EFFECTS OF WHOLE-BODY VIBRATION AND RESISTANCE TRAINING ON OBESITY, OVERWEIGHT AND CARDIOPULMONARY FITNESS VARIABLES OF UNIVERSITY OF IBADAN UNDERGRADUATES

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CERTIFICATION

Icertify that this research work was carried out by Kelechi David BENSON in the Department of Human Kinetics and Health Education under my supervision.

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DEDICATION

This work is dedicated to God Almighty, the author and finisher of my faith, one and only true God, source of life, giver of inspiration and sustainer of hope and destiny. Also, in loving memories of my Sister and Dad, whose inspiration formed the basis for this laudable achievement-May the Lord, grant them eternal rest in his bosom.

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ABSTRACT

Physical inactivity in daily life is a globalhealth concern linked to metabolic syndrome, poor anthropometric and mal-functional cardiopulmonary indices. This induces obesity and overweight, which are the fifth leading global mortalityrisk and increase diseases with consistent prevalence among youths. Previous studies have focused largely on conventional regimes to correct health challenges associated with obesity, overweight and mal-functional cardiopulmonary indices with little attention paid to Whole-body Vibration (WbV) and Resistance Training (RT). This study was, therefore, designed to examine the effects of WbV and RT on obesity, overweight and cardiopulmonary fitness variables (systolic blood pressure, diastolic blood pressure, peak expiratory flow, peak VO_2) of University of Ibadan undergraduates. The moderating effects of gender and stage of development were also examined.

The study was hinged on the Newton's Second Law of Motion, while the pretest-posttest control group experimental design of 3x2x2 factorial matrix was adopted. Sixty-five sedentary undergraduates were purposively recruited from the Faculties of Education, Law, The Social Sciences and Arts. Percent body fat measures were taken to ascertain their fitness level at the entry point; these were compared with percent body fat norm values of (male -13.6, 16.4) and (female -23.8, 24.5). Participants were assigned to WbV (20), RT (26) and control (19) groups, while treatment lasted 12weeks. Instruments used were WbV machine, multi-gym facility and the bench press. Data were subjected to percentages and Analysis of covariance at 0.05 level of significance.

Participants were female (58.5%),and were adolescents (23.1%)and young adults (76.9%). Treatment had significant main effects on anthropometric variables: percent body fat ($F_{(3,61)}$=9.36; partial η^2=0.24), BMI ($F_{(3,61)}$=28.32; partial η^2=0.48), lean body weight ($F_{(3,61)}$=12.23; partial η^2=0.29), flexibility ($F_{(3,61)}$=13.78; partial η^2=0.31), average leg power ($F_{(3,61)}$= 8.74; partial η^2=0.22) and arm strength ($F_{(3,61)}$=33.91; partial η^2=0.53).

Participants in WbV (1229.67) had a higher mean score than those in RT (1220.48) and control (936.70) groups. Treatment also had significant main effects on cardiopulmonary fitness variables: systolic blood pressure ($F_{(3,61)}$=64.08; partial η^2=0.21), diastolic blood pressure ($F_{(3,61)}$=3.12; partial η^2=0.09); peak expiratory flow ($F_{(3,61)}$=41.92; partial η^2=0.58) and PeakVO_2 ($F_{(3,61)}$=25.20; partial η^2=0.45).Participants in WbV (44.34) had a higher mean score than those in RT (43.68) and control (42.18) groups. There was a significant main effect of gender ($F_{(2,62)}$=42.31; partial η^2=0.41) in favour of the male participants from WbV groups, while that of stage of development was not significant. The two-way interaction effect of treatment and gender was significant ($F_{(6,58)}$=6.32; partial η^2=0.18) in favour of male participants from the WbV groups, while treatment and stage of development, and gender and stage of development were not significant. The three-way interaction effect was also not significant.

Whole body vibration, more than resistance training, enhanced cardiopulmonary fitness variables and reduced obesity and overweight among undergraduates of University of Ibadan. Therefore, it should be used regularly to control obesity and overweight and improve cardiopulmonary indices among undergraduates, particularly the female.

Keywords: Obesity and university life, Whole body vibration, Resistance training

Word count: 474

CHAPTER ONE

INTRODUCTION

Background to the Study

Adolescencehas been identified as the period that occurs after childhood and before adulthoodin human growth and development. It represents a critical transition in the life span of any individual which is characterized by a verygreat pace in growth and change in the biological processes which drives many aspects of this growth and development where adolescence, being the product of the transition of childhood through puberty stage.

Adolescents, who make up 20% of the world's population with 85% living in developing countries are saidto have little disease burden when compared with children and adults categoriesand were neglected for several years(Dehne Karl and Riedner, 2001).Gauthier, Hickner and Ornstein, 2000 submitted that consistent trend of increasing obesity prevalence among children and adolescents exists particularly over the past three decades. There are available studies showing prevalence of obesity among Nigerian adolescents and in 2008, more than 1.4 billion adults (20 years and above) were overweight, and of these over 200 million men and nearly 300 million women were obese (WHO, 2011;Innocent, Abali, Collins, Kenneth, Miracle, Samson, Okechukwu and Efosa, (2013). This is an alarming data especially when the health challenges associated with this medical condition is considered. Some authors conducted a study among Nigerian adolescents and found prevalence level ranging from 4% for the ages 13-15 years and 3% for the ages 16-18 years with greater values among the femalecategories and also prevalence values ranging from 0.9% to 2.7% (Ansa, Odigwe and Anah (2001) and Akinpelu, Oyewole and Oritogun, 2008).

Esan (2010), identified inactivity as the major risk factor for the development of coronary heart disease along with other diseases (as stated by American Heart Association, 2005). Obesity is a global epidemic and seenas one of the major causes of non-communicable chronic diseases. It is one of the leading causes of morbidity and mortality in both developed and developing countries (Sultan, Nawaz, Sultan and Fayaz, 2004). Studies have shown that obesity is linked with non-communicable disorders that include hypertension, stroke, Type 2 diabetes mellitus, breast and prostate cancers arthritis and coronary heart disease (Azizi, Rahmani, Emami and Tehran, 2000; Weiss, Dziura, Burgert, Tamborlane, Taksali, Yeckel, Allen, Lopes, Savoye, Morrison, Sherwin and Caprio, 2004).

Experts have maintained that obesity among children and adolescents has reached an epidemic proportion in developed countries and is even more pronounced now in developing countries, Nigeria inclusive. In a survey studyit was opined that this trend has led to increase changes in lifestyle and associated increasein burden of non-communicable diseasesin Nigeria andother developing countries in Africa(WHO Technical Report, 2000; Filozof, Gonzalez, Sereday, Mazza, Braguinsky 2001 and Rivera, Barquera, Campirano, Campos, Safdie and Tovar, 2002; and (Wang and Lobstein, 2006; Chhatwal , Verma , and Riar,2004).

Energy imbalance in calories consumed and calories expended and many other factors such as inactivity,genetic predisposition, dietary changeand recently childhood under nutrition remains the fundamental cause of overweight and obesity such that the medical costs associated with being overweight and obese are enormous, and involved direct and indirect costs. The direct medical costs usually include preventive, diagnostic, and treatment services related to obesity while the indirect costs are related to morbidity and mortality costs(WHO,2008 and Innocent,Kenneth,Miracle,Samson,Okechukwu and Efosa(2013). Theseauthors stated that morbidity costs are defined as the value of income lost from decreased productivity, absenteeism, restricted activity, and hospital admission days and mortality costs are the value of future income lost by the premature death of patients who are obese.In the United States of America, the total cost in 2008 was about 147 billion dollars (Wolf and Wolf and Colditz, 1998 and Finkelstein, Trogdon, Cohen, Dietz, 2009; Innocent et. al, 2013).It has also been observed that Nigeriahas no documented estimates from the available literature; however, the cost may run into several billions of naira annually.

Resistance training is a component of sports and physical fitness used to enhance the size of a muscle and to improve appearance (American Academy of Pediatrics, 2011). Its programmes may include the use of weight machines, free weights, elastic tubing, or an athlete's own body weight.Training with weights, using muscles to work against the extra poundsisreferredto resistance training and it is seen as a conscious effort to strengthen and enhance the amount of muscle mass in the body by allowing the muscles work harder than they are used to.

Resistance training exercise causes the contraction of the muscles by opposing an external resistance with the expectation of increase in tone, mass, strength, and endurance-and has been introduced into weight control programmes for overweight individuals as an activity meant to increase the metabolic rate without high impact. Resistance training may stimulate bone mineralization in youth and have a positive effect on bone density similar to the geriatric population (Blimkie, Rice and Webber, 1996; Morris, Naughton, Gibbs, Carlson and Wark, 1997).

Strength training, with propertechniques and supervision have been found to increase strength in preadolescents and adolescents as established in other weight management studies while frequency, intensity,mode, and duration will contribute to a properly structured resistance programme. Other authors opined that there is a need to embark on constructive venture such as designed resistance programme to reduce the rate of decline in physiological functioning and muscular strength that is usually brought about by decrease in physical activity(Falk and Tenenbaum, 1996; Payne, Morrow, Johnsonand Dalton, 1997) Talabi, Ajayi-Vincent, Adesina and Aribamikan 2010). Resistance training with high intensity has been shown to improve muscular strengthand body composition while such improvementat strength occur with virtually all modes of strength training of at least 8 weeks' duration as low as once or twice a week with noticeable benefits(Talabi et. Al 2010).

Proper resistance training can enhance strength without instant muscle hypertrophy in adolescent which can be linked to a neurologic mechanism whereby training increases the number of motor neurons recruitedto fire with each muscle contraction (Ramsay, Blimkie, Smith, Garner, MacDougall and Sale, 1990; Ozmun, Mikesky, and Surburg 1994; Guy and Micheli, 2001). When compared with other forms of training, resistance training has been shown to have beneficial, significant and insignificant effect on several measurable health indices, such as body composition, body weight, cardiovascular fitness, bone mineral density, blood lipid profiles, mental health lean body weight and percent body fat(Faigenbaum, 2000; Stricker, 2002and Esan, 2010).

The quantity and quality of resistance exercises and its frequency are determined by specific programme goalsin that apparent adverse effect donotoccur on growth plates, linear growth or the cardiovascular system.Athletes with preexisting medical conditionlike hypertension may needto undergo medical examination to reduce the potential for additional elevation of blood pressure with strength training(Bailey and Martin, 1994; Faigenbaum, 2000; Stricker and Van Heest, 2002).Whole body vibration (WBV) refers to a process whereby low frequency vibration which ranges from 0.5 Hz to 80 Hz is transmitted into the human body, through a large contact area such as feet while standing, the butt while sitting, or the reclining body when in contact with the vibrating surface(Rittweger, 2002; Torvinen, 2002; Roelants, 2004 and Verschueren, 2004 and Roelants, 2003).It presentsitself as a viable alternative for conventional traditional resistance training and aerobics in individuals and is seen as a relatively new but effective measure to prevent muscular atrophy and osteoporosis and research suggests that whole body vibration training can be an effective alternative to conventional exercise programmes to improve strength and increase fat free mass (Rittweger et al 2002).

Whole body vibration training is a relatively popular form of training in the fitness industry owing to its reported benefits in bringing about greater muscle fiber during exercise which leads to greater increase in lean body mass, weight loss, and changes in body composition.According toRotmuller, (1995) and Rittweger, (2002), whole body vibration was researched upon for therapeutic and sport performance benefits; it is assumed that whole body vibration with amplitude of 2 to 6 mm and a frequency of 20 to 30 Hz evokes muscle contractions which probably induce it via the monosynaptic stretch reflex.

It involves a mechanical stimulus whichgainsentrance into the human body when exposed to direct contact with vibration surface, or applied directly to the muscle belly or the tendon of muscle by a vibration unit (punctual system) It is performed on a platform that generatesvertical sinusoidal vibrations (a smooth repetitive oscillation) whichstimulate muscle contractions that are comparable to the tonic vibration reflex. The use of platforms represents the most common form of vibration exercise. Basically, using eitherthe predominantly vertical direction (vertical platform) or those that vibrate through rotation about a horizontal axis such that distances farther from the axis of rotation result in larger amplitude vibrations (oscillating platform) (Abercromby, Amonette, Layne, McFarlin, Hinman and Paloski, 2007).

Previous studies have found whole body vibration load dependent increase, in Maximum oxygen consumed ($MaxVO_2$), Heart rate (HR), Blood pressure (BP), and Rate of perceived exertion (RPE) (Rittweger, 2001 and Rittweger, 2002). There are a few other theories of how vibration stimuli can excitethe neuromuscular system such as a stimulation of Ia afferents via spindle, resulting in facilitating the TM homonymous, a motor neuron and/or perturbation of the gravitational field during the time course of intervention (Cardinale and Bosco, 2003; Ronnestad, 2004). Comparingwhole body vibration training to other traditional training regimes, itrequires significant less time and, therefore, can be expected to reach a higher compliance in previously inactive patients (Rittweger,2002). It has beenestablished that working out on a vibration platform results in strength increase similar to other conventional resistance training. The manipulation of frequency (rate of vibration) and amplitude (size of movement) creates what is known as acceleration, which can be comparedwith gravitational (or g-) forces on earth. The human body adapts and to responds to the force of gravity on earth, which is defined as one g-force. The force of gravity the body experience is dependent on mass (weight) therefore; by increasing mass the human body builds strength to cope with the increase in force.It is evident thatwhole body vibration exercise can bring about an increase in strength (isometric and isokinetic) and improve lean muscle mass, in both trained and untrained subjects.

Authors have demonstrated that WBV exercises might improve muscle strength, postural control (Russo, Lauretani, and Bandinelli, 2003) and muscle power (Schuhfried, Mittermaier, Jovanovic, Pieber, and Paternostro-Sluga, 2005). Also, health-related quality of life is increased while the risk of fall is decreased. Whole body vibration training manipulates acceleration, creating an environment in which the human body is stimulated to increase strength due to higher g-forces, without any need for additional loads placed on the musculoskeletal system. It is also observed that oxygen consumption increases with body weight as well as frequency and amplitude of vibration exercise and also, indications exist that better results may be achieved with whole body vibration in the area of explosive power (Rittweger,2002; Delecluse, Roelants and Verschueren, 2003). Athletes who trainwith whole body vibrationplatform increased their leg press by a significant amount of force, average velocity and power (Bosco, Colli, Introini, Cardinale, Tsarpela, Madella, Tihanyi and Viru, 1999). In a research conducted by a team of researchers fromItaly, who considered the effects of whole-body vibration training on various measures in female competitive athletes; they observed that the vibration group displayed a significant improvement in flexibility, leg extension strength and countermovement jump performance (American Journal on Physical and Medical Rehabilitation, 2006).

Whole body vibrationtraining produced higher strength levels within six weeks in a comparative study with other conventional training methods and it does so through its use of gravity-added acceleration in the "force" equation and the reflexive muscle contraction it provokes (Delecluse et al. 2003). In a weight loss study done in Europe, it was revealed that whole body vibration group lost 11% body weight during intervention phase and maintained 10.5% of that loss. Also, when compared to a group that used diet + conventional exercise which lost 7%, whole body vibration training is an efficient way to lose weight, and shrink visceral fat. There was an improvement of 48 cm^2 in the visceral fat level of the whole body vibration training group compared to 18cm^2 in the Diet + Conventional Exercise groupin the same study.

This weight loss was caused by the whole body vibration's metabolic alteration and hormone effect. Whole body vibration training also improves quality of life, walk pattern, balance, and motor capacity in elderly (Bruyere, Wuidart, Di Palma, Gourlay, Ethgen, Richy, Reginster, 2005) and for other age group as well. It was further observed that strength training plays a significant role in many health factors significantly.

Statement of the problem

There is a major concern about the low level of vigorous physical activity and high rates of sedentary behaviour among today's adolescents. Insufficient physical activity in daily life induces obesity and increases the risk of diseases such as diabetes mellitus, hypertension and heart related problems. Physical inactivity comprises an important worldwide epidemic that has been linked to the metabolic syndrome. According to W.H.O estimation in 2005, 400 million adults (9.8%) are obese, and these can be traced back to lifestyle adopted while they were much younger. Obesity and overweight have been observed to be the fifth leading risk for global mortality.Increased weight gain, which is associated with increased lean and fat mass, along with the associated increase in total blood volume may be accompanied by an increase in stroke volume, cardiac output and circulatory preload and afterload that can lead to left ventricular hypertrophy and sustained rise in blood pressure. An estimation of 2.8 million people die each year as a result of being obese or overweight as observed and then 23% of the ischaemic heart disease,44% of the diabetes burden, and between 7% and 41% of certain cancer burdens are equally attributable to overweight and obesity(WHO, 2008).

The menace of sedentary living, especially among adolescent population is a serious public health issues to health care providers. Insufficient knowledge of the current trends in the field of exercise and wellness, poor exposure to basic exercise which could serve as a bail out to poor body composition and cardiovascular inefficiencies such as cancer, heart disease and sterility, and inadequate orientation as to the benefits of exercise are among numerous issues to be tackled by all and sundry in the health care profession, more especially exercise scientists.

In a related study, it was shown that obesity prevalence of 4.2% exist using BMI, whereas, the prevalence of obesity using the whole body vibration technique was 37.2% with majority being females. Conventional training regimes like aerobics and resistance exercises have been found to havea high effect in improving the health status of individuals and recruiting up to 40%-60%muscle fibres during exercise session (Shephard, 2006;Andrew Hamilton,http://www.pponline.co.uk/encyc/vibrationtraining-and-performance). However, these training regimes have their limitations in the areas of exercise stress, overall training time, venues for training and adherence to training programmes. Hence, whole body vibration training is being introduced to see if similar or even better amount of improvement can be achieved, given same training condition with little or less exercise stress on the muscles.Whole body vibration training needs significant less time and, therefore, can be expected to reach a higher compliance in previously inactive patients, and has been found to recruit nearly 100% of muscle's fibres(Shephard, 2006) during training session. Whole body vibration training stimulates muscular blood flow, which can speed up recovery from workouts and rehabilitation from injury. Increased blood flow will bring restorative nutrients to muscles cells and clear out damaged tissue fasterwhile the tonic stretch produced during whole body vibration training interacts with the muscle's own contraction frequencies, causing the fast-twitch muscle which contracts at a rate of 30-70 times a second when stimulated by a heavy load weight training and speed training frequencies to be stimulated even harder with greater fibre recruitment without the need for a huge mental input from the individual. Therefore, this study investigatedeffects of whole body vibration and resistance training on obesity, overweight and cardiopulmonaryfitness variables of University of Ibadan students.

Main objective of the Study

The main objective of this study was to investigate effects of whole body vibrationand resistance training on obesity, overweight and cardiopulmonaryfitness variables of University of Ibadan students.

The specific objectives for this study were to;

1(a) determine the main effects of treatments on obesity and overweight fitness variables (Muscle strength, Body mass index (Bmi), Lean body weight (LBW), and Percent body fat (%BF) of University of Ibadan students.

(b) determine the main effect of treatments on cardiopulmonary fitness variables (Peak expiratory flow rate (PEFR), Forced vital capacity (FVC), Forced expiratory volume in 1^{st} second (FEV_1), Heart rate, Blood pressure (systole and diastole) and PeakVO_2) of University of Ibadan students.

2 (a)determine the main effect of gender on obesity and overweight fitness variables (Muscle strength, Body mass index (Bmi), Lean body weight (LBW), and Percent body fat (%BF) of University of Ibadan students.

(b) determine the main effect of gender on cardiopulmonary fitness variables (Peak expiratory flow rate (PEFR), Forced vital capacity (FVC), Forced expiratory volume in 1^{st} second (FEV_1), Heart rate, Blood pressure (systole and diastole) and $PeakVO_2$) of University of Ibadan students.

3 (a) determine the main effect of stage of development on obesity and overweight fitness variables (Muscle strength, Body mass index (Bmi), Lean body weight (LBW), and Percent body fat (%BF) of University of Ibadan students.

(b) determine the main effect of stage of development oncardiopulmonary fitness variables (Peak expiratory flow rate (PEFR), Forced vital capacity (FVC), Forced expiratory volume in 1^{st} second (FEV_1), Heart rate, Blood pressure (systole and diastole) and $PeakVO_2$) of University of Ibadan students.

4 (a) determine the interaction effect of treatment and gender on obesity and overweight fitness variables (Muscle strength, Body mass index (Bmi), Lean body weight (LBW), and Percent body fat (%BF) of University of Ibadan students.

(b) determine the interaction effect of treatment and genderoncardiopulmonary fitness variables (Peak expiratory flow rate (PEFR), Forced vital capacity (FVC), Forced expiratory volume in 1^{st} second (FEV_1), Heart rate, Blood pressure (systole and diastole) and $PeakVO_2$) of University of Ibadan students.

5 (a) determine the interaction effect of treatments and stage of development on obesity and overweight fitness variables (Muscle strength, Body mass index (Bmi), Lean body weight (LBW), and Percent body fat (%BF) of University of Ibadan students.

(b) determine the interaction effect of treatmentsand stage of development oncardiopulmonary fitness variables (Peak expiratory flow rate (PEFR), Forced vital capacity (FVC), Forced expiratory volume in 1^{st} second (FEV_1), Heart rate, Blood pressure (systole and diastole) and $PeakVO_2$) of University of Ibadan students.

6 (a) determine a two-way interaction effect of gender and stage of development on obesity and overweight fitness variables (Muscle strength, Body mass index (Bmi), Lean body weight (LBW), and Percent body fat (%BF) of University of Ibadan students.

(b) determine a two-way interaction effect of gender and stage of development oncardiopulmonary fitness variables (Peak expiratory flow rate (PEFR), Forced vital capacity (FVC), Forced expiratory volume in 1^{st} second (FEV_1), Heart rate, Blood pressure (systole and diastole) and PeakVO_2) of University of Ibadan students.

7 (a) determine a three-way interaction effect of treatments, gender and stage of development on obesity and overweight fitness variables (Muscle strength, Body mass index (Bmi), Lean body weight (LBW), and Percent body fat (%BF) of University of Ibadan students.

(b) determine a three-way interaction effect of treatments, gender and stage of development on cardiopulmonary fitness variables (Peak expiratory flow rate (PEFR), Forced vital capacity (FVC), Forced expiratory volume in 1^{st} second (FEV_1), Heart rate, Blood pressure (systole and diastole) and PeakVO_2) of University of Ibadan students.

Research Questions

The following research questions were addressed in the study:

1. What is the obesity and overweightfitness variablestatusof male participants under study?

2. What is the obesity and overweightfitness variablestatusof female participants under study?

3. What is the cardiopulmonary fitness variables performance capacity of male participants under study?

4. What is the cardiopulmonary fitness variables performance capacity of female participants under study?

Hypotheses

These hypotheses were tested in the study:

1. There will be no significant main effect of treatments on;

(a) obesity and overweight fitness variables (Muscle strength, Body mass index (Bmi), Lean body weight (LBW), and Percent body fat (%BF)

(b) cardiopulmonary fitness variables (Peak expiratory flow rate (PEFR), Forced vital capacity (FVC), Forced expiratory volume in 1^{st} second (FEV_1), Heart rate, Blood pressure (systole and diastole) and $PeakVO_2$) of University of Ibadan students.

