EFFECTS OF A 12-WEEK EXERCISE PROGRAMME ON ABDOMINAL ADIPOSITY, SELECTED CARDIORESPIRATORY INDICES AND QUALITYOF LIFE IN APPARENTLY HEALTHY SEDENTARY ADULTS

BY

AYODELE AKINTUNDE, AKINREMI
B.Sc. Physiotherapy (Ibadan), M.Sc. Human Physiology (Jos)
NLPT (Nig.), MNSP (Nig.), MISCP (Ireland)

Matric No: 75019

A Thesis in the Department of Physiotherapy,
Submitted to the Faculty of Clinical Sciences
In partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY (CARDIOPULMONARY PHYSIOTHERAPY)

of the

UNIVERSITY OF IBADAN

April 2013

_______________________ Supervisor

_______________________ Head of Department

CERTIFICATION

We certify that this study was carried out by Mr A. A. Akinremi in the Department of Physiotherapy, University of Ibadan, Ibadan, Nigeria.

……………………..…..

SUPERVISOR
Prof. Arinola O. Sanya
B.Sc. Physiotherapy, PhD. (Ibadan)
FNSP, MNIM
Department of Physiotherapy
College of Medicine,
University of Ibadan, Nigeria

……………………..…..

CO- SUPERVISOR
Dr. Arinola A. Sanusi
MBBS, FMCA, DA (UK), FWACS
Department of Anaesthesia
College of Medicine,
University of Ibadan, Nigeria

DEDICATION

This work is dedicated to the memory of my late father

Pa Joseph Sunday Akinbola Akinremi.

He sacrificed to get me started.

ABSTRACT

Abdominal adiposity may be associated with impaired cardiorespiratory function and reduced quality of life. Studies have reported that aerobic exercises significantly reduce general adiposity, but has little or no effect on abdominal adiposity. However the effects of a combination of aerobic and abdominal strengthening exercises on abdominal adiposity are not known. Also it is not clear whether any change in abdominal adiposity may be accompanied by changes in cardiorespiratory function and quality of life of Apparently Healthy Sedentary Adults (AHSA). Hence, this study was designed to evaluate the effects of a 12-week aerobic and abdominal strengthening exercise programme on abdominal adiposity, cardiorespiratory function and quality of life of AHSA.

Two hundred and fourteen consenting AHSA participated in this quasi experimental study. They were recruited from the University College Hospital community and randomly assigned into Exercise Group (EG) and Control Group (CG). The EG comprised 105 participants while the CG comprised 109 participants, however 74 participants in the EG and 68 in the CG completed the study. Both groups received health promotion education, while only participants in the EG went through exercise training which included aerobic and abdominal strengthening exercises. Exercise was carried out thrice weekly for 12 consecutive weeks. Adiposity indices- Waist Circumference (WC), Waist-to-Hip Ratio (WHR), Sum of Abdominal Skinfold (SAS); Cardiorespiratory indices- Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Heart Rate (HR), Forced Vital Capacity (FVC), Forced Expiratory Volume in first second (FEV_1), Peak Expiratory Flow Rate (PEFR), Maximum Oxygen Consumption (VO_{2max}) and Quality of Life (QoL) were assessed at baseline, 4^{th}, 8^{th} and 12^{th} weeks for both groups. Quality of life was assessed using World Health Organization Quality of Life (WHOQoL) questionnaire. Data were analysed using descriptive statistics, t-test and repeated measures ANOVA at p=0.05.

Participants in the EG and CG were comparable in age (35.4±9.7 and 34.7±7.6yrs); weight (76.6±13.8 and 74.8±12.6kg); and height (1.6±7.0 and 1.6±7.2m) at baseline. The EG had significant increases between the scores at baseline and at the end of the 12^{th} week of study in $VO2_{max}$ (14.3±5.3 and 15.4±4.8L/kg/min), PEFR (366.4±69.3 and 473.1±64.2L/sec), FEV_1 (2.1±0.6 and 2.8±0.6L), FVC (2.6±0.6 and 3.5±0.7L) and QoL score (262.6±35.5 and 332.8± 32.4). However, there were significant decreases in WC (94.4±10.8 to 89.2±9.8cm), SAS (77.3±17.6 to 69.3±16.9mm), SBP (119.5±12.3 to 112.1±8.1mmHg), DBP (75.4±9.7 to 67.4±6.1mmHg) and HR (81.4±10.7 to 70.1±6.2b/min). Within the CG, there was a significant increase in DBP (73.5±8.4 to 77.3 ±7.3mmHg), but there was none in other parameters. At the end of the12^{th} week showed significant differences between the EG and CG in WC (89.2±9.8 and 93.7±9.7cm), SAS (69.3±16.9 and 77.3±17.6mm) and VO_{2max} (15.4±4.8 and14.4±7.1L/kg/min); PEFR (473.1±64.2 and 420.7±74.8 L/sec), SBP

(112.1±8.1and119.6±7.1mmHg), DBP (67.4±6.1 and 77.4 ±7.9mmHg), HR (70.1±6.2 and 77.4±5.8b/min) and QoL (332.8±32.4 and 255.0± 29.5) respectively.

Twelve-week aerobic and abdominal strengthening exercise programme reduced abdominal adiposity, improved cardiorespiratory function and quality of life in apparently-healthy sedentary adults. A combination of aerobic and abdominal strengthening exercise programme is recommended to people in this category for beneficial.

Keywords: Abdominal strengthening exercise, Abdominal adiposity, Cardiorespirator y function, Quality of life

Word count: 494

ACKNOWLEDGEMENT

Fundamentally, all thanks be to God for He is the Author and Perfecter of all things. Nothing can be without Him, and with Him all things are possible. This dream has come through because of His Grace.

My profound gratitude goes to my Teacher, Mentor Supervisor and Mother Professor Arinola Olasunmbo Sanya. Her relentless support, encouragement and motivation inspired me to move on at every stage of this endeavour. She spared no effort to ensure this work was properly planned and well implemented. Words are not sufficient to express my gratitude. For sure, those who make others rise, never fall. May you continue to rise higher and fly further in Jesus name. May your seeds never walk in darkness.

Many thanks to my Co-supervisor Dr (Mrs) Arinola Sanusi. Her continuous confidence in my ability is noteworthy. For all the support, goodwill and linkages, words aren't enough. Those who smoothen the path of others never stumble in life. May your seeds never stumble in the path of life in Jesus name.

Sincere thanks to all my teachers at all levels of Physiotherapy training, especially during the postgraduate programme. Professor Arinola O. Sanya, Dr A. O. Akinpelu, Dr B. O. A. Adegoke, Prof. T. K Hamzat, Dr O. Ayanniyi, Dr A. F. Adeniyi, Dr A. C Odole and Dr O. O. Ogwumike; also Dr A. A. Fabunmi, Mr A. Jaiyesimi, Mrs N. Odunaiya. Special thanks also goes to the non-academic staff of the Department of Physiotherapy, particularly, Mr Oyegunle (rtd), Mr Oyekunle, Mrs Adenekan, Mr Egbeyale, Mrs Olorode. Special thanks also to Mr Sanni (Sannitherapy) for his assistance.

To Ruth and Raymond – my able assistants, and Rev Fr. Kuti, you all will never lack help. I appreciate you. Likewise, the assistance of the clinicians at the University College Hospital, Ibadan cannot be overlooked, especially those at the cardiopulmonary unit. Heartfelt gratitude goes to all the teachers, residents and friends at the Anaesthesia Department of the University of Ibadan.

To my parents, Late (Pa) & Mrs J. S. Akinremi, I not only appreciate you, but also rejoice with you because the investment you made some decades ago, when you insisted and sacrificially, against the advice of friends and relatives, registered me at the University of Ibadan Staff School, is still paying off. Daddy, even in death you were right! I am indebted in many ways. Iya-Akin, for the ceaseless prayers, I remain ever grateful.

To my special siblings, Akinremi, A. Akinyinka (Esq), FCA; Akinremi Olayemi (M.Sc); Akinremi Tolulope (M.Sc); Akinremi Anuolwapo (MBA) and Akinremi Grace. Without mincing words, you all are a great asset. The shared tears, sorrows, joys, jubilations and silent solemn moments have made us stronger.

To my friend and wife, living on this side of eternity will certainly be lonely and 'uneventful', if it is not accompanied by a beautiful, big, bold and brilliant damsel all packaged in Abiola Wuraola Akinremi. From two of us, over a decade ago, now our 'company' has grown in leaps and bounds to include Fortune Ayomiposi Akinremi, Blossom Ayomikun Akinremi and Glory Oluwasikemi Akinremi. What else can a gentle man ask for? I appreciate and love you all.

Sharing time, space and ideas with you all has added value to my life.

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

As the prevalence of obesity is rising worldwide, it poses one of the most serious public health challenges of the 21st century (National Center for Health Statistics, 2004; Ochs-Balcom et al., 2006). A high proportion of death resulting from chronic diseases is attributable to increasing prevalence of obesity in both middle and low income countries (WHO, 2008a). Obesity has been linked with a number of cardiometabolic abnormalities such as impaired glucose tolerance, dyslipidaemia and hypertension (Ritchie and Connell, 2007). Individuals with excess abdominal adiposity are exposed to increased risk of cardiovascular diseases, diabetes, hypertension, and other chronic diseases and consequently reduced quality of life (WHO, 2004).

Increased abdominal adiposity has also been linked with impaired cardiovascular and respiratory function (Farrell et al., 2004). A study by Calabro and Yeh (2008) supports the role of abdominal adipose tissue in the development of a systemic inflammatory state, which contributes to obesity-associated vasculopathy and cardiovascular risk. Likewise, excess abdominal obesity measured using waist circumference and waist-hip-ratio have been used to predict poor pulmonary function (Chen et al 2007) and low cardiorespiratory fitness (Silmara et al., 2009). Investigating the relationship between cardiorespiratory fitness (CRF) and all-cause mortality, Farrell et al. (2004) showed that low CRF is an important predictor of all-cause mortality and recommended that CRF should be considered when examining the impact of abdominal adiposity on quality of life.

Report from a recent study (Ismail et al, 2012), suggests that abdominal adiposity can be used to predict the incidence of Coronary Heart Disease (CHD) independent of body mass index; and that low abdominal fat is associated with reduced CHD risk (Canoy, 2010). Large waist circumference has also been found to be positively associated with high systolic and diastolic blood pressure (Gruson et al, 2010).

Total body fat and central adiposity are inversely associated with lung function, but the amount of fat-free mass correlates positively with lung function (Wannamethee et al, 2005). Excess abdominal adiposity alters the pressure-volume characteristics of the thorax and restricts the descent of the diaphragm, thereby limiting lung expansion (Harik-Khan et al, 2001). This reduction in ventilation at the lung bases can lead to closure of peripheral lung units, ventilation to perfusion ratio abnormalities and arterial hypoxaemia (Canoy et al, 2004). Central obesity increases oxygen demand of respiratory muscles which can lead to respiratory muscle inefficiency (Parameswaran et al, 2006), reduce expiratory reserve volume, reduce forced vital capacity (FVC) and increase the work of breathing (Ochs-Balcom et al, 2006). Wannamethee et al, (2005) showed that waist circumference was negatively associated with Forced expiratory volume in the first second (FEV_1) and FVC.

Quality of life refers to the physical, psychological, and social domains of health, seen as distinct areas that are influenced by a person's experiences, beliefs, expectations, and perceptions (Brook et al, 2003). Aspects of quality of life that affect health, either physical or mental, are referred to as health-related quality of life (HRQOL) (U.S. Department of Health and Human Services 2000). HRQOL and its determinants have been explored since the 1970s and include measurement of subjective components of human function and well-being (McHorney, 2004). Obesity affects important aspects of HRQOL, including physical health, emotional well-being, and psychosocial function (Doll et al, 2000). Both cross-sectional and longitudinal studies have shown HRQOL to diminish as BMI increases from normal to obese (Fontaine and Barofsky, 2001; Ford et al, 2001). Furthermore, HRQOL has been used to monitor the efficacy of obesity treatment (Kolotkin et al, 2002)

Regular physical activity using large muscle groups produces cardiovascular and respiratory adaptations that increase exercise capacity, endurance, and skeletal muscle strength. Aerobic exercise has been shown to prevent the development of coronary artery disease (CAD), improve ventilatory efficiency and reduce the risk of chronic diseases, including type 2 diabetes, osteoporosis, obesity, depression and cancer of the breast and colon (American Heart Association, 2003). A study by Alberga et al (2008) showed that a combination of aerobic and strengthening exercises were associated with reduced risk of cardiovascular disease, increased lean body mass, improved muscular strength, and reduced general adiposity and blood pressure in overweight individuals. Their study concluded that regular participation in a well prescribed exercise program should be considered an important component of health promotion and primary prevention of chronic diseases.

1.2 Statement of the Problem

Despite the association between abdominal obesity phenotype and health risk (National Center for Health Statistics, 2004), leading health authorities still recommend weight loss of between 5% and 10 % as a primary treatment strategy for the reduction of obesity and its related comorbid conditions (Lau, et al, 2006; US Department of Health, 2006). While the causal link between abdominal adiposity and morbidity is still growing, accruing evidence suggests that the quantity of intra-abdominal fat explains the association between abdominal obesity, morbidity and mortality (Kuk, et al, 2006; WHO, 2008b).

Overweight and obesity, which were previously thought to be infrequent, are increasingly becoming visible in Nigeria (Puepet et al, 2002). A 2008 WHO report puts the prevalence of overweight and obesity in Nigeria at 26% and 6.5% respectively (WHO, 2011). In Nigeria early data in the middle and later part of the last century suggested a low prevalence (Lawoyin et al, 2002; Johnson, 1970). However recent rports from various studies indicate an increasing prevalence (Akpa et al, 2006; Adedoyin et al, 2009; Amole et al, 2011). In a population based study among apparently healthy adults in southwestern Nigeria, obesity prevalence was reported to be 21% among males and 28% among females (Kadiri and Salako, 2004). Another study on hypertensive patients showed prevalence rates of 17.6% in females and 50.5% among males (Amodu et al, 2005).

It has been advocated that apparently healthy sedentary adults should be the focus of screening and primary prevention strategies to proactively combat the global increase in obesity-related disorders (Ross et al, 2002), but this population rarely received adequate clinical attention in this regard (Sanya, 2010). This may be due, in part, to the inconsistency in reports of studies that investigated the effect of exercise on abdominal adiposity. Studies have reported that aerobic exercise significantly reduce general adiposity, but has little or no effect on abdominal adiposity (King et al, 2008; Williams, 2008; Nicklas et al, 2009).

Also strengthening exercises have been recommended as an integral part of exercise therapy program for obesity management (Pollock t al, 2000; Pescatello rt al, 2004 and Sigal et al, 2004). While these recommendations are primarily based on effects of strengthening exercises on muscle strength, there is dearth of information on the influence of abdominal muscle strengthening exercise in obesity management.

While evidence on the effects of different combination of exercises regimen on abdominal adiposity continues to grow (Ross and Janssen, 2001, Donnelly et al, 2003; Ross et al, 2004; Okura et al, 2005; Okura et al, 2007), little is known about the effects of a combination of aerobic and abdominal strengthening exercises on abdominal adiposity (Slentz et al, 2004 Donnelly and Smith, 2005). Also it is not clear whether changes in abdominal adiposity, if any, might be accompanied by changes in cardiorespiratory function and quality of life of Apparently Healthy Sedentary Adults (AHSA).

Hence, this study was designed to evaluate the effects of a 12-week supervised aerobic and abdominal strengthening exercise programme on abdominal adiposity indices of waist circumference, waist–hip-ratio and abdominal skinfolds; and also to find out the effect of this exercise programme on cardiopulmonary functions and quality of life, irrespective of changes in abdominal adiposity. Therefore, this study was designed to address the following questions:

1. What would be the effects of a 12-week aerobic and abdominal strengthening exercise programme on selected indices of abdominal adiposity (waist circumference, waist-to-hip ratio, sum of abdominal and suprailiac skinfold thickness) in apparently healthy sedentary adults?

2. What would be the effects of a 12-week aerobic and abdominal strengthening exercise programme on selected cardio-respiratory indices (Heart Rate, Systolic Blood Pressure, Diastolic Blood Pressure, Peak Expiratory Flow Rate, Forced Vital Capacity, Forced Expiratory Volume in first second, Forced Expiratory Ratio, Maximum Oxygen Consumption) and quality of life in apparently healthy sedentary adults in response to abdominal fat loss?

1.3 Aims of the Study

This study was aimed at:

1. Evaluating the effects of a 12-week aerobic and abdominal strengthening exercise programme on selected indices of abdominal adiposity in apparently healthy sedentary adults.
2. Investigating the effect of a 12-week aerobic and abdominal strengthening exercise programme on selected cardio-respiratory indices and quality of life in apparently healthy sedentary adults.

1.4 Hypotheses

1.4.1 Main Hypothesis

A 12-week aerobic and abdominal strengthening exercise training programme would have no significant effect on selected indices of abdominal adiposity, cardiorespiratory indices and quality of life in apparently healthy sedentary adults.

1.4.2 Sub Hypotheses

The following hypotheses were tested:

1. There would be no significant difference in the waist circumference of participants between experimental and control groups at the baseline of study.
2. There would be no significant difference in the waist-to-hip ratio of participants between experimental and control groups at the baseline of study.
3. There would be no significant difference in the sum of abdominal skin-folds of participants between experimental and control groups at the baseline of study.
4. There would be no significant difference in the peak expiratory flow rate of participants between experimental and control groups at the baseline of study.
5. There would be no significant difference in the forced expiratory volume in the first second of participants between experimental and control groups at the baseline of study.
6. There would be no significant difference in the forced vital capacity of participants between experimental and control groups at the baseline of study.
7. There would be no significant difference in the forced expiratory ratio of participants between experimental and control groups at the baseline of study.
8. There would be no significant difference in the systolic blood pressure of participants between experimental and control groups at the baseline of study.
9. There would be no significant difference in the diastolic blood pressure of participants between experimental and control groups at the baseline of study.
10. There would be no significant difference in the heart rate of participants between experimental and control groups at the baseline of study.

11. There would be no significant difference in the maximum oxygen consumption of participants between experimental and control groups at the baseline of study.
12. There would be no significant difference in the sum of quality of life domains scores of participants between experimental and control groups at the baseline of study.
13. There would be no significant difference in the waist circumference of participants between experimental and control groups at the end of 12th week of study.
14. There would be no significant difference in the waist-to-hip ratio of participants between experimental and control groups at the end of 12th week of study.
15. There would be no significant difference in the sum of abdominal skin-folds of participants between experimental and control groups at the end of 12th week of study.
16. There would be no significant difference in the peak expiratory flow rate of participants between experimental and control groups at the end of 12th week of study.
17. There would be no significant difference in the forced expiratory volume in the first second of participants between experimental and control groups at the end of 12th week of study.
18. There would be no significant difference in the forced vital capacity of participants between experimental and control groups at the end of 12th week of study.
19. There would be no significant difference in the forced expiratory ratio of participants between experimental and control groups at the end of 12th week of study.

20. There would be no significant difference in the systolic blood pressure of participants between experimental and control groups at the end of 12th week of study.
21. There would be no significant difference in the diastolic blood pressure of participants between experimental and control groups at the end of 12th week of study.
22. There would be no significant difference in the heart rate of participants between experimental and control groups at the end of 12th week of study.
23. There would be no significant difference in the maximum oxygen consumption of participants between experimental and control groups at the end of 12th week of study.
24. There would be no significant difference in the sum of quality of life domains scores of participants between experimental and control groups at the end of 12th week of study.
25. There would be no significant difference in waist circumference of participants in the experimental group at baseline, 4th, 8th, and 12th week of study.
26. There would be no significant difference in waist-to-hip ratio of participants in the experimental group at baseline, 4th, 8th and 12th week of study.
27. There would be no significant difference in sum of abdominal skin-folds of participants in the experimental group at baseline, 4th, 8th and 12th week of study.
28. There would be no significant difference in peak expiratory flow rate of participants in the experimental group at baseline, 4th, 8th and 12th week of study.
29. There would be no significant difference in forced expiratory volume in the first second of participants in the experimental group at baseline, 4th, 8th and 12th week of study.

30. There would be no significant difference in forced vital capacity of participants in the experimental group at baseline, 4th, 8th and 12th week of study.
31. There would be no significant difference in forced expiratory ratio of participants in the experimental group at baseline, 4th, 8th and 12th week of study.
32. There would be no significant difference in systolic blood pressure of participants in the experimental group at baseline, 4th, 8th and 12th week of study.
33. There would be no significant difference in diastolic blood pressure of participants in the experimental group at baseline, 4th, 8th and 12th week of study.
34. There would be no significant difference in heart rate of participants in the experimental group at baseline, 4th, 8th and 12th week of study.
35. There would be no significant difference in maximum oxygen consumption of participants in the experimental group at baseline, 4th, 8th and 12th week of study.
36. There would be no significant difference in the sum of quality of life domains scores of participants in the experimental group at baseline, 4th, 8th and 12th week of study.
37. There would be no significant difference in waist circumference of participants in the control group at baseline, 4th, 8th, and 12th week of study.
38. There would be no significant difference in waist-to-hip ratio of participants in the control group at baseline, 4th, 8th and 12th week of study.
39. There would be no significant difference in sum of abdominal skin-folds of participants in the control group at baseline, 4th, 8th and 12th week of study.
40. There would be no significant difference in peak expiratory flow rate of participants in the control group at baseline, 4th, 8th and 12th week of study.

41. There would be no significant difference in forced expiratory volume in the first second of participants in the control group at baseline, 4th, 8th and 12th week of study.
42. There would be no significant difference in forced vital capacity of participants in the control group at baseline, 4th, 8th and 12th week of study.
43. There would be no significant difference in forced expiratory ratio of participants in the control group at baseline, 4th, 8th and 12th week of study.
44. There would be no significant difference in systolic blood pressure of participants in the control group at baseline, 4th, 8th and 12th week of study.
45. There would be no significant difference in diastolic blood pressure of participants in the control group at baseline, 4th, 8th and 12th week of study.
46. There would be no significant difference in heart rate of participants in the control group at baseline, 4th, 8th and 12th week of study.
47. There would be no significant difference in maximum oxygen consumption of participants in the control group at baseline, 4th, 8th and 12th week of study.
48. There would be no significant difference in the sum of quality of life domains scores of participants in the control group at baseline, 4th, 8th and 12th week of study.

1.5 Delimitation

This study was delimited as follows:

1. Participants: This study was delimited to apparently-healthy sedentary male and female adults between the ages of 20 and 60 years (Slentz et al, 2004; Schmitz et al., 2007)

2. Anthropometric Measurements: to selected anthropometric indices of Waist Circumference (WC), Waist-Hip-Ratio (WHR), Sum of abdominal skin-fold and supra-iliac skinfold (Canoy, 2010).
3. Cardiorespiratory Measurements: to selected cardiorespiratory indices of resting Diastolic Blood Pressure (DBP), resting Systolic Blood Pressure (SDP), resting Heart Rate (HR), Peak Expiratory Flow Rate (PEFR), Forced Expiratory Volume in the first second (FEV1), Forced Vital Capacity (FVC), Forced Expiratory Ratio (FER) and Maximum Oxygen Consumption (VO_2max) were measured (Silmara et al., 2009).
4. Quality of Life: This study was delimited to the Physical, Psychological, Social and Environmental components of quality of life as contained in the World Health Organization Quality of Life Bref Form (WHOQOL-Bref)
5. Exercise state of participants: This study was delimited to participants who were not involved in exercises at competitive or recreational levels aside what was done in the gymnasium during the study (Donovan et al., 2005).
6. Location: This study was carried out at the Exercise Laboratory of the Department of Physiotherapy, College of Medicine, University of Ibadan.
7. Exercise Intervention: The exercise intervention of the study was delimited to general aerobics exercises, breathing exercises and circuit abdominal strengthening exercises for a 12-week period (King et al, 2008).

1.6 Limitation

This study had the following limitation:

Most of the individuals involved in this study had to go to their offices/workplace in the mornings and only use their break period to participate in the study, hence it was not practicable to carry out skinfold thickness measurement in the morning as recommended by standard protocol.

1.7 Inclusion Criteria

i. Apparently healthy male and female adults, between the ages of 20 and 60 years, who had baseline values 'safe for exercises' as screened by the researcher using the Exercise Readiness Questionnaire (Slentz et al, 2004)

ii. Apparently healthy male and female adults who were not engaged in routine exercise training at recreational or competitive level (Ross et al, 2004; Slentz et al, 2004).

iii. Prospective participant who could perform the 3-minute step test exercise heart rate between 65- 85% of maximal heart rate (Donovan et al., 2005).

1.8 Exclusion Criteria

1. Any prospective participant who answers yes to any question in the Exercise Readiness Questionnaire and who could not get medical clearance from Physicians to commence exercise were excluded from the study (Donovan et al, 2005).
2. Pregnant women (or women who became pregnant during the course of the exercise programme) were excluded from this study (Ross et al, 2004; Sternfield et al, 2004).
3. Prospective participant who had concurrent pathologies such as diabetes, hypertension, stroke, cardiovascular or respiratory disorders were excluded from this study (Slentz et al, 2004).

4 Individuals who had to commence exercise training at recreational or competitive level after enrolling for the study were excluded from continuing with the programme (Ross et al, 2004; Slentz et al, 2005).

1.9 Significance of the Study

The outcome of this study provided more clinical evidence on the effectiveness of combined aerobic and abdominal strengthening exercises in reducing abdominal adiposity in apparently healthy sedentary adults. This may further strengthen clinical judgment of healthcare providers to better manage apparently healthy individuals who report to the clinic with complains about their abdominal bulge. This study also showed that additional benefits of improved cardiopulmonary function and quality of life may be obtained from a combination of aerobic and abdominal strengthening exercises in apparently healthy sedentary adults.

CHAPTER TWO

LITERATURE REVIEW

2.1. Epidemiology of Obesity

Overweight and obesity are defined as abnormal or excessive adiposity that may impair health (WHO 2004). Globally, obesity has more than doubled since 1980 and by the end of 2008, more than 1.4 billion adults, 20 years and older, were overweight, out of which over 200 million men and nearly 300 million women were obese (WHO, 2008a). Excessive adiposity is the fifth leading risk for global deaths resulting in about 2.8 million adult mortality annually (WHO, 2008a). Obesity accounts for about 44% of the disease burden of diabetes, 23% of ischaemic heart disease and between 7% and 41% of certain cancers (WHO, 2008a).

Most of the information on prevalence of obesity are derived from North America and Europe. For example in the United States, data from the National Health and Nutrition Examination Survey (2007 - 2008), showed that 72.3% of men, 64.1% of women, and 68.0% of adults overall were either overweight or obese, with 32.2% of men, 35.5% of women, and 33.8% of adults overall being obese. The survey also showed racial differences in the prevalence of obesity, with the Non-Hispanic white adults having a prevalence of 32.8%, compared with 44.1% for non-Hispanic blacks and 38.7% for Hispanics. Racial differences are especially pronounced among women: 33.0% of non-Hispanic white women are obese compared with 49.6% and 43.0% of non-Hispanic black and Hispanic women, respectively.

Likewise, excess body adiposity constitutes a serious public health challenges in European nations (Branca et al, 2007). According to the data from the WHO European Regional Office, overweight is responsible for a large proportion of the total burden of disease in the region with more than 1 million deaths and 12 million life-years of ill health every year (James, 2004).

Even among children, prevalence of obesity is rising and is strongly associated with risk factors for cardiovascular diseases and diabetes, orthopaedic problems and mental disorders, and linked to underachievement in school and to lower self-esteem (Dietz, 2008). Metabolic and cardiovascular risk profiles tend to track from childhood into adult life, resulting in an elevated risk of ill health and premature mortality. Over 60% of children who are overweight before puberty will be overweight in early adulthood, reducing the average age at which non-communicable diseases (NCD) become apparent and greatly increasing the burden on health services, which have to provide treatment during much of their adult life (Deshmuk, 2006).

According to WHO (2008a), low- and middle-income countries are now experiencing escalating burden of morbidity and mortality. This has been attributed to the rapid upsurge in non-communicable disease risk factors such as obesity and overweight, particularly in urban settings. While historically, under nutrition has received more public health attention in the sub region, today, obesity and its associated chronic diseases have become a growing problem. Recently, obesity has been termed "silent epidemic," (Dalal et al, 2011) striking countries that are still struggling with the health and economic burdens of malnutrition, infectious disease, and high childhood mortality rates. Although data from nationally representative studies of obesity in sub-Saharan Africa are scarce, there is increasing evidence that obesity is on the increase in the sub region (Finucane et al, 2011). Some studies in urban settings have found that obesity rates are rising even more quickly in the poor than in the rich. (Ziraba et al, 2009)

As the problem of obesity continues to grow, so the morbidity and mortality associated with it. Data from WHO (Mathers et al, 2004) showed that in the African sub-region, non-communicable disease accounted for 24% of deaths in men and 25.8% deaths in women resulting in a total of 2.8 million, with cardiovascular diseases accounting for 42% of such deaths. Nigeria, being the most populous nation in the sub region had 24.2% (men) and 25.1% (women) estimated proportional deaths resulting from NCD. The magnitude of the problem in Nigeria is worthy of more attention as it bears 20% of the mortality from NCD and 41% of deaths resulting from cardiovascular disease in the sub region.

Social factors linking abdominal fat accumulation with increased disease risk have long been investigated. Brunner et al, (2004) investigated the social distribution of central obesity in the Whitehall study in Britain and found that central obesity is strongly and inversely associated with socioeconomic status. They also discovered that obesity was common in individuals with low socioeconomic status who experienced more financial strain, job insecurity, low perceived control at work, stressful life events and poor social networks, depression and low self-esteem. They suggested that central obesity may in part, explain the inequality in social distribution of metabolic syndrome and coronary heart disease in people with low socioeconomic status. Data from surveys in Europe showed that indices of abdominal adiposity of waist circumference and waist-hip ratio were inversely related to psychosocial factors and socioeconomic status, both of which in turn influences quality of life (Branca et al, 2007) and that adults who were obese adolescents are more likely to have lower incomes and experience higher degrees of social exclusion (Gortmaker, 2003).

2.2 Obesity in Nigeria

Data from WHO reported that in 2008, the prevalence of overweight and obesity in Nigeria were 26.8% and 6.5% respectively (WHO, 2011). Studies have shown that there is high prevalence of overweight and obesity in urban communities across different parts of the country. Adedoyin et al, (2009) investigated the prevalence of overweight and obesity in Ile-Ife. They observed that overall crude prevalence of overweight and obesity were 20.3% and 12.5 % respectively among adults. They also noted that the rates of overweight and obesity were more in women than in men and that obesity increased across age gradient from adolescents to adults; peaking in the 60 69-year age group.

