overweight and obesity as 17.4% and 8.7% respectively.

Akinpelu et al. (2009), reported prevalence of overweight and obesity in Lagos, South-West Nigeria as 29% and 9% respectively. Similarly, Akarolo-Anthony et al. (2014) in their study reported a prevalence of 38% and 26% respectively for obesity and overweight residents studied in Abuja, Federal Capital of Nigeria. This prevalence was also attributed to physical inactivity and much of sedentary lifestyles.

2.1.2 Assessment of Overweight and Obesity

Overweight and Obesity can be assessed by:

i. The use of BMI: The National Institute for Health and Clinical Excellence (NICE) prescribed that obesity and overweight could be determined using BMI (NICE, 2014). According to NICE, the BMI is used because it relates with body fat percentage for most adults. BMI is evaluated by using the formula: weight of the individual in kg divided by the height(squared), in metres (Kg/m2). NICE (2014) defines overweight values of BMI between 25 and 29.9 kg/m2 is termed overweight and BMI values of 30 kg/m2 or higher is termed as the individual being obese. This categorisation is similar with that of WHO, 2017. Although BMI is an acceptable estimate of body adiposity at the populace level and can be used to predict the relative risk of disease in most persons, it is not mostly a precise predictor of distribution of fats in the body, particularly in individuals with large muscle mass owing to variations in body-fat amounts and spreads (NICE, 2014). NICE (2014) advocated combining the use of waist circumference (WC) in addition to BMI to assess obesity and overweight would give a better predictor for disease risks.

ii. The use of waist circumference: A more practical index to assess a patient's belly fat or "central" fat spread (Bigard et al., 2005) is the waist circumference. The WC has been demonstrated to be positively, but not exactly, associated with disease risk. NICE mentioned that WC (Table 2.2) can be used with BMI to evaluate risk in adults with a BMI lower than 35 kg/m2 (NICE, 2014). Central obesity is linked with an increased risk of developing type 2 diabetes and coronary heart disease. However, when the BMI is greater than 35 kg/m2, the WC contributes minutely to the absolute risk values provided by the BMI (NICE, 2014). Patients having a BMI of 35kg/m2 will surpass the WC verge used to recognise persons at risk for metabolic disorder.

iii. Waist hip ratio (WHR): This is computed as the ratio of WC to the hip circumference. The WHR has been employed as a pointer or degree of an individual's wellbeing and risk of coming up with serious health challenges (Gill et al., 2006). Although there is no consensus regarding appropriate WHR thresholds, an elevated WHR is considered to be at least 1.0 in men and 0.85 in women (NICE, 2014). It was reported in the study of Gabriel et al (2007), that BMI, WC and WHR has a strong association in predicting diabetes.

iv. Hydrostatic weighing: hydrostatic weighing entails weighing the subject while submerged in water. People with added adiposity tend to stay afloat and weigh lesser underwater, whereas people with less fat tend to sink and weigh comparatively more underwater (Paul and Walton, 2002). This is because muscle is a higher density substance whereas fat is a lower density substance than water.

v. Electrical impedance: electrical impedance is a method for measuring body fat percentage using an innocuous electric current (Payne and Hathaway, 2002). Because adipose tissue resists the passage of electric current, electrical impedance can be transmitted directly through the body from an electrode using a feeble electrical current. Using current measurements, a computer calculates the percentage of body fat (Paul and Walton, 2002).

Table 2.2: Waist Circumference values for determining health risks

Risk level	Men	Women
High risk	94 cm (37 inches) or more	80 cm (31 inches) or higher
Severe risk	102 cm (40 inches) or more	88 cm (35 inches) or higher

Adopted from: NICE, 2014

vi. Skinfold measurement: It is used to determine the thickness of the subcutaneous adipose layer (Payne and Hathaway, 2002). It is determined by gripping a predetermined skin fold and measuring it with a skin-fold calliper (Paul and Walton, 2002). Various measurements are taken and entered into a formula to forecast the percentage of body fat.

2.2 Concepts of Physical Activity

Physical activity (PA) is a broad impression that is articulated in many manifestations including; performance, physical instruction, everyday actions such as ambulation, ascending and descending staircases, riding bicycle to work, taking the dog for a walk, performing domestics tasks, undertaking motion activities, exercise workouts and participating in sports. Physical activity has been described as "all physical movements carried out by skeletal muscles giving rise to a significant increase of energy expenditure above and more than the norm". (Bouchardet al., 2003). Exercise is explained as an intentional, designed and continuous repetitions of physical activity that purposes to enhance or preserve physical fitness (Bouchard et al., 2003).

Caspersen et al. (1985) provide a simple universal definition of physical fitness is "a set of attributes a person possesses or acquires that can be related to the ability to perform physical activity". The components of physical fitness include aerobic capacity, numerous systems of muscular strength, dexterity, speediness, coordination and practical technological skills. These features can be explicitly developed and mastered, and have been shown to be relevant for sporty achievements. Physical activity should not be confused with sport, according to the WHO (2010); physical activity is any motion generated or carried out by the skeletal muscles that utilizes energy systems. These activities could be sporty in nature, physical exercises and other activity such as play, strolling, performing domestic tasks and gardening. Lack of physical activity has been reported as performing or engaging in physical activities lower than 2.5 hours per week of modest – intensity (WHO, 2017). This description is in line with that of the position of the Centres for Disease Control and Prevention (CDC) which posited that an adequate level of PA should be 30 minutes/ day on a minimum of five days/ week performed at an intensity of moderate level or engaging in activities with intensities that are vigorous for a minimum of 20 minutes/ day for a minimum of three days in a week (U.S. Department of Health and Human Services, 2009). In a survey in the US, grownups were described as lacking in PA when they do not perform minimal, moderate or vigorous leisure time PA for a minimum duration of 10 minutes in a day (U.S. Department of Health and Human Services, 2009).

A report that defines physical inactivity in terms of steps per day suggests that a person who does below 5000 walking steps in a day is sedentary or not physically active to get health benefits (Tudor – Locke and Bassett, 2004). Universally, developing nation show lower incidence of inactivity compared with highly developed nations that presents with significantly higher rates of inactivity (WHO, 2010; Dumith et al., 2011).

2.2.1 Classification and Types of PA

According to Odunaiya and Oguntibeju (2013), PA can be largely described using three principles: intensity or how difficult or easy to carry out the activity, the type of energy system used when performing the activity coupled with the influence the activity exerts on the body as a whole. Physical activity with intensity that is either light or low includes slow walking, household chores, sitting, and writing; moderate intensity PA includes hurried walking, riding a bike over a plane surface, and dancing; and vigorous intensity PA includes jogging, running, skating, push-ups, treadmill running, etc. (Pate et al., 2008). It is imperative to note that mild or low intensity physical exercise do not have any health benefits accrued to it, whereas moderate to vigorous intensity PA provides significant health benefits to the performer (Odunaiya and Oguntibeju, 2013).

Physical activity classification based on energy system utilised during activity performance involves three energy systems; Adenosine triphosphate creatine phosphate (ATP-PCr) system, lactic acid system and aerobic system (Odunaiya and Oguntibeju, 2013). The utilisation of these energy systems during PA performance could occur either in aerobic or anaerobic activities. Classification of PA founded on the effect on the body tissues and system includes activities for muscle strengthening, cardiovascular training activities, weight training exercise, balance training exercise, coordination training etc (Odunaiya and Oguntibeju, 2013).

2.2.2 Structured and Unstructured PA

Structured PA is categorized as "activity supervised by an expert or other sports specialists such as activities in the gym, aerobics, dance, and bicycling that are all supervised or designed to achieve a certain intensity," whereas unstructured (or non- structured) PA is defined as "non-guided sport activity such as walking, playing actively, doing household chores, and working in a physically demanding occupation" (Esculcas and Mota, 2002). Esculcas and Mota (2000) found in a previous study that structured physical activities may be characterised by team activities or individual activity of different intensities, while non-structured physical activities are characterised by sole/twofold activities of light to moderate intensity.

In research conducted by Matthews et al. (2016) on implementing a people-based structured PA workout programme, many participants reported that structured PA had a positive impact on their lives by assisting them in making significant lifestyle changes, such as quitting or reducing smoking, increasing their levels of physical activity by registering in a gym, then losing weight. In a randomised controlled trial done by Subramanian et al. (2015) to examine the outcome of structured and non-structured PA training on intellectual capabilities in youths, they found that participants in both groups exhibited significant improvements in all neurocognitive parameters, although subjects in the structured PA group exhibited meaningful greater improvements. Subramanian et al. concluded that structured PA is more beneficial than unstructured PA when structured in accordance with WHO guidelines, most likely due to the higher intensity of exercise that the participants in the structured physical activity group were exposed to compared to the type of activity in the unstructured PA group.

Structured PA (the type that is greater than 3 metabolic equivalents (METs) done in breaks of 10 minutes or more) is connected with improved cardiorespiratory fitness (CRF) (Branch et al., 2009). McGuire and Rose (2011) found that incidental physical activity (IPA; defined as non-structured, unstructured, spontaneous-low and moderate-intensity PA executed in free-living settings) is beneficially associated with CRF, indicating that all forms of PA are beneficial to health. McGuire and Rose (2011) discovered a significant association between sporadic moderate-intensity PA (MPA; described as activity greater than 3 METs accumulated at intervals less than 10 minutes) and CRF, but not between light-intensity PA (LPA; reported as PA from 1.0 and 2.99 METs) and CRF. Considering the well-known relationship between CRF and disease and mortality, Kodama et al. (2009) observed that IPA and sporadic MPA are positively beneficiary with CRF and have significant clinical and public health implications because it has detraining effects on individuals beginning an exercise training programme.

2.3 Recommended Levels of participating in PA

The encompassing recommendation for PA participation in terms of promotion of health and prevention of disease for adults is engaging in 30 minutes per day moderate intensity PA. This is for optimum blood pressure maintenance, improved muscle strength, and healthy joint movements in order to decrease the risk of developing cardiovascular disease, been obese, type 2 diabetes, and colorectal cancer (Anderssen and Stromme, 2001).

2.3.1 Physical activity recommendations for 18–64-year-old adults (WHO, 2010)

Physical activity includes recreational PA, transport (e.g., hiking or cycling on a bike), occupational physical activity (i.e., activity at work), house hold duties, play, games, participating in sports or performing exercise that is planned and organised in 18 to 64-year-old adults. To enhance cardiovascular and musculoskeletal fitness, healthy bones, and reducing the possibility of developing non-communicable diseases and depression, some recommendations advocated are:

1. Performance of a minimum of 2.5 hours in a week of aerobic PA of moderate intensity, a minimum of 75 minutes in a week of aerobic PA of intensity that is vigorous should be performed, or an equal blend of moderate and vigorous intensity activity.

2. Exercise that is aerobic in nature should be done in pauses of not less than 10 minutes.

3. Additional health paybacks could be achieved when, aerobic PA is performed for about 5 hours in a week at a moderate intensity or 2.5 hours in a week at an intensity that is vigorous, or a corresponding mixture of moderate – and vigorous intensity activity. Physical activities involving the major muscle groups should be done not less than twice weekly (WHO,2010).

2.3.2 Physical Activity recommendations for older adults (WHO, 2010)

Activities that could be performed by older adults includes recreational PA, transport (e.g., taking a walk or bicycling), occupational PA (for actively working individuals), domestic tasks, playing games, engaging in sports or exercise that is planned or programmed in the framework of everyday, household and public activities for adults that are 65-year-old and above. To boost cardiovascular health, muscle wellness, healthy bones, efficient health, and to decrease the risk of acquiring non-infectious diseases, depression, and to prevent cognitive deterioration, some recommendations have been advocated:

1. Adults that are elderly should perform aerobic PA of a minimum of 2.5 hours in a week at intensities that are moderate; or they should engage in aerobic PA with duration not less than 75 minutes in a week utilizing activities that the intensities are vigorous, or an equal blend of activities with both intensities.

2. Aerobic exercise should be done intermittently for a minimum of 600 seconds.

3. Added health benefits are obtained when elderly adults increase their performance of aerobic PA to 300 minutes per week at a moderate intensity, or 2.5 hours weekly vigorous intensity PA, or an equal mixture of moderate and vigorous – intensity PA.

4. Elderly persons that presents with restricted mobility should engage in PA three or more times in a week to boost their balance and prevent incidents of falls.

5. Exercises for strengthening the key muscle group should be done for a minimum frequency of twice weekly (WHO, 2010).

2.4 The Economic Burden of lack of PA

Physical inactivity and obesity account for a significant proportion of lingering ailment. Mokdad et al., 2000; Finkelstein et al., 2004; Wang et al., 2004; Mokdad et al., 2004). Estimates differ, but putting them together, they are accountable for at least 500,000 premature mortality and over $100 billion in medical spending yearly in the United States of America. In relationship to the negative impact of lack of PA on wellness of individuals, developing nations are following the United States' lead. Recent analyses by the World Health Organisation (WHO) and the U.S. Centres for Disease Control and Prevention (CDC) have highlighted a rising acknowledgement of the global financial burden caused as a result of physical inactivity (Oldridge, 2008). According to an evaluation conducted by Oldridge (2008), developing nations report significantly higher levels of lack of leisure-time PA than industrialised nations. Mackay and Mensah (2004) stated that about 60-85 percent of the world's inhabitants, not excluding those in nations that are still developing, reports observed revealed that they are not sufficiently physically active enough to enjoy the benefits of good health.

Given the proportionally larger figures of people in countries that are striving to develop, the rising numbers in the prevalence of those who are obese globally, and the reduction in PA, the impending economic burden in nations such as China and India will surpass that of the United States of America (Oldridge 2008; Zhao et al., 2008). Using a cost of illness methodology, Garret et al. (2004) found that inactivity cost one health plan $86 million. According to Katzmarzyk et al. (2000), not engaging in physical activity was responsible for approximately 2.5% of the total direct costs of health care spendings costs in Canada in the year 1999. In addition, it was estimated that approximately 21,000 premature deaths were caused by inactivity in 1995. Using a survey to perform a graded evaluation of healthcare expenditures, Pratt et al. (2000) discover that individuals who were engaging in PA reported a reduced average yearly medical expenses of $1,019 compared to individuals who are sedentary with medical expenditure of $1,348. Shinogle (2008) used two other survey models to determine the estimated costs of medical spendings that is attributable to lack of PA and observed that it ranged between 11 and 16 percent of the total costs of healthcare expenditures. In this model, it was opined that not engaging in PA did not significantly raise the likelihood of incurring health expenses, however it caused an increase in the total amount spent. This outcome may indicate that individuals who were physically active possessed a previously unrecognised preference for preventative health measures.

2.5 Physical Activity and Health

Physical activity has distinct health advantages. Murphy et al. (2007) discovered that even minimal action, such as taking a walk, enhances good blood pressure, decreases percentage body fat, and reduces BMI. Other obesity-related health studies are beginning to identify physical activity levels as significant outcome predictors. According to Katzmarzyk et al. (2004), combining CRF to representations comparing mortalities in men with metabolic syndromes and men described as healthy renders the association inconsequential. They discovered that CRF has a significant robust protecting impact on wellness.

The importance of the role of PA in prevention of ill-health and health promotion is well stated (WHO, 2006). Church et al. (2007) studied post-menopausal women with elevated blood pressure and found out that even a low dose PA impacts positively on CRF in spite of the weight of the individual. Similarly, Ogwumike et al. (2014) reported that participation of post-menopausal women in moderate to vigorous intensity PA should be advocated as this could cause a decrease of high blood pressure and excessive weight with a possible reduction of CVD risk. In a study conducted by Adeniyi et al. (2010), it was demonstrated that exercise assisted in the improvements of neuromusculoskeletal disorders associated with type 2 diabetes mellitus, however on cessation of physical activity, there was a relapse of these disorders. In an in-depth review carried out by Adeniyi et al. (2010), it was found that therapeutic exercise is effective in managing sexual dysfunction in persons with diabetes. In another research carried out by Adeniyi et al. (2011), they reported that severe depressive symptoms in adolescents were linked with decreased PA. There is strong prescription for the type of PA that everyone should strive to accomplish in life to ensure that they are healthy. It is important to be and stay active whether one is elderly or youthful, strong or feeble, whether being male or female. Physical activity in any form helps in maintaining fitness and also boost mental health (Sallis, 2009). Strong evidence of the benefits of engaging in PA has been shown in reducing the risk of all – cause mortality, CVD, dangerous blood lipid profiles, type- 2 diabetes, metabolic syndrome, excessive weight, depression and some certain cancer such as colon cand breast cancer (Sallis, 2009). The author went further to reveal the positive affiliation of the benefits of participating in PA and a good cardiovascular health as well as a better cognitive function and these health benefits are enjoyed not only in adults, but in all ages of human, ethnicities and colours

(Sallis, 2009). As a result of these evidence of the advantages PA, in recent years, the emphasis of the scientific community has shifted from seeking relationship between PA and health status, to now identifying evidences for optimal doses (Warburton, 2006; Kesaniemi, et al, 2010).

Lack of PA by individuals is the fourth leading risk factor for global deaths, according to research. The effects of frequent PA for the primary and secondary prevention of some chronic diseases are now broadly recognised (WHO, 2010). These diseases represent for approximately half of the global disease burden. WHO (2007) estimates that six out of every ten fatalities are attributable to noncommunicable diseases. WHO (2007) estimates that lack of PA is the main cause of between 21-25 percent of breast and colon malignancies, 27 percent of diabetes, and 30 percent of ischemic heart disease burden. In 2008, NCDs such as CVD, diabetes, cancers of the breast and colon accounted for 63% of global fatalities (WHO, 2011). 6-10% of these were attributed to inactivity (US Department of Health, 1996). Physical inactivity has been indicated to be the major significant public health issue of this era (Blair, 2009). Morbidity is also affected by inactivity. According to the WHO, inadequate PA is the 4th foremost cause of mortality in the world, next is elevated blood pressure, smoking, and excessive sugar in the blood (WHO, 2009). Lee et al. (2012) reported a global estimate of 5,3 million deaths in a year as a result of inactivity. A new evaluation demonstrates an even greater risk of mortality due to inactivity, estimating an annual death toll of 5,3 million. A world-wide increase in PA would significantly enhance public wellness. Inadequate PA is linked with an increased chance of acquiring disease and an associated increase in mortality and morbidity (Blair, 2009; WHO, 2009).

Improving the physical activity behaviour of individuals who are not sufficiently active with diseases associated with their lifestyle is an imperative matter (Blair, 2009).

2.6 Biochemical Indices (Profile)

This is the blood's chemical substance measurement. It is a blood test that analyses electrolytes and determines the levels of circulatory enzymes (Hitosugi et al., 2004). Numerous investigations, each of which indicates the state of the organ that is been investigated, may be included in the analysis. The presence of disease may be indicated by an abnormal test result (Jamieson, 2005). Blood is typically drawn from a patient's vein for the vast majority of blood tests. There are numerous serum biochemistry tests that can be conducted, but not all of them must be performed on each occasion. This combination of selected serum biochemistry tests is referred to as a serum biochemistry panel or serum biochemistry indices (Hitosugi et al., 2004).

Blood serum (the fluid part of blood excluding fibrinogen) comprises of enzymes, proteins, lipids, glucose (simple sugar), and metabolites; these serum components are derived from organs such as the liver, kidney, and pancreas, and their measurement can indicate the function of these organs (Reiss et al., 2008). High density lipoprotein, low density lipoprotein, urea, creatinine, uric acid, glucose, calcium, phosphate, bilirubin, alkaline phosphatase, alanine and aspartate transferase are examples of biochemical indices (Reiss et al., 2008). Included in a typical serum biochemistry profile are the following:

Lipid profile: This includes total cholesterol (TC), HDL, LDL, and triglycerides (Gebremicael et al., 2017). The liver produces cholesterol as a portion of lipid metabolism. High cholesterol levels are linked to hormonal and metabolic disorders, disease of the liver, and severe disease of the kidney (Hitosugi et al., 2004). HDL-Cholesterol, also known as the healthy cholesterol, is one of the components of total cholesterol (Jamieson, 2005). LDL and HDL transport cholesterol back and forth between tissues and liver (Gebremicael et al., 2017). Cholesterol regulates hormones and fundamental cellular metabolism in the body. Cholesterol serves a crucial role in enzyme activity, phagocytosis, and cell growth (Gebremicael et al., 2017). McIntyre and Hazen (2010) found that an increase in lipoproteins and their lipid content, particularly cholesterol levels, raises the chances of developing of cardiovascular diseases and atherosclerosis. Current recommendations for the treatment of noncommunicable diseases focus on lowering serum cholesterol levels (Gebremicael et al., 2017).

Proteins: Albumin and globulin are the two main types of proteins constituents seen in blood, which can be analysed independently or collectively in a sole investigation known as total protein (Zhang et al., 2004). Albumin values could show when a patient is dehydrated and gives revelation of happenings in the liver, kidneys, and digestive system

(Munoz et al., 1997). High values of globulins are frequently connected with communicable diseases, immune-mediated diseases, and some categories of cancer (Olsen, 1991).

Liver Enzymes: The major common liver investigations assess the enzymes alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), and gamma glutamyl transferase (GGT) (Zhang et al, 2004). In a liver cell inflammation, disorders, or damages, ALT and AST levels is usually raised, while ALP and GGT levels is usually raised when movement of bile into the liver is diminished (Sewell et al., 1992). In cirrhosis, a high AST/ALT ratio is related with a high mortality rate (Haukeland et al., 2008). In a study conducted by Golik et al. (1991), 28.3% of the 60 obese participants had elevated serum levels of AST and ALT.

Haemoglobin A1c (HbA1c): The International Federation of Clinical Chemistry working group (IFCC) defines Haemoglobin A1c (HbA1c) as haemoglobin that is irreversibly glycated at one or both N-terminal valines of the beta chains (Nasir et al., 2010). The production rate is directly proportional to the ambient glucose concentration (Nasir et al., 2010). In patients with diabetes, the glycated haemoglobin value is used to determine the degree of glycemic control and to make therapeutic decisions (Sacks, 2007). Blood glucose concentrations fluctuate widely throughout the day due to dietary intake, physical activity, and other factors. In contrast, glycated haemoglobin concentration remains relatively stable over time. This is because the typical lifecycle of red blood cells is 120 days (Nasir et al., 2010). In individuals with a normal erythrocyte life span, the glycated haemoglobin concentration is directly proportional to the average blood glucose level over the previous 8 to 12 weeks (Sacks, 2007).

Muscle Enzymes: Creatinine kinase is the enzyme that is usually investigated to evaluate muscle health (McKeever, 2004). The enzymes AST and ALT, which are also evaluated to determine liver function health (McKeever, 2004), are of lesser standing. Activities that utilize muscles such as PA, trauma to the muscles leading to muscle inflammation are often linked with high values of muscle enzyme levels.

Electrolytes: The topmost essential electrolytes are potassium, chloride, sodium, and bicarbonate, which are constituents existing in the blood in minute amounts. Each electrolyte possesses a unique function in the body (Hitosugi et al., 2004). Electrolytes contribute to the stability and equilibrium of blood and tissue fluids (Panagiotokos et al., 2003). Electrolyte imbalances are frequently brought on by vomiting and/or diarrhoea and are associated with a number of severe metabolic diseases (McKeever, 2004).

2.7 Biochemical Responses and Adaptations to Training

Aerobic training induces a considerable quantity of metabolic and physiological variations that result in enhanced performance. Multiple weeks of moderate-intensity, moderate-duration exercise increases the size and number of mitochondria as well as the capillarization of the trained muscle (McKeever, 2004). In addition, exercise and the oxidation of lipids and carbohydrates boost the activity of several aerobic enzymes (McKeever, 2004).

In reacting to a single exercise training, skeletal muscles undergo cellular changes, such as the activation of the mitogen-activated protein kinase signalling cascade (Widegren et al., 2001). Continuous exercise is also associated with a raised function of enzymes in the mitochondrial electron transport chain as well as an increase in the concentration of mitochondrial proteins (Hawley, 2002). Mitochondrial content appears to increase comparatively quickly, within 1-2 weeks of training (Burgomaster et al., 2007). During moderate and strenuous exercise, endurance training decreases the production, uptake, and oxidation of plasma glucose (Coggan et al., 1995).

Coggan et al. (1995) found that a related rise in fat oxidation compensates for the training-induced decrease in carbohydrate oxidation. The mechanism underlying the glycogen sparing effect is unclear, but it has been attributed to enhanced muscle respiratory capacity, a high level in intramuscular triglyceride concentration, and a greater mobilization of muscle mass (Burgomaster et al., 2007).