2. There will be no significant main effect of gender (male and female) on;

(a) obesity and overweight fitness variables (Muscle strength, Body mass index (Bmi), Lean body weight (LBW), and Percent body fat (%BF)

(b) cardiopulmonary fitness variables (Peak expiratory flow rate (PEFR), Forced vital capacity (FVC), Forced expiratory volume in 1^{st} second (FEV_1), Heart rate, Blood pressure (systole and diastole) and $PeakVO_2$) of University of Ibadan students.

3. There will be no significant main effect of stage of development (adolescent and young adult) on;

(a) obesity and overweight fitness variables (Muscle strength, Body mass index (Bmi), Lean body weight (LBW), and Percent body fat (%BF)

(b) cardiopulmonary fitness variables (Peak expiratory flow rate (PEFR), Forced vital capacity (FVC), Forced expiratory volume in 1^{st} second (FEV_1), Heart rate, Blood pressure (systole and diastole) and $PeakVO_2$) of University of Ibadan students.

4. There will be no significant interaction effect of treatments and gender on;

(a) obesity and overweight fitness variables (Muscle strength, Body mass index (Bmi), Lean body weight (LBW), and Percent body fat (%BF)

(b) cardiopulmonary fitness variables (Peak expiratory flow rate (PEFR), Forced vital capacity (FVC), Forced expiratory volume in 1st second (FEV_1), Heart rate, Blood pressure (systole and diastole) and PeakVO_2) of University of Ibadan students.

5. There will be no significant interaction effect of treatments and stage ofdevelopment (adolescent and young adult) on;

(a) obesity and overweight fitness variables (Muscle strength, Body mass index (Bmi), Lean body weight (LBW), and Percent body fat (%BF)

(b) cardiopulmonary fitness variables (Peak expiratory flow rate (PEFR), Forced vital capacity (FVC), Forced expiratory volume in 1st second (FEV_1), Heart rate, Blood pressure (systole and diastole) and PeakVO_2) of University of Ibadan students.

6. There will be no significant two-way interaction effect of gender and stage of development (adolescent and young adult) on;

(a) obesity and overweight fitness variables (Muscle strength, Body mass index (Bmi), Lean body weight (LBW), and Percent body fat (%BF)

(b) cardiopulmonary fitness variables (Peak expiratory flow rate (PEFR), Forced vital capacity (FVC), Forced expiratory volume in 1st second (FEV_1), Heart rate, Blood pressure (systole and diastole) and PeakVO_2) of University of Ibadan students.

7. There will be no significant three-way interaction effect of treatments, gender and stage of development (adolescent and young adult) on;

(a) obesity and overweight fitness variables (Muscle strength, Body mass index (Bmi), Lean body weight (LBW), and Percent body fat (%BF)

(b) cardiopulmonary fitness variables (Peak expiratory flow rate (PEFR), Forced vital capacity (FVC), Forced expiratory volume in 1st second (FEV_1), Heart rate, Blood pressure (systole and diastole) and PeakVO_2) of University of Ibadan students.

Delimitations of the Study

The study was delimited to the following

1. Randomized Pretest Posttest control group experimental design which adopted the 3x2x2 factorial matrix
2. Students of University of Ibadan
3. 65 sedentary undergraduates volunteers
4. Purposive and randomization techniques
5. Two experimental and one control group(s)
6. Obesity and overweight fitness variables (Arm muscle strength, Body mass index (Bmi), Lean body weight (LBW), Percent body fat (%BF).
7. Cardiopulmonary fitness variables (Peak expiratory flow rate (PEFR), Forced vital capacity (FVC), Forced expiratory volume in 1^{st} second (FEV_1), Heart rate, Blood pressure (systole and diastole) and PeakVO_2).
8. 12-week of whole-body vibrationon on the Vibration Machine
9. 12- week of resistance and weight lifting training on the Multipurpose gym
10. 20 minutes contact fortnightly on physical fitness lesson with Control group (Placebo)
11. Four research assistants
12. Descriptive statistics of frequency count, percentage; and inferential statistics of analysis of Co-variance (ANCOVA) tested at 0.05 level of significance.
13. Selected facilities and equipment;

i. University Stadium, Exercise Physiology Laboratoryand University Gymnasium
ii. Vibration machine
iii. Mercurial Sphygmomanometer
iv. Litman stethoscope
v. Skinfold Caliper
vi. Bathroom weighing scale
vii. Stadiometer
viii. Computerized Micro Spirometer
ix. Mini Wright Peak Flow Meter

Test location: Exercise Physiology Laboratory, University of Ibadan Gymnasium and University of Ibadan Stadium.

Limitation of the Study

The following limitations were encountered in this study;

Declaration of some public holidays made some participants skip training days and since they were not camped, there was little the researcher could do. Also, there were few cases of inconsistencies in training schedules by some participants who attributed that to unstable lecture time table and other personal commitments; this sometimes kept them on and off the school area and venues of training. The University gymnasium was at sometimes not accessible for a particular data meant to be collected there. However, the researcher adopted alternative measures at such cases. Power outage was a factor to contend with especially during training session and this sometimes made participants spend a little more time in the laboratory taking their sessions.

Significance of the study

Findings from this study revealed that twelve weeks of whole body vibration exercise and resistance training technique were effective in eliciting notable improvement on selected obesity, overweight and cardiopulmonary fitness parameters of adolescents and young adults. The study has established that whole body vibration training could serve as a viable alternative totraditional weight lifting and aerobic training modules.Outcome of this study has confirmed that whole body vibration training was potent in improving obesityand overweight fitness parameter of selected individuals and that with a well regulated frequency and amplitude, whole body vibration exercise could be opted for as a way to go while seeking training technique in improving selected cardiopulmonary parameters. It was also observed that resistance training was effective in bringing about needed improvement in the variables of the study.Individuals can engage in exercise work-out with little supervision on the whole body vibration machine and achieve their desired goals within a short period of time without the need to jog round the community.

Coaches and other experts in the fitness industry may adopt and adapt the use of whole body vibration to the already existing conventional training techniques for weight management programmes.

Definition of terms

- Whole body vibration: whole body vibration (WBV) is a training intervention performed on a commercially manufactured machine known as the Galileo Sport to bring about total bodily fitness on given individual.
- Frequency of vibration: a force generated by vibration machines normally andspecifically to provide loading on musculoskeletal system.
- Amplitude: refers to the amount of movement the machine induces in the muscle of given individual.
- Obesity and overweightfitness variables: it includes Strength, Body mass index (Bmi), Lean body weight (LBW), Percent body fat (%BF) that were considered as variables of analyses in this study.
- Conventional exercises: regular exercises targeted at improving the overall quality of health of an individual.
- Resistance training: an act of placing muscles against a notable resistance such as a weight or other type of load, to build strength, anaerobic endurance, and or size of skeletal muscles.
- Cardiopulmonary variables: refers to organs of the heart andlungs which were indices of analyses in this study, responsible for the absorption of gas, processing of blood and its adequate distribution in the body for proper functioning.
- Stage of development: refers to the developmental phaseof the participants who took part in the study; it’s partitioned into adolescence (16-24 years) and young adult (25 years and above) stages of development.
- Set: a set is a collection and combination of all the activities performed by participants within stipulated time schedule.

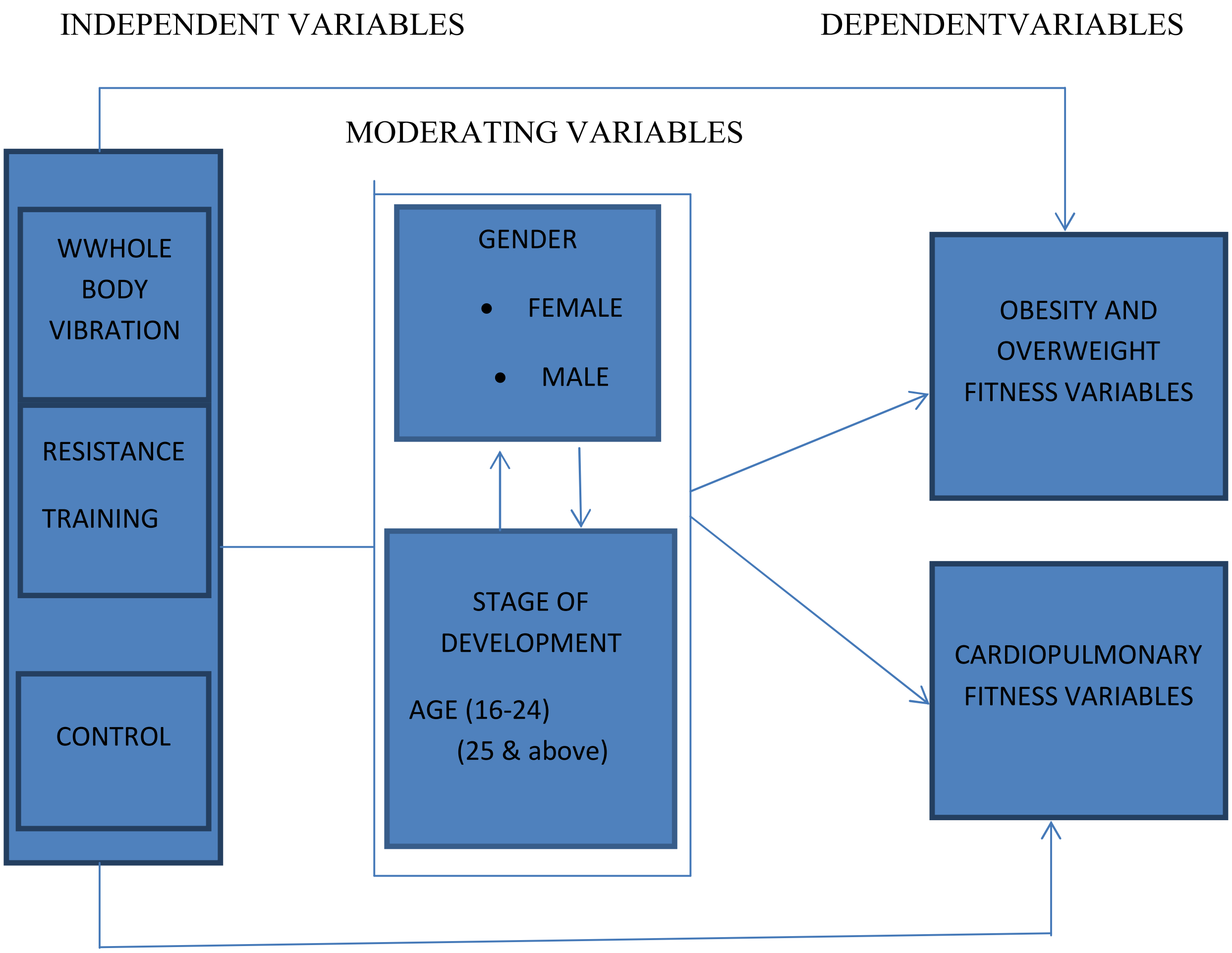
CHAPTER TWO

LITERATURE REVIEW

The review of related literature to this research was done under the following headings:

1. **Conceptual Framework of the Study**
2. **Theoretical review**
    i. Theory of Motion
3. **Review of related concepts**
    i. Concept of whole body vibration
    ii. Concept of resistance exercise training
    iii. Concepts of exercise
4. **Empirical and related studies**
    i. Scientific basis of whole body vibration exercise training on body parameters
    ii. Whole body vibration exercises and fitness training in sedentary
    iii. Physiological effects of whole body vibration on obesity, overweight and cardiopulmonary fitness parameters
    iv. Muscular excitation activities during whole body vibration exercise
    v. Contraindications to Vibration Training
    vi. Resistance exercise training and cardiopulmonary fitness parameters of adolescents and young adults
    vii. Resistance training and obesity and overweightfitness parameters adaptations of adolescents and young adults
    viii. Sedentary lifestyle and effects on adolescents
    ix. Prospects of physical conditioning and wellness programmes
5. **Appraisal of related literature**

CONCEPTUAL FRAMEWORK FOR THE STUDY



Self-developed as applied in the study

Conceptual framework

This framework was self-developed and structured to depict the relationship between whole body vibration, resistance training and control with their effect on obesity, overweight and cardiopulmonary parameters of university students. It was also designed to observed the interaction of moderating variables of gender and stage of adolescent with the two treatment groups ie whole body vibration, resistance training and control on the dependent variables.

Theory of Motion

The theory adopted in this study is the second law of motionas stated by Sir Isaac Newton. The principles of Whole Body Vibration lie in this law of motion which states mainly that the force (F) of an object is equal to the mass (M) multiplied by its acceleration (A) ($F=M\times A$). Thus, functional force can be improved by either applying more mass or more acceleration to a body. Whole bodyvibration machines, utilizes acceleration by keeping the body weight constant.

Concept of whole body vibration

Whole body vibration (WBV) is a fairly recent training modality, commercially available since the start of the millennium. Its emergence dates back to the 1970s in the former Soviet Union, with the purpose of training cosmonauts in order to prevent loss of bone mineral and muscle mass during space flights. Its first reports on athletic training came after 1985(Nazarov and Spivak 1985; Boris, François, Gérald and Bernard,2014).

Recently,it is used for personal training purposes, leading to enhanced muscular strength, bone mass, proprioception, balance, and flexibility, along with beneficial metabolic effects, such as augmentation in lipolysis, glucose tolerance, growth hormone and testosterone secretion. Authors maintained that whole body vibration (WBV) has gained much attention for its ability to improve bone mineral density (BMD) (Pitukcheewanont and Safani,2006), flexibility (Fagnani, Giombini, Di Cesare, Pigozzi andDi Salvo,2006), balance and mobility (Kawanabe, Kawashima, Sashimoto, Takeda, Sato and Iwamoto, 2007), aerobic capacity (Bogaerts, Delecluse, Claessens, Troosters, Boonen, Verschueren and 2009)and notably, muscle function. It has also been found to act on muscle function in part via the stimulation of muscle spindles, leading to the excitation of alpha motor neurons, which contract the motor units. A tonic vibration reflex or tonic contraction of the muscle results (Rehn, Lidstrom, Skoglund and Lindstrom, 2007). It is theoretically established as a useful adjunct to traditional resistance or aerobic training exercises, as it can be performed by all categories.

In a study, two uncontrolled trials have investigated home-based whole body vibration exposure with muscle strengthening exercise in adults with cystic fibrosis (Rietschel, van Koningsbruggen, Fricke, Semler, Schoenauand 2008). In the first six months of continuous whole body vibration exposure (6 - 12 minutes; 12 - 26 Hz), five days/week in eleven adults aged 29 - 38 years, it resulted in small non-significant improvements in muscle power 4.7% (range -16.4% to +74.5%) and velocity 6.6% (range -0.9% to +48.3%), as assessed by one and two-legged jumps on a Leonardo (Novotec Medical, Pforzheim, Germany) platform. However, this was observed in a second study of three months of intermittent whole body vibration exposure (18 minutes) five days/week in 10 adults (three males; seven females) aged 24 - 47 years that whole body vibrationsignificantly improved in lower-extremity muscle force and power (Rietschel, Van Koningsbruggen, Fricke, Semler and Schoenau, 2008).

Concepts of Resistance Training

Resistance training (RT) is a form of periodic exercise whereby external weights provide progressive overload to skeletal muscles in order to make them stronger and often result in hypertrophy. The external load lifted classically is expressed as a percentage of the individual's one "repetition" maximum (1 RM, the maximum load that can be lifted once through a complete range of motion). The volume (dose) of resistance training is described by the load lifted, the number of repetitions, and the number of sets of repetitions. There are numerous other variables that can be manipulated within the design of resistance training programmes, such as inter-set rest intervals, time under tension, number of sets/repetitions, and order of exercises. In our view, these variables largely are redundant in achieving a phenotype of improved strength and even more so in gaining favorable health benefits. It is typically believed that at least three sets using high loads (mostly ≥80% 1 RM) and low repetitions (Burd, West, Staples, Holwerda, Moore, Tang, Baker, and Phillips, 2009; Bweir, Al-Jarrah, Almalty, et al., 2009; Cameron, Murray, Gillespie, et al., 2010; Carpinelli, 2002 and Carpinelli, 2008) per set are best to increase muscle strength (Kraemer, Adams, Cafarelli, et al., 2002 and Ratamess, 2009), whereas lower loads (50%–70%) and higher repetitions (Carpinelli, 2008 and Delorme, 1945) are best to increase muscular endurance.

On close scrutiny, evidence to support these contentions largely is lacking (Carpinelli, 2008 and Carpinelli, Otto and, Winett, 2004). Some of the earliest reports of what is the basis of formal resistance training are from De Lorme (Delorme, 1945). These reports showed that heavy resistance training restored muscular strength and power in war veterans with physical disabilities. Conversely, resistance training received little attention for its value in disease-risk reduction until more recently. In 2010, few would argue that some form of resistance training should not be part of a complete exercise program; however, the bulk of literature on the cardio-protective effects of aerobic exercise has continued to make this form of exercise preeminent and the central focus of many physical activity guidelines in many countries in the world.

Resistance training largely has developed and more recently been diversely applied to risk reduction and health promotion based on an extrinsic weightlifting paradigm. That is, the focus often is placed on the amount of resistance, number of repetitions, sets, and myriad other seeminglycritical variables (Ratamess, 2009). The assumption also has been that at least for increasing strength, heavier resistance produced superior outcomes compared with moderate resistance. This piece maintained that critical analyses of such suppositions indicate that numerous different combinations of resistance, repetitions, and sets produce astonishingly similar, rather than disparate, strength outcomes, and most importantly, heavier was not shown to be better (Carpinelli, Otto, 1998 and Carpinelli, Otto, 2004).

Concepts of Exercise

The work of Morris and coworkers changed modern views of the relationship between physical activity, fitness, and health and inspired a new era in which the association between physical activity and human health, disease, and mortality was scrutinized scientifically. Exercise-related health benefits are related in part to favorable modulations in both the traditional and novel cardiovascular risk factors that have been observed with increased physical activity patterns or structured exercise programs (Mora , Cook , Buring , Ridker and Lee , 2007).

Physical activities are considered very important in contemporary society. Its benefits are well documented and these have both physical and physiological benefits. Participating in physical activities has been linked with reduction in tension, state of anxiety, depression and thus enhancing sense of wellness with the reduction of mortality rate in both developedand underdeveloped nations of the world.

There is an overwhelming amount of scientific evidences on the positive effects of sports and physical activity as part of a healthy lifestyle. The positive direct effects of engaging in regular physical activity are particularly apparent in the prevention of several chronic diseases which include cardiovascular disease, diabetes, and cancer. A number of factors influence the way in which physical activity impacts on the health of different populations. Physical activity, intensity and type with the combination of other factors and determinants such as nutrition, suitable footwear, clothing climate or injury, stress levels and sleep patternwill lead to benefit. There are evidences to suggest that changes in the environment can have a significant impact on opportunities for participation and in addition, the conditions under which the activity takes place. Stone (1993) listed a number of beneficial physiological changes which individuals experience from active life as including:

A lower heart rate at any sub-maximal work load;

i. a lower systolic and diastolic blood pressure at any given sub maximal work load;
ii. a greater extraction of oxygen from the circulating blood;
iii. an ability to pump a larger volume of blood with each contraction of the heart chambers;
iv. increased efficiency, leading to a lower heart work demand (power or fuel requirement) for any given external work; and
v. decreased susceptibility to degenerative diseases of modern life-style.

Individuals can acquire the physiological benefits listed above by engaging in vigorous exercises that will keep the body systems in their optimal functional capacity. There are evidences that the potential benefits from physical activity cannot be stored. This suggests that exercise habits should be continued regularly if the gain resulting from them is to be retained (Ikpeme, 1995; Onifade, Agbonjimi and Ososanya, 1991and Hockey, 1993). Therefore, it is healthier and more profitable for an individual to remain physically active than just to achieve a certain level of fitness and then return to sedentary life style. It is obvious that many feel delighted and are more able to cope effectively with the stress of life with regular exercise. It is important to know that the sort of physical activity being advocated for in this write up is not only for life extension, but what we need is an exercise/activity programmes that will bring about improved quality of life, fitness and wellness. Summarily, physical activity can make a substantial contribution to the fitness and wellbeing of people in developing countries in the following:

(i) Developed a healthy musculoskeletal tissue that is, bone, muscles and joints.

(ii) Develop a healthy cardiovascular system (heart and lungs).

(iii)Develop neuromuscular awareness (coordination and movement control of the body).

Exercises and sports have long been used in the treatment and rehabilitation of communicable and non-communicable diseases. Physical activity for individuals is a strong means for prevention of diseases and for nations is a cost-effective method to improve public health across populations.

Exercise Impact on Blood Pressure

The high prevalence of hypertension (estimated to be one third of the adult population in the United States) is due in part to lifestyle factors. Positive lifestyle modifications, including weight loss and increased physical activity, contribute significantly to blood pressure control (World Health Report 2002and Grimm Jr., Grandits, Cutler, Stewart, McDonald, Svendsen, Prineas, and Liebson, 2002). Significant reductions in blood pressure after aerobic exercise programmes of mild to moderate intensity have been a consistent finding of many well-controlled studies.

The general conclusion from these studies is that aerobic exercise training lowers blood pressure in individuals with stage 1 hypertension by ≈3.4 to 10.5 mm Hg for systolic blood pressure and 2.4 to 7.6 mm Hg (Fagard, 2001and Kokkinos, Narayan, Papademetriou , 2001) .The magnitude of the reduction may be related to the initial level of blood pressure (Motoyama, Sunami, Kinoshita, Kiyonaga, Tanaka, Shindo, Irie, Urata, Sasaki, and Arakawa,1998).Cornelissen andFagard (2005), stated that exercise-induced changes in blood pressure over a 24-hour period (ambulatory blood pressure) have been reported by a limited number of studies and are estimated to be less dramatic than for blood pressure assessed from a single measurement (mean 3.0- and 3.2-mm Hg reductions for systolic and diastolic blood pressure, respectively)Consequently, increased physical activity is now strongly recommended as part of the lifestyle modifications as an adjunct to pharmacological therapy proposed by the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure and recent European Society of Hypertension/European Society of Cardiology guidelines (Kokkinos, Pittaras, Narayan, Faselis, Singh, and Manolis 2007). Blood pressure reductions are evident at low-to-moderate exercise intensities (35% to 79% of age-predicted maximum heart rate), with some studies suggesting that low exercise intensity may be more effective in lowering blood pressure than high exercise intensity (Hagberg, Montain, Martin,and Ehsani, 1989; Rogers, Probst, Gruber, Berger and Boone, 1996).