In an urban community in northern Nigeria, Kolawole et al, (2011) reported a prevalence rate of overweight and obesity to be 53.3% and 21.0% respectively. They also pointed out that the prevalence was significantly higher in females compared to males.

In a cross sectional study in southeastern Nigeria by Ejike and Ijeh (2012) reported that the prevalence of overweight to be 17.1% among males and 22.3% among females; and obesity prevalence to be 0.4% among males and 22.3% among females. Adediran et al, (2012) conducted a cross sectional study to assess the prevalence of overweight and obesity amng urban and rural dweller in the Federal capital Territory (FCT) Abuja-Nigeria. They reported an overall prevalence of obesity of 22.3%, and that of obesity was more prevalent in the urban area than the rural area and was more common among women than men.

In a recent study, Adienbo et al, (2012) investigated the prevalence of obesity among the indigenous Kalabari ethnic group in South-south Nigeria. They reported that out of

309 adults between the ages of 20 and 70 years, 0.99% of the participants were underweight, 27.63% had normal weight, 22.04% were overweight and 49.34% were obese. Compared with obesity prevalence of 21% in southwestern (Adedoyin et al, 2009) Nigeria, obesity prevalence among the Kalabari people is relatively high.

Their study showed a high prevalence of obesity among indigenous residents of the Kalabari tribe; indicating high risk of developing obesity related health disorders. (Adienbo et al, 2012). They also noted that the highest prevalence occurred at an earlier age (30 and 39 years) compared with that of a multi-ethnic group population of the southwestern Nigeria (40 – 49 years) (Amole et al, 2011). In the Kalabari tribe study 59.79% of the females that had participated in the "fattening room visit" (iria) cultural ceremony were obese while 40.21% of them were not obese. These, when compared with iria non participants where 39.74% are obese and 60.26% not obese, shows that the iria cultural ceremony may have contributed about 29% obesity burden to the female population. This report highlighted the socio-cultural perspective of obesity in some part of Nigeria.

2.3 Obesity Phenotype

Findings from epidemiological studies showing that there is progressive increase in the incidence of chronic diseases such as hypertension, diabetes, and coronary heart disease with increasing body mass index (National Heart, Lung, and Blood Institute, 1998; WHO, 2004), had prompted attempts to classify disease risk using body mass index. The heterogeneity of metabolic risk profile found in obese individuals confirms that obesity phenotype is crucial in characterizing its health-related risks.

Both epidemiological and metabolic studies conducted over the past three decades have supported the hypothesis, first postulated by Jean Vague (Okura et al, 2002) that the complications commonly found in obese patients were more closely related to excess fat accumulation and distribution pattern rather excess weight which could be fat free mass (WHO, 2008b). Vague described the high risk form of obesity by the term "android obesity" or male type (upper body) obesity. Subsequently, leading authorities have confirmed the notion that a high proportion of abdominal fat is a major risk factor for coronary heart disease, type 2 diabetes, and related mortality (WHO, 2008a, AHA 2008). This has led to the current overwhelming evidence that abdominal obesity is a major clinical and public health issue.

Epidemiological studies have mainly used anthropometric variables such as waist to hip ratio to estimate the proportion of abdominal adipose tissue. While sophisticated imaging techniques such as magnetic resonance imaging and computed tomography, distinguishe with a high level of precision intra-abdominal or visceral fat depot from subcutaneous abdominal fat, a simple measurement of waist circumference has been shown to be the best anthropometric correlate of the amount of abdominal adipose tissue (WHO, 2008b). Studies have also confirm that waist circumference is a better correlate of changes in visceral adipose tissue over time than change in waist to hip ratio (Slentz et al, 2007)

2.4 Obesity Assessment

2.4.1 Excess Adiposity: Overweight and Obesity

Body size is usually categorized using the body mass index (BMI). For adults, a BMI between 18.5 and 24.9 kg/m^2 is classified as normal or healthy weight, BMI between

25.0 and 29.9 kg/m^2 is classified as overweight, and BMI of ≥ 30.0 kg/m^2 is obese (WHO, 2004). Obesity is further classified into three degrees, with a BMI of 30.0 to 34.9 kg/m^2 as class 1 or mild obesity, 35.0 to 39.9 kg/m^2 as class 2 or moderate obesity, and ≥ 40.0 kg/m^2 as class 3 or severe obesity. In children between the ages of 2 and 19 years, BMI percentiles adjusted for age and sex are calculated based on a compilation of national survey data collected over a 30-year period (Poirer et al, 2009). A BMI between the 5th and < 85th percentiles is healthy, between the 85th and < 95th percentiles is overweight, and at or above the 95th percentile is obese (Barlow, 2007).

2.4.2 Excess Adiposity: Assessment Methods

Excess body fat can be assessed by several methods. These methods include those for assessing total body fat mass, distribution of body fat, body composition (percent body fat), and ectopic fat.

2.4.2.1 Assessing Total Body Adiposity

Body Weight: Before the use of formulae and tables to adjust body weight for height, the diagnosis of obesity relied on the subjective interpretation of physical appearance and the absolute body weight. The use of weight alone to estimate adiposity, however, is inappropriate, because it fails to consider the fact that body weight is proportional to height, an observation first documented in the 19th century by a Belgian mathematician (Quetelet, 1968). This relationship, originally known as the Quetelet Index, is now known as BMI. The first attempt to formally diagnose obesity on the basis of body weight indexed to height in modern times was the use of actuarial tables from the Metropolitan Life Insurance Company. These tables were used to estimate ideal weight and then determine the percentage of excess weight (Stewart et al, 2007). Because these tables were not based on a simple formula and required the subjective interpretation of an individual's constitution according to normal, thin, and big frame, their use is not practical or reproducible. Thus, a simple body weight is not sufficient in and of itself for the clinical assessment of body fatness.

Body Mass Index: BMI, calculated as body weight in kilograms divided by height in meters squared (kg/m2), is one of the most commonly used anthropometric measures to assess for total body adiposity. Because of its simplicity as a measure, it has been used in epidemiological studies and is recommended as a screening tool in the initial clinical assessment of obesity (National Institutes of Health, 2000). Multiple epidemiological studies have demonstrated increased morbidity and mortality with BMI >30 kg/m2 (Lloyd-Jones et al, 2010). Data from the Prospective Studies Collaboration, which analyzed 900, 000 adults, demonstrated a 30% increase in all-cause mortality for every increase of five unit in BMI above a BMI of 25 kg/m2 (Whitlock et al, 2009).

Although the utility of BMI has been borne out in epidemiological data, there are limitations to the use of BMI alone to assess for adiposity in clinical practice, particularly among adults with BMI $\leq$ 30 kg/m^2 (Romero-Corral et al, 2008). The numerator in the BMI calculation is "total" body weight and does not distinguish between lean and fat mass. Thus, individuals with normal weight but excess body fat may not be diagnosed as overweight or obese. Conversely, adults with high levels of lean body mass may be misclassified as overweight or obese. Data from the National Health and Nutrition Examination Survey III were analyzed to compare BMI with the World Health Organization criteria for obesity (body fat > 25% in men and > 35% in women, as measured by bioelectrical impedance). This analysis demonstrated that although a BMI ≥ 30 kg/m2 had good specificity in men (95%) and women (99%) for detecting obesity, BMI had low sensitivity in men (36%) and women (49%) for diagnosing obesity (Romero-Corral et al, 2008).

In a meta-analysis that pooled 32 studies and included almost 32 000 individuals, BMI had a pooled sensitivity of 50% to identify excess adiposity and a pooled specificity of 90%, which demonstrates that half of the individuals with excess body fat were not identified as obese (Okorodudu et al, 2010).

The cut-off points of BMI used to diagnose overweight and obesity are assumed to be independent of age, sex, and ethnicity and race; however, because of age- and sex-related differences in body composition, BMI may not correlate as well with body fat in some age, sex, and ethnic groups. At similar levels of BMI, women may have higher percentages of body fat than men (Carroll et al, 2008). Hispanic women have a higher percentage body fat than black and white American women with similar BMIs (Ferna´ndez et al, 2003), and black women have a lower percent body fat than white women with the same BMI (Evans et al, 2006). The most pronounced difference in the relationship between BMI, body fat, and disease risk is seen in Asian populations, in which a given level of BMI is associated with greater adiposity and comorbidities than in other populations. Although there are no population-dependent cut points for BMI, several studies have demonstrated that cut-off points between 23 and 27 kg/m^2 may more accurately identify obesity in Asian populations (Goh et al, 2004; WHO Expert Consultation., 2004). Although BMI is more accurate than body weight alone and is simple to calculate, it does have limitations, including poor sensitivity in diagnosing excess body fatness, especially in some populations. Nevertheless, BMI is considered the primary tool for the assessment of body fatness in clinical practice because of its global acceptance and ease of calculation.

2.4.2.2 Assessing Body Fat Distribution

It is clear that simple measurements of body weight and BMI do not yield good assessments of either the body composition or distribution of body fat, especially in those with a BMI < 30 kg/m^2.

Waist Circumference(WC): WC has been shown to be a simple and inexpensive yet effective way to assess for central obesity, with excellent correlation with abdominal imaging (WHO, 2008b) and high association with CVD risk and mortality (de Koning et al, 2007). As a result, definitions of the metabolic syndrome have adapted WC as a surrogate marker of abdominal or central obesity (Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, 2001). The WC is easily measured with a tape measure while the patient is standing, wearing light clothing, and at end expiration. Despite this, WC measurements have not been well adopted in clinical practice. One issue relates to issues that surround the measurement site. In a recent review of the literature, a panel of experts found 8 different measurement locations documented for WC: (1) halfway between the lowest rib and the iliac crest (midpoint); (2) point of minimal circumference; (3) immediately above the iliac crest; (4) umbilicus; (5) 1 inch above the umbilicus; (6) 1 cm above the umbilicus; (7) at the lowest rib; and (8) point of largest circumference around the waist (Ross et al, 2008). This variability in measurements at different locations may be problematic, because all WC sites do not provide the same measurement estimate

(Mason et al, 2009; Wang et al, 2003; Bosy-Westphal et al, 2010; Bigaard et al, 2005; Willis et al, 2007).

Although the umbilicus has been found to be the least reproducible site, most of these sites have very high reproducibility and do not appear to be influenced by age or BMI (Mason et al, 2009). Measurement of WC at the iliac crest has been shown to have higher precision with training and experience to locate (Bosy-Westphal et al, 2010). Bony structures are stable landmarks that are not affected by changes in weight and which confers certain advantages, especially for longitudinal tracking of body composition. It is for these reasons that the iliac crest is currently recommended by the National Institutes of Health and National Heart, Lung, and Blood Institute (1998). The World Health Organization recommends the use of the midpoint WC measurement; however, this method relies on the identification of 2 separate locations, the iliac crest and the lowest rib, and the need to calculate the midpoint of the distance between these 2 structures, which requires more skill and time than a measurement that relies on only 1 structure, such as the iliac crest.

Another important consideration in establishing a standard site for WC measurement is the predictability of CVD morbidity and mortality associated with each measurement site. For example, WC cut points have been established based on their correspondence to a BMI of ≥ 25 kg/m^2 or ≥ 30 kg/m^2: 80 and 88 cm for women and 94 and 102 cm for men, respectively (de Koning et al, 2007). These cut-off points were established from WC measurements taken at the midpoint and were not based on risk of CVD or CVD morbidity and mortality. However, because studies have shown that WC is associated with CVD risk, it becomes important to establish the most appropriate measurement site for predicting CVD risk. Mason and Katzmarzyk (2010) identified optimal WC thresholds for the prediction of cardiometabolic risk across 4 measurement sites: iliac crest, midpoint, umbilicus, and minimal waist. The authors found that more men and women met the criterion for abdominal obesity when WC was measured at the umbilicus, 34% and 55%, respectively, compared with 23% and 31%, respectively, for measurements taken at the minimal waist. Although the magnitude of the correlation between cardiometabolic risk and WC did not differ between measurement sites, optimal cut points to predict cardiometabolic risk differed: In men, optimal cut points were 100 cm at all sites except for the minimal waist, which was 97 cm; in women, cut points were 87 cm at minimal waist, 90 cm at midpoint, 93 cm at the iliac crest, and 95 cm at the umbilicus (Mason et al, 2010). Similar observations have been noted by Bosy-Westphal et al, (2010) in which 3 WC measurement sites (rib, midpoint, and iliac crest) had similar correlations with visceral adipose tissue and cardiometabolic risk factors such as dyslipidemia, insulin insensitivity, impaired glucose tolerance and hypertension.

WC is a simple and inexpensive tool for assessing body fat distribution. It correlates well with abdominal obesity as assessed by imaging methods and is associated with increased risk for adiposity-related morbidity and mortality. It can easily be incorporated in the vital sign assessment of patients at the time the body weight is obtained. It is recommended that WC measurement at the iliac crest is the easiest and most consistent location, as described by the National Institutes of Health guidelines. This tool and its importance can be explained easily to patients. For these reasons, WC has been adopted as an ideal inexpensive clinical complement to the BMI measurement (WHO, 2004).

Hip Circumference: Hip circumference (HC) is measured at the level of the widest circumference over the buttocks. This measurement is also used to calculate the WHR, which has been debated as a useful tool for assessment of body composition. Some may argue that a ratio does not provide information on whether the WC is large or the HC narrow, because, for example, a woman with a large WC of 100 cm and wide HC of 120 cm will have the same WHR as a woman with narrow WC of 75cm and an HC of 90 cm, respectively. Based on differences in WC, these 2 women would be predicted to have a much different CVD risk profile. Others argue, however, that HC adds value to the measurement of WC because wider hips provide protection against CVD (Esmaillzadeh et al, 2006; Snijder et al, 2004). When examined with respect to all-cause mortality, however, HC alone does not appear to be a significant predictor of all-cause mortality (Mason et al, 2008).

Ratios: Various ratios can be computed from anthropometric data. The common ones are waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), and waist-to-thigh ratio (WTR). These measurements have been examined for their ability to predict risk of metabolic disorders. In fact, Reis et al (2009) compared the relative importance and joint association of overall obesity and abdominal adiposity with risk of total and cardiovascular mortality in the National Health and Nutrition Examination Survey III and found that men and women who died of CVD had greater WHR and thigh circumference at baseline.

The authors concluded that the measurement of body fat distribution by WHR carries important information to identify adults at increased risk of mortality. Elsayed et al (2008) also assessed WC and WHR as risk factors for CVD mortality in patients with chronic kidney disease. They found that WHR but not WC was associated with cardiac events in models adjusted for demographic and lifestyle characteristics, as well as baseline CVD and CVD risk factors. In the Monitoring Trends and Determinants in Cardiovascular Disease Augsburg (MONICA) study, BMI, WC, and WHR were all strongly and independently related to incident T2DM in both men and women (Meisinger et al, 2006). Each measurement was equivalent in predicting T2DM in men but not in women, and WC and BMI had the greatest risk ratio. Taylor et al (2010) also found that the magnitudes of the association between BMI, WHR, WHtR, and WC with CVD risk factors were all similar except that HC was less strongly associated with triglyceride and insulin levels. Other groups have also shown that BMI, WC, WHR, and WHtR are all closely related to CVD risk in 20- to 64-year-old Taiwanese men and women (Huang et al, 2002) and Asians in the Obesity in Asia Collaboration Study (Barzi et al, 2010).

However, in non-Asians, WHR has a stronger association with dyslipidemia than BMI (Barzi et al, 2010). Ratios involving WC, such as WHR and WHtR, as well as WC alone, have also been shown to be superior to BMI at predicting coronary heart disease incidence in white middle-aged women (Page et al, 2009). This is supported by data from the European Perspective Investigating Into Cancer and Nutrition in Norfolk (EPIC-Norfolk) study (Canoy et al, 2007) and data from the Physicians' Health Study and the Nurses' Health Study (Gelber et al, 2008). The waist-to-thigh ratio has been reported to be a strong positive predictor of mortality in both men and women and has the greatest discriminating power and strongest association with Tpye-2 Diabetes Mellitus (T2DM) in men compared with WHtR, WHR, WC, and BMI (Li et al, 2010). In women, waist-to-thigh ratio performed better than BMI in discrimination for T2DM but was not different from WHtR, WHR, and WC. These data differ somewhat from those from the Hoorn Study, in which waist-to-thigh ratio was a better predictor of future T2DM than BMI in both men and women (Snijder et al, 2003).

Whether ratios, as indices of upper to lower body fat distribution, should be used rather than BMI or WC alone for predicting risk remains debatable and controversial. For example, although Gelber et al (2008) found that WHtR had the strongest gradient in association with cardiovascular events in men and women from the Physicians' and the Nurses' Health Studies, they still concluded that there was no substantial or clinically meaningful difference between BMI and WHR in predicting cardiovascular events. Similarly, Taylor et al (2010) concluded that because of similar associations between BMI, WC, WHR, WHtR, and CVD risk factors, recommendations to replace BMI with WC-based measurements are not warranted for routine public health surveillance. Page et al (2009) suggested that ease of measurement should be a determining factor in establishing body composition indices that would predict CVD risk. Alternatively, Asian studies propose the use of WHtR (Barzi et al, 2010; Lin et al, 2002) and WHR (Barzi et al, 2010) in predicting CVD risk factors. In fact, ratios such as WHtR and WHR may provide the greatest value for uniform comparison of CVD between populations. Optimal BMI and WC values for predicting metabolic disorders differ between Mexicans, Asians, and blacks and whites (Lin et al, 2002; Berber et al, 2001; Dhaliwal et al, 2009), but WHtR and WHR adjust for these ethnic differences in body shape (Dhaliwal et al, 2009). WHtR and WHR, however, are promising measures for adjusting for ethnic differences in body shape when determining metabolic risk.

Skinfold Thickness: Because of its relatively low cost and simplicity, the measurement of skinfolds is a popular method of estimating body composition. Brozek and Keys published the first valid skinfold equations in 1951. Since that time, over a 100 prediction equations using various combinations of anthropometric variables have been reported in the literature (Jackson et al, 1985; Lohman, 1981). The skinfolds technique involves pinching the skin between the thumb and forefinger, pulling it away from the body slightly, and placing the calipers on the fold. Thus, skinfolds measure the thickness of 2 layers of skin and the underlying subcutaneous fat, and sites have been located and measured as described by Jackson and Pollock (1985) as follows:

- Chest: a diagonal fold taken on the anterior axillary fold as high as possible.
- Axilla: a vertical fold taken on the midaxillary line at the level of the xiphoid process.
- Triceps: a vertical fold measured on the posterior midline of the upper arm over the triceps muscle halfway between the acromion and the olecranon processes with the elbow extended and relaxed.
- Subscapular: a diagonal fold taken on the line coming from the vertebral border 1 to 2 cm below the inferior angle of the scapula.
- Abdominal: a vertical fold taken approx 2 cm lateral to the umbilicus.
- Suprailium: a diagonal fold taken above the iliac crest along an imaginary line extended from the anterior axillary line.
- Thigh: a vertical fold taken on the anterior aspect of the thigh midway between the hip and the knee joints.

A minimum of 3 skinfolds measurements are taken on the right side of the body at each site in rotational order by an experienced skinfolds clinician. If the readings are not within 1 mm of each other, additional measurements should be taken. Early models used the sum of 7 skinfold measurements (chest, midaxillary, triceps, subscapula, abdomen, suprailium, and thigh). A high correlation (*r* = 0.98) was found between the 7-skinfold model and one that used only 3 skinfolds (chest, abdomen, and thigh). Because of the enhanced feasibility of using only 3 measurements compared with 7, Jackson and Pollock have suggested using the 3-skinfolds model (Jackson et al, 1985). Using data compiled from 6 laboratories, Lohman et al, (2004) reported standard errors from skinfolds measurements to be 2.6 kg for fat-free mass and 3.5% for percent body fat, which were lower than for body weight or BMI.

Some of the potential sources of error found in the skinfolds method included variation in subcutaneous fat in relation to total fat, variation in skinfolds thickness in relation to subcutaneous fat, and technical error in the skinfolds measurement (Lohman, 2004). During the development of their equations, Jackson and Pollock made several observations (Jackson AS, Pollock, 1978). First, the relationship between skinfolds and body density was quadratic. The prediction errors would be larger, especially at the extremes of body fatness, if a linear regression line were used to fit the data. In fact, underestimation of percent body fat with skinfold measurements have been reported (Zillikens and Conway, 2000; Heyward et al, 2002). Second, age is independently related to body composition and should be a factor in generalized equations (Ford et al, 2003). The skinfolds method precisely measures body density; however, it requires a considerable amount of technical skill and being meticulous with site location and measurement, and it is restricted to the populations from which the prediction equation was derived.

Although the skinfolds method is an excellent field method to use in lean participants, it is difficult to obtain reliable and accurate readings on older participants with loose connective tissue or obese individuals with large folds. Finally, because of racial differences in body composition, race-specific skinfolds equations should be used (Huxley et al, 2008).

2.5 General Body Fat versus Regional Body Fat Distribution

Population-based studies have long shown that there is a clear relationship between BMI and the documented comorbidities associated with excess body fatness, (Ito et al, 2003; Katzmarzyk et al, 2002), but obesity has remained a puzzling condition for clinicians because of its remarkable heterogeneity. For instance, although obese individuals are at a greater risk of comorbidities than normal-weight individuals, some obese persons may nevertheless show trivial or even no metabolic complications, the so-called metabolically healthy obese (Sims ett al, 2002; Karelis et al, 2005; Wildman et al, 2008), whereas others with the same level of obesity, on the basis of similar BMI values, could show numerous metabolic abnormalities, including insulin resistance, glucose intolerance, dyslipidemia, systemic hypertension, and a prothrombotic inflammatory profile (Pascot et al, 2001; Bacha et al, 2003; Cnop et al, 2003; Nieves et al, 2003; Fox et al, 2007 Cartier et al, 2008). Thus, although BMI has been useful to describe secular changes in adiposity at the population level, BMI cannot always properly discriminate the risk of chronic disease at the individual level.

2.6 Pioneer Studies on Fat Distribution

Numerous epidemiological and metabolic studies published over the past 3 decades have provided support to Jean Vague's early seminal observations (Vague, 1947) that the common complications of obesity, such as insulin resistance, atherogenic dyslipidemia, type 2 diabetes mellitus (T2DM) and cerebro-vascular diseases (CVD) were more closely related to the distribution of body fat than to the absolute degree of fatness. (Pascot et al 2001; Ross etal, 2002a; Ross et al, 2002b; Bacha et al, 2003; Cartier et al, 2008; Coˆte´ et al, 2005; Nieves et al, 2003; Pascot et al 2001; Cnop et al, 2003; Fox et al, 2007; Yusuf et al, 2005;). Vague coined the term "android" obesity (more frequently found in men) to describe the high-risk form of obesity, whereas he introduced the term "gynoid" obesity to describe the low risk typical of lower body adiposity more frequently found in premenopausal women.

In the early 1980s, Bjo¨rntorp and colleagues (1984) in Gothenburg, Sweden, and Kissebah and collaborators (Kissebah et al, 1989) in the US, reported that when the ratio of waist to hip circumferences (waist-hip ratio [WHR]) was used as an index of the relative accumulation of abdominal fat, this variable was related both to the risk of coronary heart disease and T2DM and to a diabetogenic/atherogenic metabolic risk profile. They opined that the greater the relative accumulation of abdominal fat, the greater the waist circumference (WC) relative to the hip girth. This early work has had a tremendous impact on the field of body fat distribution and health, because it provided evidence that body fat distribution deserved more attention as a predictor of the comorbidities than had been, in the past, attributed to merely excess body fatness.

2.7 Factors Associated With Individual Differences in Abdominal Adiposity

Several factors are associated with differences in abdominal adiposity, such as sex, age, genetic factors, hormonal profile, smoking, and nutritional factors, as well as vigorous endurance exercise (Ross and Bradshaw, 2009). Major sex differences are observed in abdominal adiposity before menopause, with premenopausal women having on average 50% less visceral adipose tissue than men and with significantly more gluteal-femoral adipose tissue in women, which may be metabolically protective (Lear et al, 2010). Such a sex difference in visceral adiposity has been shown to largely but not entirely explain the gender gap in cardiometabolic risk variables among women (Lahti-Koski et al, 2007).With age, there is also a selective deposition of abdominal fat that is predictive of the age-related deterioration in the cardiometabolic risk profile in post menopausal women (Lee et al, 2008), particularly among those who have a family history of visceral obesity (Lahti-Koski et al, 2007).

Ethnicity and race are also associated with differences in susceptibility to the selective deposition of abdominal fat (Despre´s et al, 2000, Hoffman et al, 2005). For instance, blacks are more prone to subcutaneous adiposity than whites or Hispanics, whereas evidence available suggests that Asians may be more prone to visceral fat deposition (Hoffman et al, 2005, Kadowaki et al, 2006).

2.8 "Normal-Weight" Obesity

Studies have suggested that individuals with normal body weight as defined by BMI might still be at risk for metabolic syndrome, insulin resistance, and increased mortality if they have a high body fat content (De Lorenzo, 2007; Romero-Corral et al, 2010). A recent report from a sample of individuals representative of the adult US population showed that men of normal weight in the upper tertile of body fat percentage (>23% fat), as measured with electric bioimpedance, were 4 times more likely to have metabolic syndrome and had a higher prevalence of dyslipidemia, T2DM, systemic hypertension, and CVD than those in the lowest tertile (Romero-Corral et al, 2010). Women in the highest tertile of body fat (>33% fat) were seven times more likely to have metabolic syndrome. Interestingly, women with normal-weight obesity were almost twice as likely to die at follow-up as women in the lowest tertile of body fat. The prevalence of central obesity was low in this group of normal-weight individuals, so these associations were not explained by differences in measures of central obesity between those with normal weight obesity and control subjects. Studies have also shown that people with normal BMI but enlarged WC have a higher rate of cardiovascular events and death. Although further research is needed to clarify these interesting results, it is clear that subjects with normal weight as defined by BMI may need more detailed classification to better define their adiposity-related risk.

2.9 Assessing Changes in Distribution of Body Fat

In recent years, WC and WHR increasingly have become therapeutic goals in dietary interventions or weight loss trials, supported by the strong epidemiological evidence linking measures of body fat distribution with metabolic dysregulation, long-term cardiovascular events, and onset of T2DM; however, the advantages of assessing changes in WC or WHR over time are still controversial. Several studies have shown an association between changes in WC and changes in lipids, blood pressure, fasting blood glucose, and other cardiometabolic risk factors. Most of the studies, however, have failed to adjust for concurrent changes in BMI, and when they did adjust for changes in BMI, the association between changes in WC and change in cardiometabolic factors disappeared (Ishizaka et al, 2009; Williams, 2009). One of the only exceptions is the DESIR study (Data from an Epidemiological Study on the Insulin Resistance Syndrome), in which the adjustment for BMI change did attenuate but did not take away the association between change in WC over 9 years and several cardiometabolic risk factors, including triglycerides, blood pressure, and fasting insulin in women (Balkau et al, 2007).

Studies assessing the validity of serial measurements of WC or WHR to assess changes in abdominal visceral fat have shown conflicting results. A study in women showed an excellent correlation between change in WC and change in abdominal visceral fat as measured by CT (Dolan et al, 2007), whereas 2 studies, 1 in Asian women and 1 in patients with chronic kidney disease, showed only a mild correlation between change in WC and change in abdominal visceral fat, which suggests that most of the variability in WC was attributable to changes in subcutaneous abdominal fat (Hwang et al, 2008; Velludo et al, 2010).

Despite the limited evidence linking changes in WC to changes in cardiometabolic risk factors beyond the effect of BMI change, some reports suggest that there may be a role in measuring serial WC to assess the benefit of lifestyle interventions. In one clinical trial, patients assigned to intense exercise did not lose any significant amount of body weight, but their WC was significantly reduced at follow-up, which was associated with a benefit in regard to metabolic comorbidities (Ross et al, 2000). In another study involving different doses of exercise, the reduction in WC was independent of changes in body weight in all exercise groups (Church et al, 2009). These results cannot be extrapolated to populations that are not purposely engaged in intensive exercise programs. The assessment of changes in WC in weight loss trials or observational studies may also help to reclassify people according to the presence or absence of central obesity or metabolic syndrome, and for that matter, it may help in the estimation of incidence rates of both conditions.

2.10 Theoretical Analysis of Abdominal Adiposity and Metabolic Complications

Three main theories have been proposed to explain the relationship between abdominal adiposity and metabolic complications:

1. The portal free fatty acid model: This hypothesis argues that in visceral obesity, an uninterrupted overflow of free fatty acid from intra-abdominal or visceral adipocytes would expose the liver to high concentrations, leading to several impairments in hepatic metabolism (Mittelman et al, 2002). These include reduced extraction and degradation of insulin that exacerbates systemic hyperinsulinemia, reduced degradation of apolipoprotein B that leads to hypertriglyceridemia, and increased hepatic glucose production that leads to impaired glucose tolerance and eventually to T2DM (Lean, 2000). Therefore, under this model, one can explain the relationship between excess visceral adiposity and hypertriglyceridemia, hyperapolipoprotein B, hyperinsulinemia, and glucose intolerance that is found in at-risk overweight/ obese patients.

2. The "endocrine" function of VAT: Another advance in our understanding of adipose tissue biology was the discovery that adipose tissue is more than a triglyceride storage/mobilization organ. Indeed, numerous potentially important adipose tissue cytokines, commonly referred to as adipokines, could play a role in the dysmetabolic state associated with total/visceral adiposity (Pi-Sunyer, 2002). For instance, leptin, which is produced by adipose cells, has been shown to be better correlated with total and subcutaneous adiposity than with visceral adiposity (Yatagai et al, 2003). This may explain why circulating leptin levels

are higher in women, who have on average more subcutaneous fat than men (Cnop et al, 2003). Also adipokine, adiponectin, appears to better reflect visceral than total adiposity (Coˆte´et al, 2003; Cnop et al, 2003; Motoshima et al, 2002).

However, a key finding was the observation that hypertrophied adipose tissue is characterized by an infiltration of macrophages, some of which are a major source of inflammatory cytokines such as tumor necrosis factor-α and interleukin-6 (Weisberg et al, 2003). The cytokine interleukin-6 is a major driver of the production of C-reactive protein by the liver (Pi-Sunyer, 2002). Therefore, in abdominally obese patients, the increased production of interleukin-6 by the expanded visceral adipose depot could contribute to expose the liver to high interleukin-6 levels, which could in turn stimulate hepatic C-reactive protein production and impair liver metabolism.