Training reduces body fat until total energy expenditure equals total energy intake (McKeever, 2004). Training has acute and chronic positive effects on glucose regulation (fasting glucose, postprandial glucose, insulin sensitivity, and fasting insulin) -(Hawley and

Lessard, 2008). Muscle glycogen becomes a more important substrate source as exercise intensity increases (Kjaer et al., 1990). The post-exercise enhancement in glucose tolerance and insulin sensitivity is correlated with the depletion and resynthesis of muscle glycogen stores (Snowling and Hopkins, 2006).

In various populations, regular exercise has been associated with favourable serum lipids and lipoproteins (Hu et al., 2008; Panagiotokos et al., 2003). Exercise has been linked to an increase in plasma HDL-C and/or a reduction in total cholesterol, low density lipoprotein cholesterol (LDL-C), and triglycerides, or no change (Boardleyet al., 2007; Leon and Sanchez, 2001). Due to the wide variety of exercise practices, experimental designs, and participant's features, the effect of PA on phospholipid and lipoprotein levels is still unclear (Durstine et al., 2001).

Several investigations conducted in the late 1970s demonstrated that the blood cell concentrations of functionally distinct lymphocyte subpopulations and, as recognised later, natural killer cells were transformed otherwise (McKeever, 2004). During the eighth decade of the 20th century, immunologists' interest heightened and novel laboratory techniques for studying the early immune response to PA were created (McKeever, 2004). The number of studies on the acute and chronic immune response to exercise has increased due to the expanding curiosity of immunologists and the introduction of innovative methods.

It has been reported that exercise causes a variety of chemical (hormonal) and cellular changes in addition to physical fluctuations such as amplified blood pressure, body temperature, and oxygen consumption (Jamieson, 2005). This depends on a diversity of factors, including the kind and duration of exercise, climate, physical condition, and diet. Gabriel et al. (1992) reported that at least a portion of the exercise-induced increase in neutrophils is due to an increase in blood cortisol levels.

Sometimes, urea and uric acid levels in the serum are used to assess training-related stress (Urhausen and Kindermann, 2002). These variables may be tested at frequent interludes during aerobic training to determine the training strain effect on athletes. In addition, urea and uric acid accumulation is commonly used as an indicator of protein catabolism and adenine nucleotide degradation (Andersson et al., 2008). These include the utilisation of triglycerides for energy production, fat storage in adipose tissues, and the utilisation of cholesterol as a component in phospholipids of cellular membranes or in the synthesis of steroid hormones (Altena et al., 2006). Plasma cholesterol concentrations have been linked to coronary artery disease development (Kelley and Kelley, 2009).

2.8 Anthropometric Adaptations to Training

Anthropometry is the study of the magnitudes of bone, muscle, and adipose (fat) tissue in various regions of the human body (Taura, 2011). It is the simplest, commonly relevant, cheap, and non-invasive method for determining the dimensions, magnitudes, and constitution of the human body. It also shows health and dietary status and forecasts performance and survival (Taura, 2011).

Whenever the body is exposed to a stimulus (e.g., exercise, physical exertion, training, etc.), Kraemer et al. (2002) found that it adjusts functionally and structurally to the imposed demands. Biochemical adaptations within the musculoskeletal system have been shown to improve a person's functional capacity and reduce cardiovascular risk factors (Kraemer and Ratamess, 2005).

Exercise has been shown to increase the body's maximal oxygen uptake, body configuration, muscle strength, as well as a number of other biochemical and physiological parameters (Powers and Howley, 2004). These health benefits have not only served as the incentives for the advancement of exercise, but also as the purpose that PA is an essential element of wellness promotion.

2.9 Health Economics

Health economics involves the use of commercial theories, models, and practical methodologies to situations in health care to aid in making informed-decisions (Morris et al., 2007). Health economics consists of theories developed explicitly to comprehend the behaviour of patients, medical and healthcare professionals, and the operation of the healthcare system (Fatoye, 2015). The application of health economics facilitates resource allocation and utilisation in healthcare practise (Fatoye, 2015). Health economics (Haycox, 2009) reflects the desire to obtain maximum value for any money spent on health services, including not only clinical efficacy, but also the cost effectiveness of such services. Categorizing of importance and pronouncements regarding investments in health care industries must be done with limited resources, and economics and public health methods should be taken into consideration in the policymaking task (Cohen and Henderson, 1988). Health economics is a theoretical framework that assists healthcare professionals, healthcare decision-makers, and governments in determining how to optimally utilise limited health resources. According to Fatoye (2015), health economics is neither a form of accounting nor concerned with cost-cutting. It entails 'counting the costs' of interventions and their benefits in order to provide the correct data for the correct decision regarding the efficient use of interventions (Fatoye, 2015).

Economic Evaluation

Economic evaluation is the comparison of the prices and values of two or more alternatives (Drummond et al., 2005). The objective of the evaluation is to scrutinise the utility, effectiveness, and accessibility of a health boosting programme in order to inform resource allocation decisions (Drummond et al., 2005). Economic evaluation has wide relevance in the health care sector because scarce resources necessitate prioritisation, and health economics has inherent usefulness to all levels in the decision-making phases in the health-care industry (Drummond et al., 2005). Cost-effectiveness analysis, cost-utility analysis, and cost-benefit analysis are the various categories of economic evaluations that satisfy these situations (Drummond et al., 2005).

Important among these evaluations is the incremental analysis, or the variance among two programmes (Rome, 2014). This yields an incremental cost-effectiveness ratio (ICER) that is used in making comparisons of programmes existing in the health care segment (Rome, 2014). The two workings of a health economic evaluation are the computations of prices and outcomes of a scheme and a comparison of a substitute event (Drummond et al., 2005).

ICER =

$$\frac{Cost\ of\ Intervention 1 - Cost\ of\ Intervention 2}{Benefit\ of\ Intervention\ 1 - Benefit\ of\ Intervention 2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.1$$

Where intervention 1 is the novel intervention and intervention 2 is the standard of care or control.

The cost-effectiveness analysis (CEA) that incorporates both charges and outcomes is applied when the upshot are calculated in "natural units." As general outcome measures, 'being physically active' or 'life years gained', change in muscle strength or range of motion (Rome, 2014) can be selected as natural units deemed to have significant consequences for patients and health care. Cost-utility analysis (CUA) can be used to measure the efficacies of a particular programme or treatment by converting patient quality of life and survival to a common unit of measure (Drummond et al., 2005).

(Drummond et al., 2005) explained that the quality adjusted life year (QALY) is the utmost frequently used result unit in the CUA. Cost utility analysis is used to compare alternative interventions by reporting differences in clinical, resource utilisation, and financial outcomes (Fatoye, 2015). Cost minimization analysis (CMA) is utilised when it has been demonstrated that the outcomes of the alternative interventions being compared are identical or comparable (Haycox, 2009).

Drummond et al. (2005), stated that economic assessments of health care programmes categorize prices (costs) into three categories: direct, indirect, and intangible. Direct costs are the amount spent or saved on resources as a result of a programme (Rome, 2014). These include health care area capitals, also resources from other subdivisions, patient spendings, and helper time. Medical expenditures, such as those for experts practicing health care delivery, medicines, medical laboratory investigations, and/or facilities, are examples of health care costs (Rome, 2014). (Drummond et al., 2005) Indirect costs are the costs to the participants' (or relatives') time as a result of the programme. Indirect costs comprise costs associated with hours or days been absent from work, decreased output at work, and premature mortality (Rome, 2014). The final grouping of costs is intangible or imperceptible costs, which include the worth of an improved quality of life or health, that are not readily quantified in financial means (Rome, 2014).

2.9.1 Cost Benefit Analysis

In cost-benefit analysis (CBA), both prices and outcomes are quantified monetarily (Rome, 2014). CBA also allows for the comparison of health care sector benefits with those of other industries (Drummond et al., 2005). When comparing the cost and outcome of two or more programmes using monetary values, cost-benefit analysis (Zanke et al., 1997) enters into play. The objective of CBA is to support the decision-making process by providing pertinent information, and it is used in conjunction with other data to make allocation decisions for finite resources (Campbell and Brown, 2003). The response to the query of whether the benefits of a programme or intervention outweigh their costs. is resolved by conducting a CBA. Cost-benefit analysis requires the identification, measurement, and valuation of all relevant costs and benefits. Some disadvantages of CBA analysis include the difficulty in valuing certain benefits (and costs) such as time, lost wages, and pain and suffering (Campbell and Brown, 2003). Benefit-to-cost ratio or net benefits (benefits minus costs) are tabulated as the result of a cost-benefit analysis (Campbell and Brown, 2003).

In developing countries such as Nigeria, there are no national evidence-based guidelines or clinical and cost-effectiveness approaches for health care interventions in the management of overweight and obesity: hence the rationale for this study.

2.10 Summary of Literature on Economic Evaluations/effects of physical activity.

Internet search engines such as PubMed, Medline, and Hinari were utilised to locate literature pertinent to the primary purpose of the study. Economic evaluation, cost of care, physical activity, cost-effectiveness, and health economics were the main terms used. In Table 2.3, the available relevant studies are listed.

The studies were conducted between 2004 and 2012. All the studies were randomised controlled trials. The studies are community-based health care exploring the cost-effectiveness of pronounced PA programmes. Some of the studies had prescription exercise as a leisure activity only, telephone advice and face to face advice (Murphy et al., 2012; Elley et al., 2011; Isaacs et al.,2007; Dalziel et al., 2006; Elley et al.,2004). All the researches lasted for 12 months for CEA. Three of them evaluated CUA and presented as gradual cost-effectiveness ratios with costs / QALY (Murphy et al., 2012; Isaacs et al., 2007; Dalziel et al., 2006). None of these studies investigated the benefits or otherwise of participating in structured or unstructured PA in relation to biochemical indices of overweight and obese adults, thus the gaps observed from these studies. Although all these studies did economic evaluation, none of them compared directly the cost effectiveness or otherwise of engaging in structured and unstructured physical activities in relation to modifying health risk behaviours, hence the rational for this study.

Table 2.3: Summary of Literature on the economic benefit/effects of physical activity

Authors	Study Design	Criteria for participating in the study	Study duration	Regulator group	Analysis	Measures
Elley et al., (2004)	Cluster, RCT, Economic Perspective	Less active primary care participant (n=878),age =40-79 years	12 months	Normal care	CEA	Cost of moving to be more active
Dalziel et al., (2006)	Cluster RCT, Markov Model	Less active Primary care (n=878),age=40-79years	12 months	Traditional care	CUA	Rate per QALY
Isaacs et al.,(2007)	RCT: three armed societal costs	Not currently physically active persons with at least one cardiovascular risk factor (n=943)age=40-74years	10 weeks, 6 months, 12 months	Personalised advice and data on PA and grassroot exercise facilities	CUA	Fee per QALY
Elley et al., (2011)	RCT, societal cost	Less active women (n=1089)age=40-74 years	12 and 24 months	Common care	CEA	Price/ person that changed to been active and constant 1-12 moths 11-24 months
Murphy et al., 2012	Practical RCT, public sector outlook	Sedentary, at least one medical condition (CHD, depression, anxiety, stress) (n=2160) age=16-88 years	4 weeks telephone, 16 weeks consultation, 8 months telephone, 12 months review	Typical care, pamphlet on advantage of PA	CUA	7-day recall PA EGSD

Key: CEA - Cost-effectiveness analysis Care- Medications (drugs)
CUA - Cost-utility analysis
QALY - Quality-adjusted life years PA- Physical activity RCT- Randomized control trial

CHAPTER THREE

MATERIALS AND METHODS

3.1 Participants

Participants that took part in this research were recruited from the population of willing adults in Gwagwalada area council of the Federal Capital Territory (FCT), Abuja, Nigeria. The area council is one of the area councils of the FCT. It is mainly made up of civil servants and few individuals engaging in sundry business activities. Participants were recruited after they showed up following adverts of the study using fliers and radio announcements. They were aged from18 to 64 years. A total of 59 participants showed up, out of which only 54 met the inclusion criteria. They were randomly allocated to either of the two study groups: Structured physical activity group (SPAG, n=27) and Unstructured physical activity group (UPAG, n=27). However, only 49 participants completed the study (SPAG; n=25, UPAG; n=24), with a 9.25% (5 individuals) loss from completing the research, 49 (90.75%) finalised the study, as shown in figure 3.1.

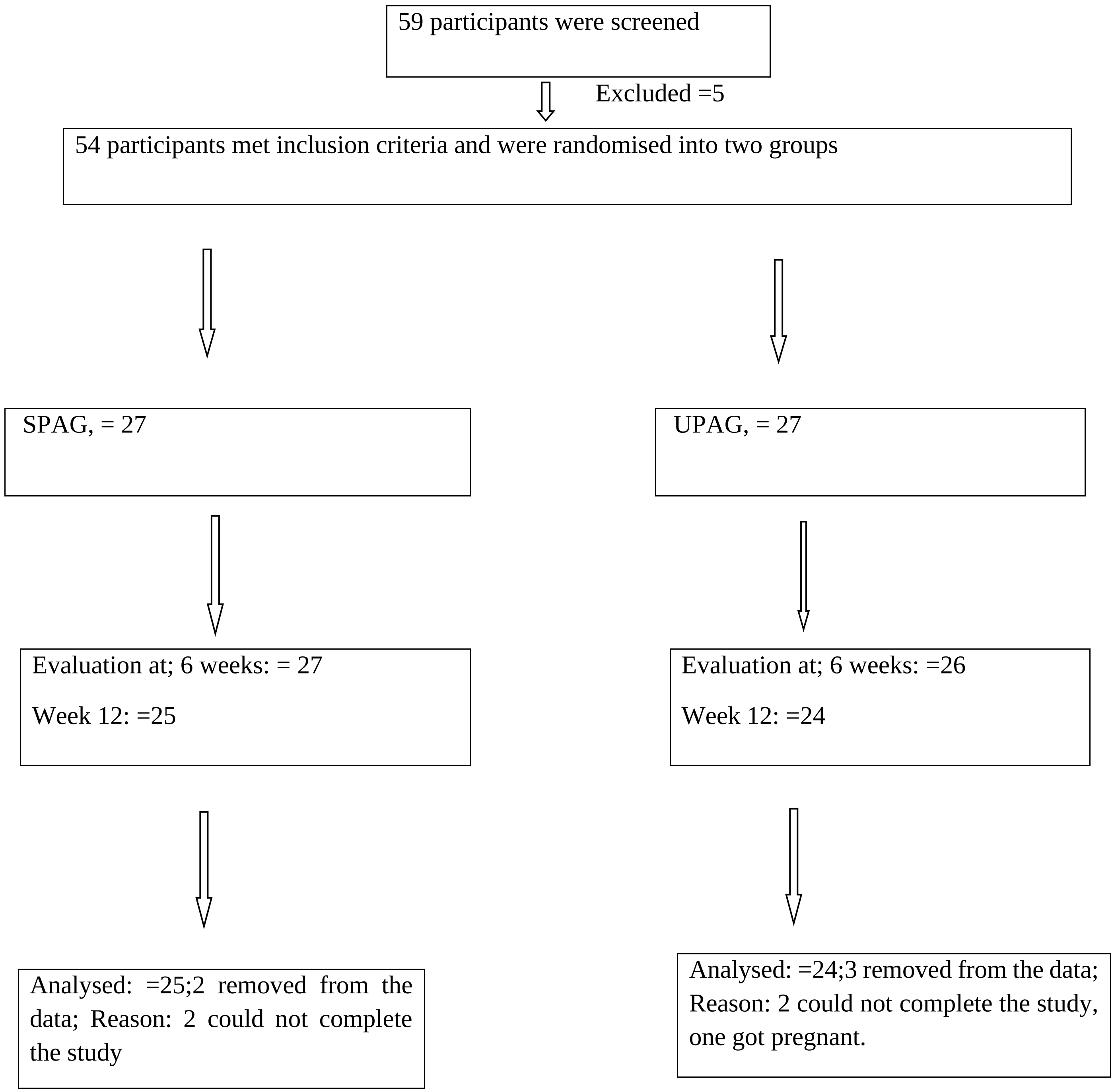

FIGURE 3.1: Flow chart showing the progression of the participants through the study

3.2 Inclusion Criterion

i. Only overweight and obese adults having a BMI of $\geq$25 kg/m^2 took part in this study.
ii. Male and female individuals with the age range of 18 and 64 years.
iii. Participants were literate in English.

3.3 Exclusion Criteria

Those that have been clinically diagnosed with one or more of the following conditions were exempted from this study; hypertension, diabetes, lower limb amputation, spinal cord injury and other obvious physical disabilities that could prevent them from participating in any physical activity.

3.4 Instruments

Instruments that were used for data collection include:

1. Stadiometer (Gulfex Medical and Scientific, England): this is a moveable instrument that was used to measure participants' height and weight in 0.1 centimetres and 1.0 kilograms respectively. The weighing scale component is calibrated from 0-240 kg while the height meter component is calibrated from 0-190 cm.
2. Mercury Sphygmomanometer (Zenith, India) and stethoscope (Lithman, Wenzhou): These were used to measure blood pressure.
3. Tape rule: An inextensible tape rule (butterfly brand made in China, Shanghai) was used to assess WC to the nearest centimetre.
4. Semi Auto-biochemical Analyser (AUDICOMAC9900, USA): It was used for the serum biochemical analysis of lipid profiles (HDL, LDL, Glycerides and total cholesterol), FBS, HbA1c and liver function tests (AST and ALT).
5. Cybex Treadmill (Model 750T, USA): This was used for the aerobic training intervention for the structured physical activity group. It has a heart rate sensor for both hands as well as a LCD screen that displays parameters such as time, speed, calories and distance covered. The speed of the treadmill can be adjusted

and it ranges from 0.5-15.6 mph (0.8-25 kph). It has a running area of 55 cm x 157 cm with a maximum user weight of 182 kg. It has an elevation range 3 to 15%. The use of a safety key feature ensures that the participants are safe from injury from the use of the treadmill. The safety key was attached to the clothing of the participants, and this will pull off and automatically shut down the treadmill if there is a fall or moving away from the running area by the participants.

6. LCD electronic digital pedometer (Model GE779SP1, Japan). It consists of a step counter ranging from 0-99999 steps, a calorie counter ranging from 0-9999.9 CAL and distance counter ranging from 0-999.99 km. This was used by participants in the structured and unstructured physical activity group to monitor the amount of walking steps done and estimate calories expended in a day.
7. Borg's Rating of Perceived Exertion (BRPE) Scale: The scale was used to monitor or prescribe levels of PA intensity (American College of Sports Medicine, 2006). According to ACSM (2006), how a person feels about exertion moderates his or her response to exercise and effort. The BRPE scale is shown in Appendix A. The BRPE consists of a category scale of 6-20. A score of 6 (no exertion at all) exhibit a heart rate in the vicinity of 60 beats per minute (ACSM, 2006).

   The BRPE was used to evaluate the intensity of the exercise program for the SPAG. Participants' level of exertion will determine the intensity of exercise.

8. Cost of Overweight/Obesity Questionnaire (Appendix B). This questionnaire was adapted and modified from a questionnaire that was used for a study on cost of Juvenile Idiopathic Arthritis (JIA) questionnaire (Ens et al.,2013) of the IWK health centre located in Halifax, Nova Scotia in Canada. It is a questionnaire that consists of twelve (12) sections and sixty (60) questions. It comprises of questions on costs of physiotherapy, cost for home adaptation/lifestyle modification, costs for appointments with the doctors/medical visits/admissions to medical facilities and loss of paid work hours as a result of obesity in monetary (Naira) value. The questionnaire was used to assess the cost-benefit analysis (direct cost) of the structured and unstructured physical activities which in turn

determined the cost of care. This was computed as net benefit in Naira. It was administered to those that took part in the study before commencement of this study and at weeks 6 and 12 of the study respectively.

9. Step count- inventory form. This was used by the participants in the structured and unstructured physical activity groups to take inventory of their step counts and calories expended per day as recorded from the pedometer (Appendix C).
10. Framingham Risk Score (FRS) questionnaire (Appendix D). The questionnaire is a self-report, specific to males or females set of rules that is used to determine possibility of developing CVD in 10 years by an individual (Chia et al., 2015). The minimum possible score is -4 for males and -5 for females, while the maximum possible score is 26 for males and females. The calculated scores indicate who is most likely to benefit from preventive measures against cardiovascular disease. The questionnaire has items such as age (years), HDL (mmol/L), TC (mmol/L), blood pressure, (mmHG), diabetes and smoking status. Chia et al. (2015), in their study to examine the validity of FRS, reported a moderate discrimination with an area under the receiver operating characteristic curve of 0.63. They concluded that the FRS predict fairly accurately for men and women and could be used in a diverse ethnic group in a grass root care setting. The FRS has been used in Nigeria by several researchers to predict the risk of developing cardiovascular diseases and it was recognised to be very consistent and valid (Dada et al., 2016, Osegbe et al., 2017, Adedoyin et al., 2018 and Amadi et al., 2019). The questionnaire was administered to both SPAG and UPAG at baseline and weeks 6 and 12 of the study respectively. The FRS assesses the risk factors of age, HDL, total cholesterol, blood pressure(systolic), diabetes and smoking. Scores are assigned to each of these risk factors ranging from -2 being the lowest possible score and 15 being the highest possible score. The risk scores are also varied for men and women. For the risk factor of age, the lowest risk score is 0 for both men and women, while the highest risk score is 15 and 12 respectively. For HDL, the lowest risk score is -2 for both men and women while the highest risk score is 2 for both males and females respectively. The risk factor for total cholesterol has a lowest score of 0 for both men and

women, with the highest score being 4 and 5 respectively for men and women. After the completion of the questionnaire by the participants, the total scores are summed up and tabulated as percentage from the risk score table to determine the participants' risk level for CVD which is rated as low (<10%), intermediate (10-19%) and high (>20%). The patient's Risk Level and scoring for the FRS are as shown in tables 3.1 and 3.2.

11. The Finnish Diabetes Risk score (FINDRISC). It is an 8 item self-report questionnaire (Appendix E) that assesses for the potential or risk of individual developing diabetes (Lindstrom and Toumilehto, 2003). The items include age (years), BMI (Kg/m^2), WC (cm), history of medications for high blood pressure, history of elevated glucose in the blood, a positive family history of diabetes, daily intake of fruits, or green vegetables (consume every day vs not), and daily PA (engaging in a minimum of 30 minutes of exercise when working at occupation or at recreation time vs not). The sensitivity, specificity, positive predictive value and negative predictive value are 52.94, 79.79, 32.1 and 90.4 respectively (Meseci et al., 2016). The FINDRISC has been used in several studies in Nigeria and it has been proven to be valid and reliable in predicting the risk of developing diabetes (Alebiosu et al., 2013). The questionnaire was administered to participants in the two groups of study at beginning of the study and at weeks 6 and 12 respectively. The lowest possible score assigned to age is 0, while the highest possible score assigned to age is 4. Family history of type-2 diabetes has scores ranging from 0-5. The scores assigned to waist circumference ranges from 0-4, while that of exercise ranges from 0-2. Dieting has a score which ranges from 0-2, while hypertension has a score which ranges from 0-2. History of blood glucose has a score ranging from 0-5 while BMI score ranges from 0-3. At the completion of the questionnaire, the total scores were summed up and the 10-year risk level of developing diabetes was then determined from the scoring and risk rating table. The minimum possible score is zero, while the maximum possible score is 27. The risk is rated as low (<7), mild (7-11), moderate (12-14), high (15-20) and very high (>20). The scoring for the FINDRISC questionnaire is shown in table 3.3.

12. Hypertension Risk Score questionnaire (HRS) (Appendix F). This self-report questionnaire was developed by Kshirsagar et al. (2010), to aid medical experts assess or predict the risk of developing hypertension in the future. It consists of a grading system that group individuals that are prone to come down with elevated blood pressure. The instrument assesses 8 identified risk factors which include age, sex, smoking, exercise (PA), a positive history of hypertension in the family, BMI, diabetes and blood pressure (systolic and diastolic). Arbitrary scores ranging from -3-14 are assigned to the items. The lowest possible score is -3, while the highest possible score 29. The HRS has been tested on black and white population and it has been found to be useful in predicting the risk of developing hypertension (Kshirsagar et al., 2010). The questionnaire was administered to participants in SPAG and UPAG at baseline and at weeks 6 and 12 of the study respectively. The scoring for the hypertension risk scores is as shown in table 3.4.