Others have noted that the favorable effects of training on blood pressure are not influenced or are only minimally influenced by exercise intensity, frequency, type, or duration.Evidence suggests that the blood pressure response to exercise is modulated by fitness. Exercise capacity has been shown to be inversely related to exercise blood pressure and to LV mass (Kokkinos, Pittaras, Narayan, Faselis, Singhand Manolis,2007). When fitness was considered, the systolic blood pressure at 5 METs was ≈10 mm Hg lower for moderately and highly fit individuals compared with the BP of the individuals in the low-fitness category. LV mass index was also significantly lower in the moderately and highly fit individuals. For every 1-MET increase in the workload achieved, a 42% reduction in the risk for LV hypertrophy was observed. Finally, 16 weeks of aerobic training resulted in significantly lower blood pressures at ≈3 and 5 METs, (Kokkinos, Narayan, Fletcher, Tsagadopoulosand Papademetriou, 1997) and regular exercise was associated with LV mass regression in older individuals with stage 2 hypertension.

Scientific basis of vibration training on obesity, overweightand cardiopulmonary parameters

Whole body vibration has been called different names in different quarters such as vibration therapy, biomechanical stimulation (BMS), and biomechanical oscillation (BMO). It is a training method employing low amplitude, and low frequency mechanical stimulation to exercise musculoskeletal structures for the improvement of muscle strength, power, and flexibility.

It has been advocated as a therapeutic method in the treatment of osteoperosis, sarcopenia, and metabolic syndrome, and is used in the fitness industry, physical therapy, rehabilitation, professional sports, and beauty and wellness applications (Albasini, Alfio; Krause, Martin, Rembitzki and Ingo, 2010; Paschold, Helmut, Mayton and Alan 2011).

Vibrating platforms fall into different categories, having main categories of machine types as: 1. High Energy Lineal, found mostly in commercial vibration training studios and gyms and its vibration direction is lineal/upward eliciting a strong stretch-reflex contraction in muscle fibres targeted by the positions of training programme. 2. Premium Speed Pivotal which is used for physiotherapy work at lower speeds and exercise workouts at "premium" speed, up to 30 Hz. It is available at commercial and home unitsoptions. 3. Medium Energy Lineal, with majority of its platforms made of plastic, have 3-D vibration which is low quality, giving slower and less consistent results. 4. Other machine types are low Energy/Low amplitude lineal and Low energy/High amplitude lineal with varying uses from osteoporosis prevention, therapy for improved blood circulation and flexibility and limited fitness.

The platform is vibrated upwards to work directly against gravity and therefore is called "hyper-gravity". The training frequency (Hz) is another of the important factors involved. The human body is designed to absorb vertical vibrations better due to the effects of gravity; however, many machines vibrate in more than one direction: sideways (x), front and the z-axis have the largest amplitude, is the most defining component in generating and inducing muscle contractions.

Concerning the z-movements, two main types of system can be distinguished (Marin andRhea;Rittweger; and Rauch 2010):

- Side alternating (pivotal) systems, operating like a see-saw and hence mimicking the human gait where one foot is always moving upwards and the other one downwards, and

- Linear systems where the whole platform is mainly doing the same motion, respectively: both feet are moved upwards or downwards at the same time. Systems with side alternation usually offer larger amplitude of oscillation and a frequency range of about 5 Hz to 35 Hz. Linear/upright systems offer lower amplitudes but higher frequencies in the range of 20 Hz to 50 Hz. Now, despite the larger amplitudes of side-alternating systems, the vibration transmitted to the head is significantly smaller than in non-side-alternating systems. This difference could be a determining factor when choosing a platform for therapy versus training effects. Also, mechanical stimulation generates acceleration forces which act on the body causing the muscles to lengthen, and this signal is received by the muscle spindle, a small organ in the muscle. This spindle transmits the signal through the central nervous system to the muscles involved (Abercromby, Amonette, Layne, McFarlin, Hinman and Paloski, 2007).

Whole body vibration exercises in fitness training

The use of whole body vibration as an exercise intervention for health promotion among sedentary adults is increasingly being considered among health professionals because, compared with conventional training methods, it offers a way of training with practical, physical and psychological advantages. Whole body vibration is a relatively current neuromuscular training method, which even at a low intensity provokes muscle length changes that stimulate the sensory receptor of the muscle spindle, thereby eliciting a tonic vibratory reflex, which is defined as a sustained contraction of a muscle subjected to vibration. Whole body vibration intervention exploits the body’s innate reflex response to disruptions in stability in order to stimulate and enhance muscle strength and performance. Practically, this training has the advantage of overcoming some of the cited inadequacies to exercise because it decreases overall training time and takes place indoors. More importantly, it offers a host of physical benefits such as improved muscular strength, flexibility, range of motion, bone density, and improved blood circulation as earlier established bysome scholars (Delecluse, Roelants, Diels, Koninckx andVerschueren, 2004).In addition, whole body vibration heightens confidence, which encourages ongoing participation and programme adherence (Hoegerand Hoeger, 2013;De Vos, Strydom, Fouché and Delport, 2009).Given these advantages, it is hereby advised that a well-structured and well supervised individualised whole body vibration exercise programme, provides an attractive mode of training for sedentary individuals.

Physiological Effects of whole body vibration on obesity, overweight and cardiopulmonary fitness parameters

Short term

Some authors have maintained that under the influence of vibration more motor units (and the correlating muscle fibers) are activated than in normal, conscious muscle contractions.Due to this, muscles are incited more efficiently (Paradisis and Zacharogiannis 2007 as cited by Delecluse, Roelants, Diels, Koninckx, and Verschueren, 2005;Lamont, Cramer, Gayaud, Acree, Bemben, Cormie, Deane, Triplett, McBride, (2006); Rittweger 2001, Abercromby, Amonette, Paloski, and Hinman, 2005). The immediate effect of whole body vibration is therefore that the muscles can be used quickly and efficiently, rendering them capable of producing more force.

Another immediate effect is an improvement of circulation of blood. Kerschan-Schindl et al 2001and Lohman et al. 2007)opined that the rapid contraction and relaxation of the muscles at 20 to 50 times per second basically works as a pump on the blood vessels and lymphatic vessels increasing the speed of the blood flow through the body. Subjects often experience this as a tingling, prickling, warm sensation in the skin.

This has been described by Stewart (2005) and Oliveri (1989) in their submissionof the appearance of vasodilatation as a result of vibration.

Long term

In order to have any effect on the body in the long term, it is vital that the body systems experience fatigue or some sort of light stress. Delecluse, Roelants, and Verschueren, 2003 and Roelants, Delecluse and Verschueren, (2004) maintained that when the body is overloaded repeatedly and regularly, the principle of super compensation appliesas in other kinds of training. This principle is the cause of the body adapting to loading. .Although, research into the structural effects of vibration training ledto the deduction that the increased strength resulting from whole body vibration training can definitely be compared to the results that can be attained with conventional methods of training. However, there are indications that better results may be achieved with whole body vibration in the area of explosive power (Delecluse, Roelants and Verschueren, 2003).

Another important difference between conventional training methods and whole body vibration is that there is only a minimum of loading. There are no additional weights necessary, which ensures that there is very little loading to passive structures such as bones, ligaments and joints. Also, it is highly suitable for professional athletes who want to stimulate and strengthen their muscles without overloading joints and the rest of the physical.

Other than its influence on the muscles, whole body vibration also has a positive effect on bone mineral density. Mechanostat and Frost, 1997 and Felsenberg, (2001) maintained that vibrations cause compression and remodeling of the bone tissue, activating the osteoblast (bone building cells), while reducing the activity of the osteoclasts (cells Repeated stimulation of this system, combined with the increased pull on the bones by the muscles will increase bone mineral density over time. It is also likely that improved circulation and the related bone perfusion due to a better supply of nutrients, which are also more able to penetrate the bone tissue,are contributing factors (Verschueren 2004;Jordan 2005; Johnell and Eisman, 2004; Rubin, Recker, Cullen, Ryaby, McCabe, and McLeod, 2004). Furthermore the Berlin Bedrest Study (BBR) proved that 10 minutes of vibration training 6 times a week prevented muscle and bone loss in total bedrest over 55 days (Rittweger et al. and Felsenberg et al. 2004; Bleeker et al. 2005; Blottner et al. 2006).

In preventing falls and the bone fractures that often result from them, enhancing bone mineral density is not the only important issue. Increased muscle power, postural control and balance are also factors worthy of consideration. Roelants et al. stated that studies involving elderly subjects have shown that issues relating to bone fractures, posture and balance can be improved using whole body vibration (Roelants et al. 2004, Bautmans et al. 2005, Bogaerts et al. and Kawanabe et al. 2007).

Muscular excitation activities during whole body vibration exercise

Sedentary, injured, and elderly people with impaired muscle activation capabilities may benefit from currently available whole body vibration training applications. In this case the results seem to be more encouraging. In fact, (Torvinen , Kannus & Sievanen, 2002) showed a net improvement of 8.5% in vertical jumping ability after four months of whole body vibration training performed with static and dynamic squatting exercises with small vibration amplitudes (2 mm) and frequencies ranging from 25 to 40 Hz in sedentary subjects. A 12 week whole body vibration training programme (frequency 35–40 Hz and amplitude 2.5–5 mm) induced a significant enhancement in isometric, dynamic, and explosive strength of knee extensor muscles in healthy, untrained, young adult women (Delecluse , Roelants and Verschueren, 2003).

Also, vertical jump improved only in the group undergoing whole body vibration training as against the group performing conventional resistance exercise. However, it should be noted that the resistance exercise programme in this study was of relatively low intensity (started with a load of 20 repetition maximum and reached 10 repetition maximum in the last four weeks) and the exercises (leg press and leg extensions) were performed to failure and not with explosive movements. The same authors also showed that 24 weeks of whole body vibrations were effective in producing a rightward shift in the force-velocity relation of knee extensor muscles and an increase infat-free mass in untrained female subjects (Roelants, Delecluse and Goris, 2004). Despite not being significantly different from the standard training groups, the results observed by both (Delecluse , Roelants , Verschueren, 2003 andRoelants , Delecluse, Goris, 2004) highlight the likelihood that long term programmes of whole body vibrations training may produce significant improvements in muscle function of the leg extensors in untrained subjects. The whole body vibration training programme was also effective in increasing bone mineral density of the hip even though the improvement was very small (+0.93%) and within the error of measurement used for establishing bone mineral density.

Also, this technology may be of benefit to the elderly or in rehabilitation programmes, because little effort is required and there is no complicated technique to master.

There is also much benefit for special populations in particular in acute bouts of whole body vibrations training. Furthermore, owing to the potential of this intervention to stimulate bone remodeling,it is possible that whole body vibration training may be a possible non-pharmacological intervention for the prevention of osteoporosis (Ward, Alsop, Caulton 2004; Rubin, Recker, Cullen 2004 and Cardinale, Leiper, Farajian 2004). The evidence above indicates that whole body vibration training may be an effective exercise intervention for reducing the results of the ageing process in musculoskeletal structures. It would also appear that whole body vibration may be an effective countermeasure to microgravity and disuse. Cardinale and Bosco (Cardinale and Bosco, 2003) have suggested that the muscle activation due to the whole body vibration may induce improvements in strength and power performance similar to those observed with strength training. As the whole body vibration exercise involves mechanical stretching (Tsuji, Kitano, Tsunoda, Himori, Okura, and Tanaka, 2014 and Figueroa, Gil, Wong et al.,2012), this fact could justify the increase of the flexibility by the exercise generated by vibration produced in oscillating/vibratory platform and the improvements observed in subjects that have performed whole body vibration (Karatrantou, Gerodimos, Dipla, and Zafeiridis, 2013 and Wheeler and Jacobson, 2013; Tsuji, Kitano. Tsunoda, Himori, Okura, and Tanaka, 2014). Moreover, an improvement of 8.2% in the sit and reach test has been reported after acute whole body vibration exercise (Cochrane and Stannard, 2005). Similarly, vibration-assisted stretching enhanced the forward split in competitive female gymnasts (Kinser, Ramsey, O'Bryant, Ayres, Sands, and Stone, 2008), suggesting improved flexibility in these elite athletes.

Di Giminiani, Manno, Scrimaglio, Sementilli, and Tihanyi, (2010) have reported that individualized whole body vibration without superimposing other exercises is an effective method of acutely increasing lower back and hamstring flexibility.Studies on the efficacy of whole body vibrationtraining produced notable results. Both positive (improved flexibility,Fagnani, Giombini, Di Cesare, Pigozzi, Di Salvo power, 2006,Bosco, Cardinale, Tsarpela, 1999 muscle strength,de Ruiter, van der Linden, van der Zijden, Hollander, de Haan, 2003 and performanceDa Silva, Nunez, Vaamonde, 2006) and otherwise.

Recent evidence suggests that whole body vibration exercise could be an alternative exercise modality for eliciting muscle strength in older adults (Bogaerts et al., 2007; Kawanabe et al., 2007; Machado et al., 2010; Tapp and Signorile, 2014). Findings of improved strength have also been shown following WBVT in younger individuals (Figueroa et al., 2010; Figueroa et al., 2012; Roelants et al., 2004). The addition of vibration to exercise programmes has been shown to increase strength and power more than exercise programs without vibration (Kawanabe et al., 2007; Ronnestad, 2004).

Contraindications to Vibration Training

Harmful effects of vibration exposure were first identified almost 100 years ago through study of the health of operators of pneumatic power tools (Hamilton, 1918). Vibration injury to the hands includes a vascular component, characterised by intermittent blanching, and a neurological component, characterised by impaired proprioception and dexterity (Mansfield, 2005). Vibration exposure has also been associated with an increased risk of low back pain for drivers of work machines (BovenziM,RuiF,NegroC, et al., 2006). As vibration is recognized as an industrial hazard, legal limits on exposure have been introduced in many countries. European occupational exposure limits can be exceeded in <5 min on some commercially available whole body vibration training platforms if used on their highest magnitude settings. It is important to balance the potential risks of adverse side-effects on the neurological and vascular systems with potential benefits when designing a whole body vibration training protocol.

The effects of vibration training on human body may depend on vibration settings (frequency, amplitude and duration) and on the exercise programme (type of exercises, intensity and volume). However, isolated cases of lower leg phlebitis (Vissers, Verrijken, Mertens, Van Gils, Van De Sompel, Truijen, et al., 2010), mild knee pain (Song, Kim, Lee, Joo, 2011) and back pain after two weeks of training (Bellia A, Sallì M, Lombardo M, D’Adamo M, Guglielmi V, Tirabasso C, et al., 2014) were reported.Chronic exposure to vibration has been studied only in the occupational setting. Some negative side effects have been identified, including spinal degeneration, vestibular disturbances, and vascular and neurological conditions (Seide, 1993). Guidelines have been published to limit the exposure to industrial WBV, but intermittent exposure while exercising on a platform has not been addressed (International Organization for Standardization, 1997). Although WBV uses frequencies and amplitudes lower than occupation vibration, a recent study (Abercromby, Amonette, Layne, McFarlin, Hinman, Paloski, 2007) estimated that the vibration dose in typical vibration training regimens (10 minutes a day at 30 Hz, 4-mm displacement) exceed the recommendations (International Organization for Standardization, 1997). They also concluded that vertical vibration, a fully upright position, and full-squat exercises were potentially harmful and that knee flexion of 26 to 30 degrees should be encouraged to minimize head vibration (Abercromby, Amonette, Layne, McFarlin, Hinman, Paloski, 2007). Exercises that involve lying or sitting on the platform (e.g., doing push-ups) should be avoided. In addition, recent work showed that amplitudes above 0.5 mm can lead to unpredictable high peak accelerations and may pose a risk to fragile bone and cartilage (Kiiski, Heinonen , Jarvinen, Kannus, Sievanen, 2008).

The most common reported side effects are transient itching and tingling (feet, legs, and nose), skin redness (legs), and muscle soreness. Incorrect exercise technique also could result in headache, motion sickness (if too much vibration is transmitted to the head), and anterior knee pain (if squatting is involved). However, no serious adverse effects were reported in recent reviews that included clinical populations (Merriman, Jackson, 2009 and Slatkovska, Alibhai, Beyene, Cheung, 2010). Before starting a vibration exercise program, the participant should be screened for possible contraindications. Exclusion criteria used in clinical trials are likely good standards to follow (Cardinale, Rittweger, 2006 and Merriman, Jackson, 2009).

Resistance training and cardiopulmonaryfitness parameters' adaptation of adolescents andyoung adult

The adaptational changes and health implications of resistance exercise are very dynamic and varies according to each individual needs. Whether training for sports performance or health enhancement, the effectiveness of the exercise prescription in manipulating the progression determines much of the success achieved of a training programme, the variation in the programme design and the individualization of the program (Kraemer, 1994). Most recently, the positive health benefits of physical activity have gained high recognition attributable to the Surgeon General's report on health and physical activity. Tartibian, Maleki, and Abbasi, (2010) found a significant rise in pulmonary parameters VC, FVC, MVV, FEF 2575%, and FEV1 after a 12-week of wrestling training while Cheng et al (2003) showed that active persons had a higher FEV1 than others . Multiple aspects may support improvement of the pulmonary function. We know that muscular imbalances-associated with inactivity causes a restriction in the thorax (Wright, Heck, &Langenkamp, 2003), and so exercise training could have a compensatory effect on this situation; furthermore, reinforcement of the auxiliary respiratory muscle is another effect of regular exercise training (Boeckh-Behrens, Buskies, Loges&Winsen, 2002).

It has been shown in studies that physical exercise can increase the residual air flow and decrease the ventilation with reinforcement of bronchi expansion during an exercisein asthmatic patients.This makes an asthmatic patient save air flow during exercise (Farid, Azad, Atri, Rahimi, Khaledan, Talaei-Khoei M, et al. 2005). In addition, improved pulmonary function following exercise training could be due to decreased airway resistance, increased airway caliber, and strengthened respiratory muscles as well as lung and thorax elasticity (Tartibian, Maleki, Abbasi**,** 2010).

Nourry et al (2005) reported a significant increase in FVC, PEF, and FEV1 of healthy prepubescent children after 8 weeks of high-intensity interval running training. Farid et al (2005) found significant elevation in FVC, MVV, PEF, FEF 25-75%, and FEV1. Tartibian, Maleki and Abbasi. (2010) found a significant rise in pulmonary parameters VC, FVC, MVV, FEF 2575%, and FEV1 after a 12-week of wrestling training.Multiple aspects may support improvement of the pulmonary function. We know that muscular imbalances-associated with inactivity causes a restriction in the thorax (Wright, Heck, &Langenkamp, 2003), and so exercise training maybe could have a compensatory effect on this situation; furthermore, reinforcement of the auxiliary respiratory muscle is another effect of regular exercise training (Boeckh-Behrens, Buskies, Loges&Winsen, 2002).

Heart rate adaptations

Heart rate is acutely elevated immediately following a workout and affected by the amount of resistance, the number of repetitions and the muscle mass involved in the contraction (small vs. Interestingly, in terms of chronic adaptations, there appears to be a reduction in heart rate from resistance training, which is considered beneficial (Stone et al., 1991). Long term adaptations observed in the research, from no change up to an 11% decrease in heart rate, may be explained by various variables such as the differences in intensity, volume, rest between large muscle mass, duration of study and fitness level of the subjects.

Heart size adaptations to resistance training

Studies which involves strength-trained athletes have shown that there is an increase in left ventricular wall thickness, absolute left ventricular wall mass, and septum (wall separating the left and right ventricles) wall thickness with resistance training (Stone et al., 1991) , as contrasted by increases in volume of the left ventricular chamber seen with aerobic-trained individuals. The extent to which the changes in the heart size from resistance training may affect cardiac output, stroke volume and heart efficiency are currently unknown.

Blood pressure adaptations to resistance training

Conservative estimates postulate that 50 million Americans, approximately 1 in 4 adults, have high blood pressure. More than 90% of these cases are identified as primary hypertension, which increases the risk of heart failure, kidney disease, stroke, and myocardial infarction (Tipton, 1984). During a resistance exercise bout, systolic and diastolic blood pressures may show dramatic increases, which suggest that caution should be observed in persons with cardiovascular disease (Stone et al., 1991) , or known risk factors. The extent of the increase in blood pressure is dependent on the time the contraction is held, the intensity of the contraction, and the amount of muscle mass involved More dynamic forms of resistance training, such as circuit training, that involve moderate resistance and high repetitions with short rests are associated with reductions in blood pressure. Studies have shown decreases in diastolic blood pressure (Harris and Holly, 1987), no change in blood pressure (Blumenthal, Siegel, and Appelbaum, 1991), and decreases in systolic blood pressure (Hagberg The effects of resistance training on blood pressure are varied due largely to differences in study design, which suggests that more research is necessary to clearly understand the role Strength training as a way to lower BP was traditionally discouraged by physicians and other health professionals largely because excessive elevations in BP have been noted during high-resistance weight-liftingexercises (80% to 100% of 1-repetition maximum) (Hurley and Roth 2000).

However, resistance training has been widely recommended in recent years for the elderly, in cardiac rehabilitation programs, and for the public because it is associated with numerous health benefits, including reducing the risk of falls by reversing or attenuating the age-related decline in bone mineral density, muscle mass, and power (Hurley and Roth,2000). The conclusion of a recent meta-analysis was that the average systolic BP reduction as a result of resistance training was ≈3 mm Hg. This is substantially less than that reported for endurance exercise (Kelly and Kelly 2000). Consequently, the recommendation of the American College of Sports Medicine is for resistance training to serve as an adjunct to an aerobic-based exercise program for BP reduction. The effects of aerobic training on resting blood pressure easily are summarized by the general findings that blood pressure, both systolic blood pressure (SBP) and diastolic blood pressure (DBP), generally are lower in fitter individuals and that longitudinal findings show that aerobic training lowers resting blood pressure and does so more in those with initial hypertension (Cornelissen and Fagard, 2005). From the few studies in this area, it does appear that, with resistance training, reductions in systolic blood pressure are comparable with aerobic training (SBP = −6 mm Hg and DBP = −4.7 mm Hg). Thus the available data on resistance training show comparable changes to aerobic training, and importantly, changes that are about the same magnitude as those induced pharmacologically.