3. Visceral obesity, a marker of dysfunctional adipose tissue leading to ectopic fat deposition: Although visceral adiposity is clearly related to the metabolic abnormalities of overweight/obesity, whether there is a causal relationship between excess visceral adiposity and metabolic complications has been debated. In numerous recent papers and review articles, it has been proposed that excess visceral adiposity may not necessarily impair carbohydrate and lipid metabolism directly but rather may reflect the relative inability of subcutaneous adipose tissue to properly adapt to positive energy balance and to expand by hyperplasia (multiplication of preadipocytes to an increase in the number of adipose cells), creating a “protective metabolic sink” (Ibrahim, 2010). Under

this model, a sedentary individual exposed to a surplus of calories would store this extra energy in subcutaneous adipose tissue. To do so, the subcutaneous fat depot would undergo hyperplasia, if need be, to allow the safe storage of this extra energy.

However, in situations in which subcutaneous fat could not undergo hyperplasia and therefore would have a limited ability to expand to store the caloric excess, as might occur in the setting of adipose tissue hypoxia (Wood et al, 2009), these excess triglyceride molecules would accumulate at undesirable sites such as liver, heart, pancreas, or skeletal muscle, a phenomenon referred to as "ectopic fat deposition." Substantial experimental evidence supports the view that excess visceral adiposity is a marker of dysfunctional adipose tissue and of ectopic fat. For instance, women, who have a lot more subcutaneous fat than men, are characterized by lower postprandial lipaemia than men because their SAT can better handle the dietary fat load than men (Couillard et al, 2003). In addition, individuals with partial lipodystrophies have more visceral/ectopic fat because of their dysfunctional SAT (Garg et al, 2004; Hegele et al, 2000). Thiazolidinediones, which improve insulin sensitivity and decrease liver fat, have been shown to induce hyperplasia of SAT, and this is probably a key mechanism explaining how this class of drugs improves glycaemia and the cardiometabolic risk profile (Miyazaki et al, 2002; Yki-Ja¨rvinen, 2004; Bertrand et al, 2010).

A negative energy balance induced by diet or by endurance exercise has been shown not only to induce weight loss but also to induce a rapid reduction of liver fat and VAT (Ross et al, 2000; Pare´ et al, 2001). Thus, under circumstances in which the “pressure” for storage of excess triglyceride molecules in SAT is decreased, there will no longer be a need to deposit triglyceride at undesired sites, and ectopic fat depot will be mobilized more readily than subcutaneous fat.

Patho-physiology of Obesity: Individuals with excess abdominal adiposity experience elevated cardiovascular morbidity and mortality, including stroke, congestive heart failure, myocardial infarction and cardiovascular death, and this is independent of the association between obesity and other cardiovascular risk factors (Lakka et al, 2002; Kenchaiah et al, 2002). Weight gain especially during adult life seems to have a great effect on diabetes and cardiovascular risk, even within the normal body mass index (BMI) range (Hu et al, 2004). American Heart Association (AHA) has reclassified abdominal obesity as a ‘major, modifiable risk factor’ for coronary heart disease (Eckel, 2004).

Different mechanisms linking obesity to cardiovascular disease have been postulated, adding weight to classical risk factors. Obesity also increases the prevalence of less conventional risk factors. Adipose tissue is an active endocrine and paracrine organ that releases a large number of cytokines and bioactive mediators, such as leptin, adiponectin, interleukin- 6 (IL-6) and tumour necrosis factor-α (TNF-α), that influence not only body weight homeostasis but also insulin resistance, diabetes, lipid levels, tension, coagulation, fibrinolysis, inflammation and atherosclerosis. Various morphological adaptations in cardiac structure andhaemodynamic function also occur in obese individuals (Poirier, et al, 2006).

2.11 Abdominal Adiposity and Health Risk

Abdominal visceral adipose tissue (VAT) is considered to be one of the most dangerous fat depots in the body, as it is strongly related to cardiometabolic risk factors and insulin resistance (Despre´s and Lemieux, 2006). Waist circumference is often considered to be the best anthropometric proxy for VAT (Bouchard, 2007); however, correlations between the two are typically on the order of 0.6–0.8 (Barreira et al, 2012; Bouchard, 2007). There is consistent evidence for a relationship between waist circumference and diabetes, cardiovascular disease and all-cause mortality (Ross et al, 2008). Studies have examined the association between directly measured VAT and mortality in humans. In a case–control design involving men, McNeely et al, (2012) demonstrated that VAT is a strong, independent predictor of all-cause mortality, after adjustment for age, subcutaneous adipose tissue (SAT) and liver fat (McNeely et al, 2012). A prospective study, showed that VAT was a significant predictor of all-cause mortality in Japanese Americans, independent of age, smoking and SAT (Kuk et al, 2006)

Katzmarzyk, et al (2012) in the Pennington Center Longitudinal Study, investigated the association between visceral adipose tissue VAT) and all-cause mortality, in a sample of 1089 white men and women, aged between 18 and 84 years. They found that abdominal VAT was significantly associated with mortality after adjustment for age, sex and year of examination. The association was stronger after the inclusion of abdominal subcutaneous adipose tissue (SAT), smoking status, alcohol consumption and leisure-time physical activity as additional covariates. When they limited the sample to participants who were free of stroke, heart disease and cancer at baseline, they observed that the strength of the relationship slightly reduced. Their results support the assertion that abdominal adiposity is an important therapeutic target for obesity reduction efforts.

The National Cholesterol Education Program's Adult Treatment Panel III report (2002) stated that the increasing prevalence of obesity has been accompanied by a parallel increase in the prevalence of metabolic syndrome, which together constitutes the "obesity epidemic." Obesity is closely associated with some major health risk factors, (Kenchaiah et al, 2002) and the prevalence of obesity continues to increase in developed countries (Mokadad et al 2003). It is well known that individuals with central (android-type) obesity are at greater risk for coronary heart disease (CHD) and several metabolic disorders (WHO, 2008b).

The intra-abdominal fat accumulation is strongly associated with metabolic disorders independent of whole-body adiposity, including high blood pressure and triglycerides as well as an increased incidence of diabetes mellitus (Kenchaiah et al, 2002; Mokadad et al 2003). Larger waist circumference or waist-hip ratio, as crude indicators of visceral fat mass, are associated with adverse metabolic profile, but their role in predicting future coronary heart disease (CHD) events has been less investigated. Epidemiologic findings suggest that these simple and inexpensive measures of abdominal fat distribution predict CHD independently of body mass index, and, to a certain extent, cardiovascular disease risk factors. The magnitude and shape of the association between abdominal adiposity and CHD have been shown to vary with age, gender, and ethnicity. Studies have also suggested that lower body fat is associated with reduced CHD risk, although the clinical relevance for this finding needs further elucidation. Assessing body fat distribution may be useful for improving CHD risk assessment, although more studies are needed to assess consistency in CHD risk predictions across populations. A consensus is also needed to define the clinically relevant cut-off points for waist circumference or waist-hip ratio (Canoy, 2010).

2.12 Abdominal Adiposity and Cardiovascular Function

As the prevalence of abdominal obesity continues to rise, the increased risk for cardiovascular disease associated with this obesity phenotype (Shahuta et al, 2004) is becoming a major concern and emphasises the need to address this problem. With adipose tissue being metabolically active, (Misra and Vikram, 2003) the metabolic and cardiovascular risks associated with obesity are closely associated with central (abdominal) rather than a peripheral (gluteo-femoral) fat pattern (Smith et al, 2001). Although much attention has been focused on the metabolic and cardiovascular risks associated with visceral abdominal adiposity, (Rattarasarn, et al, 2003; Faria et al, 2002) the independent predictability of abdominal subcutaneous truncal fat for cardiovascular disease has also been established (Sardinha et al, 2000)

Schutte et al, (2005), demonstrated the effect of abdominal obesity on cardiovascular function among African women. They reported that abdominal obesity as measured using waist circumference was inversely related to cardiovascular function. Their study showed that cardiac output was significantly elevated among individuals with abdominal obesity compared to individuals with healthy waist circumference. They reported that abdominally obese normotensive individuals had significantly higher arterial compliance and lower total peripheral resistance compared with normotensive lean individuals. Also, they noted that hypertensive individual with abdominal obesity had had significantly lower arterial compliance and significantly higher total peripheral resisitance when compared to the normotensive individuals with abdominal obesity. Pulse pressure also noted to be significantly elevated in abdominally obese hypertensive individuals compared to the lean and obese normotensive individuals (Schutte et al, 2005).

The importance of the endothelium in maintaining a healthy vasculature has been increasingly recognized, especially regarding release of nitric oxide (NO), which possesses a number of antiatherogenic properties (Vita and Keaney, 2002). Studies have detected impaired brachial artery flow-mediated dilation (FMD), a well-validated measure of vascular endothelial function in adolescents with cardiovascular risk factors (Vita and Keaney, 2002). Endothelial dysfunction is particularly relevant given recent studies indicating that it predicts cardiovascular mortality and morbidity and that it may be an early manifestation of atherosclerotic disease (Vita and Keaney, 2002). In addition, interventions that improve NO-dilator function, including exercise training (Maiorana, et al, 2001), are cardioprotective. Early detection and treatment of endothelial dysfunction may represent a novel primary prevention strategy in adolescents who are at elevated risk of the development of cardiovascular disease in later life.

2.13 Abdominal Adiposity and Respiratory Function

Studies have established obesity as being associated with respiratory complications such as obstructive sleep apnoea and obesity hypoventilation syndrome, asthma both in children and adults (Tantisira and Weiss, 2005); and is believed to reduce lung volumes. Poor respiratory function predicts overall mortality as well as death due to pulmonary diseases (Schunemann et al, 2000; Strachan, 2004), cardio vascular diseases and stroke (Sowers, 2003).

A number of studies have reported an inverse relation between various indices of obesity or fat distribution and respiratory function. These indices include measures of overall adiposity, such as weight or body mass index (weight (kg)/height (m2), and measures of fat distribution, such as waist circumference (WC) (Raison et al, 2001), percentage of fat mass, and skin fold thickness (Chen et al, 2007). Differential fat distribution among males and females tends to affect the pulmonary functions (Slawomir et al, 2007).

Abdominal adiposity markers like Waist Hip Ratio (WHR) and WC may influence pulmonary function through a mechanism that may restrict the descent of the diaphragm and limit lung expansion, compared to overall adiposity, which may compress the chest wall (Saxena et al, 2009). Clinical studies have evaluated the relation of WHR and WC, to poor respiratory functions in both mildly obese and morbidly obese persons (Canoy et al, 2004; Chen et al, 2001; Harik-Khan et al, 2001). Ochs-Balcom, et al, (2006), opined that abdominal adiposity is a better predictor of pulmonary function than weight or BMI, and investigators should consider it when investigating the determinants of pulmonary function.

Pulmonary gas exchange may be affected by morbid obesity. Morbidly obese individuals have poorer exercise capacity and may also have poorer pulmonary gas exchange compared to healthy, non-obese counterparts because of the added energy needed to move fat mass (Zavorsky et al, 2007). The increase in mechanical ventilator constraints and lower lung volumes from large amounts of abdominal fat causes poor lung function and is thus one exercise-limiting factor in morbidly obese individuals (Wang et al, 2004). The decrease in lung volumes, specifically expiratory reserve volume (as an index of decreased functional residual capacity) is a cause for poor gas exchange in the lung.

2.14 Abdominal Adiposity and Physical Activity

Both increased abdominal adiposity and reduced physical activity are strong and independent predictors of CHD (Li et al, 2006) and death (Hu et al, 2004). In general, for each unit of BMI increment, the risk of CHD increases by 8%. On the other hand, each 1 h-MET (metabolic equivalent) increase in activity score is associated with an 8% decrease in CHD risk. Most heart attacks can be predicted from nine easily measurable and modifiable factors, including abdominal adiposity and regular physical activity (Yusuf et al, 2005). In most studies (Hu et al, 2004, Li et al, 2006 Stevens et al, 2002) being physically active moderately attenuated but did not eliminate the adverse effect of obesity on coronary health, and being lean did not counteract the increased risk associated with physical inactivity. But several studies lend support to current exercise guidelines, which endorse moderate-intensity exercise for at least 30 minutes per day (Li et al, 2006). Weight gain during adulthood is a strong and independent risk factor for premature death, regardless of the level of physical activity (Hu et al, 2004).

Physical activity improves glucose tolerance and sensitivity by improving non-insulin-dependent glucose uptake; it improves the ratio between HDL and LDL cholesterol because it increases the activity of lipoprotein lipase; it decreases triacylglycerols, increases fibrinolysis, decreases platelet aggregation, improves oxygen uptake in the heart as well as in peripheral tissues, lowers the resting heart rate by increasing vagal tone, and lowers blood pressure (Hu et al, 2004, Li et al, 2006). Physical activity also directly increases myocardial oxygen supply, improving myocardial contraction and electrical stability (Li et al, 2006).

Cross-sectional data indicate that high levels of cardiorespiratory fitness are associated with low prevalence of metabolic syndrome (Lakka et al, 2003; Jurca et al, 2004; Farrell et al, 2004). Studies have found that cardiorespiratory fitness is a significant predictor for metabolic syndrome incidence (Carnethon et al, 2003; LaMonte et al, 2005). Another study found that 20 weeks of aerobic exercise training reduced metabolic syndrome prevalence (Katzmarzyk et al, 2003). Clinical intervention studies in obese people have also revealed that regular aerobic exercise training clearly improves risk factors for metabolic syndrome (Watkins et al 2003; Frank et al, 2003).

2.15 Abdominal Adiposity and Quality Of Life

Aspects of quality of life that can be shown to affect health, either physical or mental, are referred to as health-related quality of life (HRQOL) (James, 2004). HRQOL and its determinants have been explored since the 1970s and include measurement of subjective components of human function and well-being (Adams et al, 2006).

Obesity affects important aspects of HRQOL, including physical health, emotional well-being, and psychosocial function (Doll et al, 2000; Fotaine and Barofsky, 2001; Ford et al, 2001; Sullivan et al, 2001; Hassan et al, 2003). Both cross-sectional and longitudinal studies have shown HRQOL to diminish as BMI increases from normal to obese (Doll et al, 2000; Fontaine et al, 2003; Ford et al, 2001; Sullivan et al, 2001; Kolotkin et al, 2001; Heo et al, 2003; Goins et al, 2003; Burns et al, 2001; Damush et al, 2002; Daviglus et al, 2003). Using the data from the Community Tracking Study, Wells and Fuller, (2005) examined the impact of obesity on HRQL. They found that obesity predicted impaired physical HRQL, with an effect size similar to poverty after adjusting for chronic conditions.

HRQOL has also been used to measure the efficacy of treatment for obesity (Howard et al, 2003; Yusuf et al, 2005). Previous studies of HRQOL and of attempts to lose weight have sampled individuals who sought intensive weight loss treatment in a university or hospital setting (Eckel et al, 2004; Peeters et al, 2003; Nicholls et al, 2006). However, such persons could have had significantly more psychological or affective disorders, including eating disorders (Eckel et al, 2004; Kwiterovich, 2002), or been predominantly older white women from higher sociodemographic groups (Peeters et al, 2003; Nicholls et al, 2006). Therefore, the results of these studies might not be generalizable to the overall obese population.

HRQOL and self-report of trying to lose weight have not been studied in a nationally representative sample of overweight and obese adults. Although many overweight adults try to lose weight (Chanet al, 2002), the cues for these attempts are not fully understood. Motivation for weight loss can include perceived appearance or the desire to improve health (Frenais et al, 2001; Mertens and Van Gaal, 2006). Research has shown that not all overweight or obese individuals perceive that their health is poor or are interested in losing weight (Blair and Church, 2004). Treatment algorithms for obesity are based on body size and comorbidities, factors that may not motivate all individuals to lose weight. Because perceived need and motivation for weight loss vary, tools used to evaluate readiness to lose weight also need to vary. HRQOL has been suggested as a tool to identify patients suitable for different weight loss interventions (Olshansky et al, 2005). In both clinical and public health settings, measures of HRQL may be more relevant for function and survival than physiologic and clinical assessments.

Many obese and overweight adults try to lose weight (Bish et al, 2005; Kruger et al, 2004), and motivation for weight loss can include perceived appearance or the desire to improve health (Clarke, 2002; Putterman and Linden, 2004). Research has shown that evaluating HRQOL is important in assessing the impact of weight management interventions (Duncan et al, 2003). Wille et al, (2008) examined the impact of obesity and overweight on HRQoL and emotional well-being in overweight children undergoing treatment. They reported that overweight children showed statistically significant impairment in the overall health and emotional well-being compared to the non-overweight counterpart at baseline. At the end of the study, they found that most of the overweight and obesed participants improved their BMI, perceived health, emotional well-being, and HRQoL.

2.15.1 The WHOQOL-BREF

The assessment of health-related quality of life (QoL) is a burgeoning area of study (Camfield and Skevington, 2008; Mason and Skevington 2004). The World Health Organization (WHOQOL Group, 1996) defines quality of life as 'individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns. This definition reflects the view that quality of life refers to a subjective evaluation that is embedded in a cultural, social and environmental context'. The World Health Organization Quality of Life (WHOQOL) questionnaires are among the most widely used QoL assessment tools in the world. The short version, the WHOQOL-BREF, is particularly popular, since its brevity reduces participant response burden and thus facilitates its use in conjunction with other measures (WHOQOL Group, 1998). Compared to other related instruments, such as the SF364, the WHOQOLBREF has very strong cross-cultural applicability (Li et al, 2009), and is thus readily suited to culturally diverse contexts.

The WHOQOL-BREF is a 26-item, self-administered, generic questionnaire that is a short version of the WHOQOL-100 scale (Skevington et al, 2004).The response options range from 1 (very dissatisfied/very poor) to 5 (very satisfied/very good). Assessments are made over the preceding two weeks. It consists of domains and facets (or sub-domains). The items on "overall rating of QOL" (OQOL) and subjective satisfaction with health constitute the general facet on OQOL and health. The instrument has four domains, namely, physical health (seven items), psychological health (six items), social relations (three items) and environment (eight items). Domains scores obtained from WHOQOL-BREF have been reported to demonstrate high correlation (r = 0.89) with that from WHOQOL-100 (WHO Group, 1998). Also WHOQOL –BREF has been shown to have good discriminant validity, construct validity, internal consistency, and test-retest reliability in several studies (Yao et al, 2002; Min et al, 2002; Trompenaars et al, 2005; Beriim et al, 2005). It is a very useful tool that has been used in assessing quality of life in chronic conditions (Niemi et al, 1988; Trompenaars et al, 2005; Beriim et al, 2005).

Scores from WHOQOL-BREF can be used majorly in three ways (WHO, 1996). The first is a summation of the raw scores of the constituent items. The second and third ways consist of transforming the raw scores. In the second way, the raw scores are transformed into scores that range from 4-20, to be in line with the WHOQL-100 Instrument. The third way, which is the percentage scale maximum (% SM) is a standardized conversion of Likert scale data projected onto a 0–100 scale. The WHOQOL Group has provided guidelines for these conversions (WHO, 1998). The advantage of the percentage scale maximum transformed score method (i.e., % SM) is that it can be used for making comparison with other scales.

The WHOQOL-Bref was of interest to this study for the following reasons: First, it was simultaneously developed in diverse cultures, thus overcoming the usual controversy of applying a questionnaire articulated in one culture in a different culture (Skevington et al, 2004). Second, the WHOQOL-Bref consists of three parts. The first part, which is the general facet on health and QOL, represents the issues of subjective well-being/ general life satisfaction/ global QOL (Cummins, 2005). The theoretical basis for this assumption is that the general facet is the scale that forms the first level of deconstruction of the WHOQOL construct of life quality (Cummins, 2005). The second part of the WHOQOL-Bref concerns HRQOL issues and consists of the physical health and psychological health domains. The third part of the questionnaire, which deals with contextual issues, is constituted by the social relations and environment domains.

2.16 Spirometry

Spirometry is a physiological test that measures how an individual inhales or exhales volumes of air as a function of time. The primary signal measured in spirometry may be volume or flow.

Spirometry is invaluable as a screening test of general respiratory health in the same way that blood pressure provides important information about general cardiovascular health (Miller et al, 2005). Most important of spirometry tests are the forced vital capacity (FVC) and the forced expiratory volume (FEV) in one second (Aurora et al, 2004).

Spirometry can be used for diagnostic purposes to evaluate symptoms, signs or abnormal laboratory tests; measure the effect of disease on pulmonary function; screen individuals at risk of having pulmonary disease; assess pre-operative risk; assess prognosis and also assess health status before beginning strenuous physical activity programmes (Paoletti et al, 2005). For monitoring purposes, spirometry is useful in assessing therapeutic intervention; describe the course of diseases that affect lung function; monitor people exposed to injurious agents and monitor for adverse reactions to drugs with known pulmonary toxicity. Spirometry is also for public health purposes in epidemiological surveys; derivation of reference equations and clinical research (Miller et al, 2005)

2.16.1 FEV^1 and FVC Manoeuvres

Definitions: FVC is the maximal volume of air exhaled with maximally forced effort from a maximal inspiration, i.e. vital capacity performed with a maximally forced expiratory effort, expressed in litres at body temperature and ambient pressure saturated with water vapour (BTPS) (Wagner et al, 2005). FEV^1 is the maximal volume of air exhaled in the first second of a forced expiration from a position of full inspiration, expressed in litres at BTPS (Leach et al, 2002).

Test Procedure: There are three distinct phases to the FVC manoeuvre, as follows: 1) maximal inspiration; 2) a ‘‘blast’’ of exhalation; and 3) continued complete exhalation to the end of test (EOT). The clinician should demonstrate the appropriate technique and follow the procedure. The subject should inhale rapidly and completely from functional residual capacity (FRC), the breathing tube or mouth piece should be inserted into the subject's mouth, making sure the lips are sealed around the mouthpiece and that the tongue does not occlude it, and then the FVC manoeuvre should be begun with minimal hesitation (Miller et al, 2005). Reductions in PEF and FEV^1 have been shown when inspiration is slow and/or there is a 4–6 s pause at total lung capacity (TLC) before beginning exhalation. It is, therefore, important that the preceding inspiration is fast and any pause at full inspiration be minimal (i.e. only for 1–2 s) (Bucca et al, 2001).

The test assumes a full inhalation before beginning the forced exhalation, and it is imperative that the subject takes a complete inhalation before beginning the manoeuvre. The subject should be prompted to ''blast,'' not just ''blow,'' the air from their lungs, and then he/she should be encouraged to fully exhale. Throughout the manoeuvre, enthusiastic coaching of the subject using appropriate body language and phrases, such as ''keep going'', is required. It is particularly helpful to observe the subject with occasional glances to check for distress, and to observe the tracing or computer display during the test to help ensure maximal effort. If the patient feels ''dizzy'', the manoeuvre should be stopped, since syncope could follow due to prolonged interruption of venous return to the thorax. This is more likely to occur in older subjects and those with airflow limitation. Performing a vital capacity (VC) manoeuvre, instead of obtaining FVC, may help to avoid syncope in some subjects. Reducing the effort partway through the manoeuvre (Stollar et al, 2003) may give a higher expiratory volume in some subjects, but then is no longer a maximally forced expiration. Well-fitting false teeth should not be routinely removed, since they preserve oropharyngeal geometry and spirometry results are generally better with them in place (Bucca et al, 2001). Testing can be done with the patient in sitting or standing, but this must be documented on the report (Miller et al, 2005).

Additional Criteria: A cough during the first second of the manoeuvre can affect the measured FEV^1 value. Coughing in the first second or any other cough that, in the clinician's judgment, interferes with the measurement of accurate results will render a test unacceptable (Miller et al, 2005). A Valsalva manoeuvre (glottis closure) or hesitation during the manoeuvre that causes a cessation of airflow in a manner that precludes an accurate estimate of either FEV^1 or FVC will render a test unacceptable (Eigen et al, 2001). There must be no leak at the mouth (Leach et al, 2002). Patients with neuromuscular disease may require manual or other assistance from the clinician to guarantee an adequate seal. Obstruction of the mouthpiece, e.g. by the tongue being placed in front of the mouthpiece or by teeth in front of the mouthpiece, or by distortion from biting, may also affect the performance of either the device or the subject (Swanney et al, 2000).

Summary of acceptable blow criteria: The acceptability criteria are a satisfactory start of test and a satisfactory EOT. In addition, the clinician should observe that the subject understood the instructions and performed the manoeuvre with a maximum inspiration, a good start, a smooth continuous exhalation and maximal effort. An acceptable procedure should meet the following conditions: 1) satisfactory start of expiration, without hesitation; 2) without coughing during the first second of the manoeuvre, thereby affecting the measured FEV^1 value, or any other cough that, in the clinician's judgment, interferes with the measurement of accurate results (ATS, 2005); 3) without early termination of expiration; 4) without a valsalva manoeuvre (glottis closure) or hesitation during the manoeuvre that causes a cessation of airflow, which precludes accurate measurement of FEV^{1} or FVC (ATS, 2005); 5) without a leak (ATS, 2005); 6) without an obstructed mouthpiece (e.g. obstruction due to the tongue being placed in front of the mouthpiece, or teeth in front of the mouthpiece, or mouthpiece deformation due to biting); and 7) without evidence of an extra breath being taken during the manoeuvre (Aurora et al, 2004; Miller et al, 2005).

Between-manoeuvre evaluation: An adequate test requires a minimum of three acceptable FVC manoeuvres. Acceptable repeatability is achieved when the difference between the largest and the next largest FVC is less than 0.150 L and the difference between the largest and next largest FEV^{1} is less than 0.150 L (Coates et al, 2001). If these criteria are not met in three manoeuvres, additional trials should be attempted, up to, but usually no more than, eight manoeuvres (Miler et al, 2000). Large variability among tests is often due to incomplete inhalations. Some patients may require a brief rest period between manoeuvres (Bucca et al, 2001).

Manoeuvre repeatability: For FVC measurements, acceptability is usually determined by ascertaining that the recommendations on performing the FVC test are met. The repeatability criteria are used to determine when more than three acceptable FVC manoeuvres are needed; these criteria are not to be used to exclude results from reports or to exclude subjects from a study (Wagner et al, 2005). In addition, the repeatability criteria are minimum requirements. Many subjects are able to achieve FVC and FEV^{1} repeatability to within 0.150 L. Manoeuvres with an unacceptable start of test or a cough must be discarded before applying the repeatability criteria and cannot be used in determining the best values (Swanney et al, 2000).

Maximum number of manoeuvres: Although there may be some circumstances in which more than eight consecutive FVC manoeuvres may be needed, eight is generally a practical upper limit for most subjects (Aurora et al, 2004). After several forced expiratory manoeuvres, fatigue can begin to take its toll on subjects and additional manoeuvres would be of little added value. In extremely rare circumstances, subjects may show a progressive reduction in FEV^{1} or FVC with each subsequent blow. If the cumulative drop exceeds 20% of start value, the test procedure should be terminated in the interest of patient safety. The sequence of the manoeuvres should be recorded.

Test result selection: FVC and FEV^{1} should be measured from a series of at least three forced expiratory attempts that have an acceptable start of test and are free from artifact, such as a cough. The largest FVC and the largest FEV^{1} (BTPS) should be recorded after examining the data from all acceptable manouvers.

2.16.2 Peak Expiratory Flow Rate

Definition: PEFR is the highest flow achieved from a maximum forced expiratory manoeuvre started without hesitation from a position of maximal lung inflation (Miller et al, 2005). When it is obtained from flow–volume curve data, It is expressed at BTPS in Ls-1. The defining characteristics of the flow–time curve, in relation to PEF, are the time taken for flow to rise from 10% of PEFR to 90% of PEFR, i.e. the rise time (RT), and the duration that flow is .90% of PEF, called the dwell time (DT). When PEF is obtained with portable monitoring instruments, it is expressed in L/min.

Test Procedure: PEFR must be achieved as rapidly as possible and at as high a lung volume as possible, in order to obtain the maximum value (ATS, 2005). The subject must be encouraged to blow as vigorously as possible. The neck should be in a neutral position, not flexed or extended, and the subject must not cough. A nose clip may not be necessary. After the point of full lung inflation, the subject must deliver the blow without any delay. Hesitating for as little as two seconds or flexing the neck allows the tracheal visco-elastic properties to relax and PEFR to drop by as much as 10% (Miller et al, 2005). Tonguing, spitting or coughing at the start of the blow may falsely raise the recorded PEF in some devices (Miller et al, 2005).

In the laboratory, the subject must perform a minimum of three PEFR manoeuvres. When PEFR is a self-administered recording, it is important that the subject has been adequately taught how to perform the test, when to perform it and what action to take depending on the resulting value obtained. Regular checks of the patient's PEF technique and meter are an important part of the follow-up.

Within-manoeuvre Evaluation: The subject must be observed to ensure a good seal at the mouth, no hesitation occurred, and there was no abnormal start to the manoeuvre.

Between-manoeuvre Evaluation: The PEFR values and their order must be recorded so that manoeuvre-induced bronchospasm can be detected. If the largest two out of three acceptable blows are not reproducible within 40 L/min-1, up to two additional blows can be performed. Ninety-five per cent of untrained healthy subjects and patients can reproduce PEFR to within 40 L/min-1, and 90% to within 30 L/min-1 (Miller et al, 2005). If satisfactory repeatability has not been in achieved in five attempts, more are not likely to be helpful (ATS, 2005).

Test result selection: The largest value from at least three acceptable blows is recorded.

2.17 Exercise and Obesity

It has been noted that small differences in abdominal fat volume can significantly alter risk profile (Fox et al, 2007). Evidence-based guidelines on the management of obesity promote the use of waist circumference as a measure of abdominal obesity for predicting excess relative risk of disease and monitoring the effect of intervention in overweight and obese persons (National Institute of Health, 1998).

Lifestyle interventions incorporating caloric restrictions and /or increased energy expenditure through increased physical activity can help reduce abdominal fat deposit, thereby ameliorating this risk. Exercise therapy is an integral component of obesity management, and may affect the selective loss of abdominal adipose tissue. While there are inconsistencies in the report of interventional studies investigating the effects of exercise on abdominal adiposity, the most potent exercise prescription for abdominal adiposity benefit is still unclear.