Table 3.1: 10- Year Patient's Risk level using the FRS

Patient's Risk Level

Risk Level	**10- Year CVD FRS Risk**
Low	<10%
Intermediate	10-19%
High	≥20%

Source: Chia et al. (2015)

Table 3.2: Scoring of the FRS Risk Questionnaire

Total Risk Points	Men	Women
≤3	<1.0%	<1.0%
-2	1.1%	<1.0%
-1	1.4%	1.0%
0	1.6%	1.2%
1	1.9%	1.5%
2	2.3%	1.7%
3	2.8%	2.0%
4	3.3%	2.4%
5	3.9%	2.8%
6	4.7%	3.3%
7	5.6%	3.9%
8	6.7%	4.5%
9	7.9%	5.3%
10	9.4%	6.3%
11	11.2%	7.3%
12	13.3%	8.6%
13	15.6%	10.0%
14	18.4%	11.7%
15	21.6%	13.7%
16	25.3%	15.9%
17	29.3%	18.5%
18	>30.0%	21.5%
19	>30.0%	24.8%
20	>30.0%	27.5%
≥21	>30.0%	>30.0%

Source: Chia et al. (2015)

Table 3.3: Scoring of the FINDRISC questionnaire

Total scores(points)	Risk rating	10-year risk
<7	Low	1% (1/100)
7-11	Mild	4% (1/25)
12-14	Moderate	16% (1/6)
15-20	High	33% (1/3)
>20	Very high	50% (1/2)

Source: Lindstrom and Toumilehto (2003)

Table 3.4: Scoring for the hypertension risk scores questionnaire

Total points	3-year risk %	6-year risk %	9-year risk %	Total points	3-year risk %	6-year risk %	9-year risk %
0	3.58	5.44	7.89	12	23.67	40.21	61.03
1	3.74	5.63	8.02	13	27.52	43.73	64.50
2	4.14	6.52	9.21	14	31.17	47.93	67.74
3	4.61	8.05	11.40	15	35.95	52.93	70.57
4	5.15	9.50	14.05	16	36.39	53.36	72.59
5	5.93	11.21	17.53	17	31.98	53.56	75.53
6	7.34	14.41	22.71	18	33.51	53.67	76.77
7	8.91	17.94	28.92	19	36.03	54.23	77.80
8	11.10	22.29	36.18	20	40.22	59.11	79.86
9	13.72	26.83	42.56	21	47.07	64.18	82.24
10	16.81	31.73	49.64	22	52.53	65.97	83.23
11	20.72	36.63	55.80	≥23	53.31	70.51	87.07

Source: Kshirsagar et al. (2010)

3.5 Venue

The study was done in the health promotion gymnasium of the Department of Physiotherapy, University of Abuja Teaching Hospital, Gwagwalada, Abuja.

3.6 Methods

3.6.1 Research Design

The Randomized Clinical Trial was used in this study.

3.6.2 Sample Size calculation

The least sample size was determined by using the formula (Noordzij, 2010):

$$n = 2 \times \frac{(Z\alpha + Z_\beta)^2 \times p\,(1-p)}{(d)} \quad \ldots\ldots 3.1$$

The sample size was calculated using the prevalence of overweight/ obesity reported by Chigbu et al. (2018), a standard normal deviate of 1.96 and a 95% Confidence Interval with the level of significance for α and β set at 0.05 and 0.20 respectively and a power of 80%.

Where:

n= Sample size

Zα = Z statistic for α with the conventional multiplier of 1.96

Z_β = Z statistic for β with the conventional multiplier of 0.84

p = prevalence of obesity in adult Nigerians (6.0% or 0.06) (Chigbu et al., 2018)

d = Desired level of precision (20% or 0.20)

$$n = 2 \times \frac{(1.96 + 0.84)^2 \times 0.06\,(1-0.06)}{(0.20)} = 22 \quad \ldots\ldots 3.2$$

Minimum sample size = 22 per group. 10% of the sample size was taken into consideration due to attrition. Therefore, the minimum sample size was 25 per group.

3.6.3 Sampling technique and assignment into groups

Fliers announcing the research was printed in English language and distributed in churches, mosques, market place etc, radio announcements were also done. Four research assistants (RA) who are physiotherapist were trained to carry out the sampling and assignment into groups. Purposive sampling technique was used to recruit overweight and obese participants. Eligible participants with overweight and obesity were randomly assigned (by means of table of random numbers) to one of these two groups:

1. SPAG.
2. UPAG.

A sample frame of participants was drawn, the starting point in the table of random numbers was chosen arbitrarily by blindly placing a pencil at a point in the table. Moving across the table from that point, the first two digits that are within the range of numbers in the frame was assigned to group 01, the next two digits moving across was assigned to group 02, the next two digits to group 01 and the next two digits to group 02. The process was continued until all the numbers in the frame were assigned into a group.

Assignment to both groups was done by the research assistants to blind the participants' selection from the researcher.

3.6.4 Procedure for Data Collection

Ethical approval was sought and obtained from the Ethics Review Research Committee of the University of Ibadan/University College Hospital, Ibadan (UI/EC/19/0613) (Appendix G) and the University of Abuja Teaching Hospital, Abuja (UATH/HREC/PR/2020/006) (Appendix H), before the commencement of the study. This study was also registered with Pan Africa Clinical Trial Registry PACTR 202010681941735.

The purpose and procedure of the study was explained to the prospective participants and their informed consent (Appendix I) was obtained prior to the commencement of the study. Willing participants were screened and those eligible were randomly assigned using table of random number into any of the two-study group. The structured group were engaged in aerobic training program using treadmill, flexibility exercise and resistance training, while the unstructured physical activity group were given pedometers to wear and taught how to use it and record the step count of walking engaged in unguided physical activity and also the calories burnt per day. The structured physical activity group were also given pedometers to wear and use also during the course of the intervention and outside the intervention to also monitor their steps and calories per day. The intervention was for a 12-

week period. The participant's phone numbers were taken and they were called from time to time and advised on healthy dieting and health education about regular participation in physical activities for health benefits.

The four Research Assistants (RAs) was trained to measure the participants' variables and also administer the research questionnaires to the participants. Recordings of participants' data were carried out by the RAs to ensure additional blinding of the researcher to the data.

Baseline measurement of the variables (Biochemical and anthropometric) from all participants was obtained before commencement of training (intervention). The Cost of Overweight/obesity Questionnaire was also administered to the participants. The FRS, FINDRISC and HRS to assess for CVD, diabetes and hypertension respectively were also administered to the participants of this study. Documentation of variables was also carried out at the ends of weeks 6 and 12 of the study using a data form (Appendix J). The participants were given some stipends as incentives to cover for their transport fare when they come for intervention and when data was to be collected. Participants were informed that they could withdraw from participation at any time at will.

3.6.5 Measurements

a. Height and weight to assess BMI

The participants wearing a light apparel top vest and a pair of shorts stood barefooted on the stadiometer with the knee joints straight and hand by the flanks of the body. Height was measured as distance between the apex of the head and the heels and documented to the near 1.0 centimetre. With participants looking straightforward and hands resting by the sides of the body, the researcher takes note and record the weight of the participant on the weighing scale and recorded it to the closest 1.0kg. Participants' weight and height were assessed prior to commencement of the research, at weeks 6 and at 12 of performing the activities. This was done for all the participants in both groups (National Institute for Care and Excellence [NICE], 2014).

BMI was determined from the formula; BMI = weight value ÷ (value of the height)^2

b. Waist Circumference

Waist circumferences were measured in duplicate with an inelastic measure to the nearest 1.0 centimetre (Taylor et al., 2000). With the participant standing straight and the hands raised, WC was measured at the least circumference between the iliac crest and the rib cage (Taylor et al., 2000). All these measurements were done with the participants wearing light clothe-a vest and a pair of shorts (Taylor et al., 2000). The measurement of WC was done and recorded for all participants in the two groups at pre, 6^{th} week and12^{th} week of the study, respectively.

c. Biochemical indices

The blood samples were obtained from the participants at the gymnasium of the Health Promotion Unit of the Department of Physiotherapy, University of Abuja Teaching Hospital, Abuja by a qualified and licensed Medical Laboratory Scientist under standard aseptic conditions. This was done prior to commencement of the intervention at weeks 6 and 12 of the study. The test was done for all the participants in both groups. The test was conducted in the Medical Laboratory Department of the University of Abuja Teaching Hospital, Abuja.

d. **Cost-Benefit Analysis (cost of care)**

This was assessed using the adapted and modified cost of overweight/obesity questionnaire. It was used in determining the economic cost of living with overweight and obesity for persons undertaking structured and unstructured physical activity programmes. The questionnaire is a 60- entry self- report questionnaire made up of 12 sections (sections A-L) that measure the monetary cost (in Naira) based on number of visits to the physiotherapists, family physicians, specialist doctors, emergency units. It also measures costs of transportation, hospital admissions and feeding including loss of paid work hours in monetary values within the study period. The total costs as a result of obesity and overweight expended in Naira will be summed and computed to determine the monetary gain after the intervention. The questionnaire was administered to both the structured and unstructured physical activity groups, respectively at pre study, 6th week and12th week period of the study, respectively.

e. **Disease risk scores**

The following disease risk scores were assessed;

i. Cardiovascular risk score- this was assessed using the Framingham Risk Score (FRS) questionnaire.

ii. Diabetes risk score- this was assessed using the Finnish Diabetes Risk Score (FINDRISC) questionnaire.

iii. Hypertension risk score- this was assessed using the Hypertension Risk Score questionnaire (HRS).

All the questionnaires were administered to the participants in both groups at pre, 6th week and12th week of the study. All the questionnaires are in English language and are self-report questionnaires.

f. **Measurement of blood pressure**

The participants' blood pressure was assessed as described by Pickering and Stevens (2013): They were asked to be seated comfortably in a chair with the elbow resting on a table any tight clothing around the arm was loosen or removed. The cuff of the sphygmomanometer was placed and secured round the superior arm. The diaphragm of the stethoscope was placed over the brachial artery and the pulse listened to. The cuff was inflated slowly and listens for when the pulse will disappear. This is a sign to stop inflating the cuff. The cuff was then deflated slowly while listening to the sound of the pulse and also observing the mercury indicator of the sphygmomanometer. The sphygmomanometer value was taken note of at the point when the pulse reappears- this is the systolic blood pressure. The cuff was further collapsed and the value on the sphygmomanometer indicator is also observed and recorded at the point in which the pulse disappears- this is the diastolic blood pressure. The blood pressure was recorded to the nearest mmHg (Pickering and Stevens, 2013). The blood pressure was measured for all the participants in both groups at beginning, weeks 6 and 12 of the research.

3.7 Intervention (Training Protocol)

There were two groups of physical activities; the SPAG and UPAG: the intervention for the two groups was for a period of 12-weeks. At the beginning and after the 12-weeks intervention period, participants were given some health education on physical activity, diet and other health promotion measures and were asked to continue their physical activities on their own. Each group differed from the other as described below;

3.7.1 Structured physical activity group

The intervention for the SPAG was based on the recommendation of WHO (2010) for PA for persons who are between the ages of 18 to 64 years. The WHO recommends 5 hours in a week of moderate intensity aerobic PA or 2,5 hours of vigorous-intensity aerobic PA every week or an equal blend of moderate vigorous intensity activity. Borg's rate of perceived exertion (BRPE) was the instrument that was utilized to determine the intensity of the physical activity.

3.7.1.1 Warm up:

The intervention consists of 5 minutes warm up flexibility exercises. The flexibility exercises comprise neck stretches (10 repetitions), upper limb stretches (10 repetitions) and lower limb stretches (10 repetitions).

3.7.1.2 Aerobic exercise:

After the warm up, the participant was placed on a treadmill program, the Healthy Living and Obesity Research Group's (HALO) protocol (4-minute stages) was adopted for this study as described by Breithaupt et al. (2012).The speed was increased after every four minutes and also inclined based on the protocol as shown in Table 3.5.The participant continued the workout on the treadmill until a stage is reached in which the participant describes the exercise as "very hard" and they can no longer continue with the workout (scale of sixteen to seventeen on the BRPE (ACSM, 2006). This stage has been found to correspond to 70-85% of the maximal heart rate. The speed and duration of the workout were recorded. This was the baseline workout parameter. The aerobic workout was done 3 days in a week.

Progression of the activity was done based on the recommendation of the American College of Sports Medicine (ACSM). The ACSM recommended that progression is done by increasing the duration the activity is carried by 5 to 10 minutes every 1 to 2 weeks over the initial 4 to 6 weeks, and then by 15 minutes every 2 weeks over the next 6 weeks (ACSM, 2006).

Table 3.5: HALO Protocol, 4-minute stages

Stage:	Speed (MPH):	Elevation (%):
0	Self-paced	0
1	“	3.0
2	“	6
3	“	9
4	“	12
5	“	15
6	“	18

Source: Breithaupt et al. (2012)

3.7.1.3 Resistance exercise:

Participants also underwent resistance exercises using dumbbells for upper limbs exercises. The resistance exercise was aimed at increasing muscular endurance, strength, coordination, reduction in body fat and general fitness. The resistance exercise was undertaken by the participants as described by Thompson et al. (2010): using dumbbells, 1 repetition maximum (1RM) of each of the participants was determined. One RM is defined as the maximal resistance (weight) that can be moved through the complete range of a movement for a sole replication in a controlled style with proper stance (Thompson et al., 2010). When the 1RM was determined, a load (weight) of 45%-50% of the 1RM was recommended by Kraemer and Ratamess (2004). All exercise sessions were performed at alternate days thrice/week. The dumbbell exercises consist of movements which drilled the bulky muscle groups in the higher body. The exercises are shoulder press, standing pull, side lateral raise, up right rowing, side bend. The dumbbell exercise build-up the chest, shoulders, biceps, triceps, back, thighs, and abdominals. Participants did a performance of 10 repetitions in 3 sets of each exercise, with half a minute break between the activity (Kraemer and Ratamess, 2004). Participants gripped the dumbbell bars strongly, and elevated and let down the weights slowly in a continuous motion. If participants became exhausted during the workout, they perform a stretch workout until they gained back their strength. Progression was done once the participants could comfortably achieve the upper limit of the prescribed repetition range by increasing the load by 5% (Thompson et al., 2010).

3.7.1.4 Cool down:

The intervention also included a cool down period of 5-10 minutes which comprised flexibility exercise. The flexibility exercise included stretches of all the major muscles of the neck, upper and lower limbs (10 repetitions of each of the exercise). The cool down also included breathing exercises.

The 12-week training program for the structured physical activity group include three training sessions per week (Mondays, Wednesdays, Fridays or Tuesdays, Thursdays and Saturdays respectively) on the treadmill in the gymnasium of the Department of Physiotherapy, University of Abuja Teaching Hospital, Abuja. Participants in the structured physical activity group were also given pedometers to wear to determine the sum of steps walked and calories expended daily.

3.7.2 Unstructured physical activity group

The participants for the UPAG were given a pedometer each. Participants were taught how to wear the pedometer. They were instructed to position the pedometer on their waist band midline of the thigh (for men, on their belts or trouser, while for the women on their skirt or trouser as the case might be) (Le- Masurier et al., 2013; Tudor- Locke et al., 2008; Tudor-Locke and Bassett, 2004). They were taught how to take readings from the pedometer and then record readings on the step count inventory form that was given to them. The guidelines and use of the pedometer was observed based on the previous descriptions and guidelines (Le- Masurier et al., 2013; Tudor- Locke et al., 2008; Tudor-Locke and Bassett, 2004) which stipulate that an activity of walking with step count of not less than 10000 steps per day five times a week. The participants were also taught some flexibility exercises to be done by them in their various homes. They continued on this activity on their own pace at an intensity that was determined by them. The activity was also for 12-weeks. The step count inventory form was collected from them by the researcher at the end of each week.

Plate 3.1: Some participants in the SPAG undergoing warm up flexibility exercises

Plate 3.2: Participants in the SPAG doing stretches before the aerobics exercise

Plate 3.3: A male participant in the SPAG undergoing aerobic exercise on the treadmill

Plate 3.4: A female participant in the SPAG undergoing aerobic exercise on the treadmill

3.8 Data Analyses

Obtained data was cleaned and entered into and analysed using SPSS version 21. Data analysis was done as itemized below:

i. Socio demographic data were presented in the form of frequency tables.
ii. Descriptive statistics was used to present pre-test and after-test measurement, by displaying the values as mean, standard deviation and histograms.
iii. Repeated measures (Within-subjects) ANOVA was used to compare the values at the reference point, weeks 6 and 12 intervention results of the clinical characteristics, the cost of care, biochemical indices and disease risk scores (FRS, FINDRISC and HRS scores) of the participants in both groups. Least significant difference (LSD) post-hoc multiple comparisons was used to additionally test for any significant difference found in the ANOVA F-ratios.
iv. Paired sample t-test was used to determine the difference in HbA1c of the participants in both groups at base line and 12th week of the study.
v. Independent Student’s t- test was used to analyse the difference in the clinical characteristics, the cost of care, biochemical indices and disease risk scores (FRS, FINDRISC and HRS scores) of the participants between the structured and unstructured physical activity groups.
vi. Level of alpha was set at 0.05.

CHAPTER FOUR

RESULTS

4.1 Socio-demographics characteristics of participants

Fifty-nine participants showed up for the study out of which only 54 met the inclusion criteria. They were randomly allocated to the two study groups: SPAG, n=27 and UPAG, n=27). However, 49 participants completed the study (SPAG; n=25; UPAG; n=24). A 9.25% (5 participants) drop-out from the study was noted as only 49 (90.75%) completed the study. Socio-demographic characteristics of the participants are presented in Table 4.1. In the SPAG, 14 (56.00%) participants and 18 (75.00%) participants in the UPAG were married. Figure 4.1 shows that 32.00% and 29.20% of participants were aged 30-39 years among the SPAG and UPAG respectively. Half of the participants in the UPAG (12) compared to 48.00% in the SPAG were 40-49 years old, while 20.00% and 20.80% were aged 50-59% in the SPAG and UPAG respectively. Mean age was 43.48±6.85 and 44.88±7.54 (range 31-55) years in the SPAG and UPAG, respectively. There were more females 15 (60.00%) and 14 (58.30%) than males in the SPAG and UPAG, respectively. The majority of the participants, 24 (96.00%) in the SPAG and 21 (87.50%) participants in UPAG had tertiary education. The majority (64.00%) participants and 13 (54.20%) in the SPAG and UPAG, respectively were employed.

Table 4.1 Socio-demographics characteristics of participants

Socio-demographics	SPAG		UPAG	
	N	%	N	%
Sex				
Male	10	40.00	10	41.70
Female	15	60.00	14	58.30
Civil status				
Married	14	56.00	18	75.00
Single	11	44.00	4	16.70
Divorced	0	0.00	1	4.20
Widowed	0	0.00	1	4.20
Education level				
Secondary	1	4.00	2	8.30
Tertiary	24	96.00	21	87.50
No education	0	0.00	1	4.20
Occupation				
Employed	16	64.00	13	54.20
Unemployed	2	8.00	0	0.00
Student	1	4.00	1	4.20
Self employed	6	24.00	10	41.70
Mean Age (years) ±SD	43.48 ± 6.85		44.88± 7.54	
Range (years) 31-55				
Overweight	13		12	
Obese	12		12	

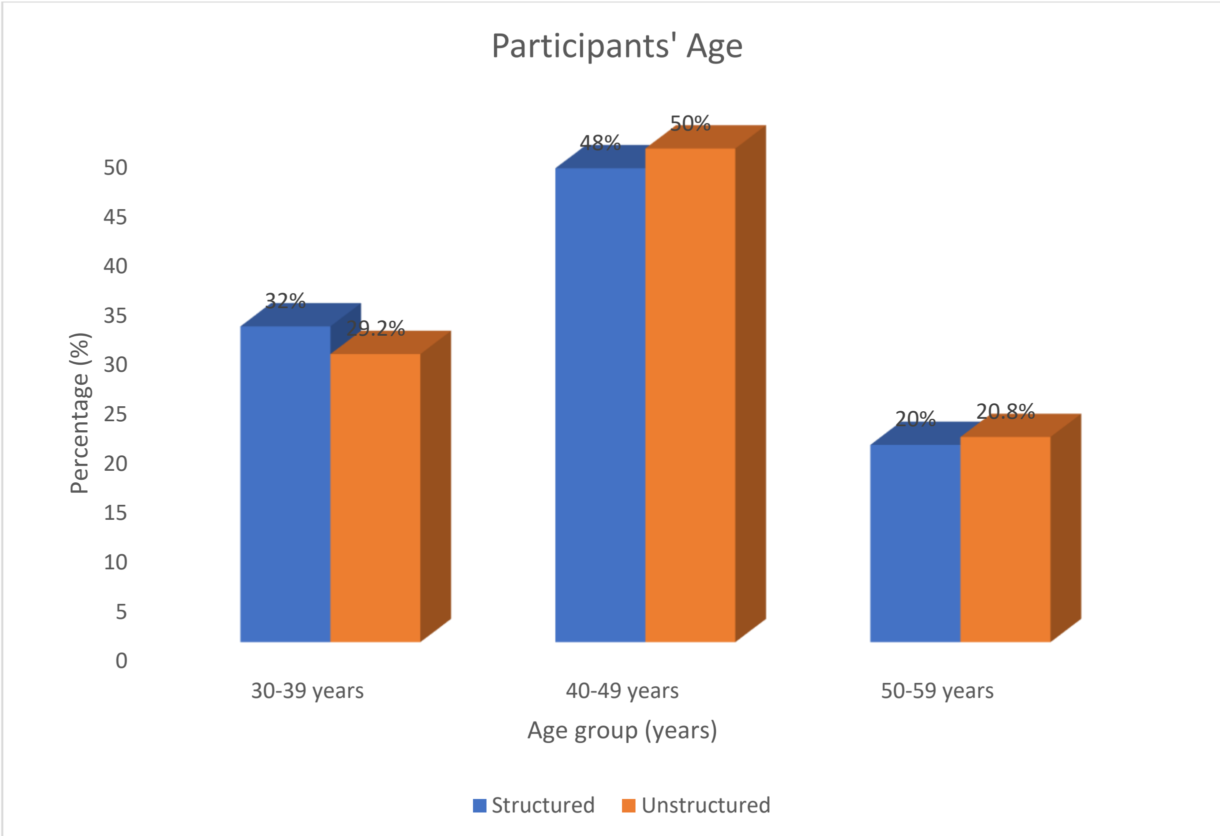

Figure 4.1: Age group distribution of participants

4.2 Comparisons of the Clinical characteristics of the participants in the structured physical activity group across the study period

The clinical characteristics of the participants in the SPAG are presented in Table 4.2. Results showed that the mean systolic blood pressure (SBP) at baseline was 123.60 mmHg ± 7.43SD, 118.76 mmHg ± 3.53 SD at the 6^{th} week and 117.0 mmHg ± 3.93 SD at the 12^{th} week of study, respectively, while the mean diastolic blood pressure (DBP) at baseline was 86.40 mmHg ± 9.19 SD, 78.40 mmHg ± 7.74 SD at the 6^{th} week and 74.80 mmHg ± 5.68 SD at the 12^{th} week, respectively. The mean BMI of the participants was 33.92 kg/m^2 ± 1.59 SD and 30.09 kg/m^2 ± 3.07 SD at reference line and week 12 of the study, respectively. It was seen that there was significant difference in SBP ($F= 10.541$, $p< 0.00$), DBP ($F= 14.980$, $p<0.00$), weight (mean =92.36 kg ± 6.72 SD, $F= 8.256$, $p= 0.00$), BMI (mean= 33.92 kg/m^2 ± 1.59 SD, $F= 13.146$, $p< 0.00$), waist circumference (mean= 102.08 cm ± 6.10 SD, $F=8.872$, $p< 0.00$) of the SPAG across the study period.

4.3 Comparison of Clinical characteristics of the participants in the unstructured physical activity group across the study period

Table 4.3 showed the clinical characteristics of those in the UPAG. The mean SBP at baseline, 6^{th} week and 12^{th} week were 122.71 mmHg ±7.22 SD, 118.96 mmHg ± 4.66 SD and 117.08 mmHg ± 4.64 SD, respectively, while the mean DBP at baseline, 6^{th} week and 12^{th} week were 85.21 mmHg ± 7.44 SD, 80.21 mmHg ± 9.03SD and 75.42 mmHg ± 7.21 SD, respectively. The average weight of the participants was 92.54 kg ± 7.07 SD and 86.25 kg ± 5.71 SD at baseline and at week 12 of the study respectively. Their mean waist circumference was 103.33cm ± 4.64 SD and 97.17 cm ± 5.71 SD at baseline and at the12^{th} week of the study respectively. There was a significant difference in weight (mean=92.54 kg ±7.07 SD, $F= 4.704$, $p= 0.01$), BMI (mean=32.53 kg/m^2± 3.01 SD, $F= 3.455$, $p= 0.04$), waist circumference (mean=103.33 cm ± 4.64 SD, $F=8.894$, $p< 0.00$) of the UPAG across the study period.