Resistance training and obesity and overweight fitness parameters adaptations

Muscle fiber adaptations

The increase in size of muscle is referred to as hypertrophy. The 'pump' one feels from a single exercise bout is referred to as transient hypertrophy. This short term effect is attributable to the fluid accumulation, from blood plasma, in the intracellular and interstitial spaces of the muscle.In contrast, chronic hypertrophy refers to the increase in muscle size associated with long-term resistance training. Increases in the cross-sectional area of muscle fibers range from 20% to 45% in most training studies (Staron, Leonardi, Karapondo, Malicky, Falkel, Hagerman and Hikida, 1991). Muscle fiber hypertrophy has been shown to require more than 16 workouts to produce significant effects (Staron et al., 1994). In addition, fast-twitch (glycolytic) muscle fiber has the potential to show greater increases in size as compared to slow-twitch (oxidative) muscle fiber (Hather, Tesch, Buchanan, and Dudley, 1991).

There is a general believed that the number of muscle fibers possessed by an individual is established by birth and remains fixed throughout the rest of his life. Therefore, the hypertrophy adaptations seen with resistance training are a net result of subcellular changes within the muscle which include: more and thicker actin and myosin protein filaments, more myofibrils (which embody the actin and myosin filaments), more sarcoplasm (the fluid in the muscle cell), and plausible increases in the connective tissue surrounding the muscle fibers (Wilmoreand Costill, 1994).

Muscular strength adaptations

The increases in muscular strength during the initial periods of a resistance training programme are not associated with changes in cross-sectional area of the muscle (Sale, 1988).Moritani and deVries, 1979, opined that changes in strength evidenced in the first few weeks of resistance training are more associated with neural adaptations which encompass the development of more efficient. The motor unit (motor nerve fiber and the muscle fibers it innervates) recruitment is central to the early (2 to 8 weeks) gains in strength. Collectively, the learned recruitment of additional motor units, which may respond in a synchronous (the coincident timing of impulses from 2 or more motor units) fashion (Wilmore and Costill, 1994), the increased activation of synergistic muscles, and the inhibition of neural protective mechanisms (Kraemer, 1994), all contribute to enhance the muscle's ability to generate more force. It's being observed that possibility exist that two adjacent muscle fibers, with different motor nerves, could result in one fiber being activated to generate force while the other moves passively and changes in strength are more likely attributable to hypertrophy of the muscle fibers or muscle group in the long run (Sale, 1988).

The range of increase of strength is quite variable to the individual and may range from 7% to 45% (Kraemer, 1994). Behm and Sale, (1993) noted that strength results appear to be velocity specific, which best characterizes the probability that the greatest increase in strength occur at or around the velocity of the training exercise. Therefore, slow-speed training will result in greater gains at slow movement speeds, while fast-speed training will realize the improvements in strength at faster movement speeds. A prevalent issue in analyzing the diverse results of strength adaptations in training studies depends upon the subjects' preparation for the investigation. Although several researchers often select untrained subjects, the failure to plan and control for a learning effect (subject improves because they learn the correct performance of the muscle action) may result in erroneous conclusions from the study.Resistancetraining induced significant gains in lean body mass and strength. The lack of body mass loss observed with resistancetraining in this study supports the findings of others and is driven by an increase in lean body mass (Castaneda et.al, 2002,Davidson et.al, 2009,Donnelly, Jakicic, Manore, Rankin & Smith, 2009,Schmitz, Jensen, Kugler, Jeffery, Leon, 2003 &Sigal et.al, 2007). However, there are conflicting reports in the literature on whether or not resistancetraining induces fat mass loss: some randomized controlled trials find that resistancetraining significantly reduces fat mass (Schmitz, Jensen, Kugler, Jeffery, Leon, 2003), while others either report a statistically insignificant trend (Schmitz, Hannan, Stovitz, Bryan, Warren, Jensen, 2007&Sigal et.al, 2007) or no change in fat mass (Castaneda et.al, 2002, Davidson et.al, 2009,&Olson, Dengel, Leon, Schmitz, 2007).

The present study supports the latter observation,however, emphasis should be made that resistance training significantly improved lean body mass as confirmed by both BOD POD and thigh muscle area measurements. Recommendations from the American College of Sports Medicine (2009) provide a figure that proposes three potential mechanisms by which resistance training might lead to fat mass loss (Donnelly, Jakicic, Manore,training is not effective for weight loss, resistancetraining is still endorsed as an effective means for obesity treatment. Similarly, other consensus documents and study reports include tables showing that resistancetraining results in decreases in fat percentage, with the suggestion that this decrease in fat percent indicates a decrease in fat mass (Banz et.al, 2003,Pollock et. at, 2000, &Williams et.al, 2007). The problem with reporting changes in fat percent, instead of absolute fat mass, is demonstrated by the resistancetraining group in the present study, for whom fat percent did significantly decrease without any change in absolute fat mass. In other words, the changes in percent body fat were driven solely by the increase in lean body mass induced with resistancetraining. Perhaps the most commonly cited reason for the reduction of fat mass and body weight by resistancetraining is that resting metabolic rate (RMR) theoretically increases as lean body mass increases (Lemmer et. al, 2001&Pollock et al, 2000), resulting in a steady state increase in total energy expenditure and a corresponding negative shift in energy balance.

Although we did not directly measure RMR in the present study, we observed that RT increased lean body mass without a significant change in fat mass or body weight, irrespective of any change in RMR that might have occurred. Strength training with greater intensity (fewer repetitions and greater weight) with multiple sets can elicit greater improvements in strength and power, and may not be appropriate for older nonathletic participants (Pollock, Vincet, Corbin, Pangrazi, 1996).In terms of chronic adaptations, there appears to be a reduction in heart rate following resistance training, which is considered beneficial (Kravitz, 1996)

Studies suggest that regular exercise has a positive effect on body weight, body composition, and aging (Andersen, and Jakicic, 2009, Falls, 1968 and Heyward, V. 1991). A variety of exercise modes benefits body composition, improves health, and enhances exercise performance. Moderate-intensity cardiorespiratory exercise and weight training, regardless of gender, are effective for decreasing body fat percentage, fat weight, and body weight (Heyward, 1991). Resistance training helps build fat-free mass and bone-mineral status (Lohman, 1995 and Wilmore, and Costill, 1994), as well as promoting positive changes in body composition (Broeder, Burrhus, Svanevik, & Wilmore 1992, Kwon, Han, Ku, Ahn, Koo, Kim, & Min, 2010, Marra, Bottaro, Oliveira and Novaes, 2005and Ucan, 2013). Resistance training is a common mode to increase FFM and decrease BF percentage (Ferreira, Medeiros, Nicioli, Nunes, Shiguemoto, Prestes, Verzola, Baldissera, and Perez, 2010, Heyward, 1991, Ucan, 2013 and Wilmore, and Costill, (1994). In a study by Harber et al. (2004), a circuit resistance training program of 10 exercises for 10 weeks at 3 times per week in young adult men (aged 18–35) found no differences in body weight, FFM, FM, or percentage BF.

Bone tissue adaptations

In response to loading of the bone, created by muscular contractions or other methods of mechanical forces, the bone begins a process of bone modeling which involves the manufacture of protein molecules that are deposited in the spaces between bone cells. This leads to the creation of a bone matrix which ultimately becomes mineralized as calcium phosphate crystals, resulting in the bone acquiring its rigid structure. This new bone formation occurs chiefly on the outer surface of the bone, or periosteum.

Activities that stimulate bone growth need to include progressive overload, variation of load, and specificity of loading (Conroy, Kraemer, Maresh, and Dalsky, 1992). Specificity of loading refers to exercises that directly place a load on a certain region of the skeleton. Sites of fractures that are most devastating are in the axial skeleton i.e the spine and hip. Conroy et al, (1992), recommended that more intense loading of the spine and hip be done during early adulthood when the body is more capable of taking on a progressive overload is necessary so the bone and associated connective tissue are not asked to exceed the critical level that would place them at risk. Programmes to increase bone growth should be structural in nature and should include exercises such as squats and lunges, directing forces through the axial skeleton and allowing for greater loads The magnitude required to produce an effective stimulus for bone remodeling appears to be a 1 repetition maximum (RM) to 10 RM load (Kraemer, 1994).For example, if a person can do 10 repetitions, but not 11 repetitions, of a particular exercise at 120 lbs, he/she is said to have a 10 RM of 120 lbs. Although multiple sets are recommended for bone modeling stimulation, the intensity of the exercise, mechanical strain on the bone, and specificity of the bone loading exercise are considered more important factors.

Body composition adaptations

Resistance training programmes increase fat-free mass and decrease the percentage of body fat. Young and Steinhard, (1995) stated that one of the outstanding benefits of resistance exercise, as it relates to weight loss, is the positive impact of increasing energy expenditure during the exercise session and somewhat during recovery, and on maintaining or increasing fat-free body mass while encouraging the loss of fat body weight. It is more likely that body composition is affected and controlled by resistance training programmes using the larger muscle groups and greater total volume (Stone, Fleck, Triplett, and Kramer, 1991).

Volume in resistance training is equal to the total workload, which is directly proportional to the energy expenditure of the workout. Total volume is the total number of repetitions (repetitions x sets) performed times the weight of the load (total repetitions x weight). Often you will see total volume calculated multiplying the number of sets x repetitions x load. For instance, three sets of 12 repetitions with 50 lbs would be expressed as 3 x 12 x 50 = 1,800 lbs of volume. An impressive finding to highlight with resistance training is that the energy expenditure following the higher total volume workouts appears to be elevated, compared to other forms of exercise, and thus, further contributes to weight loss objectives.

While aerobictraining may be beneficial for aiding in fat mass loss or the prevention of addition fat mass gain, it is, at least as practiced by most people in its current form (*i.e.,* walking), of limited benefit in preventing sarcopenia. In comparison, a noted benefit of resistance training is the natural tendency to promote gains in muscle mass or at least a better retention or slowed loss of muscle. An increase in muscle mass is the most conspicuous change in body composition that one would predict to occur with resistance training, and this is an outcome achievable in young (Phillips, Hartman and Wilkinson, 2005) and the elderly (Kosek, Kim, Petrella, Crossand Bamman, 2006), even into the 10th decade of life (Fiatarone, O'neill and Ryan, et al., 1994). However, an often underappreciated observation is a reduction in body fat mass, particularly visceral fat mass (Tresierras and Balady, 2009), that can occur with resistance training. The loss of fat, particularly visceral fat, tends to be greater in those who initially have greater visceral fat. Thus, resistance training presents an attractive primary or adjunct therapy for those who are obese or overweight or have type 2 diabetes (T2D) (Tresierras and Balady, 2009). In addition, resistance training acts to preserve muscle mass during weight loss and in doing so may eliminate or at least may attenuate the weight loss-induced decline in resting metabolic rate due to the effect of resistance training in promoting lean mass retention, which is a primary determinant of resting metabolic rate.

Lipoprotein and lipid adaptations

Research has demonstrated that low concentrations of total cholesterol and low-density lipoprotein cholesterol (LDL-C), and high levels of high-density lipoprotein cholesterol (HDL-C) are associated with a decrease in Lower concentrations of blood triglycerides and LDL-C, along with higher levels of HDL-C have been observed with endurance-trained individuals.Several investigators have reported favorable changes in blood lipids and lipoproteins following a strength training intervention (Kokkinos & Hurley, 1990). However, it was added that the lack of control in body composition, day-to-day variations in lipoproteins, dietary factors, and distinction of acute vs. chronic adaptations needs to be thoroughly addressed in future strength training research, to provide a more credible summary of the effect of resistance training on blood lipids and lipoproteins. Also, more research is needed to determine if there is an optimal resistance training format that positively affects lipoprotein-lipid profiles.

Glucose metabolism adaptations

An important risk factor for cardiovascular disease and diabetes is glucose tolerance. High blood glucose and high insulin levels can also have a deleterious effect on hypertension and blood lipids (Hurley, 1994). Initially, improvements in glucose metabolism were associated with decreases in percent body fat and increases in aerobic capacity, thus suggesting that aerobic exercise would provide the better catalyst for improvements in glucose metabolism. However, improvements in glucose metabolism with strength training, independent of alterations in aerobic capacity or percent body fat, have been shown (Hurley, Hagberg and Goldberg, 1988; Smutok, Reece, & Kokkinos, 1993). Interestingly, Smutok et al. (1993) concluded that strength training and aerobic training improved glucose tolerance and reduced insulin responses to oral glucose (in men) similarly. The strength training program consisted of two sets (90 second rests between sets) of exercise, using loads that could be lifted 12 - 15 times (per set) for 11 different exercises. Exercises included squats, leg extensions, leg curls, decline presses, pullovers, arm cross-overs, overhead presses, lateral raises, rows, hip and back exercises, and modified sit-ups. Additionally, it has been shown that body builders, who traditionally employ a high volume style of training, favorably alter glucose tolerance and insulin sensitivity (Stone et al., 1991).

Sedentary lifestyle and its effects on adolescents

Obesity in childhood is not limited to the developed countries alone. Literature indicates a rising prevalence of childhood obesity in both developed and developing countries (Akinpelu, 2008, Matsushita et al, 2004 and Rasmussen et al, 1999). De Onis and Blössner (2000) have also reported a rapid increase in the prevalence of overweight and obesityamong pre-school children in developing countries. Adolescent obesity is thought to be associated with some psychological problems like low self-esteem, feeling of inadequacy, anxiety, social dysfunction, depression and moodiness; all of which affect the personality of the adolescents (Ojofeitimi et al, 2011). It was reported that girls who are overweight or obese are prone to developing high-risk behaviours such as smoking and drinking alcohol, and are also less likely to engage in physical activities and exercise programmes that promote energy expenditure (Wadden and Stunkard, 1995).

The prevalence of overweight and obesity was 5.76% and 1.13% respectively, higher than the prevalence reported by Ben-Bassey et al, (2007) of 3.7% and 0.4% among adolescent in Lagos, Nigeria.

Prevalence of overweight and obesity was also significantly different with age in this study as reported by Ansa et al (2007), stating 1.7% obesity and 6.8% overweight among Nigerian adolescents. Adolescents aged 13-16 years had higher prevalence of overweight and obesity than others. Ansa et al (2008) also reported a prevalence of 4% in adolescents (13-15years) and 3% in (16-18years) and it was observed from this study that the prevalence of overweight and obesity seems to decrease with age for both sexes. Sex difference in the prevalence of underweight was significant (p=0.001) from this study.

Girls had a lower prevalence (13.48%) than boys (18.65%). However, a contrary observations was made from these studies; Ansa et al (2001), Francis et al (2009), Reddy et al, (2009), Al-Sendi et al (2003), Bader et al (2008) and Wang et al (2009) who all reported a higher prevalence of overweight in female than male adolescents. However, Kautianinen et al (2002) and Hong et al (2007) reported a higher prevalence of obesity in boys than in girls among Finnish adolescents and Ho Chi Minh City respectively. Prevalence of obesity from this study was significantly higher in boys than in girls. Francis et al (2009) attributed the higher prevalence of overweight among female adolescent with high consumption of sweetened beverage. Ansa et al (2008) found no significant association between overweight/ obesity and the consumption soft drinks among Nigerian adolescents. Many studies show that overweight and obesity in adolescence are powerful indicators of adulthood overweight and related disease (Al-Sendi et al., 2003). Similar study conducted in the Gulf Region reported that the overall prevalence of obesity among Bahraini boys and girls between 12 and 17 years of age was high, especially in girls (21% in boys, 35% in girls (Gargari et al., 2004).

Caspersen, quoting Centers for Disease Control and Prevention, 2001andWHO, 2004 stated that physical activity declines progressively from childhood to adolescents and from adolescents to early adulthood. We found low levels of habitual physical activity and high levels of sedentary behavior in participating children at 7 years of age, with declines in physical activity and increases in sedentary behavior by 9 years of age. Recent evidence, based on contemporary samples of children and adolescents that have used accelerometry with evidence-based cut points, (Reilly, Penpraze, Hislop, Davies, Grant, Paton, 2008) suggests that levels of physical activity are typically very low and levels of sedentary behavior very high. In addition, small numbers of longitudinal studies of children with objective measures (Janz , Kwon, Letuchy, 2009 and Reilly, Jackson, Montgomery, 2004) and 1 recent cross-sectional study with objective measures (Nyberg, Nordenfelt, Ekelund, Marcus, 2009) suggested that declines in physical activity may typically occur well before adolescence. Our results, therefore, add to the body of evidence that low levels of physical activity are established early in childhood and decline further during childhood and before adolescence.

The 2-year changes in physical activity and sedentary behavior observed in this study were significant and, although relatively modest in magnitude, are a great cause for concern because of the low level of baseline physical activity and high level of baseline sedentary behavior. In this study, unfavorable changes in physical activity and sedentary behavior occurred in both sexes, but these changes were generally more severe in girls than boys and in those with higher baseline weight status. Identifying factors associated with declines in objectively measured physical activity and with increases in objectively measured sedentary behavior would be useful to inform the development of future public health interventions aimed at modifying these behaviors (Sallis, Alcaraz, McKenzie, Hovell, 1999).

Public health interventions aimed at preventing declines in physical activity should be targeting elementary school–aged children because unfavorable trends in health behaviors seem to be already established before puberty. In Scotland, for example, as in some other countries, public health policy is based on the assumption that physical activity is high during childhood but declines markedly only during adolescence. Prevention of declines in physical activity in adolescent girls is a Scottish public health priority (National Health Service Health; 2010). Tracking of physical activity and sedentary behavior was moderately strong in this study, which is broadly consistent with other recent studies (Kelly, Reilly, Jackson, Montgomery, Grant, Paton, 2007 and Baggett, Stevens, McMurray, 2008) of tracking of physical activity and sedentary behavior measured objectively during childhood. However, even for the most physically active children, levels of objectively measured physical activity at both time points were low.

Prospects of physical conditioning and wellness programme

Fitness programs that are of short duration (14-15 weeks) have demonstrated positive improvements of cardiovascular risk factors. Bjurstrom and Alexion25 studied 847 volunteers in a 15-week fitness program. Subjects participated in aerobic activities for one and one-quarter hours per work day. Statistical analysis of fitness data indicated significant and positive changes in blood cholesterol, body weight. and maximum oxygen uptake (V02max). Similar results were obtained by Pauly et al. who examined subjects that participated three times or more per week in a worksite fitness program. This program lasted 14 weeks, and participants used a self-selected work schedule consisting of an aerobic program. Significant and positive changes were observed in VO_2max, blood cholesterol, and systolic blood pressure. Studies of greater duration have demonstrated that fitness gains persist over longer intervals.

Appraisal of related literature

Whole body vibration have been referred to vibration training, vibration therapy, biomechanical stimulation (BMS), and biomechanical oscillation (BMO) and has been seen as a training method which employs low amplitude, and low frequency mechanical stimulation to exercise musculoskeletal structures for the improvement of muscle strength, power, and flexibility.The use of this training mode as an exercise intervention for health promotion among sedentary adults is increasingly being considered among health professionals because, compared with conventional training methods, itoffers a way of training with practical, physical and psychological advantages.

The ability of body muscles to be used quickly and efficiently, which renders them capable of producing more force and improving blood circulation explains the immediate effect of whole body vibration use.The rapid contraction and relaxation of the muscles at 20 to 50 times per second basically works as a pump on the blood vessels and lymphatic vessels, increasing thespeed of the blood flow through the body (Kerschan-Schindl et al. 2001andLohman et al. 2007).

WBV also ensures that there is only a minimum of loading, that is additional weights are not necessary, which ensures that there is very little loading to passive structures such as bones, ligaments and joints.

For effective resistance training, there need to be a systematic administration of a sufficient stimulus, followed by an adaptation of the individual, and then the introduction of a new, progressively greater stimulus, whether one is training for sports performance or health enhancement. The success of the programme will be attributable to the effectiveness of the exercise prescription in manipulating the progression of the resistance stimulus, the variation in the programme design and the individualization of the programme (Kraemer, 1994). The benefits of activities are well documented and these have both physical and physiological benefits. Participating in physical activities has been linked with several benefits such as reduction in tension, state of anxiety, depression, and mortality rate in both developed and developing environments and enhanced sense of wellness. It is healthier and more profitable for an individual to remain physically active than just to achieve a certain level of fitness and then return to sedentary life style.

CHAPTER THREE

RESEARCH METHODOLOGY

The focus of this study, centered on the effect whole body vibration and resistance training had on obesity, overweight and cardiopulmonary fitness variables of University of Ibadan undergraduates. The methodology adopted was discussed under the following headings:

1. Research Design
2. Population
3. Sample and Sampling Technique
4. Inclusion and exclusion Criteria
5. Research Instruments
6. Validity of the instruments
7. Reliability of the instruments
8. Field testing
9. Ethical consideration
10. Procedure for Data Collection
11. Training procedures
12. Procedure for Data Analysis

Research Design

The randomized pretest posttest control group experimental research design,which adopted the 3x2x2 factorial matrix, was used for this study. The design employed two categories of participants that is, control and treatment; with the control having only one group, while the treatment had two sub groups, all served as the independent variables. It also had two moderating and two dependent variables.

Outline of the design

The design's outline is presented as follows;

Experimental Group 1	-	O_1	X_1	O_4
Experimental Group 2	-	O_2	X_2	O_5
Control Group	-	O_3	-	O_6

Where;

O_{1}- O_{3} - Pre-test measure

O_{4}- O_{6} - Post-test measure

X_{1} - Treatment group 1(Whole Body Vibration)

X_{2} - Treatment group 2(Resistance Training)

Population

The population for this study included all undergraduates of the University of Ibadan. The nation's premier university, University of Ibadan (UI), has a population of 33, 481 students with about 20,000students running different undergraduate courses.

Sample and Sampling Technique

Sixty-five (65) undergraduates of the University of Ibadan indicated their interest byvolunteering to be part of this study.They were recruited purposivelyfrom various faculties of the University. Contacts of persons who showed interest were taken and were followed-up appropriately, such that this group of individuals eventually served as the participantsfor this study. Following the recruitment process which lasted about three weeks, participants arrived at theexercise training venue, the exercise physiology laboratory, where they were randomly assigned into three groups-two treatment and control groups.

Treatment group one was made to go through 12 weeks training sessions involving whole body vibration on a vibration machine, treatment group twoalso went through 12 weeks training sessions involving resistance exercises, while the control group was placed on placebo (that is 20 minutes contact fortnightly on physical fitnesslessons).

These processes led to the posttest measures which took place after the 12 weeks of training.

Inclusion Criteria

The following were included in the study;

- Participants who hadno medical report contra-indicating exercise participation.
- Participants who were apparently sedentary.

- Participants who were not engaged in any exercise programme a week before, during and after the recruitment for this study.

Exclusion Criteria

The following were excluded from the study;

- Participants with resting heart rate above 100 beat per minute
- Participants with blood pressure measures of 140/100 millimeter per mercury
- Asthmatic patients and patients with related history
- Participants with cardiovascular, neuromuscular and other metabolic conditions

Research Instruments

The following research instruments were used for data collection;

1.) Whole Body Vibration Machine: The Galileo™2000 (White Plains, NY.) was used. It was developed to mechanically stimulate muscles at specific frequencies, typically 25-30 Hz, causing the muscles to contract and relax by natural reflex, 25-30 times per second. The Galileo™2000 functioned in a one-directional, oscillating pattern based on the concept of a center fulcrum and alternating up/down motion.