A systematic review of the available randomized control trials to 2006 suggested that interventions involving increased aerobic exercise can beneficially alter abdominal adiposity in overweight and obese individuals, and that this may occur independent of weight loss (Kay et al, 2006). Conversely, Thorogood et al, (2011) undertook a systematic review and meta-analysis of randomized controlled trials (RCTs) to evaluate the efficacy of aerobic exercise with minimal duration of 12 weeks on abdominal obesity, blood pressure, total cholesterol, triglyceride levels, and weight in overweight and obese populations. They concluded that moderate-intensity aerobic exercise program is ineffective for weight loss and abdominal fat loss intervention for overweight and obese populations but in combination with diet may provide modest improvements in cardiovascular risk. Nicklas et al, (2009) conducted a randomized control trial involving 112 women with abdominal obesity. After 20 weeks of aerobic exercise, they observed that though there was significant weight loss, there was no preferential loss of abdominal fat with either moderate- or vigorous-intensity aerobic exercise even when combined caloric restriction.

Current physical activity recommendations suggest that ~250 min of weekly aerobic-type exercise is required for body weight management (Donnelly et al, 2003; Haskell et al, 2007). The actual reduction of weight (and body fat) with this dose of regular exercise in overweight and obese individuals is often small (~2–3 kg) but increases (~5–7.5 kg) with exercise levels up to 420 min/week (Donnelly et al, 2009; Diabetes Prevention Research Group, 2002; Franz et al, 2007; Shaw et al, 2007). However, there is an emerging acceptance that even with intensive programmes, weight loss in excess of 3–4 kg is difficult to sustain (Shaw et al, 2007; Hansen et al, 2007; Franz et al, 2007), highlighting the need for alternative strategies and further rationale for promotion of VAT reduction as opposed to weight loss. In addition recent evidence has shown that aerobic exercise training (AEx) programmes of lower energy expenditure than current guidelines can induce a clinically significant reduction in VAT, even in the absence of weight loss (Johnson et al, 2009).

Although there are currently no guidelines for strengthening exercise training (SET) in the management of obesity, PST is known to positively affect insulin sensitivity and other processes associated with abdominal fat accumulation (Albright et al, 2000), and there is evidence that despite incurring a significantly lower energy expenditure than aerobic exercise therapy, SET may directly reduce abdominal adipose tissue (Kay et al, 2006).

Ismail et al, (2012) conducted a systematic review and meta–analysis comparing the effect of aerobic (AEx) and progressive strengthening exercise training (PRT) on abdominal fat. They observed a significant pooled effect size (ES) for the comparison between AEx therapy and control but not for the comparison between PRT therapy and control. Studies that compared AEx with PRT, did not report reach statistical significance (Slentz et al, 2007). Also interventions that combined AEx and PRT therapy versus control did show statistical significance (Shaw et al, 2007;). Aerobic exercise is central for exercise programmes aimed at reducing abdominal adiposity, particularly when combined with strengthening exercises (Thorogood et al, 2011). Most of the aerobic exercise program reviewed by Ismail et al (2012) where restricted to cycle ergometer, while the weight machine was the most commonly used for strength training. Since exercise mode plays a significant role in physiological adaptation to training, it might be informative to test the feasibility and efficacy of multi-modal training as a means of reducing abdominal adiposity.

CHAPTER THREE

MATERIALS AND METHODS

3.1 MATERIALS

3.1.1 Participants

The experimental group consisted of 11 male and 63 female participants between the ages of 20 and 60 years; while the control group was made up of 9 males and 59 female participants between the ages of 20 and 58 years.

3.1.2 Instruments

The following instruments were used for data collection in the study:

1. Portable weighing scale: A portable weighing scale (SECA, Model 7621019009) with measurement ranging from 0 kilogramme to 140 kilogramme was used to measure weights of participants in kilogramme (Plate 1).
2. Height meter: A height meter made in Germany (SECA, Model 220) calibrated in centimeters with measurements ranging from 20 centimeters to 210 centimeters was used to measure the heights of participants in meters. The height measurements were taken in centimeters and later converted to meters (Plate 2).
3. Digital Blood Pressure Monitor: A digital sphygmomanometer made in United States of America by OMRON (Model:HEM-712) with measurement range from 0 to 299 millimeter of mercury was used to measure systolic and diastolic blood pressure in millimeters of mercury.

4. Tape Measure: An inelastic tape measure made in China (Model: Butterfly) calibrated in centimeter from 0 centimeter to 150 centimeters was used to measure waist and hip circumference in centimeters.
5. Peak Flow Meter: A portable peak (Mini- Wright, Model -0120) by Clement Clarke International, England, calibrated in liters per minutes and ranging from 60 liters per minute to 800liters per minute, was used to measure the peak expiratory flow rate of participants in liters per minute using disposable individual adult mouthpiece (Plate 3).
6. Spirometer: A portable spirormeter made by Wedge Bellows, England was used to measure the forced vital capacity and forced expiratory volume in first second in millimeters and milliliters per second respectively (Plate 4).
7. Spirometer Mouthpiece: A vitalograph spirometer mouth piece made in United Kingdom was assigned and used by each participant while assessing their respiratory parameters.
8. Informed Consent form: This was used to seek and obtain written informed consent from participants (Appendix II).
9. Assessment Format: This is a recording format developed by the researcher to document all the measurements taken (Appendix III).
10. Exercise Readiness Questionnaire (ERQ): This instrument was used to determine whether physical activity is safe for participants. It consists of 10 questions to which participants answered yes or no (Appendix IV).
11. Exercise Mat: This was used by participants for aerobic exercises during the circuit training.
12. Compact Disc Player: A compact disc player by LG Corporation, Japan was used to play aerobic disc during the exercise session

13. Aerobic Video Compact Disc: An aerobic compact disc containing recorded sessions of aerobic exercises by Exercise Television, USA, was used for the aerobic sessions.
14. Metronome: A laboratory metronome made in Germany by Wilter was used to set the cadence during the step test (Plate 5).
15. Television screen: A 24-inch television was used to show recorded aerobic exercise protocol for the study
16. Skinfold Caliper: A skin-fold caliper by Evaluation Instruments, USA, calibrated in millimeters ranging from 0 millimeters to 70 millimeters was used to assess the skin-fold thickness of participants (Plate 6).
17. Stairway: A wooden stairway, with hand-held rails and rungs of variable height of 18.5; 33; 47; and 57 centimeters on one side and 21; 37 and 57 centimeters on the other side was used for stair climbing exercise (Plate 7).
18. Stepper: The Kettler Power Stepper made in Germany by Freizert Marke Kettler (Model: Stratos GT) was used for stepping exercise as part of the circuit training (Plate 8).

Plate 1. A portable weighing scale (SECA, Model 7621019009) used to measure weights of participants in kilogramme.

Plate 2. A height meter (SECA, Model 220) used to measure the heights of participants in centimeters.

Plate 3. A portable peak flow meter (Mini- Wright, Model -0120) used during the study for measuring peak expiratory flow rate in liters per second.

Plate 4. A portable spirormeter made by Wedge Bellows, England used during the study to measure forced vital capacity (in liters), forced expiratory volume in first second (in liters per second) and forced expiratory ratio (%).

Plate 5. A laboratory metronome used to set the cadence during the step test

Plate 6. Skin-fold caliper by Evaluation Instruments, USA, used during the study for measuring abdominal skinfolds of participants in millimeters

19. Bicycle Ergometer: A stationary bicycle ergometer made in Germany by Freizert Marke Kettler was used for cycling exercise as part of the circuit training (Plate 9).
20. Medicine Ball: A burst resistant medicine ball of diameter 65 centimeter made in Italy (Plus Gymnic) was used to exercise as part of the circuit training (Plate 10).
21. A pair of 1.5 kilogramme dumb-bell was used as part of the circuit training exercises (Plate 11).
22. Step Bench: A stable sturdy step bench of 25.4 centimeter high, 30.5 centimeter wide and 60 centimeter long constructed at the Instrument Section of Physiotherapy Department, University College Hospital was used to carry out exercise testing for cardioplumonary fitness.
23. A digital timer stop watch by Liaoning MEC Group Co Ltd, China was used to time all activities as necessary.
24. World Health Organization Quality of Life Questionnaire (WHOQOL-BREF) developed by World Health Organization was used to assess the quality of life of participants.

Plate 7. A wooden stairway used for stair climbing exercise during the circuit training.

Plate 8. A Kettler Power Stepper used for stepping exercise as part of the circuit training.

Plate 9. A bicycle ergometer made used for cycling exercise as part of the circuit training.

Plate 10.   A burst resistant medicine ball used during the study.

Plate 11. A pair of 1.5 kilogramme dumb-bell used as part of the circuit training exercises.

Plate 12. Step bench: A stable sturdy step bench of 25.4centimeters high, 30.5 centimeters wide and 60 centimetesr long constructed at the Instrument Section of the physiotherapy Department, University College Hospital was used to carry out exercise testing and estimation of maximum oxygen consumption.

3.1.3 Venue of Research

This study was carried out at the exercise laboratory of the Department of Physiotherapy, College of Medicine, University of Ibadan. Exercise trainings took place on Mondays, Wednesdays and Fridays between 12 noon and 6:00pm.

3.2 METHODS

3.2.1 Sample Size Determination and Sampling Technique

The sample size for the main study was determined using the formula:

$$n = \sigma^2 \left\{ \frac{Z_{(1-\alpha/2)} + Z_{(1-\beta)}}{d} \right\}^2$$

(Silmara et al., 2009)

Where n= sample size

α = statistical significance level set at 5%

$Z_{(1-\alpha/2)}$ = percentage point for statistical significance at two tails = 1.96

β = power of the study to detect type II error set at 80%

$Z_{(1-\beta)}$ = percentage point for power = -0.84

σ = standard deviation of variable (14.2cm; Ross et. al., 2004)

d = the difference to be detected (3cm; Canoy et. al., 2010)

The estimated sample size for each group in this study was 63.3. Therefore, in determining a moderate to large effect size with 80% power, a minimum of 64 participants was needed for each group (Donovan et al., 2005).

3.2.2 Sampling technique: Consecutive sampling technique was used to recruit the participants for this study. The first participant was allocated into a group by tossing a coin, while subsequent participants were allocated into groups alternately as they become available.

3.2.3 Research Design

Study Design: This study was an experimental study with pretest, post test design involving two groups.

3.2.4 Procedure

Data collection procedure:

Ethical approval was sought and obtained from the University of Ibadan and University College Hospital (UI/UCH) Health Research Ethics Committee (Appendix I). Participants were recruited through the use of advert posters containing information about the research programme, which was distributed and pasted in various public places like eateries, post-offices, worship centers and hospitals within the city of Ibadan (Ross et al, 2004; Okura et al, 2005; Church et al, 2007). The nature, purpose and procedure of the research were explained to the prospective participants in details by the researcher. Written informed consent was obtained from the prospective participant prior to the baseline assessment (Appendix II). The participants were informed of their freedom to refuse to take part in the study and their right to withdraw at any given time they choose. They were also assured of their confidentiality throughout the study. Participants completed Exercise Readiness Questionnaire (ERQ) (Appendix III) and any prospective participant who answered yes to any of the questions in the ERQ were referred to the physicians for further examination and medical clearance before such an individual was enrolled in the programme.

All volunteers who met the inclusion criteria and were able to carry out the exercise testing protocol with exercise heart rate between 65- 85% of maximal heart rate were randomly allocated into either experimental or control group (Donovan et al., 2005). Participants' demographic data of age, sex, weight, height, body mass index were obtained and recorded. Both groups received health promotion education, while only participants in the experimental group went through the exercise training programme. Before the commencement of each exercise session, measurements of resting blood pressure and heart rate were taken for each participant. Exercise training, which included aerobics and abdominal strengthening exercises were carried out under the supervision of the researcher thrice weekly for 12 consecutive weeks (Okura et al, 2005; King et al, 2008) by participants in the experimental group. Measurements of Waist Circumference (WC), Waist-to-Hip Ratio (WHR), Sum of Abdominal Skinfold (SSF), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Heart Rate (HR), Forced Vital Capacity (FVC), Forced Expiratory Volume in first second (FEV_1), Peak Expiratory Flow Rate (PEFR), Maximum Oxygen Consumption (VO_{2max}) and Quality of life (QoL) were taken at baseline and thereafter after every four weeks for participants in both groups. Quality of life (QoL) was assessed using World Health Organization Quality of Life Questionnaire-BREF (Appendix IV). All measurements taken were recorded in the Assessment Format developed by the researcher (Appendix V). The data of all indices of interest were taken at baseline to enable the researcher evaluate the pre-intervention level and justify the effect of the intervention on the selected parameters.

3.2.5 Measurements

The anthropometric assessments of body weight and height were taken at baseline and body mass index was computed for each participant. All other parameters were taken at baseline and at the end of the 4th, 8th, and 12th weeks of the study for participants in both experimental and control groups.

Anthropometric Measurements

Body Weight: The weighing scale was checked to ensure there was no zero error. If error was observed, it was corrected before use. Body weight was taken with participants mounting the platform of portable weighing scale in light dressing and without shoes. Weight measurements were read off from the scale when the pointer becomes stable. Weight was taken in kilogramme (Slentz et al, 2004; Okura et al, 2005).

Height: This was taken with participants standing erect with back against a height meter in light dressing and without shoes. Height of participants was measured from the heel of their foot to the vertex of their head. The horizontally projected indicator at right angle to the calibrated height meter was then adjusted to rest lightly on the vertex of the head. Measurements was taken in centimeters and later converted to meters (Slentz et al, 2004; Okura et al, 2005).

Body Mass Index (BMI): the body mass index of participants was estimated using the formula

$$\text{Body Mass Index} = \frac{\text{Weight (in kilogramme)}}{\text{Height}^2 \text{ (in meter)}}$$

(Wilmore and Costill, 2004; Okura et al, 2005)

Hip circumference: This was taken with participants in standing position. Using an inelastic tape measure, hip circumference of participants was taken at the level of greater trochanters in centimeters (Okura et al, 2007).

Waist circumference: Using an inelastic tape measure, with participants in erect-standing position, waist circumference measurement was taken laterally at the level of the iliac crest (McArdle et al., 2000; Slentz et al, 2004; Okura et al, 2007). Waist circumference was measured in centimeters.

Waist-Hip-Ratio (WHR): This was calculated using the following formula

$$\text{Waist-Hip-Ratio} = \frac{\text{Waist Circumference}}{\text{Hip circumference}}$$ (Wilmore and Costill, 2004)

Sum of Skinfold thickness: With participant in standing position, a skinfold caliper was used to measure skinfold thickness at two abdominal regions and summed–up in millimeters to have the sum of abdominal skinfolds (Slentz et al, 2004).

1) Abdominal skinfold: This was taken with the participant in standing position. The fold of skin and underlying subcutaneous adipose tissue was gently grasped between the left thumb and forefingers to form a distinct fold that separates from the underlying muscle. The skinfold was grasped 2 cm to the right side of the umbilicus. The jaws of the caliper were placed perpendicular to the length of the fold, and the skinfold thickness measured to the nearest 1 mm while the fingers continue to hold the skinfold. The actual measurement is read from the caliper about 3 seconds after the caliper tension is released (Bruce, 2003).

2) Supra-iliac skinfold thickness: This was taken at the iliac crest along the anterior axillary line. Abdominal and suprailaic skinfolds thickness were taken in millimeters (Slentz et al, 2004).

Cardiopulmonary Measurements

Blood pressure: This was assessed with a digital blood pressure monitor (OMRON B710). The participants were seated on a chair, while the left arm freed from clothing was positioned so that the brachial artery (at the antecubital crease) is held at heart level, roughly at the junction of the 4th intercostal space with the sternum (Naschitz and Rosner, 2007). The cuff of the blood pressure monitor was then wrapped around the left arm about 2.5 centimeters above the antecubital crease. The start button of the monitor was pressed and it inflated gradually. After a few seconds, the systolic and diastolic blood pressure readings are displayed on the monitor in millimeters of mercury (OMRON Blood Pressure Monitor Manual, 2005). Two measurements were taken after 5 and 10 minutes of rest. The mean of the two measurements was considered. If the two measurements differed by > 2 mmHg, a third measure was obtained (Okura et al, 2005). The resting systolic and diastolic blood pressures were taken before the commencement of the exercise session and recorded in millimeter of mercury.

Heart Rate: The heart rate was taken with the participants in sitting position after resting for about five minutes. The pads of the index and middle fingers were used to compress the radial artery in order to detect its pulsation. The rate was counted for fifteen seconds and then multiplied by four to get heart rate in one minute (Donovan et al 2005). The heart rate was measured in beats per minute.

Maximum oxygen consumption: This was assessed using a multistage 3-minute step test protocol developed by Siconolfi et al (1985). Firstly, a target heart rate of 65% of maximum heart rate (65% of the predicted [220 minus age] maximum HR) was determined for each participant. Then the participant was taken through the first stage which involves stepping up and down a portable 25.4 centimeter (10-inch) bench for 3 minutes at a rate of 17 steps per minute, using a metronome to guide the cadence. At the end of the three minutes, the exercise heart rate was taken and recorded. If the target heart rate was reached, the protocol was terminated. Otherwise, the participant rested for one minute before proceeding to the second stage which involves stepping at a higher rate of 26 steps per minute. Again if the target heart rate was not reached at the end of the second stage, the participant rested for one minute eventually proceeded to the third stage (34 steps per minute). The maximum oxygen consumption was estimated from a model developed by Siconolfi et al (1985) (Appendix VI). Maximum oxygen consumption was estimated in litres per minute per kilogramme body weight (l/min/kg).

Peak Expiratory Flow Rate (PEFR): The indicator of the peak flow meter was taken to '0' point, while the participant in standing position inhaled as deeply as possible, closed his/her lips tightly around the mouthpiece of the peak flow meter and blew as forcefully into the flow meter. The final position of the indicator showed the participant's peak expiratory flow rate in liters per minute. The measurement was taken three times and the highest was recorded (ATS, 2005).

Forced Vital Capacity (FVC): In erect position, the participants made a maximal inspiratory effort with lips tightly closed around the mouthpiece of the portable spirometer and exhale forcefully and continuously for about six seconds through the mouthpiece into the spirometer (Saxena et al, 2009). The largest measurement was taken after 3 acceptable trials which were within 100 millilitres from each other.

Forced Expiratory Volume in one second (FEV_1): Few seconds of the measurement maneuver for FVC, the values of the FVC, FEV_1 and FER were shown through the digital display of the handheld portable spirometer (Saxena et al, 2009). The largest FEV_1 measurement was taken after 3 acceptable trials which were within 100 millilitres from each other. The measurements of FVC and FEV_1 were taken in liters, while the FER was taken as percentage of FEV_1 over FVC.

In order to control cross infection while taking the spirometry measurements, each individual was given a one-way valve ‘vitalograph’ mouthpiece and the portable spirometer was disinfected every week with methylated spirit.

Quality of Life Assessments

Quality of life was assessed using the World Health Organization Quality of Life Questionnaire BREF Version (WHOQOL-BREF). This is a self-administered questionnaire, in which participants respond to questions relating to their overall quality of life, overall health and other domains of their lives within the past two weeks. These domains are physical domain, psychological domains, social domains and environmental domains. The mean score of each domain is calculated and converted into transformed scores on a scale of 0 to 100 using the transformation table (Appendix 6). Domain scores are scaled in a positive direction, with a higher score denoting higher quality of life.

3.2.6 Exercise Testing

A 3-minutes step test protocol was used to assess participants’ response to exercise. The participant stepped up and down a 25.4 centimeter step bench for three minutes at a cadence of 26 steps per minute. At the end of the third minute, the participant sat down and the exercise heart rate was taken and recorded. All volunteers who were able to carry out the exercise testing protocol with exercise heart rate between 65- 85% of maximal heart rate were considered as being able to safely tolerate the exercise programme. (Watts et al, 2004; Donovan et al., 2005)

3.2.7 Exercise Protocol

Participants were asked to maintain their usual dietary habit and activity of daily living (Church et al, 2007). Participants in both groups received health promotion education, but only those in the experimental group went through the exercise intervention. The exercise intervention programme consisted of general aerobic exercises and abdominal strengthening exercises. The abdominal strengthening exercises were arranged in a circuit of ten stations. Exercises were carried out thrice a week on alternate days with a day of rest in-between under supervision (Watts et al, 2004; Okura et al, 2005; Church et al, 2007).

General aerobic exercise: This began with warm-up exercise, followed by general aerobics and rounded-up with cool-down exercises. The warm-up exercise comprised of stretching exercise which included: alternate high knee raise, shoulder lift, leg and hand swing. The aerobic exercise was done with the aid of recorded aerobic exercise by Exercise TV and includes torso twist, abdominal crunch, alternate torso twist and abdominal crunch, shoulder to knee stretch; while the cool down comprised of breathing and stretching exercises. The duration of the general aerobic session was maintained at 15 minutes during the first 4 weeks, it was then progressed from 15 minutes from to 20 minutes; from 20 minutes to 25 minutes, and from 25 minutes to 30 minutes thereafter every four weeks.

Circuit Training: Abdominal exercises from a commercially recorded video disc were used during the study. It contained abdominal exercises rahging from mild for beginners, to moderate to advanced exercises. From observation from Pilot study, mild abdominal exercises for beginners were used throughout the study. The circuit training consisted of abdominal exercises and various mode of aerobic exercises arranged in ten stations. The exercises include: stepping exercise, hip rolls, weight lifting exercise using 1.5 kilogramme dumb-bell, modified bridging, stairs climbing, double knee to chest, bicycle ergometery, alternate straight leg raise, trunk stretching exercise using medicine balls and seated knee tucks. Local contemporary music was used to guide the tempo of the circuit exercises. The duration in each station was progressed from two minutes to two and half minutes to three minutes every four weeks with a change over period of one minute in-between the stations; increasing the total duration of the circuit training session from 30 minutes to 35 minutes and 40 minutes every four weeks. The change over period enabled participants to change from one station to the next in a clockwise direction. During the change period, participants were taken through breathing exercises followed by free-style dancing.

Station I: Stepping exercise

The participant stepped on the Kettler Power Stepper, supported by holding the hand-rail with both hands, and stepped against the resistance of the stepper with alternate legs. Stepping cadence was guided by the tempo of the background music.

Station II: Hip rolls

The participant laid on the back with both knees bent and feet flat on the mat, and rolled both knees first to the right and then to the left. The participants performed two sets of ten slow rolls to each side, with ten seconds rest.

Station III: Dumb-bell exercise

The participants held a pair of 1.5 kiolgramme dumb-bell, while standing erect with both hands by the side. Each participant performed two sets of ten repetition of full shoulder abduction while maintaining extended elbows, with ten seconds rest. This was followed by ten repetitions of elbow flexion. This was repeated for two minutes.

Station IV: Modified bridging

The participant laid on the back, with both knees bent and arms lying alongside the body. With knees and feet parallel, the participant was required to shift the body weight unto the shoulders while lifting the buttocks off the mat. In this position, the participant then lifted the right leg off the mat, maintaining it for ten seconds. This process was repeated using the alternate leg, with ten seconds rest in between.

Station V: Stair Climbing

The participant climbed up and down a wooden stairway consisting of hand-rails and rungs of variable height of 18.5; 33; 47; and 57 centimeters on one side and 21; 37 and 57 centimeters on the other side. Movement up and down the stairs took place for two minutes, while the cadence was guided by the tempo of the background music.

Station VI: Double knee to chest

The participant laid on the back with both knees and feet on the floor. Both knees were slightly drawn to the chest as far as possible and held with both hands. The participants then pulls the knees with both hands in the fully flexed position towards the chest, then participant the attempted to extend both legs against the pull of the hands. When this procedure was correctly done, there was isometric contraction of the abdominal muscles. The position was held for five seconds. Then the knees were straightened and the participant returns to the starting position. This was done for 12 repetitions.

Station VII: Bicycle ergometer

Participant sat on the stationary bicycle, then seat was adjusted with the participant's knee slightly bent (5 to 10 degrees) from full extension, with the ball of the foot on the pedal at its lowest point in the arc of movement. The participant pedaled the bicycle freely for two minutes.

Station VIII: Alternate leg raise

In supine lying position, the participant flexed one hip through 45 degrees with the knee extended and held in position for ten seconds. The hip extensors of the resting leg contract isometrically with the lower abdominal muscles to fix the pelvis. This was repeated using the alternate leg. The whole process was carried out for ten repetitions.

Station IX: Trunk movement exercises using medicine ball

In standing position with both feet slightly apart, the participant held the medicine ball with both hands, elbows fully extended. The participants then moved the ball from the right side to the left side for fifteen repetitions, then diagonally from above the right shoulder to the left knee. After 30 repetitions, this movement was carried out from above left shoulder to the right knee for another 30 repetitions.

Station X: Seated knee tucks

The participant in sitting position with both knees bent and heels on the mat, while supporting the body weight on the buttocks and both hands. The participant lifted the heels off the mat and drew both knees to the chest, and then returned to the starting position. Two sets of ten lifts were carried out with twenty second rest between sets.

3.3 Data Analysis

Data obtained from the study was summarized, presented and analyzed as follows:

1. Descriptive statistics of mean and standard deviation was used to summarize the data, while tables and graphs were used to present the data on abdominal adiposity, selected cardiopulmonary indices and quality of life.
2. Independent t-test was used to test for significant difference between the two groups.
3. Repeated Measures Analysis of Variance was used to test for within group comparisons.

Alpha level was set at 0.05 while the Bonferroni adjustment was used to set alpha level at 0.17 for each of the multiple comparisons (Ross et al, 2004).

3.4 Pilot study

A 2-week pilot study was carried out to test the feasibility of the experimental procedure and appropriateness of the exercises for exercise-naïve individuals. This also helped the researcher to familiarize himself with the experimental procedure, documentation process, exercise testing, exercise sessions, equipments, exercise sequence, exercise timing and duration. This was necessary to make the supervised exercise programme and data collection process as smooth as possible.

Participants: 20 apparently healthy sedentary adults comprising of 10 males and 10 females who satisfied the inclusion criteria volunteered to participate in the pilot study. Participants were between the ages of 23 to 45 years and were randomly assigned into either experimental or control group. All the participants in the experimental group carried out the exercise testing and went through the experimental procedure as proposed. Modifications were made to the experimental procedure following observations from the pilot study. Participants in both groups also received health promotion education.

Equipment Testing: Equipment were tested to ascertain proper function. During the course of the pilot study, it was observed that some equipment, such as exercise stepper and bicycle ergometer, would require routine service. Calibration of equipment was checked and corrected were necessary. Standard measurement protocols were carried out using the equipment. Test retest reliability of measuring equipment was carried out to ensure the reliability of the equipment used for this study.

Procedure: The entire exercise testing and exercise training procedure was carried out during the pilot study. From the observations made, it was necessary to create three stations for the smooth running of the study protocol: assessment cubicle; aerobic station and circuit training station. The movement of participants from the moment they arrive was arranged to follow a smooth sequence. When the participants arrived, they first report at the assessment cubicle. Their forms are checked to verify the informed consent was signed and Exercise Readiness Questionnaire is duly filled and signed. Thereafter, baseline measurements were taken. Participants then proceeded to the general aerobic station and circuit training station.

Exercise Appropriateness:

a) Exercise Sequence: The circuit training was initially proposed to consist of ten abdominal exercises in series. During this pilot study, it was observed that participants became bored before the completion of the circuit session; some also complained that it was rather cumbersome changing from lying position to lying positions ten times in series. The sequence of the ten stations was rearranged such that a mat exercise was followed by a general or flexibility exercise.

b) Exercise Content: The circuit training was proposed to comprise only abdominal exercises which include curl-up, diagonal; curl-up, alternate straight leg raise, bilateral straight leg raise, head and shoulder lift, knee bent sit- up, seat lift, through leg reach, alternate knee-to-chest and double knee-to-chest. However, during this pilot, it was observed that most of the participants had difficulty in performing these exercises, while the few who did complained of neck pain and abdominal muscle soreness. Hence the ten stations in the circuit training were modified to include four general exercises using all body part, four abdominal exercises for beginners which pose less stress on the neck and abdominal muscles and two flexibility exercises.

Time Allocation: It was initially proposed that exercise in each station in the circuit training will last for 3minutes and subsequently progressed after with one minute after every four weeks. However during the pilot study, it was observed that this time duration for each circuit station was too much for sedentary participants, as most of the participants found it difficult to carry out the exercise for the stipulated 3minutes. Therefore, the time allocated for each station in the circuit training was adjusted to begin with two minutes for the first four weeks and progressed to two and half minutes for the second four weeks and finally to three minutes for the last four weeks. Also a change over period of one minute was introduced in-between the stations, bringing the total duration of the circuit training session from 30 minutes to 35 minutes and 40 minutes every four weeks.

Clarity of Instruction: The pilot study provided opportunity to test the clarity of instruction to guide the exercise sessions. Pictorial depictions of exercise to be carried out in each of the exercise station during the circuit training were pasted accordingly.

The 142 participants who completed the study were made up of 20 male and 122 female adults who were apparently healthy and were not engaged in routine exercise either at recreational or competitive level within the last six months.

Two hundred and fourteen individuals consisting of 32 male and182 female apparently healthy volunteers who were not engaged in routine exercise either at recreational or competitive level within the last six months were enrolled for the study.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1 Physical characteristics and baseline data of participants in experimental and control groups

A total of 284 individuals showed interest in the study. Out of which 15 individuals did not show up for screening while another 55 individuals did not meet the inclusion criteria. Individuals who had concurrent pathologies such as diabetes, hypertension, stroke, cardiovascular or respiratory disorders and pregnant women were excluded from the study. Also women who became pregnant during the course of the study were excluded from continuing in the study. Two hundred and fourteen individuals consisting of 32 male and182 female volunteers satisfied the inclusion criteria and participated in the study. They were randomly allocated into either experimental or control group using consecutive sampling technique.

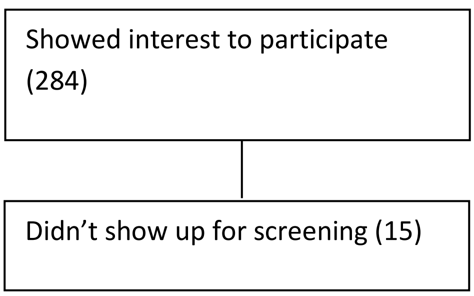
At baseline the experimental group comprised of 105 participants, 17 males and 88 females with age ranging from 20 to 60 years, while the control group had 109 participants consisting of 15 males and 94 females between the ages of 20 and 58 years. However, 142 (66.4%) participants made up of 74 (34.6%) participants in the experimental group and 68 (31.8%) in the control group completed 12 weeks of the study. 72 (33.6%) of the total 214 participants opted out of the study for various reasons on their own volition at various stages. Such reasons include inability to make time commitment, decision to diet, pregnancy, excess weight loss, refusal to continue in assigned group, relocation from Ibadan and other logistic problems. Number of participants who opted out of the study was higher in control group (41) compared with the experimental group (31) (See Figure 1).