Table 4.2: Within-group comparison of blood pressure and BMI of the SPAG across different study periods

Clinical characteristics	Baseline		6 Weeks		12 Weeks			
	Mean	SD	Mean	SD	Mean	SD	F	p-value
SBP (mmHg)	123.60*	7.43	$118.76^{\#}$	3.53	$117.00^{\$}$	3.93	10.541	<0.00
DBP (mmHg)	86.40*	9.19	$78.40^{\#}$	7.74	$74.80^{\$}$	5.68	14.980	<0.00
BMI (kg/m^2)	33.92*	1.59	$31.87^{\#}$	3.00	$30.09^{\$}$	3.07	13.146	<0.00
Waist Circumference(cm)	102.08*	6.10	$99.72^{\#}$	6.02	$94.88^{\$}$	6.35	8.872	<0.00

F- ANOVA statistic, Alpha level = 0.05

"Post hoc." superscripts (*, #, $) for a specific result: Mean values having different superscript are significantly different; Mean values having no superscript are not significantly different.

Table 4.3: Within-group comparison of blood pressure and BMI of the UPAG across different study periods

Clinical characteristics	Baseline		Week 6		Week 12			
	Mean	SD	Mean	SD	Mean	SD	F	p-value
SBP (mmHg)	122.71*	7.22	118.96$^{\#}$	4.66	117.08$^{\$}$	4.64	6.192	0.00
DBP (mmHg)	85.21*	7.44	80.21$^{\#}$	9.03	75.42$^{\$}$	7.21	9.139	<0.00
BMI (kg/m2)	32.53*	3.01	31.88$^{\#}$	2.96	30.31$^{\$}$	3.06	3.455	0.04
WC (cm)	103.33*	4.64	101.42$^{\#}$	5.15	97.17$^{\$}$	5.71	8.894	<0.00

SD- Standard deviation, F- ANOVA statistic**,** Alpha level = 0.05

"Post hoc." superscripts (*, #, $) for a specific result: Mean values having different superscript are significantly different; Mean values having no superscript are not significantly different.

4.4 Comparison of baseline, weeks 6 and 12 cost of care following structured physical activity

Table 4.4 showed comparison cost of care among the SPAG across the research period. There was significant difference in the cost of care across the study period among the participants in the SPAG (F=15.138, p= 0.00). It was observed that health care cost was significantly reduced at week 6 compared to when the study was commenced, week 12 compared to week 6 and week 12 compared to when the study commenced.

4.5 Comparison of baseline, weeks 6 and 12 serum Total cholesterol following structured physical activity

It was observed in table 4.4 below that TC was significantly different across the study period among participants in the SPAG (F=3.744, p=0.03). Serum TC was significantly reduced at week 6 compared to when the study was commenced, week 12 compared to week 6 and week 12 compared to when the study commenced.

4.6 Comparison of baseline, weeks 6 and 12 and serum High Density Lipoprotein following structured physical activity

Table 4.4 showed comparison of serum HDL among the SPAG during the study period. There was significant difference in serum HDL in the study period among participants in the SPAG (F=1.068, p=0.03). It was observed that serum HDL was significantly amplified at week 6 compared to when the study was commenced, week 12 compared to week 6 and week 12 compared to when the study commenced.

4.7 Comparison of baseline, weeks 6 and 12 serum Low Density Lipoprotein following structured physical activity

Table 4.4 showed comparison of serum LDL among the SPAG in the study period. Following structured PA, there was significant difference in serum LDL in the study period among participants in the SPAG (F=3.167, p=0.04). It was observed that serum LDL was significantly decreased at week 6 compared to when the study was commenced, week 12 compared to week 6 and week 12 compared to when the study commenced.

4.8 Comparison of baseline, weeks 6 and 12 serum Triglycerides following structured physical activity

Results in Table 4.4 showed comparison of serum TG for the three study periods among the SPAG. It was shown that serum TG was significantly different across the study period among the participants in the SPAG (F=2.860, p=0.04). Serum TG was significantly decreased at week 6 compared to when the study was commenced, week 12 compared to week 6 and week 12 compared to when the study commenced.

4.9 Comparison of baseline, weeks 6 and 12 and serum fasting blood glucose following structured physical activity

Table 4.4 showed comparison of serum FBG among the SPAG in the study period. Following structured PA, there was significant difference in serum FBG across the study period (F=27.867, p=0.00). It was observed that serum FBG was significantly decreased at week 6 compared to when the study was commenced, week 12 compared to week 6 and week 12 compared to when the study commenced.

4.10 Comparison of baseline and 12th week HbA1c following structured physical activity

There was no significant difference in HbA1c in the baseline and 12th week following structured PA (Table 4.5). From the results, it was seen that there was no significant reduction of HbA1c at baseline (4.69%) compared with that of the 12th week (4.65%).

Table 4.4: Within-group comparison of cost of care, TC, HDL, LDL, TG and FBG of the SPAG across different study periods

	Baseline		Week 6		Week 12			
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**F**	**p-value**
Cost of care (₦)	135200.00*	50372.48	101984.00#	41809.64	66822.00$	38822.65	15.138	0.00
TC (Mmol/L)	5.11*	1.15	4.65#	0.92	4.38$	0.75	3.744	0.03
Serum HDL (Mmol/L)	1.13*	0.31	1.23#	0.28	1.24$	0.29	1.068	0.03
Serum LDL (Mmol/L)	4.28*	1.35	3.97#	1.00	3.50$	0.90	3.167	0.04
Serum TG (Mmol/L)	1.54*	0.59	1.34#	0.35	1.27$	0.26	2.860	0.04
Serum FBG (Mmol/L)	6.80*	0.87	5.94#	0.47	5.55$	0.37	27.867	0.00

SD- Standard deviation, F- ANOVA statistic**,** Alpha level = 0.05

"Post hoc." superscripts (*, #, $) for a specific result: Mean values having different superscript are significantly different; Mean values having no superscript are not significantly different.

Table 4.5: Within-group comparison of HbA1c of the SPAG across different study period

HbA1c (%)		Mean	SD	T	Df	p-value
Pair 1	Baseline	4.69	0.62	1.207	24	0.24
	12 WEEKS	4.65	0.01			

Alpha level was set at 0.05

4.11 Comparison of baseline, weeks 6 and 12 serum AST following structured physical activity

Table 4.6 showed comparison of serum AST among the SPAG in the study period. Following structured PA, there was momentous difference in serum AST across the study period (F=7.976, p=0.00). It was observed that serum AST was significantly decreased at week 6 compared to when the study was commenced, week 12 compared to week 6 and week 12 compared to when the study commenced.

4.12 Comparison of baseline, weeks 6 and 12 serum ALT following structured physical activity

There were no significant changes in serum ALT in the baseline, 6th week and 12th week following structured PA (Table 4.6). At the baseline serum ALT was 8.00 Iu/L, at 6th week, it was 7.92 Iu/L and at 12th week, it was found to be 7.96 Iu/L.

4.13 Comparison of baseline, weeks 6 and 12 cardiovascular disease risk score following structured physical activity

Table 4.6 showed comparison of cardiovascular disease risk score among the SPAG across the study period (F=3.374, p=0.04). Following structured PA, average cardiovascular disease risk score was reduced at week 6 when compared with the baseline values, week, 12 when compared with week 6 values, and week 12 compared to the values at the commencement of the study.

4.14 Comparison of baseline, weeks 6 and 12 diabetes risk score following structured physical activity

Table 4.6 showed comparison of diabetes risk score among structured group across the study period. Following structured PA, average diabetes risk score was significantly different across the study period (F=32.179, p=0.00). There was a reduction of risks in week 6 compared to when the study commenced, week 12 compared to week 6 and week 12 compared to when the study commenced.

4.15 Comparison of baseline, weeks 6 and 12 hypertension risk score following structured physical activity

Table 4.6 showed comparison of hypertensive risk score among the SPAG across the study period. Following structured PA, average hypertensive risk score was significantly different across the study period (F=25.076, p=0.00). A reduction in the risk of developing hypertension was observed in week 6 compared to when the study was commenced, week 12 compared to week 6 and week 12 compared to when the study commenced.

4.16 Comparison of baseline, weeks 6 and 12 cost of care following unstructured physical activity

Table 4.7 showed comparison of cost of care following unstructured PA across the study period. It was shown that cost of care was not significantly different in the study period. At the baseline, the cost of care was found to be ₦179,266.67, after the 6^{th} week of the study, it reduced slightly to ₦173,333.33 and it was found to be ₦135,712.50 by the 12^{th} week.

4.17 Comparison of baseline, weeks 6 and 12 serum Total Cholesterol following unstructured physical activity

Table 4.7 showed comparison of serum TC following unstructured PA across study period. It was shown that serum TC was no meaningful change across the study period. The result revealed that at the baseline serum TC was found to be 5.05 Mmol/L, 6^{th} week was 5.04 Mmol/L and that of the 12^{th} week was reduced slightly to 4.66 Mmol/L. All these were insignificant.

4.18 Comparison of baseline, weeks 6 and 12 serum High Density Lipoprotein following unstructured physical activity

Table 4.7 showed comparison of serum HDL following unstructured PA across study period. It was shown that there was significant change in serum HDL across the study period (F=1.739, p=0.00). There was an increase in serum HDL in weeks 6 and 12 of the study in the UPAG.

4.19 Comparison of baseline, weeks 6 and 12 serum Low Density Lipoprotein following unstructured physical activity

Table 4.7 showed comparison of serum LDL following unstructured PA across the study period. It was shown that there was significant difference in serum LDL at week 6 compared to baseline (F=0.8, p=0.04). There was a reduction in serum LDL in weeks 6 and 12 the of the study.

4.20 Comparison of baseline, weeks 6 and 12 serum Triglycerides following unstructured physical activity

Table 4.7 showed comparison of serum TG following unstructured PA across study period. It was shown that serum TG was significantly different at week 6 compared to when the study was commenced, week 12 compared to week 6 and week 12 compared to when the study commenced.

(F=1.421, p=0.03). There was reduction in serum TG across the study period.

4.21 Comparison of pre-commencement of the study, weeks 6 and 12 serum fasting blood glucose following unstructured physical activity

Table 4.7 showed comparison of serum FBG following unstructured PA across the study period. It was shown that serum FBG was pointedly different across the study period (F=31.663, p=0.00). There was a reduction of serum FBG of the participants in the UPAG in weeks 6 and 12 respectively.

4.22 Comparison of baseline, weeks 6 and 12 HbA1c following unstructured physical activity

Table 4.8 showed comparison of HbA1c following unstructured PA across the study period. It was shown that HbA1c was significantly different in week 12 compared to when the study was commenced (t= 4.566, p= 0.00).

Table 4.6: Within-group comparison of AST, ALT, Cardiovascular disease risk score, Diabetes risk scores and Hypertension risk scores of the SPAG across different study periods

	Baseline		6 Weeks		12 Weeks			
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**F**	**p-value**
Serum AST (IU/L)	11.04*	1.34	$10.04^{\#}$	1.10	$9.84^{\$}$	0.94	7.976	0.00
Serum ALT(IU/L)	8.00	2.12	7.92	1.50	7.96	1.27	0.014	0.99
Cardiovascular disease risk score(points)	8.12*	3.95	$6.24^{\#}$	3.50	$5.48^{\$}$	3.63	3.374	0.04
Diabetes risk score(points)	13.16*	2.34	$8.64^{\#}$	2.46	$7.88^{\$}$	2.73	32.179	0.00
Hypertension risk score(points)	12.20*	3.30	$8.84^{\#}$	1.80	$7.16^{\$}$	2.36	25.076	0.00

SD- Standard deviation, F- ANOVA statistic, Alpha level = 0.05

"Post hoc." superscripts (*, #, $) for a specific result: Mean values having different superscript are significantly different; Mean values having no superscript are not significantly different.

Table 4.7: Within-group comparison of cost of care, TC, HDL, LDL, TG and FBG of the UPAG across different study periods

	Baseline		6 Weeks		12 Weeks			
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**F**	**p-value**
Cost of care (₦)	179266.67	89998.47	173333.33	87213.77	135712.50	75752.39	1.873	0.16
Serum TC (Mmol/L)	5.05	1.13	5.04	0.97	4.66	0.60	1.341	0.27
Serum HDL (Mmol/L)	1.23*	0.35	$1.31^{\#}$	0.34	$1.41^{\$}$	0.28	1.739	0.00
Serum LDL (Mmol/L)	3.74*	1.33	$3.49^{\#}$	1.12	$3.34^{\$}$	0.84	0.8	0.04
Serum TG (Mmol/L)	1.54*	0.50	$1.42^{\#}$	0.35	$1.36^{\$}$	0.21	1.421	0.03
Serum FBG (Mmol/L)	6.60*	0.55	$6.00^{\#}$	0.34	$5.67^{\$}$	0.28	31.663	0.00

SD- Standard deviation, F- ANOVA statistic**,** Alpha level was set at 0.05

"Post hoc." superscripts (*, #, $) for a specific result: Mean values having different superscript are significantly different; Mean values having no superscript are not significantly different.

Table 4.8: Within-group comparison of HbA1c of the UPAG across different study period

HbA1c (%)		Mean	SD	T	Df	p-value
Pair 1	Baseline	4.96	0.64	4.566	23	0.00*
	12 WEEKS	4.63	0.01			

*-Significant, SD- Standard deviation, DF= Degree of Freedom, t= Student t statistic**,**
Alpha level was set at 0.05

4.23 Comparison of baseline, weeks 6 and 12 serum AST following unstructured physical activity

Table 4.9 showed comparison of serum AST following unstructured PA across the study period. It was shown that serum AST was significantly different at week 6 compared to when the study was commenced, week 12 compared to week 6 and week 12 compared to when the study commenced (F=2.124, p=0.01).

4.24 Comparison of baseline, weeks 6 and 12 serum ALT following unstructured physical activity

Table 4.9 showed comparison of serum ALT following unstructured PA across study period. It was noted that there was no significant change in serum ALT across the study periods.

4.25 Comparison of baseline, weeks 6 and 12 cardiovascular disease risk score following unstructured physical activity

Table 4.9 showed comparison of cardiovascular disease risk score following unstructured PA across the study period. It was shown that the average cardiovascular disease risk score was significantly different at week 6 compared to when the study was commenced, week 12 compared to week 6 and week 12 compared to when the study commenced (F=3.007, p=0.04).

4.26 Comparison of baseline values, weeks 6 and 12 diabetes risk score following unstructured physical activity

Table 4.9 showed comparison of diabetes risk score following unstructured PA across the study period. It was shown that the average diabetes risk score was pointedly changed across the study period (F= 27.656, p= 0.00). The mean diabetes risk score was reduced at week 6 compared to when the study was commenced, week 12 compared to week 6 and week 12 compared to when the study commenced.

4.27 Comparison of baseline, weeks 6 and 12 hypertension risk score following unstructured physical activity

Table 4.9 showed comparison of hypertension risk score following unstructured PA across the study period. It was observed that average hypertension risk score was significantly reduced across the study period (F= 25.430, p= 0.00).

4.28 Comparison of cost of care at the 12th week between structured and unstructured physical activity groups

Table 4.10 showed comparison of the 12th week cost of care between structured and unstructured PA. It was shown that average cost of care was meaningfully reduced in SPAG than UPAG (t= 3.981, p= 0.00).

4.29 Comparison of serum total cholesterol at the 12th week between structured and unstructured physical activity groups

Table 4.10 showed comparison of the 12th week serum TC between structured and unstructured PA. It was observed that no significant change was seen in serum TC in both study groups. The result revealed that a comparison of the 12th week serum TC in both groups, SPAG had 4.38 Mmol/L whereas UPAG had 4.66 Mmol/L. This was insignificant.

4.30 Comparison of serum high density lipoprotein at the 12th week between structured and unstructured physical activity groups

Table 4.10 showed comparison of the 12th week serum HDL between structured and unstructured PA. Results showed that there was a significant change in serum HDL in the SPAG and UPAG (t= 2.035, p= 0.04). SPAG had a lower HDL (1.24 Mmol/L) compared to the UPAG that their HDL was higher (1.41 Mmol/L).

Table 4.9: Within-group comparison of AST, ALT, Cardiovascular disease risk score, Diabetes risk scores and Hypertension risk scores of the UPAG across different study periods

	Baseline		6 Weeks		12 Weeks			
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**F**	**p-valu**
Serum AST (IU/L)	11.46*	1.62	$11.04^{\#}$	1.27	$10.67^{\$}$	1.05	2.124	0.01
Serum ALT (IU/L)	7.75	2.19	7.75	2.01	8.21	1.25	0.485	0.62
Cardiovascular disease risk score (points)	8.04*	3.91	$6.71^{\#}$	3.39	$5.54^{\$}$	3.27	3.007	0.04
Diabetes risk score (points)	14.00*	2.21	$9.67^{\#}$	2.48	$9.00^{\$}$	2.86	27.656	0.00
Hypertension risk score (points)	12.08*	3.09	$8.63^{\#}$	1.86	$7.33^{\$}$	2.01	25.43	0.00

SD- Standard deviation, F- ANOVA statistic**,** Alpha level = 0.05

"Post hoc." superscripts (*, #, $) for a specific result: Mean values having different superscript are significantly different; Mean values having no superscript are not significantly different.

Table 4.10: Between-group comparison of Cost of care, TC and HDL among the SPAG and UPAG

Physical Activity	**Mean**	**SD**	**T**	**Df**	**p-value**
Structured[1]	₦66822.00	38822.65	3.981	47	0.00*
Unstructured[1]	₦135712.50	75752.39			
Unstructured[2]	4.66Mmol/L	0.60	1.448	47	0.15
Structured[2]	4.38Mmol/L	0.75			
Unstructured[3]	1.41Mmol/L	0.28	2.035	47	0.04*
Structured[3]	1.24Mmol/L	0.29			

*-Significant, SD- Standard deviation, DF= Degree of Freedom, t= Student t statistic**,** Alpha level was set at 0.05

Key:1- cost of care

2-TC

3- HDL

4.31 Comparison of serum low density lipoprotein at the 12th week between structured and unstructured physical activity groups

Table 4.11 showed comparison of 12th week serum LDL between structured and unstructured PA. It was observed that serum LDL was not remarkably different between the study groups. The SPAG had a serum value of 3.50 Mmol/L compared to UPAG who had 3.34 Mmol/L.

4.32 Comparison of serum triglycerides at the 12th week between structured and unstructured physical activity groups

Table 4.11 showed comparison of the 12th week serum TG between structured and unstructured PA. It was noticed that there was no significant difference in serum TG between the SPAG (1.27 Mmol/L) and the UPAG (1.36 Mmol/L).

4.33 Comparison of serum fasting blood glucose at the 12th week between Structured and unstructured physical activity groups

Table 4.11 showed comparison of the 12thweek serum FBG between structured and unstructured PA. It was observed that there was no significant difference in serum FBG in the study groups although UPAG had a slight increase (7.85 Mmol/L) than the SPAG (5.55 Mmol/L). This result was found to be insignificant.

4.34 Comparison of serum HbA1c at the 12th week between structured and unstructured physical activity groups

Table 4.11 showed comparison of the 12th week serum HbA1c between structured and unstructured PA where it was observed that serum HbA1c was not significantly different between the SPAG (4.65%) and the UPAG (4.63%) at the 12th week of the study.

Table 4.11: Between-group comparison of LDL, TG, FBG and HbA1c among the SPAG and UPAG

Physical Activity	Mean	SD	T	Df	p-value
Unstructured[4]	3.34 Mmol/L	0.84	-0.659	47	0.51
Structured[4]	3.50 Mmol/L	0.90			
Unstructured[5]	1.36Mmol/L	0.21	1.309	47	0.20
Structured[5]	1.27Mmol/L	0.26			
Unstructured[6]	7.85Mmol/L	10.69	1.075	47	0.29
Structured[6]	5.55Mmol/L	0.37			
Unstructured[7]	4.63%	0.52	-0.17	47	0.87
Structured[7]	4.65%	0.59			

Alpha level was set at 0.05

Key:

4- LDL

5- TG

6- FBG

7- HbA1c

4.35 Comparison of serum AST at the 12^{th} week between structured and unstructured physical activity groups

Table 4.12 showed comparison of the 12^{th} week serum AST between structured and unstructured PA, where was shown that serum AST was significantly different in the SPAG compared to UPAG (t= 2.902, p= 0.00). The SPAG had a serum level of 9.8 IU/L which was lower to that of the UPAG (10.6 IU/L).

4.36 Comparison of serum ALT at 12 weeks between structured and unstructured physical activity groups

Table 4.12 showed comparison of 12 weeks serum ALT between the structured and unstructured PA groups. It was observed that serum ALT was not significantly different between the SPAG (7.96 IU/L) and the UPAG (8.21 IU/L).

4.37 Comparison of cardiovascular disease risk score at 12^{th} week between structured and unstructured physical activity groups

Table 4.12 showed comparison of 12^{th} week cardiovascular disease risk score between structured and unstructured PA groups. It was observed that cardiovascular disease risk score was not significantly different in both study groups. The SPAG had 5.48 points while the UPAG had 5.54 points and the end of the 12^{th} week.

4.38 Comparison of diabetes risk score at 12^{th} week between structured and unstructured physical activity groups

Table 4.12 showed comparison of 12 weeks diabetes risk score between structured and unstructured PA groups. It was observed that diabetes risk score was not significantly different in the SPAG (7.88 points) and the UPAG (9.00 points).

4.39 Comparison of hypertension risk score at 12^{th} week between structured and unstructured physical activity groups

Table 4.12 showed comparison of 12 weeks hypertension risk score between structured and unstructured physical activity. It was observed that hypertension risk score was not significantly different in the study groups. The UPAG had 7.33 points while the SPAG had 7.16 points.

Table 4.12: : Between-group comparison of AST, ALT, Cardiovascular Disease Risk Score, Diabetes Risk Score and Hypertension Risk Score among the SPAG and UPAG

Physical Activity	Mean	SD	T	Df	p-value
Unstructured[8]	10.67 IU/L	1.05	2.902	47	0.01*
Structured[8]	9.84 IU/L	0.94			
Unstructured[9]	8.21IU/L	1.25	0.688	47	0.50
Structured[9]	7.96IU/L	1.27			
Unstructured[10]	5.54(points)	3.27	0.062	47	0.95
Structured[10]	5.48(points)	3.63			
Unstructured[11]	9.00(points)	2.86	1.403	47	0.17
Structured[11]	7.88(points)	2.73			
Unstructured[12]	7.33(points)	2.01	0.276	47	0.78
Structured[12]	7.16(points)	2.36			

*-Significant, Alpha level was placed at 0.05

Key:

8- AST

9- ALT

10- Cardiovascular Disease Risk Score

11- Diabetes Risk Score

12- Hypertension Risk Score

4.40 Hypotheses testing

Hypothesis 1: There will be no significant difference among the baseline, 6^{th} week and 12^{th} week cost of care following structured PA among adults with overweight and obesity.

Level of alpha= 0.05

Statistics: Repeated measures ANOVA

F value = 15.138 (p = 0.00)

Since the p – value was lower than the set level of alpha, it was determined that there was significant difference among the baseline, 6^{th} week and 12^{th} week cost of care following structured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 2: There will be no significant difference among the baseline, 6^{th} week and 12^{th} week serum total cholesterol following structured PA among adults with overweight and obesity.

Level of alpha= 0.05

Statistics: Repeated measures ANOVA

F value = 3.744 (p=0.03)

Since the p – value was found to be lower than the set level of alpha, it was decided that there was significant difference among the baseline, 6^{th} week and 12^{th} week serum total cholesterol following structured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 3: There will be no significant difference among the baseline, 6^{th} week and 12^{th} week serum high density lipoprotein following structured PA among adults with overweight and obesity.

Level of alpha= 0.05

Test: Repeated measures ANOVA

F value = 1.068 (p= 0.03)

Since the p – value was lower than the level of alpha, it was concluded that there was significant difference among the baseline, 6^{th} week and 12^{th} week serum high density lipoprotein following structured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 4: There will be no significant difference among the baseline, 6^{th} week and 12^{th} week serum low density lipoprotein following structured PA among adults with overweight and obesity.