2.) Weighing scale: A Hanson model portable weighing scale made in Ireland was used to measure total body weight in kilograms. The range of graduation is 0-18kg. Weight was recorded to the nearest 0.1kg.

3.) Mercury sphygmomanometer: The free style Accoson Aneroid sphygmomanometer made in England was used to measure blood pressure.

4.) Stethoscope: The Littman's stethoscope manufactured by 3m company U.S.A was used to measure heart rate and blood pressure.

5.) Skinfold caliper: Lange skinfold Caliper/Pat No.3,008,239 made by Cambridge Scientific Industries Cambridge Maryland Incorporated, U.S.A. was used to measure the following body sites; triceps subscapular, abdomen, suprailium and thigh. The Caliper was graduated from 0mm to 67mm, with a constant jaw pressure of 10g/mm.

6.) Stadiometer:was used to measure the height of participants.

7.) Stopwatch: The track star jewels digital stopwatch made in Switzerland was used in timing the participants' heart rate, speed, flight time and other related exercise measurement.

8.) Hand grip dynamometer: Xinjing sports Wolibiao; Serial no: 0574-8137-8898 13004651895xinjingsport@163.com,was used to estimate participants' arm strength.

9.)Computerized Micro Spirometer: It is a battery operated Micro Spirometer manufactured by Micro Medical Ltd; P.O Box 6 Rochester, Kent ME1 2AZ with age and height correction values (B.T.P.S).It is calibrated from 0.10-9.99 litres. It was used to measure both forced vital capacity (FVC) and forced expiratory volume in 1^{st} second (FEV_1).

10.) Mini Wright Peak Flow Meter: This is a product of Clement ClarkeInternational Ltd.15 Wigmore Street, London W1H 9LA, England. It is calibrated from 0-800L/min with a reliability value of 0.91. It was used to measure peak expiratory flow rate (PEFR).

11.)Standard athletics track: A traditional 440-yard 0.25-mile track, in which each straight way and curve is 110 yards long and half of each length is 55- yards.

12.)Multi-gym: A multi-purpose gym with eight stations and a weight-health master 20lbs, made in USA were used for the resistance training session.

Validity of the instruments

Instruments used for the study were standardized with various ranges of validity attached to it, handy and were used in the measurement of anthropometric and cardiopulmonary variables and also, for muscle excitation as has been used in previous study.

Reliability of the instruments

Thedegree of consistency between the sets of scores obtained with the same instrument and the extent to which the results were consistent and accurate for the total population under study were obtainedusing the Cronbach Alpha reliability approach. Therefore, reliability values of selected instruments for the study were as follows: Mini Wright Peak Flow Meter; 0.91, spirometer; 0.98 for both FVC and FEV_1.

Field Testing

The field testing of the instruments was conducted in the Exercise Physiology Laboratory of the Department of Human Kinetics and Health Education, University of Ibadan witha set of ten (10) volunteers from the polytechnic Ibadan. The essence was to allow the researcher familiarize himself with the technicalities of each of the instruments and to ascertain their working condition before embarking on the study.

Procedure for Data Collection

Ethical approval was gotten by researcher from the University of Ibadan Ethical Committee by making copies of the proposal available to them. This process led to the publicity and sensitization of Undergraduates about the research in the selected faculties and then recruitment process followed afterwards. Each recruited participant was made to sign a consent form in order to be part of thestudy, after a thorough explanation its benefits andthe procedures to be followed had been discussedwith them. Data on the obesity, overweight and cardiopulmonary parameters of the participants were collected by researcher and his assistants before (Pre) and after (Post) training programme which lasted for twelve (12) weeks. The American College of Sports Medicine recommendations for cardio/aerobics and strength training was adopted. This recommends that for frequency, healthy adults train two to three times per week while an older adult or sedentary should start with two times per week and choose light intensity exercises. Training sessions should be spread out throughout the week while observing a 48 hour break between sessions. Then for sets and repetitions, eight to 10 different exercises should be adopted. An individual should start by doing eight to 12 repetitions of each exercise to improve strength and power. That in order to improve muscular endurance, increase to 10 to 15 repetitions within a weight that one can reach fatigue within the given repetition range. While choice of exercises should be such that targets all of the major muscle groups. Compound and isolation exercises must be included, but focus most of one's training around compound exercises. It should be noted that isolation exercises are single-joint movements that target only one muscle group. Triceps press downs and biceps curls are isolation exercises. Compound exercises are multi joint movements that work more than one muscle group. Squats, chest presses, overhead presses and dead lifts are compound exercises.

The researcher's team alsoincluded physiotherapists, exercise physiologists and a medical doctor from the University-these experts assisted throughout the training and data collection process. To prevent accident situations during the training, participants were assured that medical assistance had been sought in order to allay their fears. A letter was written to the University of Ibadan medical centre to keep them aware and to seek assistance in case of emergency during the research work. Participants' clinic cards were kept close-by.

Test location: University of Ibadan gymnasium, Stadium and Exercise physiology laboratory

The following data were also collected:

1.) **Gender:** The sex of the participants was recorded

2.) Age: The age as at last birthday was recorded in years.

3.) Height: Participants dressed in light, non-bulky clothing, pull off their shoes and stood on the stadiometer with their back against its upright. Record was taken accordingly.

4.) Weight: Total body weight was measured using a Hanson model portable weighing scale, each participant was made to wear light sport wear without shoes, and arm relaxed by the side, measurement was recorded to the nearest kg, to the preciseness allowed by the weighing scale.

5.) Body Mass Index: The weight (kg) of participants was measured and divided by the square of height measured; outcome then was used to calculate BMI (W/H^2).

6.) Systolic and diastolic blood pressure: The cuff of the sphygmomanometer was wrapped evenly and snugly around the arm of the participants at 2.5cm above the site of brachial pulsation. The pressure at which the first sound (korotkoff) was heard was recorded as the systolic blood pressure. The researcher continued with the deflating of the cuff noting the point when the last sound was heard and was recorded as diastolic blood pressure both in mmHg.

7.) Skinfold (Percent Body Fat): The researcher pinched the right side (for consistency) of the participants' skin at the appropriate site to raise a double layer of skin and the underlying adipose tissue, but not the muscle. The caliper was then applied 1cm below and at right angles to the pinched site and a reading was taken two seconds after and recorded in mm.

8.) Arm strength: The subject held the dynamometer in the hand that was tested, with the arm at right angles and the elbow by the side of the body. The handle of the dynamometer was adjusted while the base rested on first metacarpal (heel of palm) and the handle rested on middle of four fingers. Subject squeezed the dynamometer with maximum isometric effort, which was maintained for about 5 seconds. No other body movement was allowed. The subjects were encouraged to give maximum effort.

9.) PEFR: Subjects were encouraged to blow the sensor as vigorously as possible. The neck wasplaced in a neutral position, not flexed or extended, and the subject did not cough. A nose clip was used. After the point of full lung inflation, the subject delivered the blow without any delay. Hesitating for as little as 2 seconds or flexing the neck allows the tracheal visco-elastic properties to relax and PEFR to drop by as much as 10%. Tonguing, spitting or coughing at the start of the blow must be discouraged.

10.) FVC: The basic forced volume vital capacity (FVC) test varies slightly depending on the equipment used. Participants were asked to take the deepest breath he/she could, and then exhaled into the sensor as hard as possible, for as long as possible, preferably at least 6 seconds. During the test, soft nose clips was used to prevent air escaping through the nose. It was directly followed by a rapid inhalation (inspiration), in particular when assessing possible upper airway obstruction. Filter mouthpieces was used to prevent the spread of microorganisms. The test was preceded by a period of quiet breathing in and out from the sensor (tidal volume).

11.) FEV_1: Participants were asked to take the deepest breath of air he/she could, and then forcibly blow out in one second, after full inspiration.

12.)PeakVO_2:Cooper 12-Minute Run/Walk Test Protocol;

i. Researcher measured the height and weight of each participant who took part in the study and recorded the results on the participant's data sheet. Body mass was measured to the nearest 0.01kg and height to the nearest 0.1cm.
ii. Each participant was made to complete a 5 min general warm-up followed by 5-min of dynamic stretching.
iii. Each participant was informed that the objective of the test was to cover as many distances as possible on the track within the allotted 12min.
iv. Stop watch was then started at the same time that the 12-min run/walk test was initiated.
v. Encouragement was provided to those who took part in the test.
vi. Periodic time check was made and feedback was provided to each participant, such as "5 minutes to go, 1 minute remaining…10 seconds…5 seconds…and stop."
vii. Distance covered was estimated based on the number of laps completed and the spot on the track where each participant stopped. It was recorded on each participant's data sheet.
viii. Participants were allowed adequate time for cool-down consisting of slow walking and stretching.
ix. Their Vo_2Max was calculated and recorded, using the equations provided on each participant's data sheets and below.

TRAINING PROCEDURES

Resistance Training

Week: 1-3

Activity/Mode: Lateral pull, Chest Press, Leg Lift,Biceps Curl,Weight lift, Dip swing and Sit up

Warm-up/ Lead up: 10 minutes

Participants had their warm-up for a period of 10 minutes to condition the body and loosen the muscles for the activities performed. After this process, participants were exposed to the strength training machine (the multi-gym) while researcher performed each of the activity expected of the participants. Researcher placed participants on the strength training machines and instructed them on the procedures they followed.

FREQUENCY: 3days/ week

Participants attended training sessions for a period of three convenient days in a week and were trained in line with recommendations by the (American College of Sports Medicine) ACSM (The American College of Sports Medicine recommends doing 30 minutes of moderately intense cardio five days a week, or 20 minutes of vigorous cardio three days a week).

INTENSITY: 6 kg

This is the amount of load each participant lifted within a spelt out time at these particular weeks. Participants complied as much as possible with allotted time.

REPETITION:10-15

Participants performed each activity for a period of 10-15times repeatedly in this phase without any interruption in the flow and within assigned time.

REST BETWEEN ACTIVITIES: 20 seconds

Participants were allowed a rest period of 20 seconds after each activity. The training process was in work-rest ratio of 1:2, making sure that the muscles were relaxed enough to take up next activity.

SET: 2

Participants were exposed to all these activities twice after a necessary rest interval was observed.

REST BETWEEN SET: 5 minutes

Every participant had a 5-minute rest session after a set was completed before commencing the second set.

Cool down phase: 10 minutes

Participants were exposed to cool down session which lasted for a period of 10 minutes. The essence was to loosen the muscles that were put into use for the training. These were very light exercises of the lowest intensities.

Week: 4-6

Activity/Mode: Lateral pull, Chest Press, Leg Lift,Biceps Curl,Weight lift, Dip swing and Sit up

Warm-up/ Lead up: 10 minutes

Participants had their warm-up for a period of 10 minutes to condition the body and loosen the muscles for the activities performed. After this process, participants were exposed to the strength training machine (the multi-gym) as researcher performed each of the activity expected of the participants. Researcher placed participants on the strength training machine and instructed them on the procedures they followed.

FREQUENCY: 3days/ week

Participants attended training sessions for a period of three convenient days in a week and were trained in line with recommendations by the (American College of Sports Medicine) ACSM.

INTENSITY: 12kg

This was the amount of load which each participant lifted for this stage within spelt out time.

REPETITION:10

Participants performed each activity for a period of 10 times repeatedly in this phase without any interruption in the flow and within assigned time.

REST BETWEEN ACTIVITIES: 30 seconds

Participants was allowed a rest period after each activity. The training process was in work-rest ratio of 1:2, making sure that the muscles were relaxed enough to take up next activity.

SET: 2

Participants were exposed to all these activities twice after a necessary rest interval was observed.

REST BETWEEN SET: 5 minutes

Every participant had a 5-minute rest session after a set was completed before commencing the second set.

Cool down phase: 10 minutes

Participants were exposed to cool down session which lasted for a period of 10 minutes. The essence was to loosen the muscles that were put into use for the training. These were very light exercises of the lowest intensities.

Week: 7-9

Activity/Mode: Lateral pull, Chest Press, Leg Lift,Biceps Curl,Weight lift, Dip swing and Sit up

Warm-up/ Lead up: 10 minutes

Participants had their warm-up for a period of 10 minutes to condition the body and loosen the muscles for the activities performed. After this process, participants were exposed to the strength training machine (the multi-gym) and other activities while researcher performed each of the activity expected of the participants. Researcher placed participants on the strength training machine and instructed them on the procedures they followed.

FREQUENCY: 3days/ week

Participants attended training sessions for a period of three convenient days in a week and were trained in line with recommendations by the (American College of Sports Medicine) ACSM.

INTENSITY: 12kg

This was the amount of load each participant lifted for these weeks.

REPETITION:20

Participants performed each activity for a period of 20 times repeatedly in this phase without any interruption in the flow and within assigned time.

REST BETWEEN ACTIVITIES: 30 seconds

Participants had a rest period after each activity. The training process was in work-rest ratio of 1:2, making sure that the muscles were relaxed enough for next activity.

SET: 2

Participants were exposed to all these activities twice after necessary rest intervals had been observed.

REST BETWEEN SET: 10 minutes

Every participant had a 10-minute rest session after a set was completed before commencing the second set.

Cool down phase: 10 minutes

Participants were exposed to cool down session which lasted for a period of 10 minutes in order to loosen the muscles that were put into use for the training. These were very light exercises of the lowest intensities.

Week: 10-12

Activity/Mode: Lateral pull, Chest Press, Leg Lift,Biceps Curl,Weight lift, Dip swing and Sit up

Warm-up/ Lead up: 10 minutes

Participants had their warm-up for a period of 10 minutes to condition the body and loosen the muscles for the activities performed. After this process, participants were exposed to the strength training machine (the multi-gym) and other activities as researcher performed each of the activity expected of the participants. They were exposed to the activities and given instructions which they followed.

FREQUENCY: 3days/ week

Participants attended training sessions for a period of three convenient days in a week and were trained in line with recommendations by the (American College of Sports Medicine) ACSM.

INTENSITY: 24 kg

This had to do with the amount of load which each participant lifted for these phase. Participants were made to comply as much as possible with allotted time.

REPETITION:15

Participants performed each activity for a period of 15 times repeatedly in this phase without any interruption in the flow and within assigned time.

REST BETWEEN ACTIVITIES: 30 seconds

Participants had a rest period after each activity. The training process was in work-rest ratio of 1:2, making sure that the muscles are relaxed enough to take up next activity.

SET: 2

Participants were exposed to all these activities twice after necessary rest intervals had been observed.

REST BETWEEN SET: 10 minutes

Every participant had a 10-minute rest session after a set was completed before commencing the second set.

Cool down phase: 10 minutes

Participants were exposed to cool down session which lasted for a period of 10 minutes. The essence was to loosen the muscles that were put into use for the training. These were very light exercises of the lowest intensities.

Whole body Vibration Training

Vibration Machine: The Galileo™2000 (White Plains, NY.) was used. It stimulates muscles at specific frequencies, typically 25-30 Hz, causing the muscles to contract and relax by natural reflex, 25-30 times per second and functions in a one-directional, oscillating pattern based on the concept of a center fulcrum and alternating up/down motion.Participants wore no shoes but wore similar cotton socks to avoid the dampening effect of the sole of the shoes

Week: 1-3

Activity/Mode: Standingflat feet, 90^0Squatting, Side stretching, Squatting on the toes, Plate hand placement.

Warm-up/ Lead up: 10 minutes

Participants had their warm up session for 10 minutes to condition the body and loosen the muscles for the activities to be performed. After this, they were placed on the whole body vibration machine in order to start the exercises expected of them.

Frequency: (10**-**15 HZ) this has to do with the force generated by the vibration machines normally,to provide loading on the musculoskeletal system. For the first three weeks, participants were exposed to a frequency of 10-15 hz during training sessions.

Amplitude: (2mm)

This is the amount of movement the machine induces in the muscle. The amplitude of the vibration machine was set at 2 mm i.e. lowest amplitude to cater for the first three weeks and allow inducement in the muscles.

SESSIONS:3 days

Participants attended training sessions for three convenient days in a week and trained in line with required recommendations.

DURATION /ACTIVITY:100 seconds

Each of the activity was performed on the vibration platform for 100 seconds, well supervised by the researcher and his assistants.

SET: 2

Participants were exposed to all these activities twice after the required rest intervals have been observed.

REST BETWEEN SET: 5 minutes

Every participant had a 5-minute rest session after a set was completed, before commencing the second set. Participants who successfully completed the two sets moved on to the cool down activities.

Cool down phase: 10 minutes

Participants were exposed to cool down session which lasted for 10 minutes. This assisted to loosen the muscles that were put into use for the training. They were very light exercises of the lowest intensities, performed with ease.

Week: 4-6

Activity/Mode: Standingflat feet, 90^0Squatting, Side stretching, Squatting on the toes, Plate hand placement.

Warm-up/ Lead up: 10 minutes

Participants had their warm up session for 10 minutes to condition the body and loosen the muscles for the activities to be performed. After this, they were placed on the whole body vibration machine in order to start the exercises expected of them.

Frequency: (20-25 HZ) this has to do with the force generated by the vibration machines normally,to provide loading on the musculoskeletal system. For these phase of three weeks, participants were exposed to a frequency of 20-25 hz during training sessions.

Amplitude: (2mm)

The amplitude of the vibration machine remained at 2 mm for this phase of three weeks for inducement of the muscles.

SESSIONS:3 days

Participants attended training sessions for three convenient days in a week and had their training in line with required recommendations.

DURATION /ACTIVITY:100 seconds

Each of the activity was performed on the vibration platform for 100 seconds, well supervised by the researcher and his assistants.

SET: 2

Participants were also exposed to all these activities twice after necessary rest intervals had been observed.

REST BETWEEN SET: 5 minutes

Every participanthad a 5-minute rest session after a set was completed, before commencing the second set. Participants who successfully completed the two sets moved on to the cool down activities.

Cool down phase: 10 minutes

The cool down session lasted for a period of 10 minutes. The essence was to loosen the muscles that were put into use for the training; adopting very light exercises of the lowest intensities.

Week: 7-9

Activity/Mode: Standingflat feet, 90^0Squatting, Side stretching, Squatting on the toes, Plate hand placement.

Warm-up/ Lead up: 10 minutes

Participants had warm up session for 10 minutes to condition the body and loosen the muscles for the activities performed.

Frequency: (25-30 HZ) Participants were exposed to a frequency of 25-30 hz during this phase of training in the research work.

Amplitude: (4mm)

The amplitude of the vibration machine was increased by 2mm, and set at 4 mm for this phase of three weeks, to allow for more inducement of the muscles.

SESSIONS:3 days

Participants attended three days training sessions for a period of three weeks and were trained in line with required recommendations in the training package.

DURATION /ACTIVITY:100 seconds

Each of the activity was performed on the vibration platform for 100 complete seconds and was supervised by the researcher and his assistants.

SET: 2

Participants were exposed to all these activities twice after necessary rest intervals were observed.

REST BETWEEN SET: 5 minutes

Every participant had a 5-minute rest session after a set was completed, before commencing the second set.

Cool down phase: 10 minutes

The cool down phase lasted for a period of 10 minutes. It involved very light exercises done without much intensity to help relax the body muscles.

Week: 10-12

Activity/Mode: Standingflat feet, 90^0Squatting, Side stretching, Squatting on the toes, Plate hand placement.

Warm-up/ Lead up: 10 minutes

Participants had their warm up session for 10 minutes to condition the body and prepare the muscles for the activities to be performed. After this, participants were placed on the whole body vibration machine in order for them to begin the exercises expected of them.

Frequency: (30-32 HZ) this is the force the vibration machinegeneratedin order to provide loading on the musculoskeletal system. Participants were exposed to a frequency of 30-32 hz during this stage of the training.

Amplitude: (4mm)

The amplitude of the vibration machine was left at 4 mm for the remaining three weeks, to allow for more inducement of the muscles.

SESSIONS:3 days

Participants attended the training sessions for three convenient days a week and were trained in line with required recommendations in the training package.

DURATION /ACTIVITY:100 seconds

Each of the activity was performed on the vibration platform for 100 seconds, well supervised by the researcher and his assistants.

SET: 2

Participants were exposed to vibration training twice after necessary rest intervals were observed.

REST BETWEEN SET: 5 minutes

Every participant had a 5-minute rest session after a set had been completed, before commencing the second set. Participants who successfully completed the two sets moved towards taking the cool down activities.

Cool down phase: 10 minutes

Participants were exposed to cool down session which lasted for 10 minutes. This include very light exercises of the lowest intensity ebb or done without any intensity.

Procedure for Data Analysis

Descriptive statistics of frequencycount and percentage with inferential statistics of Analysis of Co-variance (ANCOVA) was used to analyze the data at 0.05 level of significance.

CHAPTER FOUR

RESULT ANALYSES AND DISCUSSION OF FINDINGS

The study was carried out to determine the effect of whole body vibration and resistance training on obesity, overweight and cardiopulmonary fitness variables of University of Ibadan undergraduates. Data were collected through the pre and post approach and were subjected to analyses with the results presented below;

Presentation of results

DEMOGRAPHIC VARIABLES

Table 4.1: Frequency distribution of participants' stage of development characteristics

Age Brackets	Frequency	Percentage	Valid Percent	Cumulative Percent
(16-24 yrs)	62	95.38	95.38	95.38
(25 yrs and above)	3	4.62	4.62	100.0
Total	65	100.0	100.0	

The table 4.1 above indicates the characteristics of participants' stageof development, having 62 (95.38%) participants within the age bracket of 16-24 years and 3(4.62%) within the age bracket of 25 years and above.

Table 4.2: Frequency distribution of Participants Gender characteristics

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	27	41.5	41.5	41.5
Female	38	58.5	58.5	100.0
Total	65	100.0	100.0	

The table 4.2 above shows the gender characteristics of participants, having 38 (58.5%)participants as females and 27 (41.5%) participants as males. This implies that majority of the participants who took part in the study were females.

Table 4.3: Frequency distribution of Participants' Height characteristics

Height	Frequency	Percentage	Valid Percent	Cumulative Percent
1.5m	5	7.7	7.7	7.7
1.6m	29	44.6	44.6	52.3
1.7m	25	38.5	38.5	90.8
1.8m	5	7.7	7.7	98.5
1.9m	1	1.5	1.5	100.0
Total	65	100.0	100.0	

The table 4.3 above shows the height characteristics of participants which had the height of majority within the bracket of 1.6 (44.6%) and1.7 (38.5%) respectively.