The physical characteristics and baseline anthropometric data of experimental and control groups at baseline are shown in Table 1. An independent t test was calculated comparing the physical characteristics and anthropometric indices of participants in experimental and control groups. No significant difference was observed ($t(212) = 1.9$, $p>0.05$) in the mean age between both groups. The mean age for the experimental group (35.4 ± 9.7years), was not significantly different from the mean age of participants in the control group (34.7 ± 7.6 years) at baseline. Also no significant difference was observed in the mean weight ($t(212) = 1.78$, $p>0.05$) and body mass index ($t(212) = 0.04$, $p>0.05$) between the two groups. The mean weight for the experimental group (76.6 ± 13.8 kg), was not significantly different from the mean weight of participants in the control group (74.8 ± 12.6 kg) at baseline. Likewise, the mean body mass index of participants in the experimental group (28.9 ± 4.7 kg/m^2), was not significantly different from the mean body mass index of participants in the control group (28.9 ± 5.4 kg/m^2) at baseline.

No significant difference was observed in the abdominal adiposity indices of waist circumference ($t(212) = 0.28$, $p > 0.05$), waist-hip-ratio ($t(212) = 1.4$, $p > 0.05$) and sum of abdominal skinfolds ($t(212) = 0.94$, $p>0.05$) between the two groups at baseline. The mean waist circumference for the experimental group (94.4 ± 10.8 centimeters), was not significantly different from the mean waist circumference of participants in the control group (93.8 ± 11.1 centimeters) at baseline. The mean waist-hip-ratio for the experimental group (0.87 ± 0.06), was not significantly different from the mean waist-hip-ratio of participants in the control group (0.85 ± 0.07) at baseline.

Similarly, the mean sum of abdominal skinfolds of participants in the experimental group (77.3 ± 17.6 millimeters), was not significantly different from that of the participants in the control group (76.8 ± 18.3 millimeters) at baseline. Comparison of physical characteristics and selected anthropometric indices of participants between the two groups showed no significant difference at baseline of study. This suggests that the two groups were comparable at baseline of the study.

Cardiopulmonary indices of participants in the experimental and control groups at baseline are presented in Table 2. An independent t test was calculated comparing between the selected cardiopulmonary indices of participants in experimental and control groups at baseline. No significant difference was observed in the pulmonary indices of forced vital capacity (t(212) =0.31, p>0.05), forced expiratory volume in the first second (t(212) =0.43, p>0.05), forced expiratory ratio (t(212) =0.14, p>0.05) and peak expiratory flow rate (t(212) =0.42, p>0.05). The mean forced vital capacity of participants in the experimental group (2.6 ± 0.6 liters), was not significantly different from that of participants in the control group (2.9 ± 0.7 liters) at baseline.



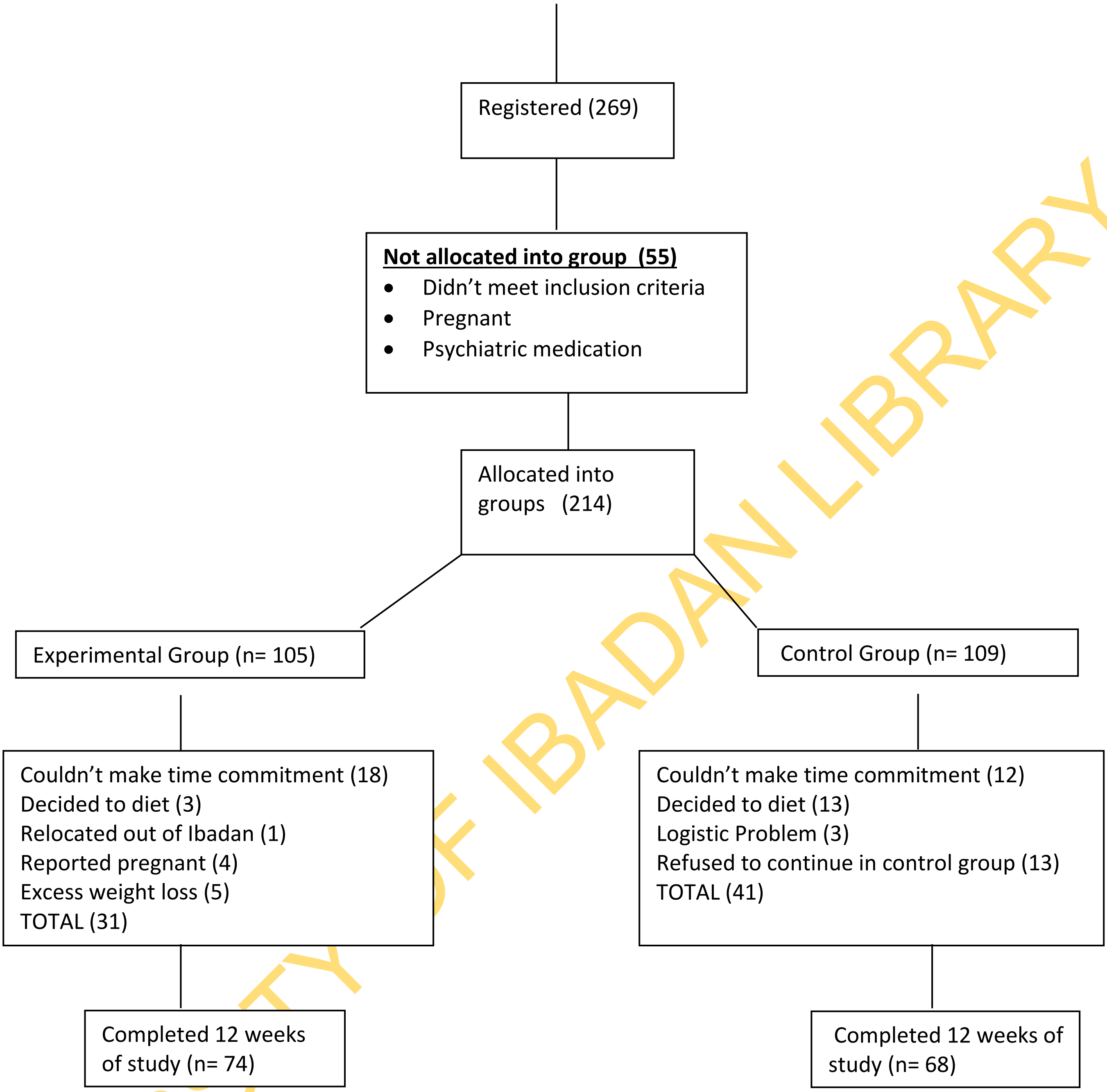


Figure 1. Flow chart of participants for the study

The mean forced expiratory volume in the first second of the experimental group (2.1 ± 0.6 liters), was not significantly different from the mean forced expiratory volume in the first second of participants in the control group (2.2 ± 0.6 liters) at baseline. Also the mean forced expiratory ratio for the experimental group (78.3 ± 9.9), was not significantly different from that of the participants in the control group (80.9 ± 6.3) at baseline. Likewise, the mean peak expiratory flow rate of participants in the experimental group (366.4 ± 69.3 liters/m^2), was not significantly different from the mean peak expiratory flow rate of participants in the control group (372.1 ± 71.2 liters/m^2) at baseline.

An independent t test showed no significant difference in the systolic blood pressure ($t(212) = 1.16$, $p > 0.05$), diastolic blood pressure ($t(212) = 1.11$, $p > 0.05$), heart rate ($t(212) = 0.51$, $p > 0.05$) and estimated maximum oxygen consumption ($t(212) = 0.82$, $p > 0.05$) between the two groups at baseline. The mean systolic blood pressure for the experimental group (119.5 ± 12.3mmHg), was not significantly different from the mean systolic blood pressure of participants in the control group (118.1 ± 10.7mmHg) at baseline. The mean diastolic blood pressure for the experimental group (75.4 ± 9.7mmHg), was not significantly different from the mean diastolic blood pressure of participants in the control group (73.5 ± 8.4 mmHg) at baseline. Similarly, there was no significant difference in the mean heart rate of participants in the experimental group (81.4 ± 10.7beats/minute) and that of the participants in the control group (80.8 ± 10.1beats/minute) at baseline. The mean estimated maximum oxygen consumption for the experimental group (14.3 ± 5.3 ml/kg/min), was also not significantly different from that participants in the control group (14.4 ± 4.8 ml/kg/min) at baseline. Comparison of cardiopulmonary indices of participants between the two groups showed no significant difference at baseline of study. This suggests that both groups had comparable cardiopulmonary indices at baseline of the study.

Table 1. Comparison of physical characteristics, anthropometric and abdominal indices of participants in experimental and control groups at baseline of study

Variables	Experimental n=105 Mean ± S.D	Control n= 109 Mean ± S.D	t-value	p-value
Age (yrs)	35.4± 9.7	34.7 ± 7.6	1.92	0.55
Weight (kg)	76.6 ± 13.8	74.8 ± 12.6	1.78	0.64
BMI (kg/m^2)	28.9 ± 4.7	28.9 ± 5.4	0.04	0.97
WC (cm)	94.4 ± 10.8	93.8 ± 11.1	0.28	0.99
WHR	0.87 ± 0.06	0.85 ± 0.07	1.42	0.15
SAS	77.35 ± 17.6	76.8 ± 18.3	0.94	0.35

KEY

Age (yrs):	Age of participants in years
Height (cm):	Height of participants in centimeters
Weight (kg):	Weight of participants in kilogramme
BMI:	Body Mass Index
WC (cm):	Waist circumference in centimeters
WHR:	Waist- Hip Ratio
SAS:	Sum of Abdominal Skinfold

Table 2. Comparison of cardiorespiratory indices of participants in experimental and control groups at baseline of study

Variables	Experimental n=105 Mean ± S.D	Control n= 109 Mean ± S.D	t-value	p-value
SBP (mmHg)	119.5 ± 12.3	118.1 ± 10.7	1.16	0.19
DBP (mmHg)	75.4 ± 9.7	73.5 ± 8.4	1.11	0.26
Heart Rate (b/min)	81.4 ± 10.7	80.8 ± 10.1	0.51	2.61
FVC (L)	2.6 ± 0.6	2.9 ± 0.7	0.31	1.21
FEV_1 (l)	2.1 ± 0.6	2.2 ± 0.6	0.43	1.17
FER	78.3 ± 9.9	80.9 ± 6.3	0.14	0.28
PEFR (L/min)	366.4 ± 69.3	372.1 ± 71.2	0.42	0.19
VO_{2max}	14.3 ± 5.3	14.4 ± 4.8	0.82	0.41

KEY

SBP (mmHg): Systolic Blood Pressure (millimeter of mercury)
DBP (mmHg): Diastolic Blood Pressure (millimeter of mercury)
Heart Rate (b/min): Heart rate (beats per minute)
FVC (L): Forced Vital Capacity (measured in liters)
FEV_1 (l/sec): Forced Expiratory Volume in One second (measured in liters per second)
FER: Forced Expiratory Ratio
PEFR (L/min): Peak Expiratory Flow Rate (measured in liters per minute)
VO_{2max}: Maximum oxygen consumption (milliliters/kilogramme/minute)

The baseline scores of the individual domains of the quality of life and the sum of the domain scores in experimental and control groups are shown in Table 3. The four domains of quality of life assessed include: physical, psychological, social and environmental domains. An independent t test analysis was carried out to compare the four different domains and the sum of the domain score of quality of life of participants in experimental and control groups at baseline. No significant difference was observed in the mean physical domain score ($t(212) = 0.15$, $p > 0.05$). The mean physical domain score for the experimental group (68.0 ± 11.7), was not significantly different from the mean physical domain score of participants in the control group (69.5 ± 11.6) at baseline. There was no significant difference in the mean psychological domain score ($t(212) = 0.54$, $p > 0.05$). The mean psychological domain score for the experimental group (65.3 ± 9.8), was not significantly different from that of participants in the control group (66.2 ± 10.5) at baseline. Similarly, comparison between the social domain scores ($t(212) = 0.89$, $p > 0.05$) and environmental domain scores ($t(212) = 1.25$, $p > 0.05$) of participants in the experimental and control groups were not significantly different at baseline. The mean social domain score for the experimental group (66.7 ±13.2), was not significantly different from that of the participants in the control group (70.6 ± 12.5) at baseline. Likewise, the mean environmental domain score of participants in the experimental group (63.6 ± 10.8), was also not significantly different from that of participants in the control group (65.3 ± 14.0) at baseline.

The sum of quality of life domain scores ($t(212) = 1.41$, $p > 0.05$) was not significantly different between the two groups. The mean sum of quality of life domain scores of participants in the experimental group (262.6 ± 35.5), was not significantly different from that of participants in the control group (271.6 ± 37.9) at baseline.

Comparison of quality of life domains and the sum of quality of life domain scores of participants between the two groups showed no significant difference at baseline of study. This suggests that the two groups were comparable at baseline of the study.

TABLE 3: Comparison of quality of life domains scores of participants in experimental and control groups at baseline of study

Variables	Experimental n=105 Mean ± SD	Control n= 109 Mean ± SD	t-value	p-value
QOL Physical	68.0 ± 11.7	69.5 ± 11.6	1.5	0.17
QOL Psychological	65.3 ± 9.8	66.2 ± 10.5	0.54	0.95
QOL Social	66.7 ± 13.2	70.6 ± 12.5	0.89	0.91
QOL Environmental	63.6 ± 10.8	65.3 ± 14.0	1.25	0.21
QOL Total	262.6±35.5	271.6± 37.9	1.41	0.31

Key

QOL Physical: Physical domain scores of Quality of Life
QOL Psychological: Psychological domain scores of Quality of Life
QOL Social: Social domain scores of Quality of Life
QOL Environmental: Environmental domain scores of Quality of Life
QOL Total: Total of Quality of Life domains scores

4.1.2 Changes in abdominal adiposity indices of participants in experimental and control groups at baseline and across the various assessment periods during the study

Participants in the experimental group were taken through an exercise and health promotion education programme for a period of 12 weeks. Assessments of indices of abdominal adiposity were carried out at every four weeks. Changes in the abdominal adiposity indices of participants in the experimental group from baseline across the various assessment periods are shown in Table 4.

One-way repeated measures ANOVA was carried out to compare the mean waist circumference, waist-to-hip ratio and sum of abdominal skinfolds at four different times: baseline, 4^{th}, 8^{th}, and 12^{th} week. A significant difference was found in the mean waist circumference ($F(3,219) = 240.5$, $p < 0.05$) of participants in the experimental group. A post-hoc analysis showed that mean waist circumference significantly reduced from baseline (94.4 ± 10.8cm) to 8^{th} week (90.1 ± 9.9cm) and to 12^{th} week (89.2 ± 9.8cm). The waist-to-hip ratio of participants in the experimental group was significantly different across the various assessment periods ($F(3,219) = 57.1$, $p < 0.05$). Further analysis showed that the waist-to-hip ratio of participants in the experimental group reduced significantly from baseline (0.87 ± 0.06) to 12^{th} week (0.84 ± 0.05). For the sum of abdominal skinfolds, a significant difference was also found across the four assessment periods ($F(3,219) = 226.5$, $p < 0.05$). Post-hoc analysis showed that the mean sum of abdominal skinfolds, significantly reduced from baseline (77.3 ± 17.6mm) to 8^{th} week (71.0 ± 17.1mm), from 4^{th} week (72.1 ± 18.7mm) to 12^{th} week (69.3 ± 16.9mm) and again from baseline (77.3 ± 17.6mm) to 12^{th} week (69.3 ± 16.9mm).

TABLE 4. Comparison of abdominal adiposity indices of participants within experimental group at baseline and across the various assessment periods during the study

Week N	Baseline 105 Mean ± SD	4 97 Mean ± SD	8 78 Mean ± SD	12 74 Mean ± SD	F-value	p-value
WC	94.4 ± 10.8	91.3 ± 10.1	90.1 ± 9.9*	89.2 ± 9.8	240.5	0.001
WHR	0.87±0.06	0.85±0.06	0.84±0.06	0.84±0.05*	57.1	0.01
SAS	77.3 ± 17.6	72.1 ± 18.7	71.0 ± 17.1*	69.3±16.9	226.5	0.001

KEY:

WC (cm): Waist circumference in centimeters
WHR: Waist- Hip Ratio
SAS(mm): Sum of Abdominal Skinfold in millimeter
*: Significant

Changes in the abdominal adiposity indices of participants in the control group from baseline across the various assessment periods are shown in Table 5.

A one-way repeated measures ANOVA was computed to compare the mean waist circumference, waist-to-hip ratio and sum of abdominal skinfolds at four different times: baseline, 4^{th}, 8^{th}, and 12^{th} week. No significant difference was found in the mean waist circumference ($F(3,201) = 0.69$, $p > 0.05$) of participants in the experimental group. Also there was no significant difference in the mean waist circumference at baseline (93.8 ± 11.1cm), 4^{th} week (92.0 ± 10.3cm), 8^{th} week (93.3 ± 10.3cm) and 12^{th} week (93.7 ± 9.7cm).

The waist-to-hip ratio of participants in the control group was not significantly different across the various assessment periods ($F(3,201)= 0.74$, $p > 0.05$). There was no significant difference in the mean waist-to-hip ratio of participants in the control group from baseline (0.85 ± 0.07) to the 4^{th} week (0.85 ± 0.08), 8^{th} week (0.86 ± 0.08) and 12^{th} week (0.85 ± 0.07). Also no significant difference was found in the mean of sum of abdominal skinfols of participants in the control group across the various assessment periods ($F(3,201) = 1.22$, $p > 0.05$). There was no significant difference in the mean sum of abdominal skinfols of participants in the control group from baseline (76.8 ± 18.3mm) to the 4^{th} week (75.1 ± 16.9mm), 8^{th} week (76.5 ± 17.6mm) and 12^{th} week (77.3 ± 17.6mm).

TABLE 5. Comparison of abdominal adiposity indices of participants within control group at baseline and across the various assessment periods during the study

Week N	Baseline 109 Mean ± SD	4 74 Mean ± SD	8 71 Mean ± SD	12 68 Mean ± SD	F-value	p-value
WC	93.8 ± 11.1	92.0 ± 10.3	93.3 ± 10.3	93.7 ± 9.7	0.69	1.55
WHR	0.85 ± 0.07	0.85 ± 0.08	0.86 ± 0.08	0.85 ± 0.07	0.74	2.15
SAS	76.8 ± 18.3	75.1 ± 16.9	76.5 ± 17.6	77.3 ± 17.6	1.22	0.68

KEY:

WC (cm): Waist circumference in centimeters
WHR: Waist- Hip Ratio
SAS (mm): Sum of Abdominal Skinfold in millimeter

4.1.3 Changes in abdominal adiposity indices of participants between experimental and control groups at the end of 12-week exercise programme

At the end of the 12 weeks, comparison of abdominal adiposity indices was made between participants of experimental and control group (Table 6). An independent t test comparing the mean waist circumference of participants in experimental and control groups showed a significant difference between the two groups ($t(140) = 2.6$, $p < 0.05$). The mean waist circumference of participants in the experimental group was significantly different (89.2 ± 9.8cm) compared with those of the control group (93.7 ± 9.7cm) at the end of the 12 weeks.

Similarly, the mean waist-to-hip ratio and sum of abdominal skinfolds of participants in experimental and control groups were compared using an independent t test. A significant difference was also found between the mean waist-to-hip ratio ($t(140) = 2.1$, $p < 0.05$) and sum of abdominal skinfolds ($t(140) = 2.7$, $p < 0.05$) of the two groups. The mean waist-to-hip ratio of the experimental group (0.84 ± 0.05) was significantly lower than that of the control group (0.88 ± 0.07) at the end of the 12 weeks. Likewise, the sum of abdominal skinfolds of participants in the experimental group (69.3 ± 16.9 millimeters) was significantly lower when compared with the sum of abdominal skinfolds of participants in the control group (77.3 ± 17.6 millimeters) at the end of the 12 weeks.

Table 6. Comparison of abdominal adiposity indices of participants between experimental and control groups at the end of 12-week exercise programme

Variables	Experimental n=74 Mean ± S.D	Control n= 68 Mean ± S.D	t-value	p-value
WC	89.2 ± 9.8	93.7 ± 9.7	2.6	0.01*
WHR	0.84 ± 0.05	0.88 ± 0.07	2.1	0.03*
SAS	69.3 ± 16.9	77.3 ± 17.6	2.7	0.01*

KEY

WC (cm): Waist circumference in centimeters
WHR: Waist- Hip Ratio
SAS(mm): Sum of Abdominal Skinfold in millimeter
*: Significant

4.1.4 Changes in cardiorespiratory indices of participants in experimental and control groups at baseline and across the various assessment periods during the study

Changes in the cardiorespiratory function indices of participants in the experimental group from baseline across the various assessment periods are shown in Table 7. One-way repeated measure ANOVA analysis was carried out to compare the means of cardiorespiratory function indices of participants in the experimental group at four different times: baseline, 4th, 8th, and 12th week. Significant difference was found in the mean systolic blood pressure ($F(3,219) = 17.1$, $p < 0.05$) of participants in the experimental group across the various assessment periods in the study. A post-hoc analysis showed that mean systolic blood pressure significantly reduced from baseline (119.5 ± 12.3mmHg) to 12th week (112.1 ± 8.1mmHg) and again from 4th week (116.8 ± 11.2mmHg) to 12th week (112.1 ± 8.1mmHg).

The diastolic blood pressure of participants in the experimental group was found to be significantly different across the various assessment periods ($F(3,219) = 26.9$, $p < 0.05$). Further analysis showed that the diastolic blood pressure of participants in the experimental group reduced significantly from baseline (75.4 ± 9.7mmHg) to 8th week (71.6 ± 8.0mmHg), from 4th week (73.3 ± 8.9mmHg) to 12th week (67.4 ± 6.1mmHg), and again from baseline (75.4 ± 9.7mmHg) to 12th week (67.4 ± 6.1mmHg).

The mean heart rate of participants in the experimental group was also found to be significantly different across the four assessment periods ($F(3,219) = 32.4$, $p < 0.05$). Post-hoc analysis showed that the mean heart rate of participants in experimental group significantly reduced from 81.4 ± 10.7b/min at baseline to 75.2 ± 7.8 b/min by the 8th week; and from 78.1 ± 9.6b/min in the 4th week to 70.1 ± 6.2b/min at the end of the 12th week. Significant decrease was also noticed from baseline (81.4 ± 10.7 b/min) to 12th week (70.1 ± 6.2 b/min).

Similarly, the mean forced expiratory volume in the first second ($F(3,219) = 99.7$, $p < 0.05$) and forced vital capacity ($F(3,219) = 136.7$, $p < 0.05$) of participants in the experimental group were significantly different across the assessment periods. Post-hoc analysis showed that the mean forced expiratory volume in the first second significantly increased from baseline (2.1 ± 0.6 liters) to 8th week (2.6 ± 0.5 liters) and from 4th week (2.3 ± 0.4 liters) to 12th week (2.8 ± 0.6 liters). Also, post-hoc analysis of the mean forced vital capacity showed significant increase from baseline (2.6 ± 0.6 liters) to 4th week (2.9 ± 0.6 liters), to 8th week (3.2 ± 0.6 liters) and to 12th week (3.5 ± 0.7 liters). On the contrary, the difference in the mean forced expiratory ratio of participants in the experimental group was not significant across the various assessment periods ($F(3,219) = 0.89$, $p > 0.05$). No significant difference was found between the means at baseline (78.3 ± 9.9), 4th week (79.2 ±6.0), 8th week (79.0 ± 5.9), and 12th week (78.5 ± 5.1).

The peak expiratory flow rate of participants in the experimental group was significantly different across the various assessment periods ($F(3,219) = 217$, $p < 0.05$). Further analysis showed that the peak expiratory flow rate of participants in the experimental group increased significantly from baseline (366.4 ± 69.3 liters/min) to 4th week (442.1 ± 64.1 liters/min), 8th week (465.0 ± 63.1 liters/min) and to 12th week (473.1 ± 62.4 liters/min) of study.

The estimated maximum oxygen consumption of participants in the experimental group was also found to have significantly increased across the four assessment periods ($F(3,219) = 175$, $p < 0.05$). Post-hoc analysis showed that the estimated mean maximum oxygen consumption of participants in experimental group significantly increased from baseline

(14.3 ± 5.3 ml/kg/min) to 8th week (15.0 ± 5.4 ml/kg/min) and from 4th week (14.8 ± 5.4 ml/kg/min) to 12th week (15.4 ± 4.8 ml/kg/min) of study.

TABLE 7. Comparison of cardiorespiratory indices of participants in experimental group at baseline and across the various assessment periods during the study

Week N	Baseline 105 Mean ± SD	4 97 Mean ± SD	8 78 Mean ± SD	12 74 Mean ± SD	F-value	p-value
SBP	119.5±12.3	116.8±11.2	117.1±8.0	112.1±8.1*	17.1	0.03*
DBP	75.4 ± 9.7	73.3 ± 8.9	71.6±8.0*	67.4 ± 6.1	26.9	0.005*
H. R	81.4 ± 10.7	78.1 ± 9.6	75.2 ± 7.8*	70.1 ± 6.2	32.4	0.007*
FVC	2.6 ± 0.6	2.9 ± 0.6*	3.2 ± 0.6	3.5 ± 0.7	136.7	0.006*
FEV_1	2.1 ± 0.6	2.3 ± 0.4	2.6 ± 0.5*	2.8 ± 0.6	99.7	0.009*
FER	78.3 ± 9.9	79.2 ± 6.0	79.04 ± 5.9	78.5 ± 5.1	0.89	0.74
PEFR	366.4 ± 69.3	442.1 ± 64.12*	465.0 ± 63.1	473.1 ± 64.2	217.0	0.005*
VO_{2max}	4.3 ± 5.3	14.8 ± 5.4	15.0 ± 5.4*	15.4 ± 4.8	175	0.004*

KEY:

SBP: Systolic Blood Pressure (millimeter of mercury)
DBP: Diastolic Blood Pressure (millimeter of mercury)
H. R: Heart rate at rest (beats per minute)
FVC: Forced Vital Capacity (liters)
FEV_1: Forced Expiratory Volume in One second (measured in liters per second)
FER: Forced Expiratory Ratio
PEFR: Peak Expiratory Flow Rate (measured in liters per minute)
VO_{2max}: Maximum oxygen consumption (milliliters/kilogramme/minute)
*: Significant

Changes in the abdominal adiposity indices of participants in the control group from baseline across the various assessment periods are shown in Table 8. No significant difference was found in mean systolic blood pressure ($F(3,201)=0.39$, $p>0.05$). The difference between the mean systolic blood pressure of participants in the control group at baseline (118.1 ± 10.7 mmHg), 4th week (118.3 ± 8.2 mmHg), 8th week (117.8 ± 8.4 mmHg) and 12th week (119.6 ± 7.1 mmHg) of study were not significantly different. However, there was significant difference in the mean diastolic blood pressure ($F(3,201)= 13.29$, $p<0.05$) of participants in the control group during the period of study. Further analysis showed that significant increase was found in the mean diastolic blood pressure of participants in the control group from baseline (73.5 ± 8.4 mmHg) to the 12th week (77.4 ± 7.9 mmHg) of study.

The mean heart rate ($F(3,201) = 2.56$, $p > 0.05$) and estimated maximum oxygen consumption ($F(3,201) = 0.56$, $p > 0.05$) of participants in the control group showed no significant difference across the four assessment periods. No significant difference was found between the mean heart rate of participants in the control group at baseline (80.8 ± 10.1 beat/min), 4th week (78.5 ± 10.9 beats/min), 8th week (79.0 ± 9.5 beats/min), and 12th week (77.4 ± 5.8 beats/min) of study. Likewise, no significant difference was found in the mean estimated maximum oxygen consumption of participants in the control group at baseline (14.4 ± 4.8 ml/kg/min), 4th week (14.8 ± 4.2 ml/kg/min), 8th week (14.5 ± 4.1 ml/kg/min), and 12th week (14.4 ± 7.1 ml/kg/min) of study.

The mean forced expiratory volume in the first second ($F(3,201) = 0.41$, $p > 0.05$) and mean forced vital capacity ($F(3,201) = 1.21$, $p > 0.05$) of participants in the control group showed no significant difference across the four assessment periods. No significant difference was found in the mean forced expiratory volume in the first second of participants within the control group at baseline (2.2 ± 0.6 liters), 4th week (2.4 ± 0.6

liters), 8th week (2.4 ± 0.5 liters), and 12th week (2.4 ± 0.6 liters) of study. Similarly, no significant difference was found in the mean forced vital capacity of participants within the control group at baseline (2.9 ± 0.7 liters), 4th week (3.1 ± 0.7 liters), 8th week (3.1 ± 0.8 liters), and 12th week (3.1 ± 0.7 liters) of study. The difference in the forced expiratory ratio of participants in the control group was not significant ($F(3,219) = 0.63$, $p > 0.05$). No significant difference was found between the means at baseline (80.9 ± 6.3), 4th week (78.1 ± 5.4), 8th week (78.4 ± 5.7), and 12th week (77.9 ± 5.3).

The difference in the mean peak expiratory flow rate of participants in the control group was not significant across the various assessment periods ($F(3,201) = 2.19$, $p > 0.05$). No significant difference exists in the mean peak expiratory flow rate of participants in the control group at baseline (372.1 ± 71.2 liters/min), 4th week (434.0 ± 69.6 liters/min), 8th week (419.5 ± 72.0 liters/min) and 12th week (420.7 ± 78.4 liters/min).