Level of alpha: 0.05

Test: Repeated measures ANOVA

F value = 3.167(p=0.04)

Since the p – value was found to be lower than the set level of alpha, it was concluded that there was significant difference among the baseline, weeks 6 and 12 serum low density lipoprotein following structured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 5: There will be no significant difference among the baseline, 6^{th} week and 12^{th} week serum triglycerides following structured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 2.860 (p=0.04)

Since the p – value was less than the alpha level, it was concluded that there was significant difference among the baseline, 6th week and 12th week serum triglycerides following structured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 6: There will be no significant difference among the baseline, 6th week and 12th week serum fasting blood glucose following structured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 27.867 (p= 0.00)

Since the p – value was less than the alpha level, it was concluded that there was significant difference among the baseline, 6th week and 12th week serum fasting blood glucose following structured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 7: There will be no significant difference among the baseline and 12th week serum HbA1c following structured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Student t- test

t value = 1.207 (p=0.24)

Since the p – value was greater than the alpha level, it was concluded that there seem to be no significant difference among the baseline and 12th week serum HbA1c following structured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **FAILED TO BE REJECTED.**

Hypothesis 8: There will be no significant difference among the baseline, 6th week and 12th week serum AST following structured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 7.976 (p= 0.00)

Since the p – value was less than the alpha level, it was concluded that there was significant difference among the baseline, 6th week and 12th week serum AST following structured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 9: There will be no significant difference among the baseline, 6th week and 12th week serum ALT following structured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 0.014 (p=0.99)

Since the p – value was greater than the alpha level, it was concluded that there seem to be no significant difference among the baseline, 6th week and 12th week serum ALT following structured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **FAILED TO BE REJECTED.**

Hypothesis 10: There will be no significant difference among the baseline, 6th week and 12th week cardiovascular disease risk score following structured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 3.374 (p=0.04)

Since the p-value was less than the alpha level, it was concluded that there was significant difference among the baseline, 6th week and 12th week cardiovascular disease risk score following structured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 11: There will be no significant difference among the baseline, 6th week and 12th week diabetes risk score following structured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 32.179 (p=0.00)

Since the p-value was less than the alpha level, it was concluded that there was significant difference among the baseline, 6th week and 12th week diabetes risk score following structured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 12: There will be no significant difference among the baseline, 6th week and 12th week hypertension risk score following structured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 25.076 (p<0.00)

Since the p-value was less than the alpha level, it was concluded that there was significant difference among the baseline, 6th week and 12th week hypertension risk score following structured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 13: There will be no significant difference among the baseline, 6th week and 12th week cost of care following unstructured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 1.873 (p=0.16)

Since the p-value was greater than the alpha level, it was concluded that there seem to be no significant difference among the baseline, 6th week and 12th week cost of care following unstructured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **FAILED TO BE REJECTED.**

Hypothesis 14: There will be no significant difference among the baseline, 6th week and 12th week serum total cholesterol following unstructured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 1.341 (p=0.27)

Since the p-value was greater than the alpha level, it was concluded that there seem to be no significant difference among the baseline, 6th week and 12th week serum total cholesterol following unstructured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **FAILED TO BE REJECTED.**

Hypothesis 15: There will be no significant difference among the baseline, 6th week and 12th week serum high density lipoprotein following unstructured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 1.739 (p= 0.00)

Since the p-value was less than the alpha level, it was concluded that there was significant difference among the baseline, 6th week and 12th week serum high density lipoprotein following unstructured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 16: There will be no significant difference among the baseline, 6th week and at 12th week serum low density lipoprotein following unstructured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 0.8 (p=0.04)

Since the p-value was less than the alpha level, it was concluded that there was significant difference among the baseline, 6th week and 12th week serum low density lipoprotein following unstructured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 17: There will be no significant difference among the baseline, 6th week and 12th week serum triglycerides following unstructured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 1.421 (p=0.03)

Since the p-value was less than the alpha level, it was concluded that there was significant difference among the baseline, 6th week and 12th week serum triglycerides following unstructured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 18: There will be no significant difference among the baseline, 6th week and 12th week serum total fasting blood glucose following unstructured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 31.663 (p=0.00)

Since the p-value was less than the alpha level, it was concluded that there was significant difference among the baseline, 6th week and 12th week serum total fasting blood glucose following unstructured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 19: There will be no significant difference among the baseline and 12th week serum HbA1c following unstructured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Paired t- test

t value = 4.566 (p=0.00)

Since the p-value was less than the alpha level, it was concluded that there was significant difference among the baseline and 12th week serum HbA1c following unstructured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 20: There will be no significant difference among the baseline, 6th week and 12th week serum AST following unstructured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 2.124 (p=0.01)

Since the p-value was less than the alpha level, it was concluded that there was significant difference among the baseline, 6th week and 12th week serum AST following unstructured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 21: There will be no significant difference among the baseline, 6^{th} week and 12^{th} week serum ALT following unstructured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 0.485 (p=0.62)

Since the p-value was greater than the alpha level, it was concluded that there seem to be no significant difference among the baseline, 6^{th} week and 12^{th} week serum ALT following unstructured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **FAILED TO BE REJECTED.**

Hypothesis 22: There will be no significant difference among the baseline, 6^{th} week and 12^{th} week cardiovascular disease risk score following unstructured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 3.007 (p=0.04)

Since the p-value was less than the alpha level, it was concluded that there was significant difference among the baseline, 6^{th} week and 12^{th} week cardiovascular disease risk score following unstructured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 23: There will be no significant difference among the baseline, 6th week and 12th week diabetes risk score following unstructured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 27.656 (p=0.00)

Since the p-value was less than the alpha level, it was concluded that there was significant difference among the baseline, 6th week and 12th week diabetes risk score following unstructured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 24: There will be no significant difference among the baseline, 6th week and 12th week Hypertension risk score following unstructured PA among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Repeated measure ANOVA

F value = 25.43 (p=0.00)

Since the p-value was less than the alpha level, it was concluded that there was significant difference among the baseline, 6th week and 12th week Hypertension risk score following unstructured PA among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 25: There will be no significant difference in the 12th week cost of care between the structured and unstructured PA groups among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Student t-test

t value = 3.981 (p=0.00)

Since the p-value was less than the alpha level, it was concluded that there was significant difference in the 12th week cost of care between the structured and unstructured PA groups among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 26: There will be no significant difference in the 12th week serum total cholesterol between the structured and unstructured PA groups among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Student t-test

t value = 1.448 (p= 0.15)

Since the p-value was greater than the alpha level, it was concluded that there seem to be no significant difference in the 12th week serum total cholesterol between the structured and unstructured PA groups among adults with overweight and obesity.

Judgment: The null hypothesis was hence **FAILED TO BE REJECTED**

Hypothesis 27: There will be no significant difference in the 12th week serum high density lipoprotein between the structured and unstructured PA groups among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Student t-test

t value = 2.035 (p= 0.04)

Since the p-value was less than the alpha level, it was concluded that there was significant difference in the 12th week serum high density lipoprotein between the structured and unstructured PA groups among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 28: There will be no significant difference in the 12th week serum low density lipoprotein between the structured and unstructured PA groups among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Student t-test

t value = 0.659 (p= 0.51)

Since the p-value was greater than the alpha level, it was concluded that there seem to be no significant difference in the 12th week serum low density lipoprotein between the structured and unstructured PA groups among adults with overweight and obesity.

Judgment: The null hypothesis was hence **FAILED TO BE REJECTED.**

Hypothesis 29: There will be no significant difference in the 12th week serum triglycerides between the structured and unstructured PA groups among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Student t-test

t value = 1.309 (p= 0.20)

Since the p-value was greater than the alpha level, it was concluded that there seem to be no significant difference in the 12th week serum triglycerides between the structured and unstructured PA groups among adults with overweight and obesity.

Judgment: The null hypothesis was hence **FAILED TO BE REJECTED.**

Hypothesis 30: There will be no significant difference in the 12th week serum fasting blood glucose between the structured and unstructured PA groups among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Student t-test

t value = 1.075 (p= 0.29)

Since the p-value was greater than the alpha level, it was concluded that there seem to be no significant difference in the 12th week serum fasting blood glucose between the structured and unstructured PA groups among adults with overweight and obesity.

Judgment: The null hypothesis was hence **FAILED TO BE REJECTED.**

Hypothesis 31: There will be no significant difference in the 12th week serum HbA1c between the structured and unstructured PA groups among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Student t-test

t value = 0.17 (p= 0.87)

Since the p-value was greater than the alpha level, it was concluded that there seem to be no significant difference in the 12th week serum HbA1c between the structured and unstructured PA groups among adults with overweight and obesity.

Judgment: The null hypothesis was hence **FAILED TO BE REJECTED.**

Hypothesis 32: There will be no significant difference in the 12th week serum AST between the structured and unstructured PA groups among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Student t-test

t value = 2.902 (p= 0.01)

Since the p-value was less than the alpha level, it was concluded that there was significant difference in the 12th week serum AST between the structured and unstructured PA groups among adults with overweight and obesity.

Judgment: The null hypothesis was hence **REJECTED.**

Hypothesis 33: There will be no significant difference in the 12th week serum ALT between the structured and unstructured PA groups among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Student t-test

t value = 0.688 (p= 0.50)

Since the p-value was greater than the alpha level, it was concluded that there seem to be no significant difference in the 12th week serum ALT between the structured and unstructured PA groups among adults with overweight and obesity.

Judgment: The null hypothesis was hence **FAILED TO BE REJECTED.**

Hypothesis 34: There will be no significant difference in the 12th week cardiovascular disease risk score between the structured and unstructured PA groups among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Independent t-test

t value = 0.062 (p= 0.95)

Since the p-value was greater than the alpha level, it was concluded that there seem to be no significant difference in the 12th week cardiovascular disease risk score between the structured and unstructured PA groups among adults with overweight and obesity.

Judgment: The null hypothesis was hence **FAILED TO BE REJECTED.**

Hypothesis 35: There will be no significant difference in the 12th week diabetes risk score between the structured and unstructured PA groups among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Student t-test

t value = 1.403 (p= 0.17)

Since the p-value was greater than the alpha level, it was concluded that there seem to be no significant difference in the 12th week diabetes risk score between the structured and unstructured PA groups among adults with overweight and obesity.

Judgment: The null hypothesis was hence **FAILED TO BE REJECTED.**

Hypothesis 36: There will be no significant difference in the 12th week hypertension risk score between the structured and unstructured PA groups among adults with overweight and obesity.

Alpha level: 0.05

Test statistics: Student t-test

t value = 0.276 (p= 0.78)

Since the p-value was greater than the alpha level, it was concluded that there seem to be no significant difference in the 12th week hypertension risk score between the structured and unstructured PA groups among adults with overweight and obesity.

Judgment: The null hypothesis was hence **FAILED TO BE REJECTED.**

CHAPTER FIVE

DISCUSSION

This study compared the results of structured and unstructured physical activities on biochemical indices, disease risk scores and cost of care of adults with overweight and obesity.

5.1 Socio-demographics characteristics of participants

Overall, 49 participants participated in this research. There were more females than males in the study. This study supported the studies of Umar et al. (2016); Sanusi et al (2015); Adebayo et al (2014); Fadupin et al (2014) and Okafor et al (2014), in which they reported a greater incidence of overweight and obesity among females than males. Results from this study also showed that majority of the participants were married, had a tertiary education and were employed. This may also be attributed to the criteria used for inclusion employed in this study. This was consistent with reports from various studies that has linked overweight and obesity with successive pregnancies resulting from being married, improved socio-economic status as a result of being educated and working in the cities (Sanusi et al, 2015; Maiyaki and Garbati, 2014 and Okafor et al, 2014). Moreover, it has been reported from these studies that as a result of urbanisation, being educated and employed in the cities, individuals are constantly indulging in sedentary lifestyles from white-collar jobs, lack of physical activity and engaging in poor eating habits thus resulting in overweight and obesity in these individuals.

5.2 Comparison of baseline, weeks 6 and 12 and cost of care following structured Physical Activity

The result obtained, showed that there was significant reduction in the cost of care following the structured PA. The cost of care was reduced at the 6th week of PA and also further down at the 12th week compared to the baseline cost of care. On the average, the cost of care per month for overweight and obese participants was computed to be ₦135,200.00. These are direct costs incurred from expenditures from physician's consultation, costs of physiotherapy, costs of investigations, costs of medications, in-patient hospitalization, costs of food, transportation to and fro the hospitals as a result of overweight and obesity and also costs for use of alternative or complementary health services such as tummy trimmers, sliming teas etc.

Specifically, these costs were reduced significantly to ₦101,984.00 and ₦66,822.00 per month at weeks 6 and 12, respectively. These significant reductions maybe attributed to the effects of engaging in PA that could have improved the problems and complications associated with overweight and obesity which in turn reduced the hospital visits, physician's consultations, investigations, transportation costs to and from the hospital, and also a reduction in use of the complementary or alternative health services.

Su et al (2020) demonstrated that increased PA that is supervised with a higher intensity is associated with low medical spending in diabetes patients. This present study was consistent with findings from their study. In a survey conducted by Elizondo et al (2016), they also reported that lower health care spending is associated with moderate – vigorous intensity structured PA in individuals with or without cardiovascular disease. Findings from this study was also consistent with their study.

5.3 Comparison of baseline, weeks 6 and 12 serum Total cholesterol following structured physical activity

The outcomes from the study showed that serum TC value significantly declined at the 6th and 12th weeks of the study compared to that of the baseline. This present result supported findings from the study of Ou et al (2017) who found out that adults that were exposed to PA had their serum cholesterol reduced significantly compared to their counterpart that was not exposed, and there was reduction in serum TC in adults that were engaged in low levels of PA compared to the inactive adults. They further stated that this reduction in serum TC was more pronounced in adults that adhere more to the adult guidelines for exercise prescription as stipulated by the WHO. They concluded that when the serum TC is reduced, this helps in reduction of morbidities and mortalities associated with excess serum TC.

This study was also in consonance with a similar study by cox et al (2010) that the participants were women and some of them were exposed to aerobic activity of swimming of three times per week similar to the frequency of aerobic activity of this study. Results from the study showed a reduction of serum TC of the participants. The authors concluded that the health benefits accrued from PA depends on the intensity of PA, that is physical activities of moderate to vigorous intensity gives more health benefits. The present study was also in accord with findings from previous works conducted by Fragala et al (2017) and Amelia et al (2018), in which they showed that there was an association between reduction of serum TC and habitual aerobic and strength exercise.

However previous studies carried out by Kraus et al (2002) and Omar et al (2018) did not find any significant reduction in serum TC following PA. The current study has given more indication on the efficacy of structured PA in reducing serum TC.

5.4 Comparison of baseline, weeks 6 and 12 serum high density lipoprotein following structured physical activity

Serum HDL values in the SPAG increased significantly in weeks 6 and 12 into the intervention programme when compared with values at the baseline. The findings are consistent with earlier studies that showed an increase in serum HDL following structured PA (Halverstadt et al, 2007; Kodama et al, 2007; Racil et al, 2013; Wang et al, 2019). According to Thompson et al (2003), the increase observed in serum HDL following PA is dependent on factors such as frequency of the PA, intensity of the PA, type of PA including concomitant reductions in body weight resulting from PA. They explained further, that physical activities in line with prescribed recommendations such as that of the American College of Sports Medicine increase serum HDL. A new study by Jensen et al (2020) in which PA was used as an intervention in Alzheimer's disease patients for 16 weeks, it was found out that there was an increase in serum HDL after exposing them to a structured exercise intensity of moderate to vigorous intensity. They also found out that there was an

association between increased serum HDL and a better cognition in the participants. They concluded that structured moderate to vigorous intensity exercise is beneficial in increasing serum HDL and improving the cognition of the participants. However, a systematic review conducted by Leon and Sanchez (2001) to determine the outcome of 12-week aerobic work-out on HDL, it was found out that there was no relationship with the dose of the exercise and the increase in the serum HDL despite the increase in the serum values. They concluded that there was no sufficient evidence linking the intensity of PA to increase in serum HDL.

Result from this study has added to the evidence available that serum HDL increases with moderate to vigorous intensity PA.

5.5 Comparison of baseline, weeks 6 and 12 serum low density lipoprotein following structured physical activity

The result from this study showed a significant reduction in serum LDL of the participants following structured PA during the course of the study compared to values from the baseline. This finding supported results from previous studies which showed that there is an association between serum LDL and structured PA (Leon and Sanchez, 2001; Thompson et al, 2003; Fragela et al, 2017; Karami et al, 2020). These studies revealed a decrease in serum LDL following frequent structured moderate to vigorous intensity PA. Similarly, this study was in concordance with Halverstadt et al (2007) findings from their study when they showed that significant decrease in the levels of serum LDL is linked with frequent participation in structured PA independent of diet or change in body fat. However, there was a disagreement with the finding from this study and the study of Nieman et al (2002) who reported that moderate to vigorous intensity aerobic exercise with strength training alone did not reduce the levels of serum LDL. They observed significant effect in reduction of serum LDL when dietary modifications were added to the exercise group. The authors then advocated that for there to be a significant effect in reduction of serum LDL, exercise should be combined with lifestyle modifications. Albarrati et al's (2018) study was not supported by that of the present study. From their study they found that moderate to vigorous intensity structured PA did not have favourable effect on serum LDL.

This study employed the use of structured aerobic exercise, flexibility exercise and resistance training on overweight and obese adults and thus it has added to the body of evidence on the effects of structured PA in the reduction of serum LDL.

5.6 Comparison of baseline, weeks 6 and 12 serum triglycerides following structured physical activity

Serum TG was significantly decreased at 6 weeks compared to baseline and week 12 compared to baseline following participation in the structured PA. Several researchers have investigated the results of aerobic workout, strength training and flexibility exercise on serum TG (Skoumas et al, 2003; Fragala et al, 2017; Omar et al, 2018; Wang et al, 2019; Jensen et al, 2020; Karami et al, 2020). From the findings of their researches, it was concluded that there is an association between regular structured physical activities and serum TG. They found out that with moderate to vigorous intensity structured PA, there was a significant drop in serum TG. The result of this present study was in consonance with those of these studies.

5.7 Comparison of baseline, weeks 6 and 12 serum fasting blood glucose following structured physical activity

Following structured PA, there was significant reduction in serum FBG across the study period. This decrease may be associated with the effect of PA on FBG. According to Fragala et al (2017), the reduction in serum FBG is brought about by the increased frequency of structured PA which results in healthier glucose control as a result of fluctuations in beta cell working. These changes in beta cell functioning are associated with the insulin-dependent mechanism which brings about

uptake of glucose by cells of muscles inspired by muscle contractions during exercise activities (Richter and Hargreaves, 2013).

It was shown by Ezema et al (2014) in their study that supervised aerobic exercise is very effective in blood glucose control. Amelia et al (2018) also supported this with the findings from their study that showed that blood glucose level is controlled after participation in a programmed aerobic activity of moderate to vigorous intensity. The present study has also corroborated several other authors' findings: that moderate –vigorous intensity structured aerobic and resistance exercise have a favourable effect in reducing serum blood glucose (Norton et al, 2012; Sakung et al, 2018; Janus et al, 2019).

5.8 Comparison of baseline and 12th week HbA1c following structured physical activity

Result from this study revealed that there was no significant change in HbA1c between baseline and 12th week following structured physical activity. Glycated Haemoglobin (HbA1c) gives information about a person's mean blood sugar levels in the past three months and is used to detect the development of diabetes, and also monitor the treatment and prognosis of diabetes (Sherwani et al, 2016). Lower HbA1c values are indicative of better glucose regulation. Higher values of HbA1c may indicate poor control of glucose making the individual susceptible to diabetes.

Result from this study could be due to the fact that participants who were diagnosed with diabetes were excluded from this study; as such their glucose level was well controlled. However, results from few studies have demonstrated that a reduction in HbA1c is connected with physical activities. For instance, Fragala et al (2017) in their study reported a significant reduction in the values of HbA1c of men and women when they were exposed to frequent structured aerobic exercise and resistance training with intensities ranging from moderate–vigorous intensity activities. Similarly, Amelia et al (2018) from their study demonstrated that there was a reduction of HbA1c values in diabetes mellitus-type-2 patient after being exposed to guided moderate to vigorous intensity aerobic exercise. A recent study of Fajriyah et al (2020) also had comparable results to Amelia et al (2018). It was shown from their study that structured high intensity aerobic exercise was connected with a significant lowering of levels of HbA1c in diabetes mellitus type-2 patient. The outcome from this study was not constant with those of these other studies.

5.9 Comparison of baseline, week 6 and 12 serum AST following structured physical activity

Findings from this study demonstrated that serum AST was reduced at weeks 6 and 12 when compared with values from that of the baseline. AST is an enzyme present in muscles, kidneys and a higher concentration in the liver and heart (Esani, 2014), when the level arises (in conjunction with ALT), this indicates a liver injury (Hall and Cash, 2012). In musculoskeletal disorders and pulmonary embolism, level of serum AST is seen to be high (Esani, 2014).

Chinedu et al (2018), in their study, revealed that after aerobics exercise of moderate to vigorous intensity, levels of serum AST remained the same in the participants. This study was inconsistent with that of Chinedu et al. However, this study was consistent with other studies when it was shown that there was reduction in the values of serum AST following exposure to structured physical activities with moderate to vigorous intensity (Noori, 2011; Davoodi et al, 2012; Armand and Darvakh, 2015). Nevertheless, finding of this study differs from those of other studies when it was shown that serum AST increases after moderate to vigorous intensity PA (Pettersson et al, 2007; Uadia et al, 2016; Amah et al, 2017; Fragala et al, 2017). Amah et al based on the findings from their study and other studies advocated that exercise should be done with caution; and that values of asymptomatic increased serum AST should be interpreted bearing in mind that it could be caused by exercise and therefore avoid erroneous attribution to pathological causes.

5.10 Comparison of baseline, weeks 6 and 12 serum ALT following structured physical activity

Results from this study revealed that there was no change in serum ALT among the baseline, 6th week and 12th week following structured PA. Unlike AST, ALT is predominantly present in the liver and it is a more specific marker for liver disease than AST (Esani, 2014). ALT has low concentration in other tissues apart from the liver, levels fluctuate during the day and increases could occur as a result of use of some certain drugs and during strenuous physical activities (Hall and Cash, 2012). In the work of Armand and Darvakh, 2015, a study in which 12 weeks aerobics exercise was done in patients with obesity and diabetes a significant decline in the values of serum ALT post exercise compared to that of the baseline values was reported. The present study was contrary to this report.

Similarly, a meta-analysis conducted by Li et al (2015) demonstrated four trials on patients with non- fatty liver disease that showed that serum ALT levels were significantly reduced in participants of structured physical activities post exercise to the levels that liver functions returned to positive normal. Uadia et al (2016) revealed from their study that serum ALT was reduced after structured PA of moderate to vigorous intensity in young Nigerian adults although this reduction was not statistically significant. According to them, this result suggests that the pattern, intensity, duration and regimen of the exercise did not cause any damage to the liver. Moreover, Nuri et al (2015) in their study reported a reduction in serum ALT of post-menopausal women who had breast cancer after a 15 weeks intervention of programmed moderate to vigorous intensity exercise. The result from this work was inconsistent with all those from these other studies.

Furthermore, the result of this study was not in accord with the conclusions from the study of Amah et al (2017), in which they reported a significant rise in the level of serum ALT after exposure of the participants to a short-term aerobics exercise. Amah et al opined that this increase could be as a result of leaking of the enzymes from mechanically damaged muscles cells during exercise into the interstitial fluid. Similarly, Chinedu et al (2018) also supported the work of Amah et al (2017) but the result of this study was in disagreement with their results. They reported that there was a significant increase in serum levels of ALT following vigorous intensity exercise, and they suggested that this may be due to enzymes leaking from probably damaged or injured muscle cells to the blood stream.

Nevertheless, finding from this study was in harmony with that of Uadia et al (2016) in which they stated no significant change in the level of serum ALT after subjects were exposed to a 6 weeks aerobics and flexibility exercise. The result from this study has also provided scientific data of the effect of 12 weeks structured PA on serum levels ALT.