Table 4.4: Frequency distribution of Participants Weight characteristics

Weight	Frequency	Percentage	Valid Percent	Cumulative Percent
45-54kg	24	36.92	36.92	36.92
55-64kg	24	36.92	36.92	73.84
65-74kg	9	13.85	13.85	87.69
75-84kg	4	6.15	6.15	93.84
85-94kg	3	4.62	4.62	98.46
95kg and above	1	1.54	1.54	100.0
Total	65	100.0	100.0	

The table 4.4 above indicates the weight characteristics of participants. Majority of the participants fell within the weight range of 45kg and 64kg respectively.

Table 4.5: Frequency distribution of Participants Waist circumference characteristics

Waist Circumference	Frequency	Percentage	Valid Percent	Cumulative Percent
45-54cm	2	3.07	3.07	3.07
55-64cm	21	32.31	32.31	35.38
65-74cm	27	41.54	41.54	76.92
75-84cm	13	20	20	96.92
85-94cm	1	1.54	1.54	98.46
95 and above	1	1.54	1.54	100.0
Total	65	100.0	100.0	

The table 4.5 above shows the waist circumference characteristics of participants with 27 (41.54%) participants having the largest waist circumference.

Answers to research questions

- What is the obesity and overweight fitness variable status of male participants under study?

Table 4.6: Percent body fat norm values for male obesity and overweight fitness level

AGE CATEGORY	GENDER	NO OF PARTICIPANTS	PERCENT	VALID PERCENT	NORM VALUES	RATING
16-24 YEARS	**MALE**	25	92.59	92.59	**13.6**	**16**
25 AND ABOVE		2	7.41	7.41	**16.4**	**NIL**

The table 4.6 above shows obesity and overweight fitness variable statusof male participants when compared with percent body fat norm values. It was observed that16 (64.0%) out of 25 participants in the lower age category (16-24 years) had adequate fitness variable status at the entry point of the study whereas; all the participants at the upper age category (25 years and above) had inadequate fitness status.

- What is the obesity and overweight fitness variable status of female participants under study?

Table 4.7: Percent body fat norm value for female obesity and overweight fitness status

AGE CATEGORY	GENDER	NO OF PARTICIPANTS	PERCENT	VALID PERCENT	NORM VALUES	RATING
16-24 YEARS	**FEMALE**	37	97.36	97.36	**23.8**	**10**
25 AND ABOVE		1	2.64	2.64	**24.5**	**NIL**

The table 4.7 above shows obesity and overweight fitness variable statusof female participants when compared with percent body fat norm values. It was observed that 10 (27.03%)out of 37 participants within the age bracket 16-24 years had an adequate fitness variable status at the entry point but none had in the age bracket 25 years and above based on the comparism made.

- What is the cardiopulmonary fitness variable performance capacity of male participants under study?

Table 4.8: Peak VO_2normtable valuesfor male cardiopulmonary fitness variable performance capacity

AGE CATEGORY	GENDER	FREQUENCY	PERCENT	VALID PERCENT	NORM VALUES	RATING
16-24 YEARS	**MALE**	25	92.59	92.59	**50.9**	**1**
25 AND ABOVE		2	7.41	7.41	**46.4**	**NIL**

The table 4.8above shows cardiopulmonary fitness variable performance capacityof male participants when compared with peak VO_2norm values. It was observed that only 1 (4.00%)of the participants within the age bracket of 16-24 years had adequate cardiopulmonary fitness performance capacityat the entry point. Similarly, neither of the participants in the age bracket 25 years and above possessed adequate cardiopulmonary fitness performance capacityat the entry point.

- What is the cardiopulmonary fitness variable performance capacity of female participants under study?

Table 4.9: Peak Vo_2 normtable values for female cardiopulmonary fitness variable performance capacity

AGE CATEGORY	GENDER	FREQUENCY	PERCENT	VALID PERCENT	NORM VALUES	RATING
16-24 YEARS	**FEMALE**	37	97.36	97.36	**38.9**	**1**
25 AND ABOVE		1	2.64	2.64	**36.9**	**NIL**

The table 4.9 above shows cardiopulmonary fitness variable performance capacityof female participants when compared with peak VO_2norm value. It was observed that only 1(2.70%) out of the participants within the age bracket of 16-24 years possessed adequate cardiopulmonary fitness performance capacityat the entry point- others did not. Similarly, theparticipant in the age bracket 25 years and above did not possess adequate cardiopulmonary fitness performance capacityat the entry point.

Hypotheses Testing

Ho 1a(i): There will be no significant main effect of treatments on arm strength of University of Ibadan undergraduates

Table 5.4: ANCOVA showing the significant main effect of treatments on arm strength of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	10388.416	3	3462.805	55.666	.000	.732
Pretest	7225.342	1	7225.342	116.151	.000	.656
Treatment groups	4218.584	2	2109.292	33.908	.000	.526
Residual	3794.599	61	62.207			
Total	14183.015	64				

In table 5.4 above, it was observed that there was significant main effectof treatments on the arm strength of University of Ibadan undergraduates ($F_{(3,61)}$ = 33.908, $p<.05$, η^2=.526). Null hypothesis was therefore rejected.

Table 5.5: Estimated Meanvalues from the analysis of significant main effect of treatments on arm strengthof University of Ibadan undergraduates.

Treatment	Mean	Std. Error
Whole Body Vibration	52.711	1.777
Resistance Training	46.205	1.549
Control	32.234	1.813

Table 5.5 above shows the estimated mean values from the analysis of significant main effect of treatments on the arm strength of University of Ibadan undergraduates. Treatment had more effect on participants in the whole body vibration group than on those in the resistance training and control groups respectively.

Post Hoc Tests/Arm Strength

Scheffe

(i)TREATMENT GROUPS	(J)TREATMENT GROUPS	Mean Difference(I-J)	Std. Error	Sig.
WHOLE BODY VIBRATION	RESISTANCE TRAINING	3.2346	3.9653	.718
	CONTROL	16.8763*	4.2710	.001
RESISTANCE TRAINING	WHOLE BODY VIBRATION	-3.2346	3.9653	.718
	CONTROL	13.6417	4.0238	.005
CONTROL	WHOLE BODY VIBRATION	-16.8763*	4.2710	.001
	RESISTANCE TRAINING	-13.6417	4.0238	.005

It is evident from the result of the post-hoc analysis that the direction of significance was between whole body vibration and control (p= .001) and between resistance training and control (p= .005) respectively.

Ho 1a(ii): There will be no significant main effect of treatment on body mass index of University of Ibadan undergraduates.

Table 5.6: ANCOVA showing the significant main effect of treatment on body mass index of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	503.590	3	167.863	44.117	.000	.685
Pretest	299.969	1	299.969	78.837	.000	.564
Treatment groups	215.519	2	107.759	28.321	.000	.481
Residual	232.102	61	3.805			
Total	735.693	64				

In table 5.6above, it was observed that there was significant main effect of treatments on the body mass index of University of Ibadan undergraduates ($F_{(3,61)}$ = 28.321, p<.05, η^2=.481). Null hypothesis was therefore rejected.

Table 5.7: Estimated meanvalues from the analysis of significant main effect of treatments on body mass index of University of Ibadan undergraduates

Treatment	Mean	Std. Error
Whole Body Vibration	23.015	.437
Resistance Training	25.233	.383
Control	27.719	.448

Table 5.7 above shows the estimated meanvalues from the analysis of significant main effect of treatments on the body mass index of University of Ibadan undergraduates. Whole body vibration had a better effect on participants' body mass index than resistance training. This shows that whole body vibration was a better training option in eliciting needed benefits on the body composition parameter.

Post Hoc Tests/Bmi

Scheffe

(i)TREATMENT GROUPS	(J)TREATMENT GROUPS	Mean Difference(I-J)	Std. Error	Sig.
WHOLE BODY VIBRATION	RESISTANCE TRAINING	-1.8260	.8713	.120
	CONTROL	-4.54502*	.9385	.000
RESISTANCE TRAINING	WHOLE BODY VIBRATION	1.8260	.8713	.120
	CONTROL	-2.7189*	.8842	.012
CONTROL	WHOLE BODY VIBRATION	4.5450*	.9385	.000
	RESISTANCE TRAINING	2.7189*	.8842	.012

It is evident from the result of the post-hoc analysis in this table that the direction of significance was between whole body vibration and control (p= .000) and between resistance training and control (p= .012) respectively.

Ho 1a(iii): There will be no significant main effect of treatments on lean body weight of University of Ibadan undergraduates.

Table 5.8: ANCOVA showing the significant main effect of treatments on lean body weight of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5708.996[a]	3	1902.999	479.915	.000	.959
Pretest	5193.579	1	5193.579	1309.762	.000	.955
Treatment groups	96.995	2	48.498	12.231	.000	.286
Residual	241.882	61	3.965			
Total	5950.878	64				

In table 5.8above, it was observed that there was significant main effect of treatment on lean body weight of University of Ibadan undergraduates ($F_{(3,61)}$ = 12.231, $p<.05$, η^2=.286). Null hypothesis was therefore rejected.

Table 5.9: Estimated Meanvalues of significant main effect of treatments on lean body weight of University of Ibadan undergraduates

Treatment	Mean	Std. Error
Whole Body Vibration	48.951	.449
Resistance Training	48.041	.391
Control	45.844	.460

Table 5.9 above shows the estimated mean values from the analysis of significant main effect of treatments on the lean body weight of University of Ibadan undergraduates. Whole body vibration group had a better treatment effect on participants than resistance training; which implies that whole body vibration was better at improving lean body characteristics of participants than resistance training.

Ho 1a(iv): There will be no significant main effect of treatment on percent body fat (%BF) of University of Ibadan undergraduates.

Table 6.0: ANCOVA showing the significant main effect of treatments on percent body fat (%BF) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5355.094	3	1785.031	333.884	.000	.943
Pretest	5068.005	1	5068.005	947.953	.000	.940
Treatment groups	100.126	2	50.063	9.364	.000	.235
Residual	326.122	61	5.346			
Total	5681.216	64				

In table 6.0 above, it was observed that there was significant main effects of treatment on the percent body fat (%BF) of University of Ibadan undergraduates($F_{(3,61)}$ = 9.364, $p<.05$, η^2=.235). Null hypothesis was therefore rejected.

Table 6.1: Estimated mean values of significant main effect of treatments on percent body fat of University of Ibadan undergraduates

Treatment	Mean	Std. Error
Whole Body Vibration	19.421	.518
Resistance Training	21.378	.458
Control	22.583	.534

Table 6.1 above shows the estimated mean values from the analysis of significantmain effect of treatments on percent body fat of University of Ibadan undergraduates. Participants in the resistant training group had a higher mean value than those in whole body vibration group from this analysis. This shows that resistance training remains a technique to reckon with in the area of training especially on improving body percent fats.

Ho 1b(i): There will be no significant main effect of treatment on peak expiratory flow of University of Ibadan undergraduates.

Table 6.2: ANCOVA showing the significant main effect of treatment on peak expiratory flow of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	75.434	3	25.145	28.031	.000	.580
Pretest	2.629	1	2.629	2.931	.092	.046
Treatment groups	75.201	2	37.601	41.918	.000	.579
Residual	54.718	61	.897			
Total	130.151	64				

In table 6.2 above, it was observed that there was significant main effect of treatments on the peak expiratory flow of University of Ibadan undergraduates ($F_{(3,61)} = 41.918$, $p<.05$, $\eta^2=.579$). Null hypothesis was rejected.

Table 6.3: Estimated mean values of significant min effect of treatment on peak expiratory flow of University of Ibadan undergraduates

Treatment	Mean	Std. Error
Whole Body Vibration	6.053	.219
Resistance Training	5.652	.188
Control	3.467	.218

Table 6.3 above shows the estimated mean values from the analysis of significantmain effect of treatment on peak expiratory flowof University of Ibadan undergraduates. Whole body vibration participants had a higher mean value than participants in the resistance training group and then followed by the control. The implication is that whole body vibration tends to provide a better effect in lung functions than does resistance training.

Post Hoc Tests/PEF

Scheffe

(i)TREATMENT GROUPS	(J)TREATMENT GROUPS	Mean Difference(I-J)	Std. Error	Sig.
WHOLE BODY VIBRATION	RESISTANCE TRAINING	.2535	.2860	.677
	CONTROL	2.4586*	.3081	.000
RESISTANCE TRAINING	WHOLE BODY VIBRATION	-2535	.2860	.677
	CONTROL	2.2050*	.2903	.000
CONTROL	WHOLE BODY VIBRATION	-2.4586*	.3081	.000
	RESISTANCE TRAINING	-2.2050*	.2903	.000

It is evident from the result of the post-hoc analysis that the direction of significance was between whole body vibration and control (p= .000) and between resistance training and control (p= .000) respectively.

Ho 1b(ii): There will be no significant main effect of treatment on forced vital capacity of University of Ibadan undergraduates.

Table 6.4: ANCOVA showing the significant main effect of treatment on forced vital capacity of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	15.572	3	5.191	22.441	.000	.525
Pretest	4.042E-02	1	4.042E-02	.175	.677	.003
Treatment groups	15.247	2	7.624	32.960	.000	.519
Residual	14.109	61	.231			
Total	29.681	64				

In table 6.4 above, it was observed that there was significant main effect of treatments on forced vital capacity of University of Ibadan undergraduates($F_{(3,61)}$ = 32.960, $p<.05$, η^2=.519). Null hypothesis was therefore rejected.

Table 6.5: Estimated mean values of significant main effect of treatments on forced vital capacityof University of Ibadan undergraduates

Treatment	Mean	Std. Error
Whole Body Vibration	3.491	.110
Resistance Training	3.748	.095
Control	2.593	.111

Table 6.5 above shows the estimated mean values from the analysis of significantmain effect of treatment on forced vital capacityof University of Ibadan undergraduates. Resistance training participants had a higher mean value than those in the whole body vibration group. This indicates that resistance training was more potent in eliciting required response from participants than whole body vibration technique.

Post Hoc Tests/ FVC

Scheffe

(i)TREATMENT GROUPS	(J)TREATMENT GROUPS	Mean Difference(I-J)	Std. Error	Sig.
WHOLE BODY VIBRATION	RESISTANCE TRAINING	-.2428	.1421	.240
	CONTROL	.9142*	.1530	.000
RESISTANCE TRAINING	WHOLE BODY VIBRATION	.2428	.1421	.240
	CONTROL	1.1570*	.1442	.000
CONTROL	WHOLE BODY VIBRATION	-.9142*	.1530	.000
	RESISTANCE TRAINING	-1.1570*	.1442	.000

It is evident from the result of the post-hoc analysis in this table that the direction of significance was between whole body vibration and control (p= .000) and between resistance training and control (p= .000) respectively.

Ho 1b(iii): There will be no significant main effect of treatment on forced expiratory volume in Ist second ($FEV._{1)}$of University of Ibadan undergraduates.

Table 6.6: ANCOVA showing the significant main effect of treatments on forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates.

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	61.265	3	20.422	1.549	.211	.071
Pretest	.973	1	.973	.074	.787	.001
Treatment groups	61.265	2	30.632	2.323	.107	.071
Residual	804.429	61	13.187			
Total	865.694	64				

In table6.6above, it was observed that there was no significant main effect of treatments onforced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates($F_{(3,61)}$ = 2.323, p>.05, η^2=.071). Null hypothesis was therefore accepted.

Table 6.7: Estimated means of significant main effect of treatments on forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates.

Treatment	Mean	Std. Error
Whole Body Vibration	3.345	.821
Resistance Training	4.611	.720
Control	2.249	.833

Table 6.7 above shows the estimated mean values from the analysis of significant main effect of treatment on the forced expiratory volume in Ist second of University of Ibadan undergraduates. Treatment had more effect on participants in the resistance training group than on those in the whole body vibration group followed by the control group.

Ho 1b(iv): There will be no significant main effect of treatment on resting heart rate of University of Ibadan undergraduates.

Table 6.8: ANCOVA showing the significant main effect of treatment on resting heart rate of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	6785.042	3	2261.681	53.993	.000	.726
Pretest	5808.813	1	5808.813	138.675	.000	.695
Treatment groups	289.129	2	144.564	3.451	.038	.102
Residual	2555.174	61	41.888			
Total	9340.215	64				

In table 6.8 above, it was observed that there was significant main effect of treatments on the resting heart rate of University of Ibadan undergraduates ($F_{(3,61)} = 3.451$, $p<.05$, $\eta^2=.102$). Null hypothesis was therefore rejected.

Table 6.9: Estimated mean values of significant main effect of treatment on resting heart rate of University of Ibadan undergraduates

Treatment	Mean	Std. Error
Whole Body Vibration	82.739	1.460
Resistance Training	77.643	1.279
Control	79.237	1.485

Table 6.9 above shows the estimated mean values from the analysis of significant main effect of treatment on the resting heart rate of University of Ibadan undergraduates. Treatment had a higher effect on participants in whole body vibration group, followed by participants in the resistance training category. This implies that whole body vibration had a greater ability in improving resting heart rate parameter than resistance training technique on adolescents.

Post Hoc Tests/RHR

Scheffe

(i)TREATMENT GROUPS	(J)TREATMENT GROUPS	Mean Difference(I-J)	Std. Error	Sig.
WHOLE BODY VIBRATION	RESISTANCE TRAINING	9.2808	3.4545	.033
	CONTROL	5.6816	3.7209	.318
RESISTANCE TRAINING	WHOLE BODY VIBRATION	-9.2808	3.4545	.033
	CONTROL	-3.5992	3.5055	.593
CONTROL	WHOLE BODY VIBRATION	-5.6818	3.7209	.318
	RESISTANCE TRAINING	3.5992	3.5055	.593

It is evident from the result of the post-hoc analysis in this table that the direction of significance was between whole body vibration and resistance training (p= .033).

Ho 1b(v): There will be no significant main effect of treatment on systolicblood pressure of University of Ibadan undergraduates.

Table 7.0:ANCOVA showing the significant main effect of treatment on systolic blood pressure of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5134.364	3	1711.455	26.707	.000	.568
Pretest	4652.073	1	4652.073	72.594	.000	.543
Treatment groups	1027.891	2	513.946	64.083	.001	.208
Residual	3909.082	61	64.083			
Total	9043.446	64				

In table 7.0above, it was observed that there was significant main effect of treatments on the systolic blood pressure of University of Ibadan undergraduates($F_{(3,61)}$ = 64.083, $p<.05$, η^2=.208). Null hypothesis was therefore rejected.

Table 7.1: Estimated mean values of significant main effect of treatment systolic blood pressureof University of Ibadan students

Treatment	Mean	Std. Error
Whole Body Vibration	99.691	1.808
Resistance Training	108.934	1.596
Control	107.627	1.841

Table 7.1 above shows the estimated mean values from the analysis of significant main effect treatments onsystolic blood pressure of University of Ibadan undergraduates. Resistance training had a higher mean value in this analysis over whole body vibration, an implication that whole body vibration may have had an effect on the variable of analysis; resistance training had a better input and was potent in bringing about needed improvement.

Ho 1b(vi): There will be no significant main effect of treatment on diastolic blood pressure of University of Ibadan undergraduates.

Table 7.2: ANCOVA showing the significant main effect of treatment on diastolic blood pressure of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	2280.771	3	760.257	14.891	.000	.423
Pretest	2024.754	1	2024.754	39.658	.000	.394
Treatment groups	319.034	2	159.517	3.124	.051	.093
Residual	3114.368	61	51.055			
Total	5395.138	64				

In table 7.2 above, it was observed that there was significant main effects of treatment on the diastolic blood pressure of University of Ibadan undergraduates ($F_{(3,61)}$ = 3.124, $p<.05$, η^2=.093). Null hypothesis was therefore rejected.

Table 7.3: Estimated mean values from the analysis of significant main effect of treatments on diastolic blood pressure of University of Ibadan undergraduates.

Treatment	Mean	Std. Error
Whole Body Vibration	69.305	1.609
Resistance Training	73.859	1.427
Control	74.451	1.648

Table 7.3 above shows the estimated mean values from the analysis of significant main effect treatments on the diastolic blood pressure of University of Ibadan undergraduates. Estimated mean value of resistance training was higher in this analysis than that of the whole body vibration. This suggests that resistance training technique was a better option in eliciting required response from participants than whole body vibration.

Ho 1b(vii): There will be no significant main effect of treatment on peak$VO_2$of University of Ibadan undergraduates.

Table 7.4:ANCOVA showing the significant main effect of treatment on peak VO_2 of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5778.170	3	1926.057	28.071	.000	.580
Pretest	2595.769	1	2595.769	37.832	.000	.383
Treatment groups	3458.232	2	1729.116	25.201	.000	.452
Residual	4185.371	61	68.613			
Total	9963.541	64				

In table 7.4 above, it was observed that there was a significant main effect of treatment on the peak $VO_2$of University of Ibadan undergraduates. ($F_{(3,61)}$ = 25.201, $p<.05$, η^2=.452). Null hypothesis was therefore rejected.

Table 7.5: Estimated mean values of significant main effect of treatment on peak VO_2 of University of Ibadan undergraduates.

Treatment	Mean	Std. Error
Whole Body Vibration	41.367	1.863
Resistance Training	36.476	1.630
Control	23.179	1.901

Table 7.5 above showed the estimated mean values from the analysis of significant main effect of treatment on the peak $VO_2$of University of Ibadan undergraduates. Whole body vibration had a higher effect on participants, given the higher estimated mean value recorded as against resistance training. This is an implication that whole body vibration was a better technique at improving the function ability of any given adolescent.

Post Hoc Tests/Peak Vo_2

Scheffe

(i)TREATMENT GROUPS	(J)TREATMENT GROUPS	Mean Difference(I-J)	Std. Error	Sig.
WHOLE BODY VIBRATION	RESISTANCE TRAINING	2.8183	3.1105	.665
	CONTROL	16.7587*	3.3504	.000
RESISTANCE TRAINING	WHOLE BODY VIBRATION	-2.8183	3.1105	.665
	CONTROL	13.9404*	3.1564	.000
CONTROL	WHOLE BODY VIBRATION	-16.7587*	3.3504	.000
	RESISTANCE TRAINING	-13.9404*	3.1564	.000

It is evident from the result of the post-hoc analysis that the direction of significance was between whole body vibration and control (p= .000) and between resistance training and control (p= .000) respectively.

Ho 2a(i): There will be no significant main effect of gender on arm strength of University of Ibadan undergraduates.

Table 8.2: ANCOVA showing the significant main effect of gender on arm strength of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	8628.411	2	4214.205	48.155	.000	.608
Pretest	1443.088	1	1443.088	16.108	.000	.206
Gender	2458.578	1	2458.578	27.442	.000	.307
Residual	5554.605	62	89.590			
Total	14183.015	64				

In table 8.2 above, it was observed that there was significant main effects of gender on thearm strength of University of Ibadan undergraduates ($F_{(2,62)}$ = .000, p<.05, η^2=.307). Null hypothesis was therefore rejected.