TABLE 8. Comparison of cardiorespiratory indices of participants in control group at baseline and across the various assessment periods during the study

Week N	Baseline 109 Mean ± SD	4 74 Mean ± SD	8I 71 Mean ± SD	12 68 Mean ± SD	F-value	p-value
SBP	118.1±10.7	118.3±8.2	117.8±8.4	119.6±7.1	0.39	0.18
DBP	73.5 ± 8.4	72.4 ± 6.8	75.8± 7.5	77.4 ± 7.9	13.29	0.03*
H. R	80.8 ± 10.1	78.5 ± 10.9	79.0 ± 9.5	77.4 ± 5.8	2.56	0.06
FVC	2.9 ± 0.7	3.1 ± 0.7	3.1 ± 0.8	3.1 ± 0.7	1.21	0.07
FEV_1	2.2 ± 0.6	2.4 ± 0.6	2.4 ± 0.5	2.4 ± 0.6	0.41	0.75
FER	80.9 ± 6.3	78.1 ± 5.4	78.4 ± 5.7	77.9 ± 5.3	0.63	0.16
PEFR	372.1 ± 71.2	434.0 ± 69.6	419.5 ± 72.0	420.7 ± 78.4	2.19	0.09
VO_{2max}	14.4 ± 4.8	14.8 ± 4.2	14.5 ± 4.1	14.4 ± 7.1	0.56	0.14

KEY:

SBP: Systolic Blood Pressure (millimeter of mercury)
DBP: Diastolic Blood Pressure (millimeter of mercury)
H. R: Heart rate at rest (beats per minute)
FVC: Forced Vital Capacity (liters)
FEV_1: Forced Expiratory Volume in One second (measured in liters per second)
FER: Forced Expiratory Ratio
PEFR: Peak Expiratory Flow Rate (measured in liters per minute)
VO_{2max}: Maximum oxygen consumption (milliliters/kilogramme/minute)

4.1.5 Changes in cardiorespiratory indices of participants between experimental and control groups at the end of 12-week exercise programme

Cardiopulmonary indices of participants in the experimental and control groups at the end of the 12 week exercise programme are shown in Table 9. Significant difference was found in the pulmonary indices of forced vital capacity ($t(140) = 43.5$, $p < 0.05$), forced expiratory volume in the first second ($t(140) = 23.2$, $p < 0.05$) and peak expiratory flow rate ($t(212) = 14.6$, $p < 0.05$), however, no significant difference was found in the forced expiratory ratio ($t(140) = 0.6$, $p > 0.05$).

The mean forced vital capacity for the experimental group (3.5 ± 0.7 liters), was significantly higher than that of participants in the control group (3.1 ± 0.7 liters) at the end of the 12 weeks. Also, the mean forced expiratory volume in the first second of the experimental group (2.8 ± 0.6 liters), was significantly higher than the mean forced expiratory volume in the first second of participants in the control group (2.4 ± 0.6 liters), but there was no significant difference in the mean forced expiratory ratio for the experimental group (78.5 ± 5.1) and the control group (77.9 ± 5.3) at the end of the study. The difference in the mean peak expiratory flow rate of participants in the experimental group (473.1 ± 64.2 liters/m^2), was significantly higher than that of participants in the control group (420.7 ± 78.4 liters/m^2) at end of the study.

An independent t test showed significant difference in the systolic blood pressure ($t(140) = 25.4$, $p < 0.05$), diastolic blood pressure ($t(140) = 28.8$, $p < 0.05$), heart rate ($t(140) = 79.7$, $p < 0.05$) and estimated maximum oxygen consumption ($t(140) = 13.7$, $p < 0.05$) between the two groups at the end of the 12 week of study. The mean systolic blood pressure for the experimental group (112.1 ± 8.1mmHg), was significantly lower than the mean systolic blood pressure of participants in the control group (119.6 ± 7.1mmHg) at end of 12 weeks of study. The mean diastolic blood pressure for the experimental group (67.4 ± 6.1 mmHg), was also observed to be significantly lower than that of participants in the control group (77.4 ± 7.9 mmHg) at the end of study. Similarly, the mean heart rate of participants in the experimental group (70.1 ± 6.2 beats/minute), was significantly different from that of the participants in the control group (77.4 ± 5.8 beats/minute) at end of the study period. Also the mean estimated maximum oxygen consumption for the experimental group (15.4 ± 4.8 ml/kg/min), at the end of the 12 weeks, was significantly higher than that of participants in the control group (14.4 ± 7.1 ml/kg/min).

Changes in waist circumference, sum of abdominal skinfolds and corresponding change in maximum oxygen consumption in experimental and control groups across the various assessment periods are shown in Figure 2.; while changes in waist-hip-ratio, forced expiratory volume in the first second and forced vital capacity of participants in experimental and control groups across the various assessment periods are shown in Figure 3.

Table 9. Comparison of cardiorespiratory indices of participants between experimental and control groups at the end of 12-week exercise programme

Variables	Experimental n=74 Mean ± SD	Control n= 68 Mean ± SD	t-value	p-value
SBP	112.1 ± 8.1	119.6 ± 7.1	25.4	0.01*
DBP	67.4 ± 6.1	77.4 ± 7.9	28.8	0.009*
Heart Rate	70.1 ± 6.2	77.4 ± 5.8	79.7	0.003*
FVC	3.5 ± 0.7	3.1 ± 0.7	43.5	0.02*
FEV_1	2.8 ± 0.6	2.4 ± 0.6	23.2	0.03*
FER	78.5 ± 5.1	77.9 ± 5.3	0.6	0.51
PEFR	473.1 ± 64.2	420.7 ± 70.4	14.6	0.001*
VO_{2max}	15.4 ± 4.8	14.4 ± 7.1	13.7	0.04*

KEY:

SBP: Systolic Blood Pressure (millimeter of mercury)
DBP: Diastolic Blood Pressure (millimeter of mercury)
H. R: Heart rate at rest (beats per minute)
FVC: Forced Vital Capacity (liters)
FEV_1: Forced Expiratory Volume in One second (measured in liters per second)
FER: Forced Expiratory Ratio
PEFR: Peak Expiratory Flow Rate (measured in liters per minute)
VO_{2max}: Maximum oxygen consumption (milliliters/kilogramme/minute)
*: Significant

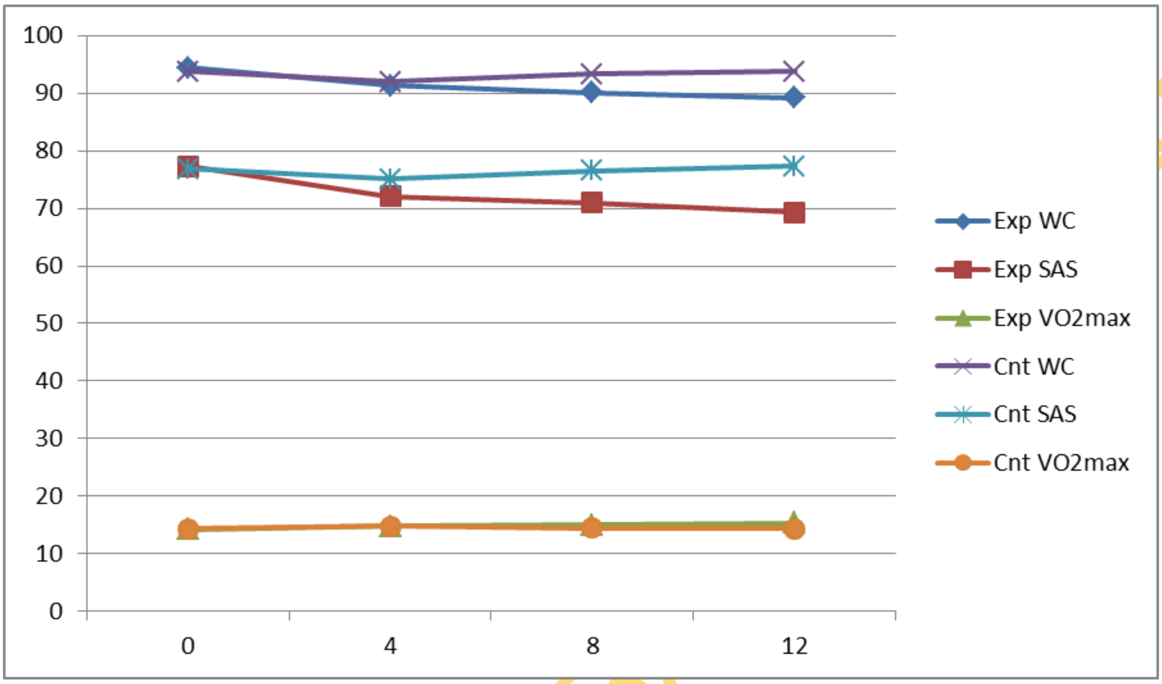


Figure 2. Changes in waist circumference, sum of abdominal skinfolds and maximum oxygen consumption in experimental and control groups across the various assessment periods.

KEY

Ex WC	Waist circumference of experimental group
Ex SAS	Sum of abdominal skin folds of experimental group
Ex VO2max	Maximum oxygen consumption of experimental group
Cnt WC	Waist circumference of control group
Cnt SAS	Sum of abdominal skin folds of control group
Cnt VO2max	Maximum oxygen consumption of control group

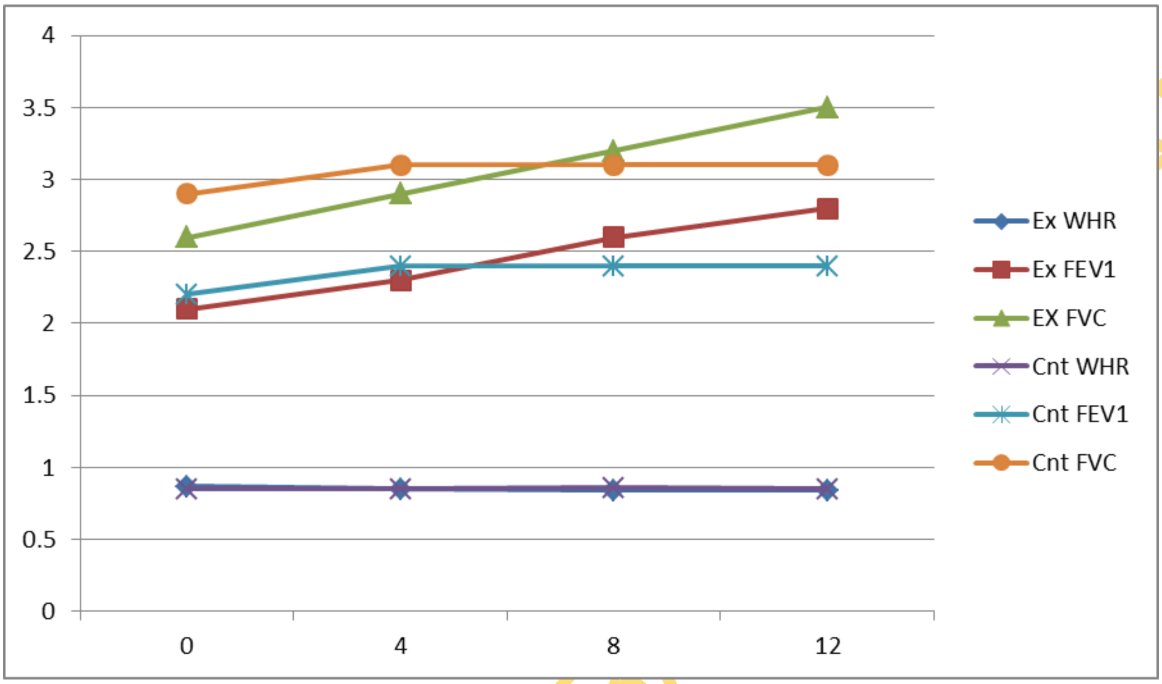


Figure 3. Changes in waist-hip-ratio, forced expiratory volume in the first second and forced vital capacity in experimental and control groups across the various assessment periods.

KEY

Ex WHR	Waist hip ratio of experimental group
Ex FEV1	Forced expiratory volume first second of experimental group
Ex FVC	Forced vital capacity of experimental group
Cnt WHR	Waist hip ratio of control group
Cnt FEV1	Forced expiratory volume in first second of control group
Cnt FVC	Forced vital capacity of control group

4.1.6 Changes in quality of life of participants in experimental and control groups at baseline and across the various assessment periods during the study

Changes in the abdominal adiposity indices of participants in the experimental group from baseline across the various assessment periods are shown in Table 10. Significant difference was found in the physical domain scores ($F(3,219) = 80.1$, $p < 0.05$), psychological domain scores ($F(3,219) = 106.7$, $p < 0.05$), social domain scores ($F(3,219) = 4.1$, $p < 0.05$) and environmental domain scores ($F(3,219) = 113.3$, $p < 0.05$) of participants in the experimental group.

Post-hoc analysis showed that the mean physical domain scores significantly increased from baseline (68.0 ± 11.7) to 4th week (75.5 ± 10.4), 8th week (80.1 ± 8.6), and 12th week (83.6 ± 8.2); while the mean score of psychological domain increased significantly from baseline (65.3 ± 9.8) to 8th week (77.9 ± 8.4) and 12th week (83.2 ± 8.0). The mean scores of the social domain also increased significantly from baseline (65.7 ± 13.2) to 8th week (80.7 ± 9.8), and 12th week (85.4 ± 10.6); similarly the mean score of environmental domain increased significantly from baseline (63.6 ± 10.8) to 12th week (80.6 ± 9.2). Changes in the domain scores of quality of life with corresponding changes in waist circumference and sum of abdominal skinfold of participants in experimental group across the various assessment periods is shown in Figure 4.

In addition, the sum of the quality of life scores of participants in the experimental group was compared across the various assessment periods using the one-way repeated measures ANOVA analysis. A significant difference was found in the sum of quality of life domain scores ($F(3,219) = 25.5$, $p < 0.05$). Follow-up post hoc analysis revealed that the sum of quality of life domain scores increased significantly from baseline (262.6 ± 35.5) to 8th week (314.7 ± 28.0) and 12th week (332.8 ± 25.4) respectively.

TABLE 10. Comparison of quality of life scores of participants in experimental group at baseline and across the various assessment periods during the study

Week N	Baseline 105 Mean ± SD	4 97 Mean ± SD	8 78 Mean ± SD	12 74 Mean ± SD	F-value	p-value
QOL_{Phy}	68.0±11.7	75.5±10.4*	80.1±8.6	83.6±8.2	80.1	0.001*
QOL_{Psych}	65.3 ± 9.8	73.7±8.6	77.9±8.4*	83.2±8.0	106.7	0.001*
QOL_{Soc}	65.7 ± 13.2	75.3±10.7	80.7±9.8*	85.4±10.6	4.1	0.03*
QOL_{Env}	63.6 ± 10.8	71.7±10.1	76.0±10.1	80.6±9.2*	113.3	0.001*
QOL_{Tot}	262.6 ± 35.5	296.2 ± 30.3	314.7 ± 28.0*	332.8 ± 32.4	22.5	0.01*

Key

QOL_{Phy} : Physical domain scores of Quality of Life
QOL_{Psych}: Psychological domain scores of Quality of Life
QOL_{Soc} : Social domain scores of Quality of Life
QOL_{Env} : Environmental domain scores of Quality of Life
QOL_{Tot}: Total domain scores of Quality of Life
*: Significant

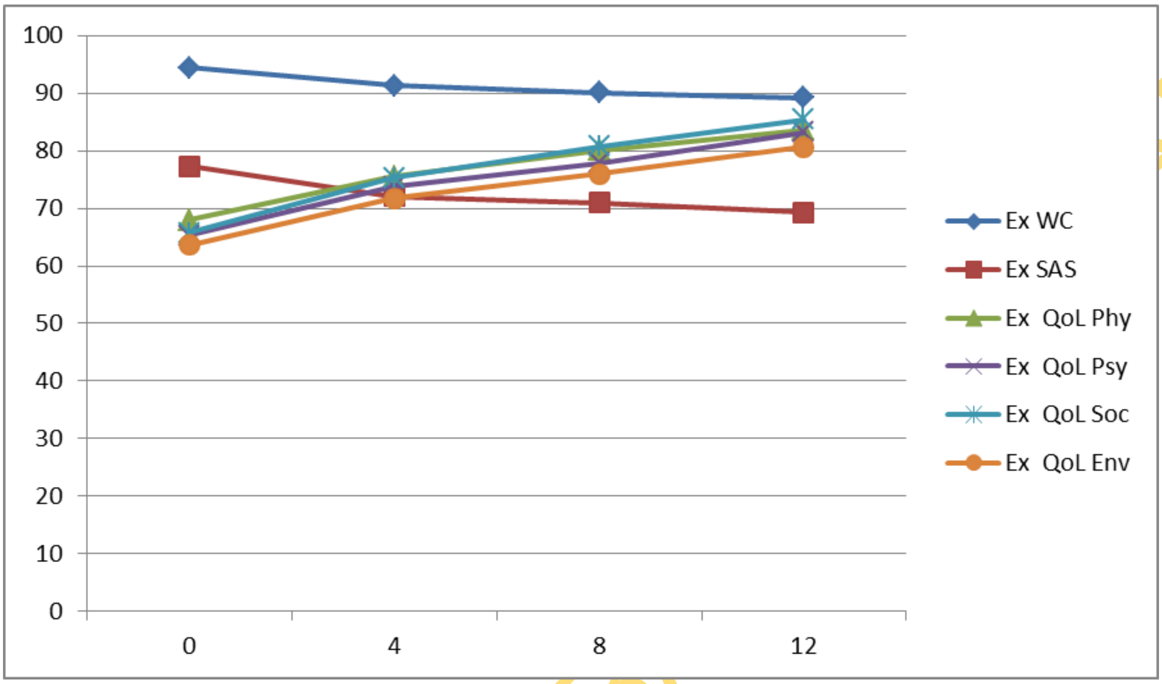


Figure 4. Changes in the scores of domains of quality of life and corresponding changes in waist circumference and sum of abdominal skinfolds of participants in the experimental group across the various assessment periods.

KEY

Ex WC	Waist circumference experimental group
Ex SAS	Sum of abdominal skin folds for experimental group
Ex QoL Phy	Quality of life physical domain scores of experimental group
Ex QoL Psy	Quality of life psychological domain scores of experimental group
Ex QoL Soc	Quality of life social domain scores of experimental group
Ex QoL Env	Quality of life environmental domain scores of experimental group

Changes in the mean quality of life scores of participants in the control group from baseline across the various assessment periods are shown in Table 11. No significant difference was found in the physical domain scores ($F(3,201) = 1.11$, $p > 0.05$), psychological domain scores ($F(3,201) = 0.49$, $p > 0.05$), social domain scores ($F(3,201) = 0.67$, $p > 0.05$) and environmental domain scores ($F(3,201) = 1.31$, $p > 0.05$) of participants in the control group.

No significant difference was found in the mean physical domain scores of participants in the control group from baseline (69.5 ± 11.6) to 4th week (73.4 ± 10.5), 8th week (64.2 ± 10.7), and 12th week (62.4 ± 9.7); also the mean score of psychological domain was not significantly different from baseline (66.2 ± 10.5) to 4th week (69.7 ± 12.7), 8th week (72.7 ± 12.1), and 12th week (63.1 ± 10.5). The mean scores of the social domain was also not significantly different from baseline (70.6 ± 12.5), to 4th week (69.9 ± 10.1), to 8th week (70.0 ± 10.4), and 12th week (64.3 ± 10.2); similarly no significant difference was found in the mean score of environmental domain from baseline (65.3 ± 14.0) to 4th week (65.2 ± 11.5), 8th week to (63.0 ± 10.2) to 12th week (65.2 ± 9.8) of study. Changes in the domain scores of quality of life and associated changes in waist circumference, sum of abdominal skinfolds of participants in the control group across the various assessment periods are shown in Figure 5.

The sum of the quality of life scores of participants in the control group was compared across the various assessment periods using the one-way repeated measures ANOVA analysis. The difference in the sum of quality of life domain scores ($F(3,219) = 0.43$, $p > 0.05$) was not significant. No significant difference was observed among the sum of quality of life domain scores at baseline (271.6 ± 37.9), 4th week (278.0 ± 33.4) to 8th week (272.9 ± 32.9) and 12th week (255.0 ± 29.5) respectively.

TABLE 11. Comparison of quality of life scores of participants in control group at baseline and across the various assessment periods during the study

Week N	Baseline 109 Mean ± SD	4 74 Mean ± SD	8 71 Mean ± SD	12 68 Mean ± SD	F-value	p-value
QOL_{Phy}	69.5 ± 11.6	73.4±10.5	64.2±10.7	62.4±9.7	1.11	0.79
QOL_{Psych}	66.2 ± 10.5	69.7±12.7	72.7±12.1	63.1±10.5	0.49	0.63
QOL_{Soc}	70.6 ± 12.5	69.9±10.1	70.0±10.4	64.3±10.2	0.67	0.12
QOL_{Env}	65.3 ± 14.0	65.2±11.5	63.0±10.2	65.2±9.8	1.31	0.47
QOL_{Tot}	271.6 ± 37.9	278.0 ± 33.4	272.9 ± 32.9	255.8 ±29.5	0.43	0.17

Key

QOL_{Phy} : Physical domain scores of Quality of Life
QOL_{Psych}: Psychological domain scores of Quality of Life
QOL_{Soc} : Social domain scores of Quality of Life
QOL_{Env} : Environmental domain scores of Quality of Life
QOL_{Tot}: Total domain scores of Quality of Life

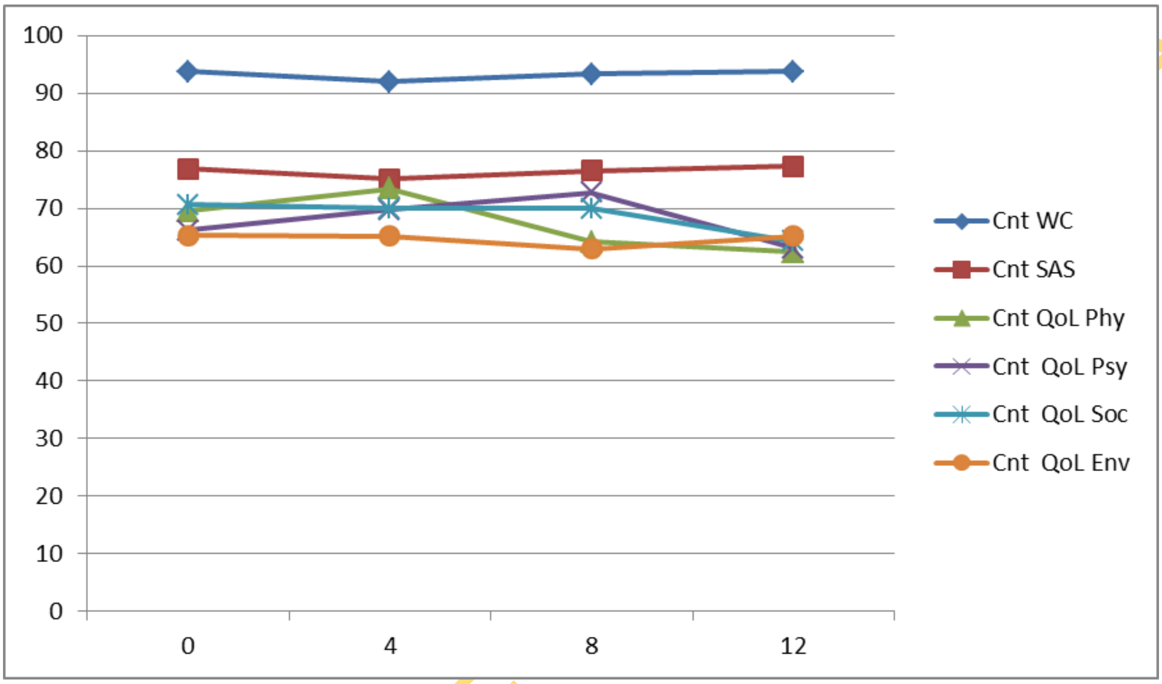


Figure 5. Changes in waist circumference, sum of abdominal skinfolds and domains scores of quality of life of participants in the control group across the various assessment periods.

KEY

Cnt WC	Waist circumference control group
Cnt SAS	Sum of abdominal skin folds for control group
Cnt QoL Phy	Quality of life physical domain scores of control group
Cnt QoL Psy	Quality of life psychological domain scores of control group
Cnt QoL Soc	Quality of life social domain scores of control group
Cnt QoL Env	Quality of life environmental domain scores of control group

4.1.6 Changes in quality of life of participants in experimental and control groups at the end of 12-week exercise programme

The quality of life scores of participants in the experimental and control groups at the end of the study period are presented in Table 12. An independent t test analysis was conducted to compare quality of life scores of participants in experimental and control groups at the end of the 12 week of study. A significant difference was observed in the mean physical domain score ($t(140) = 12.0$, $p < 0.05$). The mean scores of the physical domain for the experimental group (83.6 ± 8.2), was significantly higher than the mean scores of participants in the control group (65.4 ± 9.7) at the end of the study period.

There was significant difference in the mean score of the psychological domain ($t(140) = 12.8$ $p>0.05$). The mean psychological domain score for the experimental group (83.2 ± 8.0), was significantly higher than the mean psychological domain score of participants in the control group (63.1 ± 10.5) at the end of the study. Similarly, at the end of the 12 week of study, a significant difference was observed in the social domain scores ($t(140) = 2.4$, $p < 0.05$) and environmental domain scores ($t(140) = 12.2$, $p < 0.05$) of participants in the experimental and control groups. The mean social domain score for the experimental group (85.4 ±10.6), was significantly higher than that of the participants in the control group (65.3 ± 10.2); also the mean environmental domain score of participants in the experimental group (80.6 ± 9.2), was also found to be significantly higher than that of participants in the control group (65.2 ± 9.8) at the end of the study.

The sum of quality of life domain scores ($t(140) = 15.3$, $p < 0.05$) was found to be significantly different between the two groups. The mean sum of quality of life domain scores of participants in the experimental group (332.8 ± 32.4), was significantly higher than that of participants in the control group (255.0 ± 29.5) at the end of the study.

TABLE 12: Comparison of quality of life domains scores of participants in experimental and control groups at the end of 12-week exercise programme

Variables	Experimental n=74 Mean ± SD	Control n= 68 Mean ± SD	t-value	p-value
QOL Physical	83.6 ± 8.2	65.4 ± 9.7	12.0	0.001*
QOL Psychological	83.2 ± 8.0	63.1 ± 10.5	12.8	0.001*
QOL Social	85.4 ± 10.6	65.3 ± 10.2	2.4	0.015*
QOL Environmental	80.6 ± 9.2	65.2 ± 9.8	12.2	0.001*
QOL Total	332.8±32.4	255.0± 29.5	15.3	0.001*

Key

QOL Physical: Physical domain scores of Quality of Life
QOL Psychological: Psychological domain scores of Quality of Life
QOL Social: Social domain scores of Quality of Life
QOL Environmental: Environmental domain scores of Quality of Life
QOL Total: Sum of Quality of Life domain scores
*: Significant

4.1.7 Hypotheses Testing

Hypothesis 1

Statement: There would be no significant difference in the waist circumference of participants between experimental and control groups at the baseline of study.

Conclusion:

No significant difference observed in the waist circumference of participants between experimental and control groups at the baseline of study ($p > 0.05$).

Hypothesis 1 was NOT REJECTED (Table 1)

Hypothesis 2

Statement: There would be no significant difference in the waist-to-hip of participants between experimental and control groups at the baseline of study.

Conclusion:

No significant difference was observed in the waist-to-hip of participants between experimental and control groups at the baseline of study ($p > 0.05$).

Hypothesis 2 was NOT REJECTED (Table 1)

Hypothesis 3

Statement: There would be no significant difference in the sum of abdominal skin-folds of participants between experimental and control groups at the baseline of study.

Conclusion:

No significant difference was observed in the sum of abdominal skin-folds of participants between experimental and control groups at the baseline of study ($p > 0.05$).

Hypothesis 3 was NOT REJECTED (Table 1)

Hypothesis 4

Statement: There would be no significant difference in the peak expiratory flow rate of participants between experimental and control groups at the baseline of study.

Conclusion:

No significant difference was observed in the peak expiratory flow rate of participants between experimental and control groups at the baseline of study ($p > 0.05$).

Hypothesis 4 was NOT REJECTED (Table 2)

Hypothesis 5

Statement: There would be no significant difference in the forced expiratory volume in the first second of participants between experimental and control groups at the baseline of study.

Conclusion:

No significant difference was observed in the forced expiratory volume in the first second of participants between experimental and control groups at the baseline of study ($p > 0.05$).

Hypothesis 5 was NOT REJECTED (Table 2)

Hypothesis 6

Statement: There would be no significant difference in the forced vital capacity of participants between experimental and control groups at the baseline of study.

Conclusion:

No significant difference was observed in the forced vital capacity of participants between experimental and control groups at the baseline of study ($p > 0.05$).

Hypothesis 6 was NOT REJECTED (Table 2)

Hypothesis 7

Statement: There would be no significant difference in the forced expiratory ratio of participants between experimental and control groups at the baseline of study.

Conclusion:

No significant difference was observed in the forced expiratory ratio of participants between experimental and control groups at the baseline of study ($p > 0.05$).

Hypothesis 7 was NOT REJECTED (Table 2)

Hypothesis 8

Statement: There would be no significant difference in the systolic blood pressure of participants between experimental and control groups at the baseline of study.

Conclusion:

No significant difference was observed in the systolic blood pressure of participants between experimental and control groups at the baseline of study ($p > 0.05$).

Hypothesis 8 was NOT REJECTED (Table 2)

Hypothesis 9

Statement: There would be no significant difference in the diastolic blood pressure of participants between experimental and control groups at the baseline of study.

Conclusion:

No significant difference was observed in the diastolic blood pressure of participants between experimental and control groups at the baseline of study ($p > 0.05$).

Hypothesis 9 was NOT REJECTED (Table 2)

Hypothesis 10

Statement: There would be no significant difference in the heart rate of participants between experimental and control groups at the baseline of study.

Conclusion:

No significant difference observed in the heart rate of participants between experimental and control groups at the baseline of study ($p > 0.05$).

Hypothesis 10 was NOT REJECTED (Table 2)

Hypothesis 11

Statement: There would be no significant difference in the maximum oxygen consumption of participants between experimental and control groups at the baseline of study.

Conclusion:

There was no significant difference observed in the maximum oxygen consumption of participants between experimental and control groups at the baseline of study ($p > 0.05$).

Hypothesis 11 was NOT REJECTED (Table 2)

Hypothesis 12

Statement: There would be no significant difference in the sum of quality of life domains scores of participants between experimental and control groups at the baseline of study.

Conclusion:

No significant difference observed in the sum of quality of life domains scores of participants between experimental and control groups at the baseline of study ($p > 0.05$).

Hypothesis 12 was NOT REJECTED (Table 3)

Hypothesis 13

Statement: There would be no significant difference in the waist circumference of participants between experimental and control groups at the end of 12th week of study.

Conclusion:

Significant difference was observed in the waist circumference of participants between experimental and control groups at the end of 12th week of study ($p < 0.05$).

Hypothesis 13 was REJECTED (Table 6)

Hypothesis 14

Statement: There would be no significant difference in the waist-to-hip of participants between experimental and control groups at the end of 12th week of study.

Conclusion:

Significant difference was observed in the waist-to-hip of participants between experimental and control groups at the end of 12th week of study ($p < 0.05$).

Hypothesis 14 was REJECTED (Table 6)

Hypothesis 15

Statement: There would be no significant difference in the sum of abdominal skin-folds of participants between experimental and control groups at the end of 12th week of study.

Conclusion:

Significant difference was observed in the sum of abdominal skin-folds of participants between experimental and control groups at the end of 12th week of study ($p < 0.05$).