5.11 Comparison of baseline, weeks 6 and 12 cardiovascular disease risk score following structured PA

The chances of developing CVD by the participants was significantly reduced at the end of weeks 6 and 12 respectively of participating in structured PA. The risk of developing CVD was assessed using the FRS. Among the risk factor assessed were HDL and TC. From the results obtained from this study, the HDL of the participants was significantly increased, while TC was pointedly reduced probably due to the intervention of PA. These biochemical profiles play important roles in the development of CVDs. Since, there were positive changes in these profiles; it is thus natural that the risk of developing CVD would reduce in the participants as seen from the result of this study after the computation of the CVD risk score.

This finding supported findings by several studies (Ross,1999; D'Agostino et al, 2008; Brunzell et al, 2008) in which it was demonstrated that two of the major risk factors for CVD are; increased lipidemia of which increased levels of serum TC and decreased levels of serum HDL are involved; and also lack of PA which is also associated with hyperlipidemia. They suggested that participation in PA could help in reducing these risk factors and thus directly reducing the risk of developing CVD. Similarly, Ou et al (2017) stated that high levels serum TC and low-level serum HDL are risk factors for all high mortality associated with CVD and these risk factors disappeared with the participation in regular PA. This present study was in concordance with that of Ou et al. Albarrati et al (2018) advocated frequent participation in aerobic exercise to reduce the risk of CVD associated with increased lipidemia. Evidence from this study has also shown that frequent participation in structured PA could help in reducing the risk of developing CVD.

5.12 Comparison of baseline, weeks 6 and 12 diabetes risk score following structured physical activity

At the culmination of week 12 in the SPAG, result revealed that the risk of the participant developing diabetes was reduced by almost 50% compared to the risk at base line. In the assessment for the risk of developing diabetes, the FINDRISC questionnaire was used. Among the variables that determine this risk is diet (daily, vegetables, fruits and fibre consumption), exercise (at least 30 min/day), BMI and waist circumference. Adeniyi et al (2010) in their work to find out the major non-invasive risk factors for type 2 diabetes in advanced education tutors in North-west, Nigeria, reported that the major risks factors present in these individuals were overweight and obesity, a high waist circumference including an increased BMI amongst other factor. They advocated that if these modifiable risk factors are addressed, it would help in reducing the risk or prevention of diabetes type 2.

During the intervention for the SPAG in this study, all these variables were influenced positively: for instance, the advice given to the participants on the modification for their diet was adhered to by the participants; and also, the participation in PA during the study which had a positive impact on their BMI and waist circumferences causing a reduction, all contributed considerably to a reduction in the diabetes risk score of the participants.

Hu and associates (1999), in their cohort study involving overweight and obese women demonstrated that regular structured PA with moderate to high intensity could help reduce the risk factors associated with developing diabetes. Finding from this study was consistent with their study which showed evidence of lowered risk of developing diabetes with structured exercise intervention. Similarly, this study supported the study of Hjerkind et al (2017) in which they reported that an increased dosage of PA could decrease the chances of developing diabetes in overweight and obese patients in all categories of BMI.

The result of this study also supported a combined-situation paper of The American College of Sports Medicine and the American Diabetes Association in which they stated that participating in structured moderate to high intensity PA could help in reducing the risk associated with developing diabetes and thus in diabetes prevention (Colberg et al, 2010). Another study that this study was consistent with the result was a meta-analysis done by Appuhamy et al (2014). In their meta-analyses they studied the outcome of diets and PA on some risk factors associated with developing type-2 diabetes (Systolic blood pressure, BMI, FBG and HDL) in adults without diabetes. About 60% of the studies they examined, had participants who were either overweight or obese. The results from their study showed that adults who had PA with intensity ranging from moderate to high, had significant reduction in all these risk factors. The present study has provided scientific data on the result of structured PA in lowering the risk of developing diabetes.

5.13 Comparison of baseline, weeks 6 and 12 hypertension risk score following structured physical activity

The result of this study showed that there were significant reductions in the participants' risk of developing hypertension following structured PA by the end of weeks 6 and 12 respectively. In assessing the risk for developing hypertension, the HRS questionnaire was used in this study. Some of the variables assessed were physical activity (exercise), BMI (Overweight and obesity), systolic BP and diastolic BP. All these are modifiable risk factors for hypertension (WHO, 2021). At the commencement of this study, majority of the participants were never involved in any form of PA. It appears that PA had impacts in the reduction of these variables after the participants participated in the PA programmes. These decreases accounted for the reduction in the hypertension risk scores of the participants.

Result from this study was consistent with that of André et al (2020), in which overweight and obese women were exposed to 15 weeks of aerobic training and dietary modification. André et al found out at the conclusion of their research, that there was significant drop in BMI and overall weight of the participants at the close of their study when compared with their baseline values. This study was also in consistence with a review done by Sharman et al (2015), in which it was reported that analysis of over 50 RCTs have shown that significant falls in systolic and diastolic BP can be achieved after aerobic exercise irrespective of the participants' age, frequency of the exercise sessions or baseline of the participants' BMI.

This study has also provided scientific evidence that PA could help in reduction of some of the modifiable risks associated with hypertension.

5.14 Comparison of baseline, weeks 6 and 12 cost of care following unstructured physical activity

The activity for the UPAG was a daily walking that is being monitored with their steps count using a pedometer. The result revealed a drop although not significant in the cost of care after 6 weeks of walking, also a reduction which was also not significant was seen at the end of the 12 weeks of walking. At baseline, the mean cost of care per month was found to be ₦179,266.67 and by the 12th week there was a mean reduction to ₦135,712.50. In a study conducted be Carlson et al (2014) to estimate the association between healthcare expenditure and PA of individuals in the United State of America, they found out that those who engaged in leisure time PA of walking with moderate intensity and were classified as been not sufficiently active had a reduced direct cost of care (health care expenditure) compared to the sedentary individuals. These direct costs of care include expenditures for all inpatient and outpatient services, emergency room, home health, prescription drug, and other expenditures related to their health. They advocated that increasing PA according to guidelines may help to reduce health care spending. Finding from this study was in agreement with that of their study which showed a reduction in direct cost of care associated with moderate intensity PA.

In a study by Kato et al (2013), to evaluate the effects of walking on medical cost by simulations on diabetic patients in Japanese population, they found out that there was reduction in medical expenditures as a result of walking and the reductions corresponded to 5.2 and 8.4% respectively when the steps are increased to 3,000 and 5,000 steps daily. They demonstrated that the reduction in cost of care came as a result of the effect of PA on some diseases of lifestyles. They concluded that walking is common, popular and an accessible

PA to the populace which should be encouraged as it may help to reduce medical costs from disease from lifestyle. The present study was also in support of the result from their study. Wang et al (2004) in their study to scrutinise the connection between cost of care and moderate intensity PA in overweight and obese adults, they found out that those who engaged in moderate intensity PA paid less health care costs annually compared to the sedentary individuals. They suggested that a strategy of encouraging overweight and obese sedentary adults to participate in moderate intensity PA may be helpful in reducing health care spending. This study was also in support of finding from their study. Result from this study has shown that walking may be prescribed to overweight and obese individuals to reduce cost of care (although not significant) associated with overweight and obesity.

5.15 Comparison of baseline, weeks 6 and 12 serum total cholesterol following unstructured physical activity

It was observed from this study that, there was no significant reduction in the levels of serum TC of the UPAG participants after 6 weeks of walking, but by the end of week 12 intervention a slight reduction which was not significant was recorded. It appears that the walking as a physical activity might have influenced this reduction in the value of the serum TC at the end of the 12 weeks of engaging in PA.

Finding from this study was in consonance with a randomized control trial conducted by Coghill and Cooper (2008). Their study involved exposing the subjects in the intervention group to a 12- week moderate intensity walking. They found out at the end of their study that serum TC was reduced in the participants in the interventional group compared to individuals in the control who were not involved in walking. Similarly, another study that was supported by the finding of this study was that of Prusik et al (2018). Their study involved randomising participants into three groups: the first group were the experimental group who had intervention of 12 weeks walking combined with vitamin D supplementation; the second group had only vitamin D supplementation while the control group (the third group) had no intervention. At the conclusion of the study, it was found out that the experimental group had a decrease in serum TC. This study was also consistent with findings from an earlier study in which the authors demonstrated that adults who engaged in PA of walking for periods of 2½-4 hours or more each week tend to have decreased levels of serum TC compared to those who do not walk or exercise regularly (Tucker and Friedman, 1990).

5.16 Comparison of baseline, week 6 and 12 serum high density lipoprotein following unstructured physical activity

Serum HDL increased at the 6 weeks and 12 weeks of walking in the UPAG. The increase in the participant's serum levels seen in this study might have been due to the effect of walking as a PA by the participants in addition to adhering to the dietary advice they were given during the course of the study.

Woolf-May et al (1999) reported on the effect of three walking programmes on lipid profiles, the participants were assigned to three groups of long walkers (20-40mins/bout), intermediate walker (10-15mins/bout) and short walker (5-10mins/bout) and a control group. All the three groups performed the walking activity for 18 weeks but different duration and frequency. They found out at the end of their study that serum HDL was increased in the walking groups but not the control set although the long walkers had a higher value than the other two groups of walkers. They concluded that even though the long walker group was most effective in benefiting the lipid profiles, any form of walking could be prescribed to the sedentary population as it is better than none. Their study was supported by the finding from this study.

Another study that this study was in consonance with, was that of Sadowska-Krępa and colleagues (2020), in which they compared the effect of Nordic walking with dietary modification alone on lipid profiles of adults with obesity and overweight. At the termination of the 12 weeks study, it was observed that there was an increase in serum level HDL in the two groups although it was more in the dietary only group. Other studies have demonstrated that participating in regular low –moderate intensity PA have a beneficial property of increasing serum HDL (Parkkari et al, 2000; Albarati et al, 2018). These studies are reinforced by this present study. However, this study was inconsistent with the finding from the study of Kodama et al (2007). Kodama et al, reported that there exists no significant change in HDL linked with participating in moderate intensity PA.

This work has made available scientific indication on the effect of walking as a low to moderate intensity PA in improving serum HDL levels.

5.17 Comparison of baseline, weeks 6 and 12 serum low density lipoprotein following unstructured physical activity

The result from this study showed a decrease in serum LDL at the end of weeks 6 and 12 of walking. This was consistent with a systematic review done by Albarrati et al (2018) in which they reported that significant reduction in serum LDL is associated with moderate intensity PA. The result of this study also supported a cohort study carried out by Bemelmans et al (2012) where they exhibited that a drop in serum LDL is associated with walking. Bemelmans et al, in their study compared fast walking versus slow walking and it was reported that significant reduction in LDL was achieved more with slower walking than faster walking. A randomised crossover study by Duvivier et al (2017) to examine the effects of walking and sitting in sedentary overweight and obese adults' serum LDL, showed that compared to the participants sitting, those involved in walking had significant reduction in serum LDL. The result from study was consistent with that of their study. Parkkari et al (2000), from their randomised control trial done to investigate the effect of regular walking on serum LDL, reported that after the 20-week study those that had regular walking had a reduction in serum LDL compared to the sedentary controls. Their study was supported with the results of this study. Similarly, a meta-analysis was done by Kelley et al (2004) to investigate the result of walking on lipid profiles in adults. The authors concluded from their study that regular walking is related with a low serum LDL. The result from this study was also in agreement with the result from their study. The evidence from this study has provided a scientific proof on the effect of walking on serum LDL.

5.18 Comparison of baseline, weeks 6 and 12 serum triglycerides following unstructured physical activity

There was reduction of serum TG at 6th week and at 12th week. The result from this study was in consonance with a cross-over randomised study in which two groups of adults were exposed to walking and sitting (Chrismas et al, 2019). The sitting group activity consists of sitting down without engaging in any activity whereas, the walking group had intermittent sitting with exposure to moderate intensity walking. Chrismas et al reported that at the end of their study, they found out that those that participated in the walking activity had a significant decrease in serum levels of TG compared to the sitting group who were not exposed to walking. Another study that was supported by the result from this study was that of Kashiwabara et al (2018). Their study investigated the outcome of walking on serum TG in older women and found out that continuous walking and walking in bouts had effect in decreasing the serum triglycerides values of the participants compared to those of the control who never had any form of physical activity. The present study also provides scientific evidence on the effect of walking on serum triglycerides.

5.19 Comparison of baseline, weeks 6 and 12 serum fasting blood glucose following unstructured physical activity

During the course of this research, there was a decline in serum FBG by the 6th week and 12th week respectively following unstructured walking. This result was in agreement with the position statement of the American Diabetes association in which they stated that a moderate intensity PA such as walking could help in reducing the serum glucose levels (Colberg et al, 2016). They further stated that walking could be recommended for sedentary individuals to help in keeping them healthy and reducing mortality and morbidity linked with obesity and overweight.

The result from the study of Manohar et al (2012) was also supported by this study. They reported that moderate intensity activity such as walking have effects in both healthy and diabetic patients by reducing glucose in the blood after participation in the physical activity and this could help in reducing morbidities and mortalities. A randomised control trial conducted by Rafii et al (2018) to compare the effects of 8 week walking and Tai Chi on FBG in type-2 diabetes patients, they demonstrated that walking which was classified as moderate intensity PA was effective in significantly reducing FBG in the walking groups compared to the control that had no form of any PA. The outcome of this study was consistent with theirs.

Norton et al (2012) reported that moderate intensity PA caused a decrease in FBG in healthy adults who were insufficiently active. Their finding was supported by that from this present study. However, this study differs from that of Omar et al (2018) in that they reported that they could not demonstrate any notable change in the levels of FBG of the participants of their study after 6-month exposure to brisk walking.

5.20 Comparison of baseline, weeks 6 and 12 HbA1c following unstructured physical activity

There was significant reduction in the participants' HbA1c levels at the 12th week of participation in unstructured PA. The study was in agreement with a recent systematic review done by Moghetti et al (2020), in which they stated that engaging in walking as a non-pharmacological intervention could cause a decrease in HbA1c. In another study done by Sirisha and Paramjyothi (2019) to examine the effect of a 12- week brisk walking on HbA1c in type-2 diabetes mellitus patients, they found out that at the end of the 12 weeks of walking of at least 30 minutes, there was a decline in HbA1c levels in the post exercise compared to that of the baseline values. Their study was supported by finding from this current study.

A similar investigation was done by Yoshihara et al (2016) to find out the effect of walking on HbA1c levels in the elderly during a six-month walking intervention, and they found out that at the culmination of their study, there was a significant reduction in the HbA1c levels of the participants compared to the baseline. This result from this current study agreed with theirs. Fayehun et al (2018) led a randomised control trial to explore the effects of different number of steps of walking on HbA1c in type-2 diabetes patients for 5 months. They found out that there was reduction in the HbA1c levels of all the participants in their study, although the decrease was more in those that had a higher number of steps of walking. It was concluded from their study that regular walking could cause a decrease in HbA1c levels. The finding from this study was consistent with the result of their study. The present study has added scientific data on the effect of unstructured PA on HbA1c.

5.21 Comparison of baseline, weeks 6 and 12 serum AST following unstructured physical activity

There was a significant reduction in serum AST at the 6th week of the study and a further decrease at the 12th week of the study. Shanb et al (2009) conducted a study on fatty liver patients using moderate intensity walking on treadmill of 40 minutes duration 3 times in a week, for 8 weeks to investigate the effect of moderate intensity PA on liver enzymes. At the end of their study, they found out that there was a significant reduction in the levels of serum AST compared to that of the baseline. They concluded that moderate intensity PA has a reducing effect on serum AST. Their finding was supported by result from this study.

Another study by Islami (2015) examined the effect of moderate intensity walking on liver enzymes of young inactive women. The intervention consists of 5-minute interval walking, 45-90 minutes per session and 4 sessions per week for 6 weeks. It was reported that at the end of 6 weeks there was a significant reduction in serum AST of the participants in the study. The finding from this study was in agreement with that of the study. The present study has highlighted the outcome of unstructured PA on serum AST of overweight and obese adults.

5.22 Comparison of baseline, weeks 6 and 12 serum ALT following unstructured physical activity

Result from this study revealed that at the end of the 6th week, there was no significant difference in the serum ALT compared to the baseline values, but at the close of the 12th week, there was an increase in serum ALT compared to the baseline and 6th week values. It appears that an injury to the muscle cells as a result of exercise might have caused this increase (Chinedu et al, 2018; Amah et al, 2017). The study of Chinedu et al (2018) was supported by this study as a report of an increase in serum ALT after physical activity intervention in their study participants was made. Georgakouli et al (2015), was also supported by the finding from this study. They demonstrated that exposure to moderate intensity PA could cause an increase in serum ALT.

However, this study differed from the study of Islami (2015). Islami (2015) reported a significant decrease in serum ALT after exposing the study participants to a-15 minutes interval walking for 6 weeks. This study was also in disagreement with that of Shanb et al (2009), when it was shown that an 8-week intervention of moderate intensity PA caused a decrease in serum ALT.

The present study has added to the scientific proof on the effect of unstructured PA on serum ALT.

5.23 Comparison of baseline, weeks 6 and 12 cardiovascular disease risk score following unstructured physical activity

There was a reduction in the risk of developing CVD weeks 6 and at 12 of this study respectively. During the intervention, there was a reduction in total cholesterol of the participants and an increase in HDL values. All these variables are contributors to a low chance of developing CVD using the FRS to calculate the risk score. Inputting the results from the study into the FRS showed a reduced risk in developing CVD.

A systematic review done by Boone-Heinonen et al (2009), was supported by result from the present study when it was reported from the study that walking of moderate intensity confers properties that helps in preventing and reducing the risks of developing CVD. Boone-Heinonen et al (2009) further stated that walking is associated with reduced risk of CVD in apparently healthy individuals. They concluded by stating that CVD risks declines with increasing walking pace and distance. In another review done by Murtagh et al (2010), they reported that walking has been shown to be associated with reduction in risks of developing CVD. They opined that walking could be prescribed by clinicians for sedentary individuals to increase their PA levels as it is cheap and easily accessible to people of all ages and social strata and it also poses little risk of injury.

The report of the study of Heinonen et al (2009) was supported with result from this present study. Several other studies were supported by result from this study. These studies showed that walking has been linked with a reduction in TC, increase in HDL, reduction in blood pressure and thus a resultant decrease in CVD risks (Meyers, 2003; Thompson et al, 2003; Omura et al, 2019).

The present study has also provided scientific proof on the effect of walking on reducing the risk of developing CVD.

5.24 Comparison of baseline, weeks 6 and 12 diabetes risk score following unstructured physical activity

The result from this study showed a reduction in the risk of developing diabetes at weeks 6 and 12 of the study respectively. The FINDRISC questionnaire was used in this research to evaluate the risk for developing diabetes. Among the variables that determine the risk for developing diabetes are; exercising at least 30 minutes a day, BMI, diet (daily consumption of vegetables, fruits and fibres) waist circumference. Before the intervention and during intervention, dietary advice was given to the participants; this prompted a modification in their lifestyle, also exercise was also introduced to their lifestyle through walking as a form of PA. All these factors may have contributed in reducing the risk scores for developing diabetes in the participants. The result of this present-day study was in consonance with a systematic review done by Jeon and associates (2007) to investigate the effect of moderate intensity PA such as walking on the risk of developing type-2 diabetes. They found out from their review that regular brisk walking could significantly reduce the incidence of developing type-2 diabetes as compared with being sedentary. It was advocated by them that adherence to moderate intensity PA such as brisk walking should be recommended to individuals to reduce the risk of developing type-2 diabetes.

Result from this study also agreed with result from Hu et al (1999). It was demonstrated from their prospective study that moderate intensity PA such as brisk walking is associated with a reduced risk of developing type-2 diabetes. Appuhamy et al (2014), in their meta-analyses done to investigate the association between dietary modification and moderate intensity PA in reducing the risk of diabetes in overweight and obese adults without diabetes was supported by the finding from this study when they demonstrated that low calorie intake and fat restriction diets coupled with moderate intensity PA were associated significantly with reduced diabetes risk.

5.25 Comparison of baseline, weeks 6 and 12 hypertension risk score following unstructured physical activity

It was observed that there was a reduction in the risk of developing hypertension at weeks 6 and 12 of the study respectively. The HRS questionnaire was used to assess the risk scores for developing hypertension. The variables assessed include but not limited to; exercise, BMI, Systolic and diastolic BP. The intervention of walking (as exercise) had an impact on the other variables and this in turn may have caused a reduction in the risk scores for developing hypertension. The result from this study was supported by the guidelines from WHO (2020), that advocated that regular moderate intensity PA such as brisk walking has been known to reduce the risk of developing hypertension. Huai et al (2013) did a meta-analysis to determine the effect of moderate intensity PA in reducing the risk of developing hypertension. They found out from their study that regular moderate intensity leisure time PA such as walking is connected with a reduction in the risk of developing hypertension. This present study supported the finding from their study.

Other studies have shown that reduced risk of developing hypertension is associated with moderate intensity PA such as walking (Williams and Thompson, 2013; Diaz and Shimbo, 2013). These studies are supported by the result from this study. The present study has also provided scientific evidence on the effect of unstructured PA in lowering the risk of emerging hypertension.

5.26 Comparison of cost of care at the 12th week between structured and unstructured physical activity groups

A comparison of the cost of care showed that the SPAG spent less in medical spending compared to the UPAG. The mean cost of care per month after the intervention in the SPAG was found to be ₦66,822.00 (the baseline cost of care was ₦135,200.00), whereas that of the UPAG was found to be ₦135,712.50 (the baseline cost of care was ₦179,266.67). This lesser spending by the participants in the SPAG may be attributed to the effect of results obtained from the vigorous intensity exercise intervention which might have caused a more reduction in direct costs for hospital visits, physiotherapy costs, costs of medication, costs of food during hospital visits, costs of transportation to and from the hospital etc as a result of fewer health problems or challenges, compared to the UPAG even though they also had a reduction in their medical spending.

Su et al (2020) in their study to evaluate the health care cost among individuals with diabetes mellitus reported that those that engaged in vigorous intensity PA had lesser health care cost compared to those who engaged in moderate intensity PA. Su et al (2020) concluded that lesser health care spending is associated with physical activities that are done at higher intensities. The result from this study was consistent with that from their study.

The present study has provided scientific evidence that both structured and unstructured physical activities could reduce cost of care, but if the aim is a greater reduction in health care spending, the preferred choice is structured PA.

5.27 Comparison of total cholesterol at the 12th week between structured and unstructured physical activity groups

Result from this work showed that there exists no significant difference in serum TC between the two PA groups. In the course of the study, both groups had a reduction in their serum TC which might have been as a result of their participation in PA programmes. It appears that the reducing effect of PA on serum TC in the two groups may be the same hence the reason why there seems to be no significant change in the serum TC in both groups.

Wood et al (2019) in their systematic review and meta-analysis was supported by findings from this study when they showed evidence suggestive that vigorous intensity PA was not superior to moderate intensity PA in reducing serum TC. This study was also in agreement with the prescription exercise of the US department of Health and Human services (Piercy and Troiano, 2018). They stated that moderate intensity PA is as beneficial as vigorous intensity PA in lowering TC. They argued that less PA is needed than previously thought to achieve health benefits.

The result from this study has provided evidence suggesting that to reduce TC in overweight and obese adults, structured as well as unstructured PA could either be prescribed for the same outcome.

5.28 Comparison of serum high density lipoprotein at the 12th week between structured and unstructured physical activity groups

It was observed that there exists a significant change between the serum HDL of the structured and unstructured PA groups. The findings in both groups showed an increase in HDL, but the unstructured group had significant increase than those in the structured group.

This result was contrary to that of Kraus et al (2002) it which it was demonstrated that an increase in serum HDL is associated with vigorous intensity structured PA compared to moderate intensity unstructured PA. Their result suggested that an increase in HDL is a function of dosage-response. O'Donovan et al (2005) examined the outcome of a 24-week vigorous intensity and moderate intensity structured PA on lipid profiles. They reported that participants in the structured vigorous intensity PA had an increase in serum HDL than those in the unstructured moderate intensity PA group which was suggestive of an increased dose response to exercise. The result from this study was also in disagreement with result from their study.

Mann et al (2014) in their review reported that a high dose of exercise as represented by vigorous intensity structured PA is associated with increased HDL compared to moderate intensity unstructured PA. The result of this present study was inconsistent with their study. Another study that this study disagreed with the result was a randomised control trial done by Sarzynski et al (2018). Sarzynski et al examined the results of different doses of exercise on HDL. Their participants were assigned to three groups consisting of vigorous intensity structured PA, moderate intensity unstructured PA and a control group. The intervention was for 6 months. At the end of their study, they observed that there was an increase in HDL in the vigorous intensity structured PA group, whereas the levels of HDL remained unchanged in the moderate intensity PA group and the control group. They concluded that a higher dose of exercise volume that is structured is linked with increase in HDL.