Table 8.3: Estimated Marginal Means of effects of gender on the Arm Strength of University of Ibadan undergraduates.

Gender	Mean	Std. Error
Male	53.166	2.088
Female	38.094	1.644

Table 8.3 above shows the Estimated Marginal Means from the analysis of the effects of gender on the Arm Strength of University of Ibadan undergraduates. Treatment had more effect on male gender than on their counterparts.

Ho 2a(ii): There will be no significant main effect of gender on Body mass index of University of Ibadan undergraduates.

Table 8.4: ANCOVA showing the significant main effect of gender on Body mass index of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	311.452	2	155.726	22.758	.000	.423
Pretest	183.716	1	183.716	26.849	.000	.302
Gender	23.380	1	23.380	3.417	.069	.052
Residual	424.241	62	6.843			
Total	735.693	64				

In table 8.4above, it was observed that there was no significant main effects of gender on the Body mass index of University of Ibadan undergraduates ($F_{(2,62)}$ = .3.417, p>.05, η^2=.052). Null hypothesis was therefore accepted.

Table 8.5: Estimated Marginal Means of effects of gender on the Body mass index of University of Ibadan undergraduates.

Gender	Mean	Std. Error
Male	24.474	.542
Female	25.813	.435

Table 8.5 above shows the Estimated Marginal Means from the analysis of the effects of Gender on the Body mass index of University of Ibadan undergraduates. Treatment had a better effect on the body mass index of male participants.

Ho 2a(iii): There will be no significant main effect of gender on Lean Body Weight (LBW) of University of Ibadan undergraduates.

Table 8.6: ANCOVA showing the significant main effect of gender on Lean Body Weight (LBW) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5612.120	2	2806.060	513.569	.000	.943
Pretest	3466.281	1	3466.281	634.404	.000	.911
Gender	.119	1	.119	.022	.883	.000
Residual	338.758	62	5.464			
Total	5950.878	64				

In table 8.6above, it was observed that there was no significant main effects of gender on the Lean Body Weight (LBW) of University of Ibadan undergraduates ($F_{(2,62)}$ = .022, $p>.05$, η^2=.000). Null hypothesis was therefore accepted.

Table 8.7: Estimated Marginal Means of effects of gender on the Lean Body Weight (LBW) of University of Ibadan undergraduates.

Gender	Mean	Std. Error
Male	47.745	.535
Female	47.634	.417

Table 8.7 above shows the Estimated Marginal Means from the analysis of the effects of gender on the Lean Body Weight (LBW) of University of Ibadan undergraduates. Male gender had a higher estimated mean than female gender.

Ho 2a(iv): There will be no significant main effect of gender on Percent Body Fat (%BF) of University of Ibadan undergraduates.

Table 8.8: ANCOVA showing the significant main effect of gender on Percent Body Fat (%BF) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5255.132	2	2627.566	382.340	.000	.925
Pretest	3319.312	1	3319.312	482.997	.000	.886
Gender	.164	1	.164	.024	.878	.000
Residual	426.084	62	6.872			
Total	5681.216	64				

In table 8.8 above, it was observed that there was no significant main effects of gender on the Percent Body Fat (%BF)of University of Ibadan undergraduates($F_{(2,62)}$ = .024, p>.05, η^2=.000). Null hypothesis was therefore accepted.

Table 8.9:Estimated Marginal Means of effects of gender on the Percent Body Fat (%BF) of University of Ibadan undergraduates.

Gender	Mean	Std. Error
Male	21.051	.596
Female	21.179	.465

Table 8.9above shows the Estimated Marginal Means from the analysis of the effects of gender on the Percent Body Fat (%BF) of University of Ibadan undergraduates. There was slight difference in the estimated marginal mean value of both genders.

Ho 2b(i): There will be no significant main effect of gender on peak expiratory flow (PEF)of University of Ibadan undergraduates.

Table 9.0: ANCOVA showing the significant main effect of gender on peak expiratory flow (PEF) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	2.443	2	1.222	.593	.556	.019
Pretest	.242	1	.242	.117	.733	.002
Gender	2.211	1	2.211	1.073	.304	.017
Residual	127.708	62	2.060			
Total	130.151	64				

In table 9.0 above, it was observed that there wasno significant main effects of gender on the peak expiratory flow(PEF)of University of Ibadan undergraduates ($F_{(2,62)}$ = 1.073, $p>.05$, η^2=.017). Null hypothesis was accepted.

Table 9.1: Estimated Marginal Means of effects of gender on the peak expiratory flow (PEF) of University of Ibadan undergraduates

Gender	Mean	Std. Error
Male	5.363	.281
Female	4.986	.230

Table 9.1 above shows the Estimated Marginal Means from the analysis of the effects of gender on the peak expiratory flow (PEF)of University of Ibadan undergraduates. Effect of treatment was higher on male participants than on female participants.

Ho 2b(ii): There will be no significant main effect of gender on Forced Vital Capacity (FVC) of University of Ibadan undergraduates.

Table 9.2: ANCOVA showing the significant main effect of gender on Forced Vital Capacity (FVC) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	19.164[a]	2	9.582	63.443	.000	.672
Pretest	14.701	1	14.701	97.337	.000	.611
Gender	4.818E-03	1	4.818E-03	.032	.859	.001
Residual	9.364	62	.151			
Total	28.528	64				

In table 9.2above, it was observed that there wasno significant main effects of gender on the Forced Vital Capacity (FVC) of University of Ibadan undergraduates ($F_{(2,62)}$ = .032, p>.05, η^2=.001). Null hypothesis was therefore accepted.

Table 9.3: Estimated Marginal Means of effects of gender on the Forced Vital Capacity (FVC) of University of Ibadan undergraduates

Gender	Mean	Std. Error
Male	2.852	.083
Female	2.873	.066

Table 9.3above shows the Estimated Marginal Means from the analysis of the effects of gender on the Forced Vital Capacity (FVC) of University of Ibadan undergraduates. Treatment had a better effect on female adolescent participants than their male counterparts from the estimated marginal mean value.

Ho 2b(iii): There will be no significant main effect of gender on forced expiratory volume in Ist second ($FEV._{1)}$of University of Ibadan undergraduates.

Table 9.4: ANCOVA showing the significant main effect of gender on forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	4.221	2	2.111	.152	.859	.005
Pretest	.438	1	.438	.032	.860	.001
Gender	4.221	1	4.221	.304	.583	.005
Residual	861.472	62	13.895			
Total	865.694	64				

In table 9.4 above, it was observed that there were significant main effects of gender on theforced expiratory volume in Ist second ($FEV._{1)}$of University of Ibadan undergraduates($F_{(2,62)}$ = .304, $p>.05$, η^2=.005). Null hypothesis was therefore accepted.

Table 9.5: Estimated Marginal Means of effects of gender on the forced expiratory volume in Ist second ($FEV_{.1)}$ of University of Ibadan undergraduates.

Gender	Mean	Std. Error
Male	3.201	.756
Female	3.751	.611

Table 9.5 above shows the Estimated Marginal Means from the analysis of the effects of gender on the forced expiratory volume in Ist second ($FEV_{.1)}$ of University of Ibadan undergraduates. Female gender had a higher estimated marginal mean value than male counterparts.

Ho 2b(iv): There will be no significant main effect of gender on Resting heart rate (RHR)of University of Ibadan undergraduates.

Table 9.6: ANCOVA showing the significant main effect of gender on Resting heart rate (RHR) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	6566.263	2	3283.131	73.381	.000	.703
Pretest	6237.637	1	6237.637	139.416	.000	.692
Gender	70.350	1	70.350	1.572	.215	.025
Residual	2773.953	62	44.741			
Total	9340.215	64				

In table 9.6above, it was observed that there were significant main effects of gender on theResting heart rate (RHR)gof University of Ibadan undergraduates($F_{(2,62)}$ = 1.572, $p<.05$, η^2=.025). Null hypothesis was therefore rejected.

Table 9.7: Estimated Marginal Means of effects of gender on the Resting heart rate (RHR) of University of Ibadan undergraduates

Gender	Mean	Std. Error
Male	81.023	1.357
Female	78.779	1.096

Table 9.7 above shows the Estimated Marginal Means from the analysis of the effects of gender on the Resting heart rate (RHR)of University of Ibadan undergraduates. The estimated marginal mean value for male participants was higher in this analysis.

Ho 2b(v): There will be no significant main effect of gender on Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates.

Table 9.8: ANCOVA showing the significant main effect of gender on Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	4248.850	2	2124.425	27.471	.000	.470
Pretest	3625.648	1	3625.648	46.884	.000	.431
Gender	142.378	1	142.378	1.841	.180	.029
Residual	4794.596	62	77.332			
Total	9043.446	64				

In table 9.8 above, it was observed that there wasno significant main effects of gender on the Systolic Blood Pressure (SYST B.P)of University of Ibadan undergraduates($F_{(2,62)}$ = 1.841, $p>.05$, η^2=.029). Null hypothesis was therefore accepted.

Table 9.9: Estimated Marginal Means of effects of gender on the Systolic Blood Pressure (SYST B.P) variable of University of Ibadan undergraduates

Gender	Mean	Std. Error
Male	107.561	1.748
Female	104.472	1.421

Table 9.9 above shows the Estimated Marginal Means from the analysis of the effects of gender on the Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates. Male gender had a higher estimated marginal mean value than their female counterpart

Ho 2b(vi): There will be no significant main effect of gender on Diastolic Blood Pressure (DIAST B.P) of University of Ibadan undergraduates.

Table 10.0: ANCOVA showing the significant main effect of gender on Diastolic Blood Pressure (DIAST B.P) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	2026.015	2	1013.007	18.642	.000	.376
Pretest	1930.504	1	1930.504	35.526	.000	.364
Gender	64.278	1	64.278	1.183	.281	.019
Residual	3369.124	62	54.341			
Total	5395.138	64				

In table 10.0 above, it was observed that there wasno significant main effects of gender on the Diastolic Blood Pressure (DIAST B.P)of University of Ibadan undergraduates($F_{(2,62)} = 1.183$, $p>.05$, $\eta^2=.019$). Null hypothesis was therefore accepted.

Table 10.1: Estimated Marginal Means of effects of gender on the Diastolic Blood Pressure (DIAST B.P) of University of Ibadan undergraduates

Gender	Mean	Std. Error
Male	73.850	1.446
Female	71.818	1.181

Table 10.1 above shows the Estimated Marginal Means from the analysis of the effects of gender on the Diastolic Blood Pressure (DIAST B.P)of University of Ibadan undergraduates. Male gender had a higher estimated marginal mean than their female counterparts.

Ho 2b(vii): There will be no significant main effect of gender on PEAK $VO_2$of University of Ibadan undergraduates.

Table 10.2: ANCOVA showing the significant main effect of gender on PEAK VO_2 of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	4033.574	2	2016.787	21.086	.000	.405
Pretest	416.882	1	416.882	4.359	.041	.066
Gender	1713.635	1	1713.635	17.917	.000	.224
Residual	5929.967	62	95.645			
Total	9963.541	64				

In table 10.2above, it was observed that there were significant main effects of gender on the PEAK $VO_2$of University of Ibadan undergraduates($F_{(2,62)}$ = 17.917, p<.05, η^2=.224). Null hypothesis was therefore rejected.

Table 10.3: Estimated Marginal Means of significant main effects of gender on the PEAK VO_2 of University of Ibadan undergraduates

Gender	Mean	Std. Error
Male	41.398	2.109
Female	29.225	1.672

Table 10.3 above shows the Estimated Marginal Means from the analysis of the effects of gender on the PEAK VO_2 of University of Ibadan undergraduates. Treatment effect was higher among male participants than females, given the higher estimated marginal mean value recorded for the males.

Ho 3a(i): There will be no significant main effect of Stage of Development on Arm Strength of University of Ibadan undergraduates.

Table 11.0: ANCOVA showing the significant main effect of Stage of Development on Arm Strength of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	6173.218	2	3086.609	23.892	.000	.435
Pretest	5774.283	1	5774.283	44.696	.000	.419
Stage of Development	3.385	1	3.385	.026	.872	.000
Residual	8009.797	62	129.190			
Total	14183.015	64				

In table 11.0 above, it was observed that there was no significant main effects of Stage of Development on the Arm Strength of University of Ibadan undergraduates ($F_{(2,62)}$ = .026, $p>.05$, η^2=..000). Null hypothesis was therefore accepted.

Table 11.1: Estimated Marginal Means of significant main effects of Stage of Development on Arm Strength of University of Ibadan undergraduates

Stage of Development	Mean	Std. Error
16-24 years	43.695	2.998
25 and above	44.252	1.618

Table 11.1 above shows the Estimated Marginal Means from the analysis of the effects of Stage of Development on the Arm Strengthof University of Ibadan undergraduates. Treatment had a better effect on young adult participants as indicated from the result.

Ho 3a(ii): There will be no significant main effect of Stage of Development on Body mass index of University of Ibadan undergraduates.

Table 11.2: ANCOVA showing the significant main effect of Stage of Development on Body mass index of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	323.414	2	161.707	24.318	.000	.440
Pretest	309.846	1	309.846	46.596	.000	.429
Stage of Development	35.343	1	35.343	5.315	.025	.079
Residual	412.278	62	6.650			
Total	735.693	64				

In table 11.2 above, it was observed that there was significant main effects of Stage of Development on the Body mass index of University of Ibadan undergraduates ($F_{(2,62)}$ = 5.315, $p<.05$, η^2=..079). Null hypothesis was therefore rejected.

Table 11.3: Estimated Marginal Means of significant main effects of Stage of Development on Body mass index of University of Ibadan undergraduates

Stage of Development	Mean	Std. Error
16-24 years	23.919	.670
25 and above	25.685	.365

Table 11.3 above shows the Estimated Marginal Means from the analysis of the effects of Stage of Development on the Body mass index of University of Ibadan undergraduates. Treatment had more effect on adolescent participants than on their young adult counterparts.

Ho 3a(iii): There will be no significant main effect of Stage of Developmenton Lean Body Weight (LBW)of University of Ibadan undergraduates.

Table 11.4: ANCOVA showing the significant main effect of Stage of Development on Lean Body Weight (LBW) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5613.346	2	2806.673	515.547	.000	.943
Pretest	5412.487	1	5412.487	994.198	.000	.941
Stage of Adolescent	1.345	1	1.345	.247	.621	.004
Residual	337.532	62	5.444			
Total	5950.878	64				

In table 11.4 above, it was observed that there was no significant main effects of Stage of Development on the Lean Body Weight (LBW) of University of Ibadan undergraduates($F_{(2,62)}$ = .247, p>.05, η^2=..004). Null hypothesis was therefore accepted.

Table 11.5: Estimated Marginal Means of significant main effects of Stage of Development on Lean Body Weight (LBW) of University of Ibadan undergraduates

Stage of Development	Mean	Std. Error
16-24 years	47.412	.610
25 and above	47.759	.331

Table 11.5 above shows the Estimated Marginal Means from the analysis of the effects of Stage of Development on the Lean Body Weight (LBW) of University of Ibadan undergraduates. Young Adults participants from this analysis have a higher estimated marginal mean.

Ho 3a(iv): There will be no significant main effect of Stage of Developmenton Percent Body Fat (%BF) of University of Ibadan undergraduates.

Table 11.6: ANCOVA showing the significant main effect of Stage of Developmenton Percent Body Fat (%BF) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5255.550	2	2627.775	382.747	.000	.925
Pretest	5215.898	1	5215.898	759.718	.000	.925
Stage of Adolescent	.583	1	.583	.085	.772	.001
Residual	425.665	62	6.866			
Total	5681.216	64				

In table 11.6 above, it was observed that there was no significant main effects of Stage of Development on the Percent Body Fat (%BF) of University of Ibadan undergraduates ($F_{(2,62)}$ = .085, p>.05, η^2=..001). Null hypothesis was therefore accepted.

Table 11.7: Estimated Marginal Means of significant main effects of Stage of Development on Percent Body Fat (%BF) of University of Ibadan undergraduates

Stage of Development	Mean	Std. Error
16-24 years	20.954	.679
25 and above	21.180	.371

Table 11.7 above shows the Estimated Marginal Means from the analysis of the effects of Stage of Development on the Percent Body Fat (%BF) of University of Ibadan undergraduates. Participants within the young adult category had a higher estimated marginal mean than those in the adolescentcategory.

Ho 3b(i): There will be no significant main effect of stage of developmenton peak expiratory flow (PEF)of University of Ibadan undergraduates.

Table 11.8: ANCOVA showing the significant main effect of stage of Development on peak expiratory flow (PEF) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	1.491	2	.745	.359	.700	.011
Pretest	8.053E-02	1	8.053E-02	.039	.844	.001
Stage of Development	1.258	1	1.258	.606	.439	.010
Residual	128.661	62	2.075			
Total	130.151	64				

In table 11.8above, it was observed that there was no significant main effects of Stage of Development on the peak expiratory flow (PEF)of University of Ibadan undergraduates ($F_{(2,62)}$ = .606, p>.05, η^2=..010). Null hypothesis was therefore accepted.

Table 11.9: Estimated Marginal Means of significant main effects of Stage of Development on peak expiratory flow (PEF) of University of Ibadan undergraduates

Stage of Development	Mean	Std. Error
16-24 years	4.879	.376
25 and above	5.214	.204

Table 11.9 above shows the Estimated Marginal Means from the analysis of the effects of Stage of Development on the peak expiratory flow (PEF) of University of Ibadan undergraduates. Young adultparticipants had a better estimated marginal mean value than their adolescent counterparts.

Ho 3b(ii): There will be no significant main effect of stage of development on FVC of University of Ibadan undergraduates.

Table 12.0: ANCOVA showing the significant main effect of stage of development on forced vital capacity (FVC)of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	.395	2	.198	.419	.660	.013
Pretest	.269	1	.269	.570	.453	.009
Stage of Development	7.113E-02	1	7.113E-02	.151	.699	.002
Residual	29.285	62	.472			
Total	29.681	64				

In table 12.0 above, it was observed that there were no significant main effects ofstage of developmenton the forcedvitalcapacity(FVC)of University of Ibadan undergraduates ($F_{(2,62)}$ = .151, p>.05, η^2=..002). Null hypothesis was therefore accepted.

Table 12.1: Estimated Marginal Means of significant main effects of stage of development on forced vital capacity (FVC) of University of Ibadan undergraduates

Stage of Development	Mean	Std. Error
16-24 years	3.392	.179
25 and above	3.313	.097

Table 12.1above showed the Estimated Marginal Means from the analysis of the effects of stage of developmenton the forced vital capacity(FVC)of University of Ibadan undergraduates. Treatment effect was higher among adolescent participants than their young Adults' counterparts.

Ho 3b(iii): There will be no significant main effect of Stage of Developmenton forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates.

Table 12.2: ANCOVA showing the significant main effect of Stage of Development on forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	3.432	2	1.716	.123	.884	.004
Pretest	.124	1	.124	.009	.925	.000
Stage of Development	3.432	1	3.432	.247	.621	.004
Residual	862.262	62	13.907			
Total	865.694	64				

In table 12.2 above, it was observed that there was no significant main effects of Stage of Development on the forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates($F_{(2,62)}$ = .247, p>.05, η^2=..004). Null hypothesis was therefore accepted.

Table 12.3: Estimated Marginal Means of significant main effects of Stage of Development on forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates

Stage of Development	Mean	Std. Error
16-24 years	3.104	.976
25 and above	3.659	.530

Table 12.3 above shows the Estimated Marginal Means from the analysis of the effects of Stage of Development on the forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates. Young Adultparticipants from this analysis had a higher estimated mean value than their adolescent counterparts.

Ho 3b(iv): There will be no significant main effect of Stage of Development on Resting heart rate (RHR)of University of Ibadan undergraduates.

Table 12.4: ANCOVA showing the significant main effect of Stage of Development on Resting heart rate (RHR) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	6501.032	2	3250.516	70.982	.000	.696
Pretest	6125.270	1	6125.270	133.759	.000	.683
Stage of Development	5.119	1	5.119	.112	.739	.002
Residual	2839.183	62	45.793			
Total	9340.215	64				

In table 12.4above, it was observed that there was no significant main effects of Stage of Development on the Resting heart rate (RHR)of University of Ibadan undergraduates ($F_{(2,62)}$ = .112, p>.05, η^2=..002). Null hypothesis was therefore accepted.

Table 12.5: Estimated Marginal Means of significant main effects of Stage of Development on Resting heart rate (RHR) of University of Ibadan undergraduates

Stage of Development	Mean	Std. Error
16-24 years	79.145	1.798
25 and above	79.836	.965

Table 12.5 above shows the Estimated Marginal Means from the analysis of the effects of Stage of Developmenton the Resting heart rate (RHR)of University of Ibadan undergraduates. Young Adult participants had an improved estimated marginal mean value than their adolescent counterparts.

Ho 3b(v): There will be no significant main effect of Stageof Developmenton Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates.

Table 12.6: ANCOVA showing the significant main effect of Stage of Development on Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	4286.509	2	2143.254	27.934	.000	.474
Pretest	4194.316	1	4194.316	54.667	.000	.469
Stageof Development	180.036	1	180.036	2.347	.131	.036
Residual	4756.938	62	76.725			
Total	9043.446	64				

In table 12.6 above, it was observed that there was no significant main effects of Stageof Development on the Systolic Blood Pressure (SYST B.P)of University of Ibadan undergraduates($F_{(2,62)}$ = 2.347, p>.05, η^2=..036). Null hypothesis was therefore accepted.

Table 12.7: Estimated Marginal Means of significant main effects of Stage of Development on Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates

Stageof Development	Mean	Std. Error
16-24 years	102.664	2.265
25 and above	106.621	1.239

Table 12.7 above shows the Estimated Marginal Means from the analysis of the effects of Stageof Development on the Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates. The estimated marginal mean value of Young Adultsparticipants was seen to be higher than that of their adolescent counterparts.

Ho 3b(vi): There will be no significant main effect of Stage of Developmenton Diastolic Blood Pressure (DIAST B.P)of University of Ibadan undergraduates.

Table 12.8: ANCOVA showing the significant main effect of Stage of Development on Diastolic Blood Pressure (DIAST B.P) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	1965.295	2	982.648	17.763	.000	.364
Pretest	1957.410	1	1957.410	35.383	.000	.363
Stage of Development	3.559	1	3.559	.064	.801	.001
Residual	3429.843	62	55.320			
Total	5395.138	64				

In table 12.8above, it was observed that there was no significant main effects of Stage of Development on the Diastolic Blood Pressure (DIAST B.P)of University of Ibadan undergraduates($F_{(2,62)}$ = .064, p>.05, η^2=..001). Null hypothesis was therefore accepted.