Hypothesis 15 was REJECTED (Table 6)

Hypothesis 16

Statement: There would be no significant difference the in peak expiratory flow rate of participants between experimental and control groups at the end of 12th week of study.

Conclusion:

Significant difference was observed in the peak expiratory flow rate of participants between experimental and control groups at the end of 12th week of study ($p < 0.05$).

Hypothesis 16 was REJECTED (Table 9)

Hypothesis 17

Statement: There would be no significant difference in the forced expiratory volume in the first second of participants between experimental and control groups at the end of 12th week of study.

Conclusion:

Significant difference was observed in the forced expiratory volume in the first second of participants between experimental and control groups at the end of 12th week of study ($p < 0.05$).

Hypothesis 17 was REJECTED (Table 9)

Hypothesis 18

Statement: There would be no significant difference in the forced vital capacity of participants between experimental and control groups at the end of 12th week of study.

Conclusion:

Significant difference was observed in the forced vital capacity of participants between experimental and control groups at the end of 12th week of study ($p < 0.05$).

Hypothesis 18 was REJECTED (Table 9)

Hypothesis 19

Statement: There would be no significant difference in the forced expiratory ratio of participants between experimental and control groups at the end of 12th week of study.

Conclusion:

There was no significant difference observed in the forced expiratory ratio of participants between experimental and control groups at the end of 12th week of study ($p > 0.05$).

Hypothesis 19 was NOT REJECTED (Table 9)

Hypothesis 20

Statement: There would be no significant difference in the systolic blood pressure of participants between experimental and control groups at the end of 12th week of study.

Conclusion:

Significant difference was observed in the systolic blood pressure of participants between experimental and control groups at the end of 12th week of study ($p < 0.05$).

Hypothesis 20 was REJECTED (Table 9)

Hypothesis 21

Statement: There would be no significant difference in the diastolic blood pressure of participants between experimental and control groups at the end of 12th week of study.

Conclusion:

Significant difference was observed in the diastolic blood pressure of participants between experimental and control groups at the end of 12th week of study ($p < 0.05$).

Hypothesis 21 was REJECTED (Table 9)

Hypothesis 22

Statement: There would be no significant difference in the heart rate of participants between experimental and control groups at the end of 12th week of study.

Conclusion:

Significant difference was observed in the heart rate of participants between experimental and control groups at the end of 12th week of study ($p < 0.05$).

Hypothesis 22 was REJECTED (Table 9)

Hypothesis 23

Statement: There would be no significant difference in the maximum oxygen consumption of participants between experimental and control groups at the end of 12th week of study.

Conclusion:

Significant difference was observed in the maximum oxygen consumption of participants between experimental and control groups at the end of 12th week of study ($p < 0.05$).

Hypothesis 23 was REJECTED (Table 9)

Hypothesis 24

Statement: There would be no significant difference in the sum of quality of life domain scores of participants between experimental and control groups at the end of 12th week of study.

Conclusion:

Significant difference was observed in the sum of quality of life domain scores of participants between experimental and control groups at the end of 12th week of study ($p < 0.05$).

Hypothesis 24 was REJECTED (Table 12)

Hypothesis 25

Statement: There would be no significant difference in waist circumference of participants in the experimental group at baseline, 4th, 8th, and 12th week of study.

Conclusion:

Significant difference was observed in waist circumference of participants in experimental group. Significant reduction was observed between baseline and 8th; and 12th week of study ($p < 0.05$).

Hypothesis 25 was REJECTED (Table 4)

Hypothesis 26

Statement: There would be no significant difference in waist-to-hip of participants in the experimental group at baseline, 4th, 8th and 12th week of study.

Conclusion:

Significant difference was observed in waist-to-hip of participants in experimental group. Significant reduction was observed between baseline and 12th week of study ($p < 0.05$).

Hypothesis 26 was REJECTED (Table 4)

Hypothesis 27

Statement: There would be no significant difference in sum of abdominal skin-folds of participants in the experimental group at baseline, 4^{th}, 8^{th} and 12^{th} week of study.

Conclusion:

Significant difference was observed in sum of abdominal skin-folds of participants in experimental group. Significant reduction was observed between baseline and 8^{th}, 12^{th} week; and from 4^{th} week to 12^{th} week of study ($p < 0.05$).

Hypothesis 27 was REJECTED (Table 4)

Hypothesis 28

Statement: There would be no significant difference in peak expiratory flow rate of participants in the experimental group at baseline, 4^{th}, 8^{th} and 12^{th} week of study.

Conclusion:

Peak expiratory flow rate of participants in experimental group was significantly different. Significant increase was observed between baseline, 4^{th}; 8th and 12^{th} week of study ($p < 0.05$).

Hypothesis 28 was REJECTED (Table 7)

Hypothesis 29

Statement: There would be no significant difference in forced expiratory volume in the first second of participants in the experimental group at baseline, 4^{th}, 8^{th} and 12^{th} week of study.

Conclusion:

Significant difference was observed in the forced expiratory volume in the first second of participants in experimental group. The increase was observed between baseline and 8th; 4th and 12th week of study ($p < 0.05$).

Hypothesis 29 was REJECTED (Table 7)

Hypothesis 30

Statement: There would be no significant difference in forced vital capacity of participants in the experimental group at baseline, 4th, 8th and 12th week of study.

Conclusion:

Forced vital capacity of participants in experimental group was significantly different. Significant increase was observed between baseline, 4th; 8th and 12th week of study ($p < 0.05$).

Hypothesis 30 was REJECTED (Table 7)

Hypothesis 31

Statement: There would be no significant difference in forced expiratory ratio of participants in the experimental group at baseline, 4th, 8th and 12th week of study.

Conclusion:

No significant difference was observed in the forced expiratory ratio of participants in experimental group between baseline, 4th; 8th and 12th week of study ($p > 0.05$).

Hypothesis 31 was NOT REJECTED (Table 7)

Hypothesis 32

Statement: There would be no significant difference in systolic blood pressure of participants in the experimental group at baseline, 4th, 8th and 12th week of study.

Conclusion:

Systolic blood pressure of participants in experimental group was significantly different. Significant reduction was observed between baseline and 12th week and from 4th to 12th of study ($p < 0.05$).

Hypothesis 32 was REJECTED (Table 7)

Hypothesis 33

Statement: There would be no significant difference in diastolic blood pressure of participants in the experimental group at baseline, 4th, 8th and 12th week of study.

Conclusion:

Significant difference was observed in the diastolic blood pressure of participants in experimental group. Significant reduction was observed between baseline and 8th, 12th week; and from 4th to 12th week of study ($p < 0.05$).

Hypothesis 33 was REJECTED (Table 7)

Hypothesis 34

Statement: There would be no significant difference in heart rate of participants in the experimental group at baseline, 4th, 8th and 12th week of study.

Conclusion:

Significant difference was observed in the heart rate of participants in experimental group. Significant decrease was observed between baseline and 8th, 12th week; and from 4th to 12th week of study ($p < 0.05$).

Hypothesis 34 was REJECTED (Table 7)

Hypothesis 35

Statement: There would be no significant difference in maximum oxygen consumption of participants in the experimental group at baseline, 4th, 8th and 12th week of study.

Conclusion:

Significant increase was observed in the estimated maximum oxygen consumption of participants in experimental group. The increase was observed between baseline and 8th; 4th and 12th week of study ($p < 0.05$).

Hypothesis 35 was REJECTED (Table 7)

Hypothesis 36

Statement: There would be no significant difference in the sum of quality of life domains scores of participants in the experimental group at baseline, 4th, 8th and 12th week of study.

Conclusion:

Significant increase was observed in the sum of quality of life domains scores of participants in experimental group. The increase was observed between baseline and 8th; and 12th week of study ($p < 0.05$).

Hypothesis 36 was REJECTED (Table 10)

Hypothesis 37

Statement: There would be no significant difference in waist circumference of participants in the control group at baseline, 4th, 8th, and 12th week of study.

Conclusion:

No significant difference was observed in waist circumference of participants in the control group at baseline, 4th, 8th, and 12th week of study ($p > 0.05$).

Hypothesis 37 was NOT REJECTED (Table 5)

Hypothesis 38

Statement: There would be no significant difference in waist-to-hip of participants in the control group at baseline, 4th, 8th and 12th week of study.

Conclusion:

No significant difference was observed in waist-to-hip of participants in the control group at baseline, 4th, 8th, and 12th week of study ($p > 0.05$).

Hypothesis 38 was NOT REJECTED (Table 5)

Hypothesis 39

Statement: There would be no significant difference in sum of abdominal skin-folds of participants in the control group at baseline, 4th, 8th and 12th week of study.

Conclusion:

No significant difference was observed in the sum of abdominal skin-folds of participants in the control group at baseline, 4th, 8th, and 12th week of study ($p > 0.05$).

Hypothesis 39 was NOT REJECTED (Table 5)

Hypothesis 40

Statement: There would be no significant difference in peak expiratory flow rate of participants in the control group at baseline, 4th, 8th and 12th week of study.

Conclusion:

No significant difference was observed in the peak expiratory flow rate of participants in the control group at baseline, 4th, 8th, and 12th week of study ($p > 0.05$).

Hypothesis 40 was NOT REJECTED (Table 8)

Hypothesis 41

Statement: There would be no significant difference in forced expiratory volume in the first second of participants in the control group at baseline, 4th, 8th and 12th week of study.

Conclusion:

No significant difference was observed in forced expiratory volume in the first second of participants in the control group at baseline, 4th, 8th, and 12th week of study ($p > 0.05$).

Hypothesis 41 was NOT REJECTED (Table 8)

Hypothesis 42

Statement: There would be no significant difference in forced vital capacity of participants in the control group at baseline, 4th, 8th and 12th week of study.

Conclusion:

No significant difference was observed in the forced vital capacity of participants in the control group at baseline, 4th, 8th, and 12th week of study ($p > 0.05$).

Hypothesis 42 was NOT REJECTED (Table 8)

Hypothesis 43

Statement: There would be no significant difference in forced expiratory ratio of participants in the control group at baseline, 4th, 8th and 12th week of study.

Conclusion:

No significant difference was observed in the forced expiratory ratio of participants in the control group at baseline, 4^{th}, 8^{th}, and 12^{th} week of study ($p > 0.05$).

Hypothesis 43 was NOT REJECTED (Table 8)

Hypothesis 44

Statement: There would be no significant difference in systolic blood pressure of participants in the control group at baseline, 4^{th}, 8^{th} and 12^{th} week of study.

Conclusion:

No significant difference was observed in systolic blood pressure of participants in the control group at baseline, 4^{th}, 8^{th}, and 12^{th} week of study ($p > 0.05$).

Hypothesis 44 was NOT REJECTED (Table 8)

Hypothesis 45

Statement: There would be no significant difference in diastolic blood pressure of participants in the control group at baseline, 4^{th}, 8^{th} and 12^{th} week of study.

Conclusion:

Significant difference was observed in the diastolic blood pressure of participants in control group. Significant increase was observed in diastolic blood pressure of participants in the control group between baseline and 12^{th} week of study ($p < 0.05$).

Hypothesis 45 was REJECTED (Table 8)

Hypothesis 46

Statement: There would be no significant difference in resting heart rate of participants in the control group at baseline, 4^{th}, 8^{th} and 12^{th} week of study.

Conclusion:

No significant difference was observed in heart rate of participants in the control group at baseline, 4^{th}, 8^{th}, and 12^{th} week of study ($p > 0.05$).

Hypothesis 46 was NOT REJECTED (Table 8)

Hypothesis 47

Statement: There would be no significant difference in maximum oxygen consumption of participants in the control group at baseline, 4^{th}, 8^{th} and 12^{th} week of study.

Conclusion:

No significant difference was observed in the estimated maximum oxygen consumption of participants in the control group at baseline, 4^{th}, 8^{th}, and 12^{th} week of study ($p > 0.05$).

Hypothesis 47 was NOT REJECTED (Table 8)

Hypothesis 48

Statement: There would be no significant difference in the sum of quality of life domains scores of participants in the control group at baseline, 4^{th}, 8^{th} and 12^{th} week of study.

Conclusion:

There was no significant difference observed in the sum of quality of life domains scores of participants in the control group at baseline, 4^{th}, 8^{th}, and 12^{th} week of study ($p > 0.05$).

Hypothesis 48 was NOT REJECTED (Table 11)

4.2 DISCUSSION

4.2.1Physical characteristics, anthropometric indices and baseline data of participants in experimental and control groups at baseline of study

A total of 284 individuals showed interest in this study. They were recruited through the use of handbill and posters containing information about the research pasted in public places across the city of Ibadan. At baseline, two hundred and fourteen individuals who satisfied the inclusion criteria were randomly assigned into experimental (105) and control (109) groups. However, 142 (66.4%) participants made up of 74 participants in the experimental group and 68 in the control group completed the study, giving an attrition rate of 33.6%.

90% of the two hundred and eighty four who registered their interest were females. Out of the two hundred and fourteen who commenced the study, one hundred and eighty two (85%) were females and thirty two (15%) were males. Studies show that more women are mindful of their body cathexis than men. While men are more concerned about building their muscle bulk toward the mesomorphic body type, women are more bothered about losing weight. A study by Sternfield et al, (2004) showed that excess weight in women is associated with increased adiposity and increased interest in losing weight.

In all parameters assessed, participants in the two groups were comparable in physical characteristics of age, anthropometric indices of weight and body mass index; though both groups were overweight according to the WHO Obesity Classification (WHO, 2004) with the mean BMI of 28.9 ± 4.7 for experimental group and 28.9 ± 5.4 for the control group. Also, participants in the two groups had comparable abdominal adiposity indices at baseline; hence any difference observed in these parameters at the end of the study cannot be attributed to the differences between the two groups at baseline.

No significant difference was also observed in the cardiorespiratory indices of both the experimental and the control groups at baseline. The cardiorespiratory indices of participants in both groups were within the normal range, except for the estimated maximum oxygen consumption which was low for both groups. This is not surprising since participants in the study were sedentary adults not engaged in regular exercise. Both groups were comparable in terms of assessed cardiorespiratory function indices and quality of life at baseline. This suggests that the population studied was homogenous in nature.

4.2.2 Changes in abdominal adiposity indices of participants in experimental group from baseline to the end of study period

Significant difference was first observed between the mean waist circumference at baseline and at the end of the eighth week. This finding showed that a moderate intensity exercise of about 55-75% maximum heart rate carried out thrice weekly resulted in significant reduction in waist circumference from the eighth week.

A similar result was seen in the sum of abdominal skinfolds. A reduction of 5.2 millimeters was observed within the first 4 weeks of exercise. Reduction in the sum of abdominal skinfolds continued to the end of the 12th week; though the magnitude of the reduction between each successive assessment reduced as the study progressed. Statistically significant reduction was noticed at the end of the eighth week. In a similar manner, there was progressive reduction in the waist-to hip ratio of participants in the experimental group across the various assessment periods. Significant reduction was noticed at the end of the twelfth week of study. The result of this study showed significant reduction in abdominal adiposity indices of wasit circumference, wasit hip ratio and sum of abdominal skinfolds. Additional energy expenditure during the exercise sessions in previously sedentary individuals would create a negative energy balance, which in turn might draw on energy stored in adipose tissue. Data from this study suggest that a strictly supervised exercise programme could have a positive effect on reducing visceral, subcutaneous and total abdominal fat without caloric restriction.

This is line with report of Slentz et al, (2005), who tested the effect of different exercise amount on abdominal obesity in overweight sedentary adults. They found that moderate intensity exercise (55-65% maximum heart rate) lasting 30 minutes carried out thrice weekly prevented increase in abdominal adiposity, and that increase in duration of moderate intensity exercise above 30 minutes resulted in significant decreases in visceral, subcutaneous and total abdominal fat without changes in caloric intake. Also, Irwin et al, (2003) also reported that an increase in duration of physical activity had a significant association with the reduction of total fat.

It was observed in this study that there were variations in participants' response to abdominal adiposity changes with exercise, in some participants the waist circumference and sum of abdominal skinfolds drastically reduced, while moderate or no changes were observed for the waist-to-hip ratio; while in others, moderate reduction in waist circumference and waist-to-hip ratio were observed, whereas the sum of abdominal skinfolds did not change.

The result of this study differs from that obtained from Despres et al, (2001) who found no significant reduction in abdominal fat during a 14-month exercise training program with an average fat loss of 3.7 kg in obese women. This disparity may be due, in part, to low intensity of the reported increase in physical activities which resulted in minimal energy expenditure and consequently little impact on adiposity-change patterns. According to Ross and Janssen (2001), reduction in abdominal adiposity level in response to exercise training is influenced by baseline adiposity levels and obesity phenotype. This implies that irrespective of the obesity phenotype, the greater the abdominal fat at baseline the more the abdominal fat loss, and the smaller the abdominal fat at baseline the less abdominal fat loss. This also interprets that with the same amount of fat mass, and individual with abdominal obesity phenotype will lose more abdominal fat compared with another individual with peripheral obesity phenotype. Though the women in the study of Depres et al, were obese, their obesity phenotype was more of general obesity than abdominal obesity as their initial intra-abdominal fat area was less than the cut-off of 104.7cm2 for abdominal obesity classification (Okura et al, 2005). Hence, this might explain the minimal reduction in the abdominal adiposity in their study.

In the present study, out of the 74 (11males; 63females) participants who completed the exercise programme, 65 participants (4 males; 61 females) had abdominal obesity with initial waist circumference > 102centimeters for males and > 88centimeters for females. The observed reduction in abdominal adiposity in this study is supported by the assertion that abdominal fat loss is influenced by adiposity levels at baseline.

Another observation from this study was that moderate intensity exercise for a minimum duration of 45 minutes not only prevented increases in visceral fat but actually resulted in sizable and significant decreases in subcutaneous and total abdominal fat, suggests that this exercise prescription might be helpful in reversing excess abdominal adiposity as modifiable risk factor for metabolic disease. That this amount of exercise can reverse abdominal obesity as a modifiable risk factor for metabolic disease is supported by previous studies that showed improvements in lipids and lipoproteins (Kraus et al, 2002), insulin sensitivity (Houmard et al, 2004), and body mass and fat mass loss (Slentz et al, 2004). The importance of visceral fat and its associations with risk factors for coronary heart disease and Type 2 diabetes have been well established. Excess abdominal fat is a significantly higher correlate of insulin response to a glucose challenge, fasting triglycerides, both systolic and diastolic blood pressure, and for HDL-to-total cholesterol ratio (Schutte, et al, 2005).

Most of the data linking abdominal fat with metabolic variables are associative, not causative. There is much controversy as to whether abdominal fat is a major health culprit or simply a marker of obesity-related health problems (Klein et al, 2004). Ravussin and Smith (2002) made a compelling case that failure to develop adequate fat cell mass in the face of excess energy intake may be the primary culprit, which then leads to ectopic fat deposition and in this way link excess abdominal adiposity to disease. Either way, it seems clear that abdominal fat, whether causative or simply a more specific marker of disease risk than general obesity, is an important health parameter.

It has been demonstrated that when moderate-intensity exercise is performed for long duration (> 45 min/d), there is greater lipid and lower carbohydrate oxidation compared with shorter duration (Davis et al, 2000). Longer exercise duration is associated with a marked increase in lipolysis in abdominal subcutaneous adipose tissue in comparison with femoral adipose tissue (Horowitz et al, 2000), suggesting that exercise-induced fat loss would be associated with a preferential reduction in abdominal obesity. This may explain, in part, the reduction ion adiposity lvel observed in this study. This assertion would have important public health implications in addressing abdominal obesity and consequently related health risk (Janssen et al, 2002; Ross et al, 2002a; Ross et al, 2002b).

4.2.3 Changes in abdominal adiposity indices of participants in control group from baseline to the end of study period

One of the hypotheses put forward and tested was that there will be no significant difference in abdominal adiposity indices in the control group across the various assessment periods. The participants in this group did not go through the exercise intervention but only received health promotion education; each session lasted for 30 minutes and was carried out every four weeks. The health education session covered general topics on causes of obesity, types of obesity, health implication of abdominal obesity, obesity mangement. Number of participants in the control group reduced from 109 at baseline to 74 at the end of the 4th week, to 71 at the end of the 8th week and 68 at the end of the study. The mean values of abdominal adiposity indices of participants who completed each assessment period were compared to test for statistically significant difference across the various assessment periods.

Comparison between the mean waist circumferences across the various assessment period, showed a slight reduction from baseline to the end of the 4th week. This observed reduction may be due to the high level of attrition in this group during the first four weeks from 109 to 74 participants. Some of these were those with large waist circumference who preferred to be assigned to the experimental group or decided to diet since they were not assigned into the experimental group. However, at the end of the study, there was no difference in the mean waist circumference and waist-hip-ratio of participants in the control group across the study period. Though, there was an increase in the sum of abdominal skinfolds of participants in the control group at the end of the study period, however, it was not statistically significant.

Time has been identified as a factor for increase abdominal adiposity in sedentary adults (Sternfiled et al, 2004). Slentz et al, (2005) investigated the effects of continued physical inactivity on visceral, subcutaneous and total abdominal fat over a period of 8 months found significant increases in total, visceral and subcutaneous abdominal adiposity. In this present study, the difference was not significant. This, probably, might be due to the duration of this study period which might not be adequate to observe any significant increase in abdominal adiposity indices in this population. But, data from other studies have shown that continued physical inactivity in sedentary overweight adults resulted in significant increase in abdominal fat over time (Sternfield, et al, 2004; Schutte et al, 2005; Van Gaal et al, 2006). This emphasizes the health risk associated with continued sedentary lifestyle in apparently healthy adults.

4.2.4 Changes in cardiopulmonary indices of participants in experimental and control groups from baseline to the end of study period

Participants in the experimental group were taken through moderate intensity exercise for a period of 12 weeks and received health promotion education, while participants in the control group only received health promotion education. Participants in both groups had their cardiorespiratory parameters assessed every four weeks. At the end of the study period, changes in selected cardiorespiratory parameters of participants in each group was compared for significant difference across the various assessment periods.

For the experimental group, significant changes were observed in all the cardiorespiratory parameters assessed except forced expiratory ratio (FER). Comparison between the baseline values and the mean values at the end of the twelfth week showed significant increases in peak expiratory flow rate, forced vital capacity, forced expiratory volume in first second and estimated maximum oxygen consumption; while there were significant decreases in heart rate, systolic blood pressure and diastolic blood pressure. Further analysis showed that there were significant increases in forced vital capacity and peak expiratory flow rate from the baseline to the 4th week. Also by the end of the 8th week, significant differences were noticed in the heart rate, diastolic blood pressure, forced expiratory volume in first second and estimated maximum oxygen consumption of participants in the experimental group from baseline; while the systolic blood pressure showed significant decrease at the end of the twelfth week.

Central obesity has been known to reduce chest wall compliance, respiratory muscle function, and peripheral airway size which give rise to abnormal spirometric patterns that are associated with a restrictive lung pattern, typically seen in obesity-related lung changes (Santana et al., 2001; Canoy et al., 2004; Chen et al., 2001). The changes observed in forced vital capacity and forced expiratory volume in one second were significant. This may be related to the observed significant reduction in waist circumference, which has been established to be negatively associated with FVC and FEV1, across the age and BMI categories (Canoy et al., 2004). Chen et al, (2007) in a cross-sectional study of 1674 adults examined the predictability of waist circumference (WC) and BMI for pulmonary function in adults with and without excess body weight. They reported that irrespective of age, sex and BMI categories, WC was negatively associated with forced vital capacity and forced expiratory volume in 1 s; and that an average of 1-cm increase in WC was associated with a 13-mL reduction in forced vital capacity and an 11-mL reduction in forced expiratory volume in 1 s. Based on their study, they concluded that WC, but not BMI, is negatively and consistently associated with pulmonary function in normal-weight, overweight, and obese subjects.

The negative influence of abdominal obesity on respiratory function may be explained through inflammatory or mechanical mechanism. Visceral adipose tissue influences circulating concentrations of interleukin- 6, tumor necrosis factor-α, leptin, and adiponectin, (Armellini et al, 2000; Ker et al, 2001; Gasteyger et al, 2002; Staiger et al, 2003) which are cytokines that may act via systemic inflammation to negatively affect pulmonary function. Abdominal obesity may negatively impact pulmonary function via the action of insulin resistance. Investigators reported an inverse association of serum leptin concentration with FEV1 as well as higher levels of C-reactive protein, leukocytes, and fibrinogen, which are other markers of systemic inflammation (Sin and Man, 2003). It is believed that inflammation may be part of the link between impaired pulmonary function and mortality (Schunemann et al, 2000; Pelkonen et al, 2001; Mannimo et al, 2003). Therefore, any interventions that may help to reduce abdominal adiposity may useful in moderating this inflammatory process.

Another possible mechanism to explain the inverse association of abdominal adiposity and pulmonary function is a mechanical limitation of chest expansion during the FVC maneuver. Increased abdominal mass may impede the descent of the diaphragm and increase thoracic pressure (Mannino et al, 2003) Abdominal adiposity is likely to reduce expiratory reserve volume via compressing the lungs and diaphragm (Koenig, 2001) thereby lowering FVC measurements. Logically, since abdominal adiposity is reported to be negatively associated with FEV1 and FVC, it is expected that any intervention that reduces abdominal adiposity and strengthens abdominal muscles, as implemented in this study, should improve respiratory function. Findings from this study support this theory. Although subject to further research, if this theory is true, then therefore, moderate intensity exercise of about 45 minutes performed thrice a week might be useful in addressing systemic inflammation associated with excess abdominal adiposity and consequently improve respiratory function.

There were significant changes in FEV1, FVC, PEFR in the experimental group but, there was no significant difference in the FER in this group. FER is an index that is used to characterize lung function as either restrictive or obstructive patterns in pathologic states. Since participants in this study were apparently healthy, it is not surprising that there was no significant change in the FER. This finding is similar to that of Aaron et al, (2004), who reported that weight loss improved FEV1 and FVC but not FER in obese women.

Comparison of systolic blood pressure, diastolic blood pressure and heart rate showed significant decrease, while significant increase was observed in the estimated maximum oxygen consumption across the various assessment periods in the experimental group. Studies have shown that cardiovascular function is impaired by abdominal skinfold and waist circumference (Lakka et al, 2003; Farrell et al, 2004; Jurca et al, 2004,). Similarly, Schutte et al, (2005) found that waist circumference was positively correlated with arterial compliance, diastolic blood pressure and systolic blood pressure, while abdominal skin fold was positively correlated with total peripheral resistance but negatively correlated with arterial compliance.

Aerobic exercises have been found to improve cardiovascular function in normotensive adults independent of weight loss. Improvements in the cardiovascular parameters of participants in the experimental group might be explained by the physiological adaptation to exercise training which includes improved muscular function and strength, and improvement in the body's ability to take up and utilize oxygen (AHA, 2004). Also it has been suggested that exercise training improves the capacity of the blood vessels to dilate in response to exercise and hormones; this is consistent with better vascular wall function and improved ability to deliver oxygen to working muscles during exercise.

This finding has significant health implications. Sedentariness and abdominal obesity are 2 major risk factors for developing cardiovascular disease (Lakka et al, 2003). American Heart Association have recommended that addressing this risk factors may significantly reduce cardiovascular disease burden. From this study, it has been shown that regular participation in exercises involving aerobic and strengthening components, not only reduces abdominal adiposity, but also improves cardiovascular function in apparently healthy adults.

Although continued sedentary lifestyle is associated with increase in waist circumference and decline in cardiorespiratory function with over time, no significant change was observed in the cardiorespiratory parameters of participants in the control group except a significant decline in the diastolic blood pressure. The significant increase in the diastolic blood pressure of participants in the control group may suggest that apparently healthy sedentary adults may develop cardiovascular complications in the ensuing years and may need to be followed up.

4.2.5 Changes in quality of life of participants in experimental and control groups from baseline to the end of the 12-week study period

Results from the study showed that there was significant difference in the sum of the quality of life domain scores across the various assessment periods in experimental group. Further analysis showed significant difference was observed at the end of the eighth week of study. There was significant improvement in the physical domain at the end if the 4th week, while psychological and social domains improved significantly at the end of the 8th week of study. Environmental domain score showed significant improvement at the end of the 12th week. The sum of the quality of life scores showed significant improvement at the end of the 8th week. The quality of life of participants in experimental group improved as the study progressed. This suggests that a 12-week exercise programme improved quality of life of apparently healthy adults in response to reduced abdominal adiposity, whereas, there was no significant change in the quality of life of participants in the control group. Studies have shown that high level of adiposity impairs quality of life. Participants in the experimatal group experienced a significant reduction in all abdominal adiposity indices,they also perceived their quality of life to have significantly improved. It has been established that exercises not only improves physical aspects of health, it has also been shown to positively impact on the psychosocial dimensions of health. It is suggested that the improvement in the quality of life of participants in the experimental group might be due to the effect of the exercise programme which resulted in reduction of abdominal fat. Over 80% of participants in the experimental group reported an improvement in their ability to perform their activities of daily living and satisfaction with their capacity for work. At the end of the 12th week, 51 participants in the experimental group reported that they are able to accept their bodily appearance and enjoy life very much.

Conversely, in the control group, this was not the case. There was reduction in the perceived quality of life in participants in this group, especially in the physical, psychological and social domains, though the reduction was not statistically significant in all domains of quality of life assessed. Quality of life is an individual's subjective perception of their position in life in relation to their goals, expectations, standards and concerns. The rating of participants in this group about their quality of life may reflect by their concern about an important aspect of their life they are bothered about.

4.2.6 Comparison of abdominal adiposity indices between experimental and control groups at the end of the study period.

At the end of the 12-week study period, comparison of abdominal adiposity indices was made between participants in the experimental and control groups. In comparison with the controls, significant reductions were observed for waist circumference ($p < 0.05$), waist-to-hip ratio ($p < 0.05$) and sum of abdominal skinfolds ($p < 0.05$) in the experimental group. Put together, changes in these parameters correspond to changes in visceral and subcutaneous fat around the abdominal region.

Participants in the two groups were comparable at baseline of study; hence observed differences might be attributed to the exercise intervention. Moderate-intensity exercise is associated with a significant increase in lipolysis in abdominal subcutaneous adipose tissue in comparison with femoral adipose tissue (Arner et al, 1990; Horowitz et al, 2000). Negative energy balance created by the exercise programme in the experimental group and the continued sedentary lifestyle in the control group might be responsible for the significant difference observed in the selected indices of abdominal adiposity between the two groups. This observation is consistent with that of Sternfield et al, (2004) who found significant difference in total and abdominal adiposity in young, middle aged adults at the end of a 3-year period between participants maintained daily routine exercises and sedentary controls. They also found that total and abdominal obesity reduced steadily in the exercise group over the 3-year period while there was significant increase in adiposity of sedentary controls.