Although the result of this work was not in accordance with several other studies, it was shown that there was an increase in serum HDL associated with both structured and unstructured PA. The increase in HDL was higher in the unstructured PA group in this study. Structured or unstructured PA could be prescribed to adults as it may help in increasing serum HDL.

5.29 Comparison of serum low density lipoprotein at the 12th week between structured and unstructured physical activity groups

The result from this study showed that there was no significant change in the serum LDL in the structured and unstructured PA group although there was a decrease within the groups after the intervention. This result may suggest that structured physical activity was not superior to unstructured physical activity in lowering serum LDL.

The present study supported a randomised control trial done by Kim et al (2001) in which the result of vigorous intensity structured PA and moderate intensity unstructured PA on lipid profile was investigated over a duration of 12 months. At the conclusion of their study, they reported that although there was a decline in serum levels of LDL, the intensity of PA made little difference on serum LDL. They concluded by suggesting that frequency of activity rather than intensity may be more important in improving serum LDL. Similarly, Wood et al (2019) was supported by this study when the result of the systematic review and meta-analysis conducted by them comparing the effects of moderate and vigorous intensity PA on lipid profile showed that moderate intensity and vigorous intensity structured PA reduced serum LDL significantly but none of them is superior over the other in reducing serum LDL.

However, this study differs from that of O'Donovan et al (2005) in which they reported that after a 24 week of participation in moderate or vigorous intensity PA, those in the structured vigorous intensity PA group had a significant reduction in serum LDL, while the unstructured moderate intensity PA group showed no significant change in serum levels LDL. This study also differed from Silva et al (2016). Silver et al demonstrated from their cohort study that programmed vigorous intensity PA is associated with significant decrease in serum LDL compared to moderate intensity PA.

The present study has provided scientific data that both structured and unstructured PA may reduce serum LDL and could be explored in health promotion.

5.30 Comparison of serum triglycerides at the 12th week between structured and unstructured physical activity groups

Comparison of serum TG between SPAG and UPAG showed that there was no significant difference in serum TG between the two groups. The result of this study was in contrast with a randomised control trial done by O'Donovan et al (2005) in which they compared the effect of moderate intensity PA and vigorous intensity PA on serum TG. Result showed that at the close of the 24 weeks of their study there was a significant decline in serum TG in the vigorous intensity PA group whereas there was an increase in the TG in the moderate intensity PA group. In a systematic review carried out by Mann et al (2014), this study also differs from theirs; they revealed that a greater decrease in serum TG is associated with structured vigorous intensity PA compared to unstructured moderate intensity PA. Othman and Temur (2018) conducted an 8-week study to determine the result of regular walking and running (aerobic exercise) on some blood parameters in adults. Othman and Temur reported that at the conclusion of their study both participants had a decrease in serum TG, and there exists no significant change in both groups. Their finding was supported with the result from this study. Wood et al (2019) in their systematic review also showed that structured PA was not better than unstructured PA in regulating serum TG. The result from this present study was in consonance with the result of their study.

This study has provided scientific evidence that in modulating serum TG in overweight and obese adults, either of structured or unstructured PA programmes may be prescribed as result suggested that neither might be better than the other in lowering serum TG.

5.31 Comparison of serum fasting blood glucose at the 12th week between structured and unstructured PA groups

The result showed that serum FBG did not differ in the two groups. In a study conducted by Kong et al (2016) to investigate the effect of a 5-week structured and unstructured PA on serum FBG in overweight and obese women, they reported that even though the participants in both groups demonstrated a significant reduction in their FBG, there was no group difference in the serum FBG. Their result was supported by that of this study. This study was also in agreement with the positional statement made from Exercise and Sport Science Australia in which they stated that for a regulation or modulation of blood glucose either moderate regular structured PA (accumulated minimum of 210 minutes of moderate intensity PA each week) or mild to moderate unstructured PA (125 minutes of vigorous intensity PA each week) could be prescribed, as evidence suggests that either of them alone has been shown to be effective (Hordern et al, 2012).

However, the current study's result differs from that of Hicks et al (2021). In a systematic review of randomised controlled trials to find out the outcome of different intensities of exercise on glucose control, they reported that evidence suggests that aerobic exercise (high intensity exercise) was the most effective form of PA. In a randomised controlled trial conducted by Mendes et al (2019) to compare the effects of moderate intensity PA versus vigorous intensity PA on glycaemic control in type-2 diabetes patients, they stated a significant reduction in serum FBG, however they added that evidence suggests that vigorous intensity PA may be more effective in glucose control. This study was inconsistent with the result from their study.

The result presented in this study has provided scientific evidence suggesting that in regulating FBG either of moderate intensity PA or Vigorous intensity PA may be prescribed to patients or clients as neither was shown to be better than the other from this study.

5.32 Comparison of serum HbA1c at the 12th week between structured and unstructured PA groups

Serum HbA1c was shown not to have any significant difference between the groups. It appears that the effect on structured and unstructured PA on serum HbA1c might have been the same on all the participants in this study. Amelia et al (2018) carried out a work to determine the result of PA in regulating some biochemical profiles in patients with type-2 diabetes. They found out that both moderate and vigorous intensity PA is linked with a decreased serum HbA1c of the participants, but the vigorous intensity PA had more reducing effect. Amelia et al concluded that either moderate or vigorous intensity PA or both could be prescribed for patient and clients. Their study was not supported by findings from the result of this study. Similarly, Grace et al (2017) in their systematic review and meta-analysis were not in agreement with this study as they reported that although moderate PA and vigorous PA was associated with beneficial reduction in HbA1c, vigorous intensity PA was superior to moderate intensity PA.

Another study that was not supported by the present study was a systematic review conducted by Fajriyah et al (2020) in which they stated that both moderate intensity PA and vigorous intensity PA (represented by aerobic exercise) had beneficial effect in regulating HbA1c but more benefit was accrued from vigorous intensity PA. However, reports from this study was consistent with a meta-analysis done by Snowling and Hopkins (2006) in which they stated that moderate intensity PA and vigorous intensity PA whether structured do not differ in beneficial effect of decreasing HbA1c.

From this study it was shown that both structured and unstructured PA, may have reducing effect on serum HbA1c, however data from the study suggests that none may be superior over the other, and as such either or both may be employed in engaging in PA to reduce serum HbA1c.

5.33 Comparison of serum AST at the 12^{th} week between structured and unstructured physical activity groups

Result from this study showed that there was more decrease in serum AST in the structured PA group compared to the unstructured PA group. This may be that structured PA was more effective than unstructured PA in reducing serum AST despite both of them reduced serum AST significantly in the participants in both groups respectively.

There is a scarcity of literature to compare the outcome of structured and unstructured PA on serum AST. However, few studies have shown that serum AST is increased during excessive muscular activity which may indicate damage to the liver. Pettersson et al (2007) reported that intensive muscular activity such as weight lifting caused an increase in serum AST levels. They cautioned that exercise should be done with care so as to avoid increase in serum AST levels which could lead to erroneous interpretations of elevated liver function test. Aerobic and flexibility exercise (moderate intensity PA) have also been shown to rise AST levels within the normal plasma levels without having any adverse effect on the liver after participation in PA (Uadia et al, 2016). This study has provided evidence suggesting that participating in a structured or unstructured PA may lead to a decrease in serum AST.

5.34 Comparison of serum ALT at the 12^{th} week between structured and unstructured PA groups

Result from the study showed that at the conclusion of the study, the unstructured PA group had a higher serum ALT level compared to the structured PA group although not statistically significant.

In a case control study by Li et al (2019) in which they investigated dose–response association between PA and non-alcoholic fatty liver disease in a Chinese population they reported that an increase in serum ALT is associated with both unstructured and structured PA. Their finding was not supported by that of this study in which serum ALT was only increased slightly in the unstructured PA group.

Chen et al (2020) in their study to compare the effect of structured PA and walking on liver health of Chinese adults reported that structured PA was associated with a reduction in serum ALT, whereas walking has no association with serum ALT. The result of this study was in disagreement with that from their study. However, Abdelbasset et al (2020) differ in their study of a randomised control trial where they compared the effects of vigorous intensity exercise and moderate intensity exercise on diabetic obese patients with non-fatty liver disease. They reported from their study that there was significant reduction in serum ALT of participants in both group of intervention and none of the intervention was superior to the other in their effect on serum ALT. The result of this present study was not in accord with that of their study.

In a systematic review by Słomko et al (2021), they reported that both aerobic exercise and moderate intensity PA had the same reducing effect on serum ALT. Their systematic review was not supported by the result from this study. The result from this study has provided evidence suggesting that both structured and unstructured PA may likely cause an increase in serum levels of ALT and therefore care should be taken in administering PA to patients with liver disease.

5.35 Comparison of Cardiovascular disease risk score at 12th week between structured and unstructured PA groups

It was observed from the result of the study that the risk of developing cardiovascular disease was not significantly different in both PA groups. It is evident as seen from this study the effect of PA on some of the participants' biochemical profiles such as HDL and total cholesterol which are risk factors for CVDs.

It was reported in a study carried out by Gullu et al (2013) to evaluate the result of a 10-week aerobic PA and walking in reducing CVD risk factors of sedentary women, that both PA programmes reduced the risk factors of CVD in those who participated in the study, however the aerobic PA group had more reduction in the CVD risk factors. Myers (2003), reported that evidence suggests that both moderate intensity PA (e.g., walking) and vigorous intensity PA (e.g., aerobic exercise) may prevent or reduce the incidence of CVDs, but higher intensities provide more benefit. In simpler terms, this means that aerobic PA was more effective than walking in reducing the risk of developing CVDs even though both of them may reduce the risk factors. Their results were not supported by that of the present study.

Pinckard et al (2019) reported that both moderate intensity PA and vigorous intensity PA have been shown to reduce CVD risk by reducing adiposity, reducing total cholesterol, increasing HDL, reducing LDL and triglycerides. Their report was supported by the result from this present study. Tian and Meng (2019) in a review stated that adopting the recommendations of the American Sports Association for PA, activity of either moderate intensity or vigorous intensity PA confers on individuals' health promotion benefits that will help in the prevention and reducing the risk of developing CVDs. This study was in agreement with the finding from their study.

This study has provided scientific evidence suggesting that both structured and unstructured PA programmes are beneficial in reducing the risk of CVD. Therefore, either of the PA activity may be prescribed to patients and clients to prevent or reduce the risk of CVD.

5.36 Comparison of diabetes risk score at the 12th week between structured and unstructured PA groups

Result from the present study showed that there exists no significant change in the diabetes risk score between the structured and unstructured PA groups. This means that both PA programmes have the same effect of reducing the chance of developing diabetes in all the participants of this study.

The result of this study was consistent with the position statement of the American Diabetes Association in which they posited that structured PA and moderate intensity PA have been shown to both reduce the risk and prevent the growth of diabetes (Colberg et al., 2016). This study also supported the study of Klimek et al (2019), in which they demonstrated that a PA programme as simple as walking is as effective as a vigorous intensity PA in reducing the risk of developing type-2 diabetes as well as type-2 diabetes prevention in obese and overweight individuals. Also, in a systematic review of reviews conducted by Odunaiya and Oguntibeju (2013), it was revealed that both structured PA (for example aerobics) and moderate intensity PA could reduce the risk of diabetes mellitus. The present study was in agreement with their review.

Hu et al (1999), in their prospective study conducted over a follow up period of 8 years to compare the effects of walking and vigorous PA in reducing the risk of type 2-diabetes in women however disagreed with this study. Hu et al reported that although both walking and vigorous PA are associated with reduction in risk of developing type 2- diabetes, significant reduction in the risk of developing type-2 diabetes is more pronounced with vigorous intensity PA. Another study that this study was inconsistent with, was the cohort study done by Honda et al (2015). Result from the study of Honda et al suggests that vigorous intensity PA compared to walking is associated with a lower risk of developing type 2-diabetes. They advocated that to achieve a lower reduction in risk of developing type 2- diabetes, vigorous intensity PA alone or vigorous intensity PA combined with moderate intensity PA (such as brisk walking) should be emphasized compared to moderate intensity PA alone.

The current research has added to scientific indication on the effect of structured PA and unstructured PA in plummeting the risk of developing diabetes; thus, in minimising the chances of coming down with elevated sugar levels in the blood, either of structured or unstructured PA programmes may be prescribed to clients and patients.

5.37 Comparison of hypertension risk scores at the 12th week between SPAG and UPAG.

Findings from this research revealed that there was no significant difference in the risk of developing hypertension in both PA groups although both of them showed significant reduction in the risk of developing hypertension after exposure to the programmes. Few studies have compared the effect of structured and unstructured PA in reducing the risk of hypertension in adults.

Williams and Thompson (2013) compared the effect of modest intensity PA (e.g., walking) and vigorous intensity PA (e.g., aerobics exercise) in adults on reducing the risk of developing hypertension. They found out that walking was similar to aerobics exercise in minimising the chance of developing hypertension. The result of the present study was consistent with the result from their study.

Huai et al (2013) in their analysis of multiple scientific results on the outcome of PA on the risk of hypertension, demonstrated that both structured and unstructured PA and vigorous intensity PA were associated with a reduced risk of developing hypertension and there was no important change in the outcomes in the two PA programmes. The result of this present study was in agreement with their meta-analysis.

The present study has provided scientific data comparing the effect of structured and unstructured PA programmes in reducing hypertension risk factors in adults. This information will help in choice of PA prescription for clients or patients based on their preference and availability of resources.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

Overweight and obesity are global problems connected with numerous of ailments such as CVD, (chronic elevated blood pressure, stroke, myocardial infarction), diabetes, mental health disorders, osteoarthritis, lowered value of life and some cancers. They are serious health problems of the 21stcentury affecting an estimated 300 million people worldwide. Furthermore, they are two of the topmost preventable sources of mortality. Like most non-communicable disease (NCD), they are caused by a multitude of factors such as sedentary lifestyle, not been active physically or little levels of physical activity and unhealthy eating including alcohol consumption. Not been active physically has been shown to be a significant contributor to the high rates of obesity and overweight.

Overweight and obesity are linked with huge economic costs. These costs could either be direct or indirect costs. The direct costs could be costs in medications from managing challenges or complications associated with obesity, transportation costs to and from the hospital etc. In addition to surplus health care spending, overweight and obesity also enacts indirect expenses in the form of less efficiency and unavoidable economic loss as a result of absenteeism from work, reduced output at work, death and lasting disability. In Nigeria, there are no known estimations from the existing literature on the burden of overweight/obesity in terms of healthcare costs.

The knowledge of disease risk scores could contribute to healthy behaviours or lifestyle changes that could reduce health risks or disease burden. Since PA has been shown to have positive effects on some biochemical indices, the comparative effects in relation with biochemical indices, disease risk scores and cost of care of structured and unstructured PA among adults with overweight and obesity in a Nigerian setting were investigated in this study as there are no known data concerning this.

The review of literature for this study dwelled on description, prevalence and assessment of overweight and obesity. Classifications and types of PA were also examined in the review of literature. Structured and unstructured PA was also studied. The review also examined some selected biochemical indices associated with PA and overweight and obesity. Recommendations for physical activity were also examined in the review.

The participants for this study were recruited from the population of willing apparently healthy overweight and obese adults domiciled in Gwagwalada area council of the Federal Capital Territory, Abuja, Nigeria. Participants were recruited when they showed up from adverts from fliers and radio announcements. Four research assistants (RA) who are physiotherapists were trained to carry out the sampling and assignment into groups. Purposive selection method was used to recruit participants. Participants were screened so as to establish if they met the inclusion conditions of the study. Eligible participants were randomly allocated to one of these two groups: structured physical activity group (SPAG) or unstructured physical activity group (UPAG). The research was a randomized clinical trial listed with the Pan Africa Clinical Trial Registry (PACTR 202010681941735). Ethical approval was required and gotten from the Ethics Research Review Committee of the University of Ibadan/University College Hospital, Ibadan (UI/EC/19/0613) and the University of Abuja Teaching Hospital, Abuja (UATH/HREC/PR/2020/006) before the beginning of the study. The objectives and methods of the study was explained to the eligible participants and a written knowledgeable permission was gotten from the participants before they participated in the study.

Intervention consists of thrice a week participation in flexibility, resistant and aerobic exercise for the SPAG, while those in the UPAG were asked to do a daily self-paced walking activity monitored with a pedometer. The period of the study was twelve weeks. Outcomes were measured in terms of biochemical indices (HDL, LDL, TC, TG, FBG, HbA1c, AST and ALT); disease risk scores, FRS (cardiovascular disease), FINDRISC (diabetes) and HRS (hypertension). Cost of care was assessed using a modified cost of overweight and obesity questionnaire. Data obtained were analysed making use of descriptive and inferential statistics of Repeated measure ANOVA (LSD Post-hoc analysis was done where a significant difference was shown by ANOVA), Paired sample t-test and Student t-test

Forty-nine participants participated in the study (SPAG, n=25, UPAG, n=24). Age of the participants in the SPAG (43.48 ± 6.85 years) and UPAG (44.88 ± 7.54 years) were comparable. At the end of weeks 6 and 12 of the study, PA had effects in the cost of care, serum TC, HDL, LDL, TG, FBG, AST and disease risk scores of the SPAG, whereas at the end of the 6^{th} week and 12^{th} week of the study, the effect of PA was observed in serum HDL, LDL, TG, FBG, AST and the disease risk scores of the participants in the UPAG. Whereas the cost of care was reduced significantly from weeks 6 and 12 of the study in the SPAG, significant reductions in the cost of care was only observed at the 12^{th} week of the study in the UPAG. PA had no effect on serum ALT in both groups. PA had no superior effects on the disease risk scores in both groups. Cost of care reduced more significantly in SPAG than in UPAG post 12-week intervention. In the biochemical indices of the participants, PA had more effect on serum HDL and AST in the SPAG than the UPAG, whereas, the effect of PA was the same in serum TC, LDL, TG, FBG and HbA1c in both study groups.

Thirteen of the thirty-six proposed null hypotheses were failed to be rejected while twenty-three of the null hypotheses were rejected. Results were discussed by comparing and contrasting the findings of the study with those of related past literatures.

6.2 Conclusions

It was concluded that both structured and unstructured PA programmes had similar effects on the disease risk scores and impacted positively on some selected biochemical indices of apparently healthy overweight and obese individuals. However, structured PA had a more significant positive effect on TC, LDL, FBG and resulted in better reduction in cost of care in overweight and obese participants than unstructured PA programmes.

6.3 Recommendations

From the conclusions of this study, it is suggested that:

1. Walking (with step count monitoring) could also be prescribed to overweight and obese patients as a form of unstructured PA to clients who do not have the time or resources to engage in the well regimented form of structured PA to help in the reduction or prevention of some NCDs associated with overweight and obesity.
2. Walking as a form of PA could be prescribed to dwellers in rural communities or places where there are no healthcare experts (such as physiotherapists) to prescribe or guide PA programmes for apparently healthy individuals for health promotion activities as such unstructured PA does not pose any dangerous risk to them.
3. Awareness campaigns, outreaches and workshops should be organised for healthcare providers as well as the wide-ranging populace on the benefits of engaging in PA such as walking.
4. Enabling environment such as walkways, parks and recreation centres should be made available by the government to provide conducive environment for participation in unstructured PA.
5. More studies should be carried out to examine the long-standing effect of structured and unstructured PA on the disease risk scores and biochemical indices of overweight and obese individuals.

6.4 Contributions to Knowledge

This work has added to the knowledge that exercises to get health benefits affecting lifestyle of obese and overweight persons could also be done in places such as their home with minimal or no supervision from health experts.

6.5 Implication of this study to physiotherapy practice

The application of the findings of this study could be beneficial to physiotherapist in helping them to play more role in primary health care. Using unstructured PA in primary health care where it does not require the use of expensive equipment, facilities and much resources, physiotherapist in health promotion in the rural areas could help prevent or minimise NCDs.

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APPENDIX A

BORG'S RATE OF PERCEIVED EXERTION

- Six – No exertion at all
- Seven to eight – Extremely light (very, very light)
- Nine to ten – Very light (warm up/recovery)
- Eleven – Light (Aerobic threshold)
- Twelve to thirteen – Moderate (Anaerobic threshold)
- Fourteen to fifteen – Hard
- Sixteen to seventeen – Very hard (peak lactate tolerance)
- Eighteen to nineteen – Extremely hard (very, very hard)
- Twenty – Maximum all- out effort with absolutely nothing being held in reserve

Adapted from ACSM (2006).

Appendix B

Cost of Overweight/Obesity Questionnaire

SECTION A

1. **How much of a financial burden is your weight to you?**

- ☐ None
- ☐ Minimal
- ☐ Moderate
- ☐ Large

2. **How would you rate the resources available to help your family pay for expenses related to your weight issues?**

- ☐ Excellent
- ☐ Good
- ☐ Fair
- ☐ Poor

3. **How long have you had this excessive weight gain?**

_____________ years

4. **What gender are you?**

- ☐ Male
- ☐ Female

5. **How long does it take to drive to the hospital gym from your home?**

__________ hours ___________minutes

6. **How far is your home from the hospital?**

_________ kilometres

7. **In the future we may do follow-up studies looking at financial burden for families, can we contact you?**

☐ Yes

☐ No

SECTION B: Cost for Physiotherapy:

8. **How much did you spend last month on physiotherapy fees for your weight loss program?**

₦ ______________________

SECTION C: Cost for Home Adaptations/ Lifestyle Modifications

9. **Have you had to make adaptations to your home last month because of issues related to your excess weight?**

☐ No (SKIP to Question 10)
☐ Yes

If yes, what changes did you make last month and how much did each adaptation cost? Please only list the amount of money you have paid out-of-pocket that was not reimbursed.

Home Adaptation	**Cost for home adaptation last month**
1.	
2.	
3.	
4.	
5.	

10. Have you had to drive yourself or have someone drive you to a place originally that should have been a walking distance because you were unable to walk due to issues associated with your excess weight?

- ☐ No (SKIP to Section D)
- ☐ Yes

If yes, how much on fuel do you spend per week on fuel driving yourself to and from the place

₦___________________

SECTION D: Costs for appointments with your doctor

11. In the last month have you had an appointment with your doctor concerning health issues related to your excess weight?

- ☐ No (SKIP to Section E)
- ☐ Yes

12. If yes, how many appointments did you had with your doctor?

________________ (number of visits to the hospital)

13. How do you usually go to the hospital for your appointments?

- ☐ Personal car or vehicle
- ☐ Rental car
- ☐ Bus
- ☐ Bike
- ☐ Taxi
- ☐ Other (please specify _______________________)

14. If you drive a car for your hospital appointment how much do you usually spend on fuel? Please give the total round-trip cost for fuel.

₦________________________________

15. If you take a taxi, bus, or bike to the hospital for your appointment with your doctor how much do you usually spend for the round trip on taxi-fares or tickets?

₦_________________________________

16. During a trip to the hospital for your appointments to see your doctor how much money do you usually spend on food? Please include the total cost for food, whether purchased at the hospital or elsewhere.

₦________________________________

17. During a visit to the hospital for your appointment to see your doctor, do you ever have to spend a night outside your home because it is too difficult to travel to and from the hospital in one day?

☐No (SKIP to Question 18)

☐ Yes

If yes, how many nights have you spent away from your home in the last month as a result of your appointments?

________________________ nights away last month

Please circle the one location that best describes where you usually stay during a trip to the hospital for your appointment. Please list how much you spend on your accommodations <u>per night</u> in the right hand column?

Accommodation	**Cost per night**
Hotel	₦ per night
Family or friends	₦ per night
Other (please specify) ________________________________	₦ per night

<u>SECTION E: Costs for Medical Day Unit Visits at UATH</u>

18. In the last month did you have any Medical Day Unit visits at the UATH? (e.g. treatment for back, knee or neck pain etc)

- ☐ No (SKIP to Section F)
- ☐ Yes

If yes, how many Medical Day Unit visits did you have in the last month?

_______________ (number of Medical Day Unit visits)

19. How do you usually get to the Medical Day Unit at UATH?

- ☐ Personal car or vehicle
- ☐ Rental car
- ☐ Bus
- ☐ Bike
- ☐ Taxi
- ☐ Other (please specify ______________________)

20. If you drive a car to your Medical Day Unit visit how much do you usually spend on Fuel? Please give the total round-trip cost for fuel.

₦______________________________

21. If you take a taxi, bus or bike to your Medical Day Unit visit how much do you usually spend for the round trip on taxi-fares or tickets?