This suggests that continued sedentary lifestyle without caloric restriction in apparently healthy adults is associated with increase abdominal adiposity, while regular participation in structured exercise without caloric restriction is associated with reduced waist circumference, waist-to-hip ratio and abdominal skinfolds. This underscores the critical role of regular physical activity in attenuate health risk associated with abdominal obesity. Similar associations between increased physical activity and attenuated weight gain have been observed in several other cohort studies, such as the Coronary Artery Risk Development in Young Adults (CARDIA) Study (Schimtz et al, 2000) and the Health Professionals Follow-up Study (Koh-Banerjee et al, 2003). Also, Irwin et al. (2003) reported a statistically significant reduction in total and abdominal obesity in women following a 12 week exercise programme in comparison with controls.

The finding that exercise is associated with a substantial reduction in abdominal fat in non-dieting (i.e., no caloric restriction) adults is consistent with the findings of Slentz et al. (2004), who reported that in overweight and obese non-dieting men and women, exercise performed for 45 minutes, 4 d/wk was associated with a marked reduction in both total and abdominal (waist circumference) obesity. Also, it is line with findings of previous report from similar well-controlled trials (Nguyen-Duy et al, 2003; Eckel et al, 2004) and suggest that routine participation in moderate exercise without caloric restriction for 45 to 60 minutes is associated with substantial reductions in obesity independent of gender.

However, these findings are countered by Donnelly et al. (2003), who performed a well-designed, rigorously controlled investigation and reported that overweight and obese women were resistant to changes in body composition in response to exercise performed 5 days per week. This disparity may be due in part to the low intensity of the reported increase in physical activities which resulted in minimal energy expenditure and consequently little impact on adiposity.

Combined with the observation that abdominal obesity conveys the greatest health risk (Janssen et al, 2002; Ross et al, 2002a; Ross et al, 2002b) and that increased cardiovascular fitness is associated with a reduction in morbidity and mortality independent of BMI (Lee et al, 2009), this observations contribute to the compelling evidence that exercise without caloric restriction should be recognized as an effective strategy for abdominal obesity reduction in apparently healthy sedentary adults.

4.2.7 Comparison of selected cardiorespiratory indices between experimental and control groups at the end of the study period.

One of the aims of the study was to look at the effect of a 12-week exercise programme designed for fat loss on cardiorespiartory indices in apparently healthy sedentary adults. At the end of the 12th week, comparison of cardiorespiratory parameters was made between participants in the experimental and control groups. There was significant difference in all cardiorespiratory parartmeters assessed except the FER. The result of this study showed that exercise programme designed for abdominal fat loss produced significant improvement in the selected cardiorespiratory indices in participants in the experimental group compared with those in the control group. The observed differences may be attributed to the combination of aerobic and strengthening exercises which the participants in the experimental group went through since both were comparable at baseline. It is not surprising, however, that the FER of the two groups is not significantly different since participants in this study were apparently healthy individuals.

Longitudinal studies of pulmonary function decline showed the effect of changes in body composition on pulmonary function. These studies (Bottai et al, 2002; Chen et al, 2003; Wise et al, 2008) have implicated increased abdominal adiposity as an important predictor of pulmonary function decline and that interventions to reduce abdominal fat may be helpful. The CDC has recommended that individuals should engage regularly in moderate intensity exercises on most days of the week because of its health benefits (CDC, 2004). Impaired cardiorespiartory function and fitness is associated with increase morbidity and all-cause mortality. And it has been suggested that abdominal adiposity may best explain the association (Faria et al, 2002; Rattarasarn et al, 2003). However, from this study, it was observed that moderate exercise programme involving a combination of aerobics and strengthening exercise improved cardiorespiratory function indices in apparently healthy individuals in response to abdominal fat loss.

4.2.8 Comparison of quality of life of participants between experimental and control groups at the end of the study period.

At the end of the 12 week study period, specific domains of the physical, psychological, social and environmental of the WHOQOL-BREF, and the sum of domains of participants in the experimental and control groups were compared. There was significant difference in all the domains compared, with participants in the experimental group reporting a significant improvement in the way they perceived their health and quality of life. This observation might be explained in part, by the effects of exercise training on the physical and psychological well-being of the participants. Physical activity appears to improve health-related quality of life by enhancing psychological well-being and by improving physical functioning (Kolotkin et al, 2002), while sedentary persons with or without obesity have been shown to have significantly lower quality of life than those who are physically active (Jia and Lubetkin, 2005). Heo et al, (2003) also observed that quality of life scores of sedentary individuals with abdominal obesity were similar to those of persons with obesity related chronic diseases.

Rejeski, et al, (2006) have shown that physical activity has significant potential to influence HRQL. The most direct effects are likely in the areas of psychological wellbeing (e.g., self-concept, self-esteem, mood, and affect), perceived physical function (e.g., perceived ability to perform activities of daily living), physical well-being (e.g., perceived symptoms and perceived physical states, such as dyspnea, pain, fatigue, and energy), and, to a limited extent, cognitive function.

A randomized clinical trial involving healthy elderly persons (Stewart et al, 2001), they observed that healthy persons who were assigned to endurance exercise had better self-reported ratings of their physical functioning and health (e.g., physical and role function, experiencing of pain, perception of health status) than control participants. Also in a review, McAuley (2000) concluded that a positive association exists between physical activity habits and self-esteem in adults. The strength of this relationship, they observed increases when physical activity is personally valued and when measures of psychological well-being are specific rather than general. The association was mostly observed as part of the long-term effects of exercise training.

The observed significant improvement seen in the quality of life of participants in the experimental group as compared with those in the control group is supported by the report of a review of studies involving middle-aged adults by Fontaine and Barofsky (2001). They found that involvement in physical activity is associated with improved psychological well-being, and that the strength of these associations was directly related to the length of time that the participants had been involved in physical activity programs. Other data suggest that physical activity is related to perceived improvement in physical function in activities of daily living (Kolotkin et al, 2002).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

The aim of this study was to investigate the effect of a 12-week aerobic and abdominal strengthening exercise programme on abdominal adiposity, selected cardiorespiratory indices and quality of life among apparently healthy sedentary adults. The study attempted to provide more clinical evidence on whether supervised exercise programme would be beneficial to sedentary adults who may desire to reduce their abdominal bulge; and also to find out if this exercise programme will have any additional effect on cardiorespiratory function and quality of life in apparently healthy sedentary adults. Selected abdominal adiposity indices, cardiorespiratory indices and quality of life were studied based on literature and clinical observations. The main hypothesis was drawn for the study while several sub-hypotheses were proposed to represent each variable that was considered in this study.

Peripheral and core literatures were reviewed to reveal the rationale for carrying out the study and to justify the methodologies that were adopted. Previous studies in the area of obesity and exercises were reviewed and used to explain some of the outcomes of this study. Review of literature was done under various headings such as epidemiology of obesity, pathophysiology of obesity, abdominal obesity and health, abdominal obesity and cardiovascular function, abdominal obesity and respiratory function, abdominal obesity and quality of life. Other areas of literature reviewed were

assessment of abdominal obesity, socioeconomic burden of obesity, obesity-related health problems and justification of concept and methodology of study.

Participants were drawn into the study from the general public, and those who met the inclusion criteria were randomly assigned into either experimental or control group. Ethical approval of the University of Ibadan and University College Hospital (UI/UCH) Health Research Ethics Committee was sought and obtained prior to the study. All participants read, understood and signed the informed consent form. The control group consisted of 109 participants while the experimental group had 105 participants. Participants in both groups received health promotion education while only the experimental group went through a 12 week exercise programme comprising of aerobic exercises and abdominal strengthening exercises. Baseline data was obtained from participants in both groups. Participants were further re-assessed at the end of the fourth week, eight week and twelfth week of study. Data was analyzed using descriptive statistics of mean and standard deviation; and inferential statistics of independent t-test and repeated measure of Analysis of Variance with alpha level set at 0.05.

The result of the study showed no significant difference in all parameters assessed at baseline between the experimental and control groups. Within-group analysis in experimental group showed significant increases between the scores at baseline and at the end of the 12th week of study in the estimated maximum oxygen consumption, peak expiratory flow rate, forced expiratory volume in the first second, forced vital capacity and quality of life scores; while there were significant decreases in waist circumference, sum of abdominal skinfolds, systolic blood pressure, diastolic blood pressure, and heart rate. For the control group, significance increase was observed only in diastolic blood pressure. Between group comparisons at the end of the12th week showed significant differences between the experimental and control group in waist circumference, sum of abdominal skinfolds, estimated maximum oxygen consumption, peak expiratory flow rate, systolic blood pressure, diastolic blood pressure, heart rate and quality of life scores. Supervised exercise programme reduced abdominal adiposity; improved cardiorespiratory function indices and quality of life.

5.2 CONCLUSIONS

The following conclusions were drawn from the outcome of this study:

a) Combination of aerobic and abdominal strengthening exercises was safe and well tolerated among sedentary adults.

b) Combination of aerobic and abdominal strengthening exercises of moderate intensity was effective in reducing abdominal adiposity as assessed by waist circumference, waist-to-hip ratio and sum of abdominal skinfolds in apparently healthy sedentary adults.

c) Combination of aerobic and abdominal strengthening exercises of moderate intensity provided additional benefit of improving cardiorespiratory function of heart rate, systolic blood pressure, diastolic blood pressure, peak expiratory flow rate, forced vital capacity, forced expiratory volume in the first second and estimated maximum oxygen consumption; and quality of life in apparently healthy sedentary adults.

d) Structured exercise programme carried out in a group for three times per week for duration of 45 to 60 minutes under supervision produced significant reduction in abdominal adiposity from the eighth week in apparently healthy sedentary adults.

5.3 RECOMMENDATIONS

From the outcome of this study, the following recommendations were made to the following groups:

1. **Apparently healthy sedentary adults:**

a) Apparently healthy but sedentary individuals with or without abdominal bulge should routinely engage in moderate intensity aerobic exercises.

b) Structured aerobic exercises of moderate intensity of three sessions per week at about 45 – 60 minutes per session should be carried out by apparently healthy sedentary adults in a safe environment with expert supervision.

2. **Physiotherapists:**

a) Physiotherapists should engage in educating apparently healthy individuals on the health risks associated with excess abdominal adiposity lack of routine aerobic exercises habit.

b) Safety measures and assessments should be adhered to when taking apparently healthy sedentary individual through exercise programme to prevent complications and monitor progress of the exercise intervention.

c) Physiotherapists, as exercise therapy experts, should take more interest in the clinical management of excess abdominal adiposity and the health promotion needs of this population group

d) Every Physiotherapy Department should run exercise fitness clinics as part of their scheduled clinical services and make same available, accessible and affordable to both patients and apparently healthy individuals.

3. Physicians

a) Physicians should educate their clients on the health risks associated with excess abdominal adiposity and lack of routine exercise habit for physical fitness.; and refer appropriately for further expert management.

b) Interdisciplinary collaboration is recommended for health promotion and prevention of chronic diseases associated with excess abdominal adiposity and lack of routine exercise.

4. Health Policy Makers

a) Supportive workplace environment which provides facilities for, and promote regular leisure-time physical activity should be reinforced to meet the health promotion needs of apparently healthy adult population, since most adults spend more of their waking hours in the workplace.

b) Establishment of safe and accessible community recreational facilities will encourage participation in regular physical activity and promote healthy lifestyle behavior among the general populace.

c) Involvement of exercise experts in the planning and designing of built environment which will make it easy for individuals to incorporate regular physical activity into their daily routine in such a way that exercise for health promotion is accessible, available and affordable.

d) Collaboration between government agencies, research centers and exercise experts to proactively develop programmes to tackle the menace of morbidity and mortality associated with sedentary lifestyle, lack of routine exercise habit for health promotion and obesity at various levels.

5. Research

a) It is recommended that this study be replicated on individuals with obesity-related disorders to see the possibility of reducing onset and severity of associated complications such as diabetes and hypertension.

b) Studies should also be carried out to investigate the effect of different exercise regimens (frequencies, intensities, mode and duration) to determine which is most efficacious for this group of individuals.

c) It is also recommended that studies be carried out to investigate the long term sustainability of the health benefits of exercise programme on general obesity, abdominal adiposity, sedentary lifestyle and quality of life in this study population.

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APENDIX 1

ETHICAL APPROVAL OF UI/UCH

INSTITUTE FOR ADVANCED MEDICAL RESEARCH AND TRAINING (IMRAT)

COLLEGE OF MEDICINE, UNIVERSITY OF IBADAN, IBADAN, NIGERIA.

E-Mail - imratcomui@yahoo.com

COLLEGE OF MEDICINE • UNIVERSITY OF IBADAN

RECTE SAPERE FONS

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

NOTICE OF FULL APPROVAL AFTER FULL COMMITTEE REVIEW

Re: Effect of a 12- week Exercise Programme on Abdominal Adiposity, Selected Cardiopulmonary Indices and Quality of Life in Middle-Aged Adults

UI/UCH Ethics Committee assigned number: UI/EC/11/0060

Name of Principal Investigator: **Ayodele A. Akinremi**

Address of Principal Investigator: Department of Physiotherapy, College of Medicine, University of Ibadan, Ibadan

Date of receipt of valid application: 22/03/2011

Date of meeting when final determination on ethical approval was made: **21/07/2011**

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 21/07/2011 to 20/07/2012. 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 early in order to obtain renewal of your approval 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.*

UI/UCH EC
21 JUL 2011
APPROVED
COLLEGE OF MEDICINE, U.I.

Dr. J. A. Otegbayo,
Chairman, Medical Advisory Committee,
University College Hospital, Ibadan, Nigeria
Vice- Chairman, UI/UCH Ethics Committee
E-mail: uiuchirc@yahoo.com

Research Units: ▪Genetics & Bioethics ▪Malaria ▪Environmental Sciences ▪Epidemiology Research & Service ▪Behavioural & Social Sciences ▪Pharmaceutical Sciences ▪Cancer Research & Services ▪HIV/AIDS

APPENDIX II

INFORMED CONSENT FORM

IRB Research approval number:________________

My name is AKINREMI, AYODELE A., I am a postgraduate student of the Department of Physiotherapy, College of Medicine, University of Ibadan. I am carrying out a research on EFFECTS OF A 12-WEEK EXERCISE PROGRAMME ON ABDOMINAL ADIPOSITY, SELECTED CARDIOPLUMONARY AND QUALITY OF LIFE IN APPARENTLY HEALTHY SEDENTARY ADULTS. The purpose of the study is to find out the efficacy of a12-week exercise on abdominal bulge and physical fitness. A total of 128 participants will be involved in this study and will be randomly allocated into two groups. Participants in group I will go through exercise intervention for twelve weeks and participants in group II will be observed for the twelve weeks.

If you are allocated to group I, you will be required to carry out general aerobic exercises and abdominal strengthening exercises, for three/week with a day of rest in-between. Exercise sessions will be carried out the Exercise Laboratory of Physiotherapy Department, University of Ibadan, and it is estimated to last for 45minutes per session. It is expected that individuals increasing their level of physical activity may experience some side effects such as fatigue and muscle soreness. To prevent this, the exercise programme has been structured to progress gradually and will be performed under the supervision. Some measurement will be carried on you during the course of the study to assess your fitness level; abdominal muscle strength, body composition and quality of Life at the beginning and at every two weeks throughout the duration of the study.

In the event that you become pregnant please inform the researcher so that you can withdraw from this study. Participation in this study is free. The goal of this research is to find ways of reducing abdominal bulge while promoting your health through physical fitness. All information collected in this study will be given coded numbers and will not be linked with you in anyway, and your name or any identifier will not be used in any publication or reports from this study. Participation in this study is entirely voluntary, and you can choose not to participate, or to withdraw from this research at any time. Please note that the some of the information that has been obtained from you before you choose to withdraw may be modified and used in reports and publications. In case you suffer any injury as a direct result of your participation in this study, you will be treated and the researcher will bear the cost. During the course of this research, you will be given any information that may affect your continued participation or your health. I will appreciate your cooperation.

I have fully explained this research to ____

And have given sufficient information, including risks and benefits to make an informed decision.

Date:_______________ Signature: ___________________________

Name: ____

I have read the description of this study, and I understand that my participation is voluntary. I know enough about the purpose, method, risks and benefit of this research study and have decided to be part of it. I also understand that I may freely stop being part of this study at any time.

Now that the study has been well explained to me and I fully understand the content of the study process, I hereby sign my consent to participate in this study.

Date: _________________ Signature: _________________

Name: ____

Witness Signature/Thumbprint:_________________ Witness Name: __________________________

This research has been approved by the Health Research Ethics Committee of the University of Ibadan, and the Chairman can be contacted at:

Biode Building, 2nd Floor Room T10, Institute of Medical Research and Training, College of medicine, University of Ibadan. e-mail: uiuchirc@yahoo.com

APPENDIX III

ASSESSMENT FORMAT

Research Number:__________ Age: _________ Gender: ________ No of Pregnancy: ________

Height:__________ Occupation: ____________ Marital Status: _________ LMP: ___________

Section B:

S/N	Variables	BS	2nd	4th	6th	8th	10th	12th	14th	16th	18th	20th	22nd	24th
1	Weight													
2	BMI													
3	Heart Rate													
4	SBP													
5	DBP													
6	VO_{2max}													
7	PEFR													
8	FEV1													
9	FVC													
10	FER													
11	WC													
12	WHR													
13	QOL													

KEY:
BS: Baseline Measurement
Weight: Body Weight (Kg)
WC: Waist circumference (centimeter)
WHR : Waist-Hip-Ratio
FEV1: Forced Expiratory Volume in the first second
FVC: Forced Vital Capacity
FER: Forced Expiratory Ratio
PEFR: Peak expiratory flow rate (L/min)
BMI: Body Mass Index
HR: Resting Heart rate
SBP: Resting Systolic Blood Pressure
DBP: Resting Diastolic Blood Pressure
VO_{2max}:: Maximum oxygen consumption (l/kg/min)
QOL: Quality of Life

APPENDIX IV

EXRERCISE READINESS QUESTIONNAIRE

Research Number:			Date:
DOB:	Age:	E-mail address:	Mobile Phone Number:

Regular exercise is associated with many health benefits. Increasing physical activity is safe for most people. However, some individuals should check with o\physician before they become more physically active. Completion of this questionnaire is a first step when planning to increase the amount of physical activity in your life. Please read each question carefully and answer every question honestly:

Yes	No	1) Has a physician ever diagnosed you with a heart condition and indicated you should restrict your physical activity?
Yes	No	2) When you perform physical activity, do you feel pain on your chest?
Yes	No	3) When you are not engaging in physical activity, have you experienced chest pain in the past month?
Yes	No	4) Do you ever faint or get dizzy and lose your balance?
Yes	No	5) Do you have an injury or orthopaedic condition (such as back, pain, or knee problem) that may worsen due to change in your physical activity?
Yes	No	6) Do you have high blood pressure or a heart condition in which a physician is currently prescribing a medication?
Yes	No	7) Are you pregnant?
Yes	No	8) Do you have insulin dependent diabetes?
Yes	No	9) Are you 69 years of age or older and not used to being very active?
Yes	No	10) Do you know any other reason you should not increase your physical activity?

If you answered yes to any of the above question, talk with your physician **before** you become physically active. Tell your doctor your plan to exercise and to which question you answered yes.

If you honestly answered no to all questions you can be reasonably certain you can safely increase your level of physical activity gradually. If your health changes so you then answer yes to any of the above questions, seek guidance from a physician.

Participant’s Signature:	Date:

(Fahey et al, 1999)

APPENDIX V

MAXIMUM OXYGEN CONSUMPTION ESTIMATION PROTOCOL

Determining the target heart rate:

Target Heart Rate: (65% of the predicted [220 minus age] maximum HR)

65% x (220 - _____ [age]) = ___________________

Stepping Cadence

- In time with the beat step one foot up on the bench (1st beat), step up with the second foot (2nd beat), step down with one foot (3rd beat), and step down with the other foot (4th beat.)
- Allow the participant to practice the stepping to the metronome cadence.
- Metronome is set at 68 beats per minute (4 clicks = one step cycle) for a stepping rate of 17 steps per minute for first stage; 104 beats per minutes for second stage and 136 beats per minute for the third stage.

Stage I

- Participants are required to step up and down a portable 25.4centimeter (10-inch bench) for 3 minutes at a rate of 17 steps per minute (68 beats per minute), using a metronome.
- Monitor Heart Rate at the end of the 3rd minute.
- If target HR is reached, the protocol was terminated.
- If target heart rate is not reached, participant rest for a minute, then proceed to second stage

Stage II

- Participants are required to step up and down a portable 25.4centimeter (10-inch bench) for 3 minutes at a rate of 26 steps per minute (104 beats per minute), using a metronome.
- Monitor Heart Rate at the end of the 3rd minute.
- If target HR is reached, the protocol was terminated.
- If target heart rate is not reached, participant rest for a minute, then proceed to third stage

Stage III

- Participants are required to step up and down a portable 25.4centimeter (10-inch bench) for 3 minutes at a rate of 34 steps per minute (136 beats per minute), using a metronome.
- Monitor Heart Rate at the end of the 3rd minute.

The steady-state absolute VO2 at each stage was calculated according to the following equations:

Stage 1: VO2 (liters/minute) = (16.287 x body weight in kg)/1,000

Stage 2: VO2 (liters/minute) = (24.910 x body weight in kg)/1,000

Stage 3: VO2 (liters/minute) = (33.533 x body weight in kg)/1,000

Uncorrected VO2max (liters/minute) = stage VO2/%VO2max
Where:

- %VO2max= (0.769 x stage HR) - 48.5 (for men)

- %VO2max= (0.667 x stage HR) - 42 for women.

Finally, the uncorrected VO2max calculated from the above equations is entered in the following equations to predict VO2max according to age and sex:

VO2max male (liters/minute) = (0.348 x uncorrected VO2max) - (0.035 x age in years) + 3.011
VO2max female (liters/minute) = (0.302 x uncorrected VO2max) - (0.019 x age in years) + 1.593

(Siconolfi SF, Garber CE, Lasater TM, Carleton RA. (1985): A simple, valid step test for estimating maximal oxygen uptake in epidemiologic studies. Am J Epidemiol;121:382–90.)

APPENDIX VI

WORLD HEALTH ORGANIZATION QUALITY OF LIFE- BREF

QUESTIONAIRE AND SCORING FORMAT

WHOQOL-BREF

PROGRAMME ON MENTAL HEALTH
WORLD HEALTH ORGANIZATION
GENEVA

For office use only For office use only

	Equations for computing domain scores	Raw score	Transformed scores*	
			4-20	0-100
Domain 1	(6-Q3) + (6-Q4) + Q10 + Q15 + Q16 + Q17 + Q18 d + d + d + d + d + d + d	=		
Domain 2	Q5 + Q6 + Q7 + Q11 + Q19 + (6-Q26) d + d + d + d + d + d	=		
Domain 3	Q20 + Q21 + Q22 d + d + d	=		
Domain 4	Q8 + Q9 + Q12 + Q13 + Q14 + Q23 + Q24 + Q25 d + d + d + d + d + d + d + d	=		

* Please see Table 4 on page 10 of the manual, for converting raw scores to transformed scores.

I.D. number

ABOUT YOUABOUT YOU

Before you begin we would like to ask you to answer a few general questions about yourself: by circling the correct answer or by filling in the space provided.

What is your gender? Male Female

What is you date of birth? ________ / ________ / ________
Day / Month / Year

What is the highest education you received?
None at all
Primary school
Secondary school
Tertiary

What is your marital status?
Single Separated
Married Divorced
Living as married Widowed

Are you currently ill No Yes

If something is wrong with your health what do you think it is?_____________________________illness/ problem

Instructions

This assessment asks how you feel about your quality of life, health, or other areas of your life. Please answer all the questions. If you are unsure about which response to give to a question, please choose the one that appears most appropriate.This can often be your first response.

Please keep in mind your standards, hopes, pleasures and concerns. We ask that you think about your life in the last two weeks. For example, thinking about the last two weeks, a question might ask:

		Not at all	Not much	Moderately	A great deal	Completely
	Do you get the kind of support from others that you need?	1	2	3	4	5

You should circle the number that best fits how much support you got from others over the last two weeks. So you

		Not at all	Not much	Moderately	A great deal	Completely
	Do you get the kind of support from others that you need?	1	2	3	4	5

You would circle number 1 if you did not get any of the support that you needed from others in the last two weeks.

Please read each question, assess your feelings, and circle the number on the scale for each question that gives the best answer for you

		Very poor	Poor	Neither poor nor good	Good	Very good
1(G1)	How would you rate your quality of life?	1	2	3	4	5

		Very dissatisfied	Dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very satisfied
2 (G4)	How satisfied are you with your health?	1	2	3	4	5

The following questions ask about how much you have experienced certain things in the last two weeks.

		Not at all	A little	A moderate amount	Very much	An extreme amount
3 (F1.4)	To what extent do you feel that physical pain prevents you from doing what you need to do?	1	2	3	4	5
4(F11.3)	How much do you need any medical treatment to function in your daily life?	1	2	3	4	5
5(F4.1)	How much do you enjoy life?	1	2	3	4	5
6(F24.2)	To what extent do you feel your life to be meaningful?	1	2	3	4	5

		Not at all	A little	A moderate amount	Very much	Extremely
7(F5.3)	How well are you able to concentrate?	1	2	3	4	5
8 (F16.1)	How safe do you feel in your daily life?	1	2	3	4	5
9 (F22.1)	How healthy is your physical environment?	1	2	3	4	5

The following questions ask about how completely you experience or were able to do certain things in the last two weeks.

		Not at all	A little	Moderately	Mostly	Completely
10 (F2.1)	Do you have enough energy for everyday life?	1	2	3	4	5
11 (F7.1)	Are you able to accept your bodily appearance?	1	2	3	4	5
12 (F18.1)	Have you enough money to meet your needs?	1	2	3	4	5
13 (F20.1)	How available to you is the information that you need in your day-to-day life?	1	2	3	4	5
14 (F21.1)	To what extent do you have the opportunity for leisure activities?	1	2	3	4	5

		Very poor	Poor	Neither	Good	Very good

Table 4 - Method for converting raw scores to transformed scores

	THANK YOU FOR YOUR HEL			poor nor good		
15 (F9.1)	How well are you able to get around?	1	2	3	4	5

DOMAIN 1 DOMAIN 2 DOMAIN 3 DOMAIN 4

Raw Score

The following questions ask you to say how good or satisfied you have felt about various aspects of your life over the last two weeks

		Very dissatisfied	Dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very satisfied
16 (F3.3)	How satisfied are you with your sleep?	1	2	3	4	5
17 (F10.3)	How satisfied are you with your ability to perform your daily living activities?	1	2	3	4	5
18(F12.4)	How satisfied are you with your capacity for work?	1	2	3	4	5
19 (F6.3)	How satisfied are you with yourself?	1	2	3	4	5
20(F13.3)	How satisfied are you with your personal relationships?	1	2	3	4	5
21(F15.3)	How satisfied are you with your sex life?	1	2	3	4	5
22(F14.4)	How satisfied are you with the support you get from your friends?	1	2	3	4	5
23(F17.3)	How satisfied are you with the conditions of your living place?	1	2	3	4	5
24(F19.3)	How satisfied are you with your access to health services?	1	2	3	4	5
25(F23.3)	How satisfied are you with your transport?	1	2	3	4	5

The following question refers to how often you have felt or experienced certain things in the last two weeks.

		Never	Seldom	Quite often	Very often	Always
26 (F8.1)	How often do you have negative feelings such as blue mood, despair, anxiety, depression?	1	2	3	4	5

Did someone help you to fill out this form?..

How long did it take to fill this form out?..

Do you have any comments about the assessment?

....

....

100

	Trasnformed scores	
	4-20	0-100
7	4	0
8	5	6
9	5	6
10	6	13
11	6	13
12	7	19
13	7	19
14	8	25
15	9	31
16	9	31
17	10	38
18	10	38
19	11	44
20	11	44
21	12	50
22	13	56
23	13	56
24	14	63
25	14	63
26	15	69
27	15	69
28	16	75
29	17	81
30	17	81
31	18	88
32	18	88
33	19	94
34	19	94
35	20	100

Raw score	Trasnformed scores	
	4-20	0-100
6	4	0
7	5	6
8	5	6
9	6	13
10	7	19
11	7	19
12	8	25
13	9	31
14	9	31
15	10	38
16	11	44
17	11	44
18	12	50
19	13	56
20	13	56
21	14	63
22	15	69
23	15	69
24	16	75
25	17	81
26	17	81
27	18	88
28	19	94
29	19	94
30	20	100

Raw score	Transformed scores	
	4-20	0-100
3	4	0
4	5	6
5	7	19
6	8	25
7	9	31
8	11	44
9	12	50
10	13	56
11	15	69
12	16	75
13	17	81
14	19	94
15	20	100

Raw score	Transformed scores	
	4-20	0-100
8	4	0
9	5	6
10	5	6
11	6	13
12	6	13
13	7	19
14	7	19
15	8	25
16	8	25
17	9	31
18	9	31
19	10	38
20	10	38
21	11	44
22	11	44
23	12	50
24	12	50
25	13	56
26	13	56
27	14	63
28	14	63
29	15	69
30	15	69
31	16	75
32	16	75
33	17	81
34	17	81
35	18	88
36	18	88
37	19	94
38	19	94
39	20	100
40	20	

APPENDIX VI

KEY TO RAW DATA

AGE: Age of participants

WT: Weight (in kilogramme)

HT: Height (in meters)

BMI: Body Mass Index (kg/m2)

WC: waist circumference (in centimeters)

HC: Hip circumference (in centimeters)

WHR: Waist to Hip ratio

ASF: Abdominal skinfold

SIFF: Supra-iliac skinfold

SAF: Sum of abdominal skinfold

VO2: Maximum oxygen consumption

PEFR: Peak expiratory Flow Rate

FEV1: Forced Expiratory Volume in the first second

FVC: Forced Vital Capacity

FER: Forced Expiratory Ratio

SBP: Systolic Blood Pressure

DBP: Diastolic Blood Pressure

HR: Heart Rate

QOL-PHY: Quality of Life-Physical Domain

QOL-PSY: Quality of Life-Psychological Domain

QOL-SOC: Quality of Life-Social Domain

QOL-ENV: Quality of Life-Environmental Domain

QOL-TOT: Quality of Life-sum of domains

APPENDIX VII

RAW DATA OF PARTICIPANTS IN THE STUDY