₦______________________________

22. During a trip for a Medical Day Unit visit, how much money do you usually spend on food? Please include the total cost for food, whether purchased at the UATH or elsewhere

₦______________________________

23. During a visit to the Medical Day Unit, do you ever have to spend a night outside your home because it is too difficult to travel to and from the UATH?

☐No (SKIP to Question 24)

☐ Yes

If yes, how many nights did you spend away from your home in the past month because of Medical Day Unit visits for you?

_________________ nights away last month

Please circle the one location that best describes where you usually stay during a trip to UATH for a Medical Day Unit visit. Please list how much you spend on your accommodations per night in the right hand column?

Accommodation	**Cost per night**
Hotel	₦ per night
Family or friends	₦ per night
Other (please specify) ________________________________	₦ per night

SECTION F: Costs for Appointments at your local hospital, community health centre or doctor's office

24. **In the past month how many visits did you have with doctors or health professionals at your local hospital, community health centre or a doctor's office because of issues related to your excess weight? This may include visits to the family physician, Cardiologist, Orthopaedics, Physiotherapist, Occupational Therapist, medical laboratory etc. If you saw more than one**

doctor or health professional during a visit, please count that visit as only one visit.

____________________ visits last month

25. **Approximately how much does it cost per visit to, your local hospital, community health care centre, or doctor's office? Please include transportation, parking, and food costs?**

₦ _________________ per visit

SECTION G: Emergency Room Visits at the UATH

26. **In the past month did you go to UATH Emergency Department for reasons related to excessive weight?**
    - ☐ No (SKIP to Section H)
    - ☐ Yes

27. **In the past month how many visits did you make to the emergency department at the UATH for reasons related your excessive weight?**

_____________________ Visits

28. **How do you usually get to the emergency department at the UATH?**
    - ☐ Personal car or vehicle
    - ☐ Rental car
    - ☐ Bus
    - ☐ Bike
    - ☐ Taxi
    - ☐ Other (please specify __________________________)

29. **If you drive a car to the emergency department how much did you usually spend on fuel? Please give the total round-trip cost for fuel.**

₦_________________________

30. If you take a taxi, bus, train or bike to the emergency department at the UATH how much did you usually spend for the round trip on taxi-fares or tickets?

₦______________

31. During a visit to the UATH Emergency Department last month how much money do you usually spend on food? Please include the total cost of food, whether purchased at the UATH or elsewhere.

₦___________________________

32. During a visit to the UATH Emergency Department last month, did you have to spend a night outside your home because it is too difficult to travel to and from the UATH in one day?

□No (SKIP to Question 33)

□ Yes

If yes, how many nights have you spent away from your home last month for visits to the UATH Emergency Department?

_________________________ nights away last month

Please circle the one location that best describes where you and your child usually stayed during a trip to the UATH Emergency Department because of reasons related to your excess weight. Please list how much you spent on your accommodations per night in the right hand column?

Accommodation	**Cost per night**
Hotel	₦ per night
Family or friends	₦ per night
Other (please specify) __________________________________	₦ per night

SECTION H: Emergency Room Visits at Local Hospitals

33. In the past month did you go to a local emergency department for reasons related to your excessive weight?

- ☐ No (SKIP to Section I on page 10)
- ☐ Yes

34. In the past month how many visits did you make to your local emergency department for reasons related to your excessive weight?

____________________ visits

35. How did you usually get to the emergency department at your local hospital?

- ☐ Personal car or vehicle
- ☐ Rental car
- ☐ Bus
- ☐ Bike
- ☐ Taxi
- ☐ Other (please specify ________________________)

36. If you drive a car to your local emergency department how much did you usually spend on fuel? Please give the total round-trip cost for fuel.

₦_______________________

37. If you take a taxi, bus, train or shuttle to the emergency department at your local hospital how much did you usually spend for the round trip on taxi-fares or tickets?

₦_______________________

38. During a visit to your local emergency department last month how much money did you usually spend on food? Please include the total cost of food, whether purchased at the hospital or elsewhere?

₦__________________________

39. During a visit to your local emergency department last month, did you have to spend a night outside your home because it was too difficult to travel to and from the hospital in one day?

□No (SKIP to Question 40)

□ Yes

If yes, how many nights have you spent away from your home last month for visits to the local emergency department?

________________________ nights away last month

Please circle the one location that best describes where you and your child usually stayed during a trip to your local emergency department because of reasons related to your child's arthritis. Please list how much you spent on your accommodations per night in the right hand column?

Accommodation	**Cost per night**
Hotel	₦ per night
Family or friends	₦ per night
Other (please specify) __________________________________	₦ per night

SECTION I: Costs for Admissions to UATH

40. In the past month were you admitted to the UATH for reasons related to your excessive weight? Please do not include admissions to other hospitals.

- ☐ No (SKIP to Section J on page 11)
- ☐ Yes

41. If yes, how many days did you spend admitted to the UATH for reasons related to your excessive weight last month?

_____________ days

42. While you were admitted to the UATH what form of transportation did your relatives/carerers usually use to get to and from the hospital?

- ☐ Personal car or vehicle
- ☐ Rental car
- ☐ Bus
- ☐ Bike
- ☐ Taxi
- ☐ Other (please specify _________________________)

43. If your relatives/careres drove a car, during your admission to the UATH how much did they usually spend per day on fuel travelling to and from the hospital?

₦______________ per day

44. If your relatives/carers took a bus, bike, or taxi, during your admission to the UATH how much did they spend per day on tickets or taxi-fares?

₦______________ per day

45. How much did your immediate family usually spend per day on food eaten at the hospital?

₦______________ per day

46. Do you have other children at home who required babysitting while you were admitted to the UATH for reasons related to your excessive weight?

- ☐ No (SKIP to Question 47)
- ☐ Yes

If yes, how much did you usually spend per day on babysitting?

₦______________ per day

SECTION J: Costs for Admissions to Other Hospitals

47. In the past month were you admitted to a hospital other than the UATH for reasons related to your excessive weight? Please do not include admissions to other hospitals.

- ☐ No (SKIP to Section K)
- ☐ Yes

48. If yes, how many days last month did you spend admitted to your local hospital for reasons related to your excessive weight?

_____________ days

49. While you were admitted to the hospital what form of transportation did your relatives/careres usually use to get to and from the hospital?

- ☐ Personal car or vehicle
- ☐ Rental car

- ☐ Bus
- ☐ Bike
- ☐ Taxi
- ☐ Other (please specify ________________________)

50. If your relative/carerer drove a car, during your admission how much did they usually spend per day on fuel travelling to and from the hospital?

₦______________ per day

51. If your relatives/carerer took a bus, bike or taxi, during your admission how much did they spend per day on tickets or taxi-fares?

₦______________ per day

52. How much did your immediate family usually spend per day on food eaten at the hospital?

₦______________ per day

53. Do you have other children at home who required babysitting while you were admitted to the hospital for reasons related to your excessive weight?

- ☐ No (SKIP to Question 54)
- ☐ Yes

If yes, how much did you usually spend per day on babysitting?

₦______________ per day

SECTION K: Loss of Paid Work

54. In the past month have you taken time off of paid work for appointments, admissions or other reasons related to your excessive weight?

- ☐ No (SKIP to Question 56)
- ☐ Yes

If yes, about how much money have you lost because of missed work last month due to reasons related to your excessive weight?

₦______________________

55. In the past month have other adults in your household taken time off of paid work for appointments, admissions or other reasons related to your excessive weight? Please include only adults who live in the same residence as you.

- ☐ No (SKIP to Section L at the bottom of the page)
- ☐ Yes

a) If yes, how is this person related to you?

- ☐ Spouse
- ☐ Parents
- ☐Other (please specify ______________)

b) About how much money has he/she lost because of missed employment last month due to reasons related to your excessive weight?

₦___________________

SECTION L: Sources of Income

The following section asks questions about your family's income. As further outlined in the consent document, all information will be kept in the strictest confidence. We are asking for this information so we can compare annual costs to family income.

56. **According to your 2020 tax return how much was your gross household income? Please include all wage earners living in your home. If you do not want to answer this question, please check the box stating you have chosen not to answer.**

☐₦0-5,000	☐₦40,001-50,000	☐₦150,001-200,000
☐₦5,001-10,000	☐₦50,001-60,000	☐₦200,001-300,000
☐₦10,001-15,000	☐₦60,001-80,000	☐₦300,001-400,000
☐₦15,001-20,000	☐₦80,001-100,000	☐₦400,001-500,000
☐₦20,001-30,000	☐₦100,001-120,000	☐₦500,001-800,000
☐₦30,001-40,000	☐₦120,001-150,000	☐>₦800,000

☐ I do not want to answer this question

57. **Do you have medical coverage from any of the following insurance plans?**

☐ Private health insurance plan
☐ Social assistance health insurance plan
☐ Employer health insurance plan
☐ We do not have a health insurance plan
☐ I do not know

58. **Have you received financial assistance from any of the following resources? Please check all that apply**

☐ Community Fundraising
☐ Parent living outside your household
☐ Other family members or friends
☐ UATH Social Work
☐ Social Services
☐ Other (if so please specify: ____)

59. How much money did the resources listed in question 58 contribute last month?

Community Fundraising ₦____________________________

Parent living outside your household ₦____________________________

Other family members or friends ₦____________________________

UATH Social Work ₦____________________________

Social Services ₦____________________________

Other ₦____________________________

60. What would be useful to help you with the expenses associated with your excessive weight?

____

____

____

____

____

____

Thank you for completing this questionnaire.

APPENDIX C

STEP COUNT INVENTORY FORM

Day	Numbers of steps	Calories
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		

APPENDIX D

FRAMINGHAM RISK SCORE (FRS)

Risk Factor		Risk points			
		Men		**Women**	
Age					
30-34		0		0	
35-39		2		2	
40-44		5		4	
45-49		7		5	
50-54		8		7	
55-59		10		8	
60-64		11		9	
65-69		13		10	
70-74		14		11	
75+		15		12	
HDL (mmol/L)					
>1.6		-2		-2	
1.3-1.6		-1		-1	
1.2-1.3		0		0	
0.9-1.2		1		1	
<0.9		2		2	
Total Cholesterol(mmol/L)					
< 4.1		0		0	
4.1-5.2		1		1	
5.2-6.2		2		3	
6.2-7.2		3		4	
>7.2		4		5	
Systolic BP(mmHG)		**Not Treated**	**Treated**	**Not Treated**	**Treated**
< 120		-2	0	-3	-1
120-129		0	2	0	2
130-139		1	3	1	3
140-149		2	4	2	5
150-159		2	4	4	6
160+		3	5	5	7
Diabetes	Yes	3		4	
	No	0		0	
Smoking	Yes	4		3	
	No	0		0	
Total Points					

APPENDIX E

FINNISH DIABETES RISK SCORE (FINDRISC)

Circle the right alternative

Finnish diabetes risk score	**Alternative**	**Point(s)**
Age (years)	<35 35-44 45-54 55-64 >64	0 1 2 3 4
Family History of T2D	None Parents, siblings, children Grandparents, uncle, aunt, cousin	0 5 3
Waist circumference (cm)	Female/ Male <80/ <94 80-88/ 94-102 >88 / >102	 0 3 4
Exercise (at least 30 min/day)	 Yes No	 0 2
Diet, daily vegetables, fruits and fibre Consumption	Yes No	0 2
Hypertension	No Yes	0 2
History of blood glucose	No Yes	0 5
Body mass index (kg/m^2)	<25 25-30 >30	0 1 3

APPENDIX F

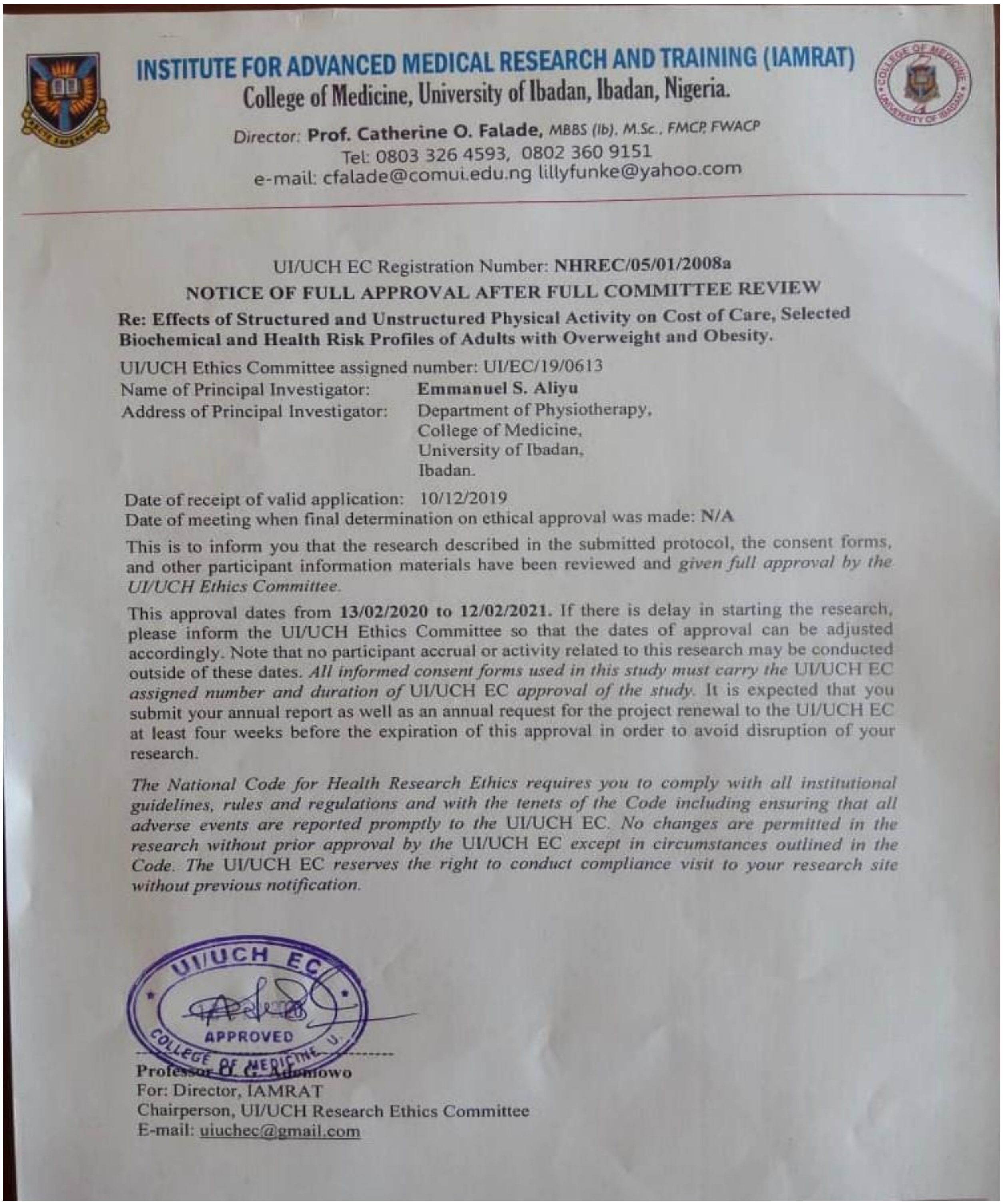
HYPERTENSION RISK SCORE (HRS)

Circle the right option

VARIABLES	POINTS	
Age (years) • < 54 • 55-64 • 65-74 • ≥ 75	 0 2 3 4	Subtotal:
Sex • Male • Female	 0 1	Subtotal:
Smoking • No • Yes	 0 1	Subtotal:
Exercise • No • Yes	 1 0	Subtotal:
Family History of Hypertension • No • Yes	 0 1	Subtotal:
Body Mass Index • < 25 (normal weight) • 25-29 (overweight) • 30-39(obese) • ≥ 40(extremely obese)	 0 1 2 3	Subtotal:
Diabetes • No • Yes	 0 1	Subtotal:
Systolic Blood Pressure (mmHg) • < 110 • 110-114 • 115-119 • 120-124 • 125-129 • 130-134 • 135-139	 0 2 3 4 6 8 14	Subtotal
Diastolic Blood Pressure (mmHg) **If age < 55 years** • < 70 • 70-79 • > 80 **If age 55-64 years** • 70-79 • > 80 **If age 65-74 years** • 70-79 • >80 **If age ≥75 years** • 70-79 • > 80	 0 2 3 -1 -1 -2 -3 -1 -2	Subtotal Total Points:

APPENDIX G

UI/UCH ETHICAL APPROVAL



INSTITUTE FOR ADVANCED MEDICAL RESEARCH AND TRAINING (IAMRAT)
College of Medicine, University of Ibadan, Ibadan, Nigeria.

Director: **Prof. Catherine O. Falade,** MBBS (Ib), M.Sc., FMCP, FWACP
Tel: 0803 326 4593, 0802 360 9151
e-mail: cfalade@comui.edu.ng lillyfunke@yahoo.com

UI/UCH EC Registration Number: **NHREC/05/01/2008a**

NOTICE OF FULL APPROVAL AFTER FULL COMMITTEE REVIEW

Re: Effects of Structured and Unstructured Physical Activity on Cost of Care, Selected Biochemical and Health Risk Profiles of Adults with Overweight and Obesity.

UI/UCH Ethics Committee assigned number: UI/EC/19/0613
Name of Principal Investigator: **Emmanuel S. Aliyu**
Address of Principal Investigator: Department of Physiotherapy, College of Medicine, University of Ibadan, Ibadan.

Date of receipt of valid application: 10/12/2019
Date of meeting when final determination on ethical approval was made: N/A

This is to inform you that the research described in the submitted protocol, the consent forms, and other participant information materials have been reviewed and *given full approval by the UI/UCH Ethics Committee.*

This approval dates from **13/02/2020 to 12/02/2021.** If there is delay in starting the research, please inform the UI/UCH Ethics Committee so that the dates of approval can be adjusted accordingly. Note that no participant accrual or activity related to this research may be conducted outside of these dates. *All informed consent forms used in this study must carry the* UI/UCH EC *assigned number and duration of* UI/UCH EC *approval of the study.* It is expected that you submit your annual report as well as an annual request for the project renewal to the UI/UCH EC at least four weeks before the expiration of this approval in order to avoid disruption of your research.

The National Code for Health Research Ethics requires you to comply with all institutional guidelines, rules and regulations and with the tenets of the Code including ensuring that all adverse events are reported promptly to the UI/UCH EC. *No changes are permitted in the research without prior approval by the* UI/UCH EC *except in circumstances outlined in the Code. The* UI/UCH EC *reserves the right to conduct compliance visit to your research site without previous notification.*

Professor O. G. Ademowo
For: Director, IAMRAT
Chairperson, UI/UCH Research Ethics Committee
E-mail: uiuchec@gmail.com

APPENDIX H

UATH ETHICAL APPROVAL

UNIVERSITY OF ABUJA TEACHING HOSPITAL

P.M.B. 228, ABUJA - F.C.T. NIGERIA
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Chief Medical Director
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FWACS, FICS, FRCOG

Chairman Medical Advisory Committee
Dr. Nicholas D. Baamlong
Bm.Bch.,FMCFM,MBA

Chairman, Board of Management
Sam Sam Jaja, Ph.D

Director of Administration
Modupe K. Adebanjo (Mrs)
BA, M.Sc, FCIA, AHAN

Our Ref: FCT/UATH/HREC/1085

Date: 30/6/20

UATH HREC Protocol number: UATH/HREC/PR/2020/015
UATH HREC Approval Number: UATH/HREC/PR/2020/006

Proposed Title: Re: Effects of structured and unstructured physical activity on cost of care, selected biochemical and health risk profiles of adults with overweight and obesity

Name of Principal Investigator: **ALIYU EMMANUEL SAMUEL**

Address of Principal Investigator: Physiotherapy Department , UATH Abuja

Date of receipt of valid application: 19/5/2020
Date when final determination of research was made: 30/6/2020
Proposed site: UATH
Sponsor: Principal Investigator

This is to inform you that the activity described in the submitted protocol/documents have been reviewed and the UATH HREC has determined that according to the National Code for Health Research Ethics, the activity described has met the criteria for approval and is thus approved.

The National Code for Health Research Ethics requires you to comply with all institutional guidelines, rules, regulations and the tenets of the code.

The approval is for one year and will lapse on 30/6/21. However, it could be renewed on request by application four weeks before the expiry of the approval.

Accept assurance of our highest regards.

30/06/2020

PROF. ABUBAKAR M. JAMDA
Chairman UATH HREC

APPENDIX I

INFORMED CONSENT FORM

Title: Effects of Physical Activity programmes on Cost of care, selected biochemical and Health Risk Profiles of Adults with Overweight and Obesity.

Introduction: This research study is being conducted by Mr. Aliyu, Emmanuel a PhD student of the Department of Physiotherapy, University of Ibadan under the supervision of Prof. A.F. Adeniyi and Dr Omoyemi O. Ogwumike.

Purpose: To determine the effects of structured and unstructured physical activity on cost of care, selected biochemical and health risk profiles of overweight and obese adults.

Procedure: If you consent to participate in this study, the following will be done.

(a) Complete the Bio data and baseline screening procedure.
(b) Complete some sets of questionnaires: cost of obesity questionnaire, Framingham Cardiovascular risk questionnaire, Finnish diabetes risk score questionnaire and hypertension risk score questionnaire.
(c) Measurement of height, weight and waist circumference.
(d) Undergo a Workout on a Treadmill, participate in some flexibility and resistance exercises or participate in a walking group that will use a step counter device, depending on which group you fall into.
(e) Participate in a training programme three times a week (Mondays, Wednesdays and Friday or Tuesday, Thursday and Saturday depending on which group you fall into) for 12-week. The total duration of each session will be done in about 60 minutes. Also you will be required to wear a physical activity monitor (pedometer) for between 30 minutes- 1 hour five days a week for 12-week to estimate the daily steps and calories expended per day.
(f) Collect your blood samples before the commencement of the study, 6-week and 12-week after the training programme.

Risks and Discomforts: There are minimal risks associated with participation in this study. There is the possibility of certain response occurring during the test. Extensive efforts are made to minimize these risks through pre-test screening and information regarding your medical history concerning your health and fitness and through careful observation during the test. Trained personnel and emergency equipment are available to immediately deal with any unusual occurrences.

Participant Responsibilities: Any past or current health symptoms that you are aware of (including shortness of breath, pain, tightness/heaviness in the chest, neck, jaw, back and/or arms) with physical effort may affect your safety during the test. It is imperative that you promptly report any of these symptoms if they occur during the test. It is your responsibility to fully disclose past medical history as requested in the pre-test screening, it is also important that you report medications that you are currently taking to the test administrator.

Expected Benefits: At your request, information pertaining to your clinical parameter will be explained to you. This information can be used to modify or design a fitness program to help you meet your treatment goals and needs. The results of this study may impact the manner in which exercise is prescribed during fitness and weight loss programme.

Confidentiality/use of Results: The information obtained from the test will be treated with confidentiality. Participant will not be identified with their results at any time, except when discussing personal results with the respective individual.

Inquires/Questions about the Research: If you have any questions, concerns and comments regarding procedure or use of results you may contact me on 08036080677 or shalomemmy@gmail.com.

Freedom of Consent

I hereby consent to voluntarily engage to this research as explained. My permission to participate in this study is voluntary. I understand that I am free to stop the test at any point if I so desire.

I have read this form and I understand the test procedure that I will perform and the attendant risks and discomforts knowing these risks and discomforts and having had an opportunity to ask questions that have been answered to my satisfaction. I consent to participate in this research.

______________________________ ____________ ____________

Name of Participant **Signature** **Date**

______________________________ ____________ ____________

Name of Witness **Signature** **Date**

APPENDIX J

DATA FORM

Sociodemographic Data

- Age ________________
- Sex ________________ Male/ Female
- Marital Status _________________ Married/ Single/ Divorced/ Widowed
- Educational level ______________________
- Occupation _____________________
- Mobile number ______________________

Clinical characteristics

Variables	Pre test	6-week	12-week
Blood pressure(mmHG)			
Weight (kg)			
Height (m)			
BMI (kg/m^2)			
Waist circumference (cm)			

Biochemical Profiles

Variables	Pre test	6 weeks	12 weeks
HDL ($mmol.L^{-1}$)			
LDL ($mmol.L^{-1}$)			
Glycerides ($mmol.L^{-1}$)			
Total Cholesterol ($mmol.L^{-1}$)			
Fasting blood sugar			
HbA1c (%)			
AST (IU/L)			
ALT (IU/L)			