Table 12.9: Estimated Marginal Means of significant main effects of Stage of Development on Diastolic Blood Pressure (DIAST B.P) of University of Ibadan undergraduates

Stage of Development	Mean	Std. Error
16-24 years	72.201	1.929
25 and above	72.760	1.053

Table 12.9 above shows the Estimated Marginal Means from the analysis of the effects of Stage of Development on the Diastolic Blood Pressure (DIAST B.P) of University of Ibadan undergraduates. Slight difference occurred between the estimated mean of both adolescents and young adultparticipants from this analysis.

Ho 3b(vii): There will be no significant main effect of Stage of Development on PEAK $VO_2$of University of Ibadan undergraduates.

Table 13.0: ANCOVA showing the significant main effect of Stage of Development on PEAK VO_2 of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	2329.328	2	1164.664	9.459	.000	.234
Pretest	2285.506	1	2285.506	18.561	.000	.230
Stage of Development	9.389	1	9.389	.076	.783	.001
Residual	7634.213	62	123.132			
Total	9963.541	64				

In table 13.0above, it was observed that there was no significant main effects of Stage of Development on the PEAK $VO_2$of University of Ibadan undergraduates ($F_{(2,62)}$ = .076, p>.05, η^2=..001). Null hypothesis was therefore accepted.

Table 13.1: Estimated Marginal Means of significant main effects of Stage of Development on PEAK VO_2 of University of Ibadan undergraduates

Stage of Development	Mean	Std. Error
16-24 years	34.802	2.911
25 and above	33.882	1.577

Table 13.1 above showed the Estimated Marginal Means from the analysis of the effects of Stage of Development on the PEAK $VO_2$of University of Ibadan undergraduates. The estimated mean value of the adolescent category was higher than that of their counterparts in the young adult category.

Ho 4a(i): There will be no significant interaction effects of treatment and gender on Arm Strength of University of Ibadan undergraduates.

Table 13.8: ANCOVA showing the significant interaction effects of treatment and gender on Arm Strength of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	12097.016	6	2016.169	56.058	.000	.853
Pretest	2175.043	1	2175.043	60.476	.000	.510
Main Effects:						
Treatment groups	3432.864	2	1716.432	47.724	.000	.622
Gender	1052.748	1	1052.748	29.271	.000	.335
Interaction Effects:						
Treatment groups x	.491.670	2	245.835	6.835	.002	.191
Gender	2085.999	58	35.966			
Residual	14183.015	64				
Total						

In table 13.8 above, it was observed that there was significant interaction effect of treatments on the Arm Strength of University of Ibadan undergraduates ($F_{(6,58)}$ = 6.835, p<.05, η^2=.191). Null hypothesis was therefore rejected.

Table 13.9: Estimated Marginal Means of significant interaction effect of treatment and gender on Arm Strength of University of Ibadan undergraduates

Treatment	Gender	Mean	Std. Error
Whole Body Vibration	Male	60.962	2.153
	Female	45.944	1.830
Resistant Training	Male	53.751	1.830
	Female	39.245	1.770
Control	Male	33.629	2.769
	Female	32.277	1.606

Table 13.9 above shows the Estimated Marginal Means from the analysis of the interaction effects of treatment and gender on the Arm Strength of University of Ibadan undergraduates. Effects of treatment were greater on male participants in the two treatment groups then followed by females in the resistant training group.

Ho 4a(ii): There will be no significant interaction effects of treatment and gender on Body mass index of University of Ibadan undergraduates.

Table 14.0: ANCOVA showing the significant interaction effects of treatment and gender on Body mass index of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	513.840	6	85.640	22.389	.000	.698
Pretest	208.042	1	208.042	54.390	.000	.484
Main Effects:						
Treatment groups	187.846	2	93.923	24.555	.000	.458
Gender	7.659	1	7.659	2.002	.162	.033
Interaction Effects:						
Treatment groups x	1.682	2	.841	.220	.803	.008
Gender	221.853	58	3.825			
Residual	735.693	64				
Total						

In table 14.0 above, it was observed that there was no significant interaction effect of treatments andgender on the Body mass index of University of Ibadan undergraduates ($F_{(6,58)}$ = .220, p>.05, η^2=.008). Null hypothesis was therefore accepted.

Table 14.1: Estimated Marginal Means of significant interaction effect of treatments and gender on Body mass index of University of Ibadan undergraduates

Treatment	Gender	Mean	Std. Error
Whole Body Vibration	Male	22.309	.707
	Female	23.514	.582
Resistant Training	Male	24.777	.560
	Female	25.658	.550
Control	Male	27.497	.880
	Female	27.803	.524

Table 14.1 above shows the Estimated Marginal Means from the analysis of the interaction effect of treatments and gender on the Body mass index of University of Ibadan undergraduates. Male participants in the whole body vibration had a better estimated marginal mean followed by their female counterparts.

Ho 4a(iii): There will be no significant interaction effect of treatments and gender on Lean Body Weight (LBW)of University of Ibadan undergraduates.

Table 14.2: ANCOVA showing the significant interaction effect of treatments and gender on Lean Body Weight (LBW) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5713.456	6	952.243	232.624	.000	.960
Pretest	2897.657	1	2897.657	707.870	.000	.924
Main Effects:						
Treatment groups	68.387	2	34.193	8.353	.001	.224
Gender	6.306E-03	1	6.306E-03	.002	.969	.000
Interaction Effects:						
Treatment groups x	4.422	2	2.211	.540	.586	.018
Gender	237.422	58	4.093			
Residual	5950.878	64				
Total						

In table 14.2 above, it was observed that there was no significant interaction effects of treatment on the Lean Body Weight (LBW) of University of Ibadan undergraduates ($F_{(6,58)}$ = .540, p>.05, η^2=.018). Null hypothesis was therefore accepted.

Table 14.3: Estimated Marginal Means of significant interaction effect of treatments and gender on Lean Body Weight (LBW) of University of Ibadan undergraduates

Treatment	Gender	Mean	Std. Error
Whole Body Vibration	Male	48.824	.871
	Female	49.018	.615
Resistant Training	Male	47.770	.583
	Female	48.315	.589
Control	Male	46.458	.915
	Female	45.638	.561

Table 14.3 above shows the Estimated Marginal Means of the interaction effect of treatments and gender on Lean Body Weight (LBW) of University of Ibadan undergraduates. The effect of treatment and gender was more prominent among female whole body vibration participants.

Ho 4a(iv): There will be no significant interaction effect of treatments and gender on Percent Body Fat (%BF) of University of Ibadan undergraduates.

Table 14.4: ANCOVA showing the significant interaction effects of treatment and gender on Percent Body Fat (%BF) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5359.391	6	893.232	160.981	.000	.943
Pretest	3165.896	1	3165.896	570.566	.000	.908
Main Effects:						
Treatment groups	77.397	2	38.698	6.974	.002	.194
Gender	.287	1	.287	.052	.821	.001
Interaction Effects:						
Treatment groups x	4.043	2	2.021	.364	.696	.012
Gender	321.824	58	5.549			
Residual	5681.216	64				
Total						

In table 14.4above, it was observed that there was no significant interaction effect of treatments on the Percent Body Fat (%BF)of University of Ibadan undergraduates ($F_{(6,58)}$ = .364, p>.05, η^2=.012). Null hypothesis was therefore accepted.

Table 14.5: Estimated Marginal Means of significant interaction effects of treatment and gender on pre-test posttest Percent Body Fat (%BF) of University of Ibadan undergraduates

Treatment	Gender	Mean	Std. Error
Whole Body Vibration	Male Female	19.845 19.118	.894 .733
Resistant Training	Male Female	21.629 21.184	.737 .677
Control	Male Female	22.075 22.729	1.055 .641

Table 14.5 above shows the Estimated Marginal Means from the analysis of the significant interaction effect of treatments and gender on the Percent Body Fat (%BF)of University of Ibadan undergraduates. Male and female participants in the resistant training group had an improved estimated marginal mean value than their counterparts in the other treatment group.

Ho 4b(i): There will be no significant interaction effects of treatment and gender on peak expiratory flow (PEF)of University of Ibadan undergraduates.

Table 14.6: ANCOVA showing the significant interaction effects of treatment and gender on peak expiratory flow (PEF) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	77.314	6	12.886	14.145	.000	.594
Pretest	3.155	1	3.155	3.463	.068	.056
<u>Main Effects:</u>						
Treatment groups	68.795	2	34.397	37.758	.000	.566
Gender	1.576E-	1	1.576E-04	.000	.990	.000
<u>Interaction Effects:</u>	04					
Treatment groups x		2	.938	1.030	.363	.034
Gender	1.877	58	.911			
Residual	52.838	64				
Total	130.151					

In table 14.6 above, it was observed that there were significant interaction effect of treatments on the peak expiratory flow (PEF)of University of Ibadan undergraduates($F_{(6,58)}$ = 1.030, p>.05, η^2=.034). Null hypothesis was therefore accepted.

Table 14.7: Estimated Marginal Means of significant interaction effect of treatments and gender on peak expiratory flow (PEF) of University of Ibadan undergraduates

Treatment	Gender	Mean	Std. Error
Whole Body Vibration	Male Female	6.374 5.857	.350 .278
Resistant Training	Male Female	5.579 5.714	.269 .265
Control	Male Female	3.189 3.561	.427 .256

Table 14.7 above shows the Estimated Marginal Means of the significant interaction effect of treatments and gender on the peak expiratory flow (PEF)of University of Ibadan undergraduates. There was a better treatment effect on male and female whole body vibration participants than there was on participants in the resistant training group.

Ho 4b(ii): There will be no significant interaction effect of treatments and gender on FVC of University of Ibadan undergraduates.

Table 14.8: ANCOVA showing the significant interaction effect of treatments and gender on forced vital capacity (FVC) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	16.733	6	2.789	12.492	.000	.564
Pretest	.223	1	.223	1.001	.321	.017
Main Effects:						
Treatment groups	9.646	2	4.823	21.605	.000	.427
Gender	.383	1	.383	1.714	.196	.029
Interaction Effects:						
Treatment groups x	.949	2	.474	2.125	.129	.068
Gender	12.948	58	.223			
Residual	29.681	64				
Total						

In table 14.8above, it was observed that there were significant interaction effects of treatments on the forced vital capacity **(**FVC)of University of Ibadan undergraduates. ($F_{(6,58)}$ = 2.125, p>.05, η^2=.068). Null hypothesis was accepted.

Table 14.9: Estimated Marginal Means of significant interaction effect of treatments and gender on FVC of University of Ibadan undergraduates

Treatment	Gender	Mean	Std. Error
Whole Body Vibration	Male	3.397	.168
	Female	3.527	.140
Resistant Training	Male	3.802	.133
	Female	3.704	.131
Control	Male	3.005	.222
	Female	2.457	.126

Table 14.9 above shows the Estimated Marginal Means from the analysis of the interaction effect of treatments and gender on the forced vital capacity(FVC)of University of Ibadan undergraduates. Estimated marginal mean of male resistant training participants were seen to be higher followed by that of the female resistant training group.

Ho 4b(iii): There will be no significant interaction effect of treatments and gender on forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates.

Table 15.0: ANCOVA showing the significant interaction effect of treatments and gender on forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	96.129	6	16.022	1.208	.316	.111
Pretest	9.309E-03	1	9.309E-03	.001	.979	.000
<u>Main Effects:</u>						
Treatment groups	48.205	2	24.102	1.817	.172	.059
Gender	5.003	1	5.003	.377	.542	.006
<u>Interaction Effects:</u>						
Treatment groups x	23.215	2	11.608	.875	.422	.029
Gender	769.564	58	13.268			
Residual	865.694	64				
Total						

In table 15.0above, it was observed that there were significant interaction effects of treatment and gender on the pre-post forced expiratory volume in Ist second ($FEV._{1)}$of University of Ibadan undergraduates ($F_{(6,58)}$ = .875, p>.05, η^2=.029). Null hypothesis was therefore accepted.

Table 15.1:Estimated Marginal Means of significant interaction effect of treatments and gender on forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates

Treatment	Gender	Mean	Std. Error
Whole Body Vibration	Male	3.303	1.293
	Female	3.423	1.061
Resistant Training	Male	3.433	1.048
	Female	5.739	1.011
Control	Male	2.642	1.708
	Female	2.113	.995

Table 15.1 above shows the Estimated Marginal Means from the analysis of the significant interaction effect of treatments and gender on the forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates. Female resistant training participants had the highest estimated marginal mean value from the result of this analysis.

Ho 4b(iv): There will be no significant interaction effect of treatments and gender on Resting heart rate (RHR) of University of Ibadan undergraduates.

Table 15.2: ANCOVA showing the significant interaction effect of treatments and gender on Resting heart rate (RHR)of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	7364.391	6	1227.399	36.030	.000	.788
Pretest	6029.994	1	6029.994	177.010	.000	.753
Main Effects:						
Treatment groups	392.366	2	196.183	5.759	.005	.166
Gender	101.617	1	101.617	2.983	.089	.049
Interaction Effects:						
Treatment groups x	505.482	2	252.741	7.419	.001	.204
Gender	1975.824	58	34.066			
Residual	9340.215	64				
Total						

In table 15.2 above, it was observed that there was significant interaction effect of treatments on the Resting heart rate (RHR)of University of Ibadan undergraduates($F_{(6,58)}$ = 7.419, $p<.05$, η^2=.204). Null hypothesis was therefore rejected.

Table 15.3: Estimated Marginal Means of significant interaction effect of treatments and gender on Resting heart rate (RHR) of University of Ibadan undergraduates

Treatment	Gender	Mean	Std. Error
Whole Body Vibration	Male	89.234	2.100
	Female	77.946	1.782
Resistant Training	Male	77.421	1.665
	Female	78.256	1.621
Control	Male	77.653	2.610
	Female	79.784	1.560

Table 15.3 above shows the Estimated Marginal Means of the significant interaction effect of treatments and gender on the Resting heart rate (RHR)of University of Ibadan undergraduates. Estimated marginal mean for male whole body vibration was well improved followed by female resistant training participants and then female whole body vibration participants.

Ho 4b(v): There will be no significant interaction effect of treatments and gender on Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates.

Table 15.4: ANCOVA showing the significant interaction effect of treatments and gender on Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5296.950	6	882.825	13.667	.000	.586
Pretest	4001.229	1	4001.229	61.944	.000	.516
Main Effects:						
Treatment groups	898.770	2	449.385	6.957	.002	.193
Gender	101.916	1	101.916	1.578	.214	.026
Interaction Effects:						
Treatment groups x	61.108	2	30.554	.473	.626	.016
Gender	3746.496	58	64.595			
Residual	9043.446	64				
Total						

In table 15.4above, it was observed that there were significant interaction effect of treatments on the Systolic Blood Pressure (SYST B.P)of University of Ibadan undergraduates ($F_{(6,58)}$ = .473, p>.05, η^2=.016). Null hypothesis was therefore accepted.

Table 15.5: Estimated Marginal Means of significant interaction effect of treatments and gender on Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates

Treatment	Gender	Mean	Std. Error
Whole Body Vibration	Male	102.988	2.846
	Female	97.537	2.346
Resistant Training	Male	109.233	2.232
	Female	108.574	2.342
Control	Male	109.262	3.707
	Female	107.060	2.153

Table 15.5 above shows the Estimated Marginal Means of the significant interaction effect of treatments and gender on the Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates. The effect of treatment on gender was seen to be higher between male and female resistant training participants, then followed by male whole body vibration participants.

Ho 4b(vi): There will be no significant interaction effect of treatments and gender on Diastolic Blood Pressure (DIAST B.P) of University of Ibadan undergraduates.

Table 15.6: ANCOVA showing the significant interaction effect of treatments and gender on Diastolic Blood Pressure (DIAST B.P) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	2412.983	6	402.164	7.822	.000	.447
Pretest	1969.011	1	1969.011	38.295	.000	.398
Main Effects:						
Treatment groups	257.389	2	128.694	2.503	.091	.079
Gender	71.917	1	71.917	1.399	.242	.024
Interaction Effects:						
Treatment groups x	59.676	2	28.838	.563	.563	.020
Gender	2982.156	58	51.416			
Residual	5395.138	64				
Total						

In table 15.6 above, it was observed that there were significant interaction effect of treatments on the Diastolic Blood Pressure (DIAST B.P)of University of Ibadan undergraduates ($F_{(6,58)}$ = .563, p>.05, η^2=.020). Null hypothesis was therefore accepted.

Table 15.7: Estimated Marginal Means of significant interaction effect of treatments and gender on Diastolic Blood Pressure (DIAST B.P) of University of Ibadan undergraduates

Treatment	Gender	Mean	Std. Error
Whole Body Vibration	Male	102.988	2.542
	Female	97.537	2.119
Resistant Training	Male	109.233	1.990
	Female	108.574	2.050
Control	Male	109.262	3.286
	Female	107.060	1.916

Table 15.8 above shows the Estimated Marginal Means of the significant interaction effect of treatments and gender on the Diastolic Blood Pressure (DIAST B.P)of University of Ibadan undergraduates. Male and female adolescent participants in the resistant training group had a higher estimated marginal mean value than their counterparts in the other treatment group respectively.

Ho 4b(vii): There will be no significant interaction effect of treatments and gender on PEAK VO_2 of University of Ibadan undergraduates.

Table 15.9: ANCOVA showing the significant interaction effect of treatments and gender on PEAK VO_2 of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	7476.678	6	1246.113	29.063	.000	.750
Pretest	822.633	1	822.633	19.186	.000	.249
Main Effects:						
Treatment groups	3343.051	2	1671.525	38.984	.000	.573
Gender	703.174	1	703.174	16.400	.000	.220
Interaction Effects:						
Treatment groups x	796.220	2	398.110	9.285	.000	.243
Gender	2486.863	58	42.877			
Residual	9963.541	64				
Total						

In table 15.9 above, it was observed that there were significant interaction effect of treatments on the PEAK VO_2 ($F_{(6,58)}$ = 9.285, p<.05, η^2=.243). Null hypothesis was therefore rejected.

Table 16.0: Estimated Marginal Means of significant interaction effect of treatments and gender on PEAK VO_2 of University of Ibadan undergraduates

Treatment	Gender	Mean	Std. Error
Whole Body Vibration	Male	51.474	2.345
	Female	33.917	1.972
Resistant Training	Male	41.184	1.934
	Female	32.333	1.863
Control	Male	21.776	3.029
	Female	23.765	1.766

Table 16.0 above shows the Estimated Marginal Means of the significant interaction effect of treatments and gender on the PEAK $VO_2$of University of Ibadan undergraduates. Treatment effect was higher first among male whole body vibration participants, male resistant training participants and then followed by female whole body vibration participants.

Ho 5a(i): There will be no significant interaction effect of treatments and stage of developmenton Arm Strength of University of Ibadan undergraduates.

Table 16.7: ANCOVA showing the significant interaction effect of treatments and stage of development on Arm Strength of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	10508.560	6	1751.427	27.646	.000	.741
Pretest	6193.344	1	6193.344	97.760	.000	.628
<u>Main Effects:</u>						
Treatment groups	2759.043	2	1379.521	21.775	.000	.429
Stage of development	26.603	1	26.603	.420	.520	.007
<u>Interaction Effects:</u>						
Treatment groups x	77.957	2	38.978	.615	.544	.021
Stage of development	3674.445	58	63.353			
Residual	14183.015	64				
Total						

In table 16.7 above, it was observed that there was no significant interaction effect of treatments and stage ofdevelopment on the Arm Strength of University of Ibadan undergraduates ($F_{(6,58)}$ = .615, p>.05, η^2=.021). Null hypothesis was therefore accepted.

Table 16.8: Estimated Marginal Means of significant interaction effect of treatments and stage of development on Arm Strength of University of Ibadanundergraduates

Treatment	Stage of development	Mean	Std. Error
Whole Body Vibration	16-24 years 25 and above	49.655 54.300	3.129 2.210
Resistant Training	16-24 years 25 and above	44.544 46.524	4.011 1.697
Control	16-24 years 25 and above	33.692 31.870	4.037 2.083

Table 16.8 above shows the Estimated Marginal Means of significant interaction effect of treatments and stage ofdevelopment on the Arm Strength of University of Ibadan undergraduates. It was observed that treatment had the greatest effect on young adult participants in the whole body vibration group then followed by the adolescent participants in same group and on young adult participants in the resistant training group.

Ho5a(ii): There will be no significant interaction effect of treatments and stageof developmenton Body mass index of University of Ibadan undergraduates.

Table 16.9: ANCOVA showing the significant interaction effect of treatments and stage of development on Body mass index of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	526.878[a]	6	87.813	24.391	.000	.716
Pretest	293.823	1	293.823	81.612	.000	.585
Main Effects:						
Treatment groups	134.167	2	67.084	18.633	.000	.391
Stageof development	18.296	1	18.296	5.082	.028	.081
Interaction Effects:						
Treatment groups x	5.485	2	2.742	.762	.471	.026
Stageof development	208.814	58	3.600			
Residual	735.693	64				
Total						

In table 16.9 above, it was observed that there was no significant interaction effect of treatments and stageof development on the Body mass index of University of Ibadan undergraduates($F_{(6,58)}$ = .762, p>.05, η^2=.026). Null hypothesis was therefore accepted.

Table 17.0: Estimated Marginal Means of significant interaction effect of treatments and stage of development on Body mass index of University of Ibadan undergraduates

Treatment	Stageof development	Mean	Std. Error
Whole Body Vibration	16-24 years 25 and above	22.237 23.426	.738 .529
Resistant Training	16-24 years 25 and above	24.856 25.307	.950 .405
Control	16-24 years 25 and above	25.922 28.197	.949 .490

Table 17.0 above shows the Estimated Marginal Means of significant interaction effect of treatments and stageof development on the Body mass index of University of Ibadan students. Treatment was most effective on adolescent category in the whole body vibration group.

Ho 5a(iii): There will be no significant interaction effect of treatments and stage of developmenton Lean Body Weight (LBW) of University of Ibadan undergraduates.

Table 17.1: ANCOVA showing the significant interaction effect of treatments and stage of developmenton Lean Body Weight (LBW) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5719.633	6	953.272	239.095	.000	.961
Pretest	4798.146	1	4798.146	1203.449	.000	.954
Main Effects:						
Treatment groups	79.721	2	39.860	9.998	.000	.256
Stage of development	4.995	1	4.995	1.253	.268	.021
Interaction Effects:						
Treatment groups x	4.788	2	2.394	.600	.552	.020
Stage of development	231.246	58	3.987			
Residual	5950.878	64				
Total						

In table 17.1above, it was observed that there was no significant interaction effect of treatments and stage of development on the Lean Body Weight (LBW) variable of

University of Ibadan undergraduates($F_{(6,58)}$ = .600, p>.05, η^2=.020). Null hypothesis was accepted.

Table 17.2: Estimated Marginal Means of significant interaction effect of treatments and stage of development on Lean Body Weight (LBW) of University of Ibadan undergraduates

Treatment	Stage of development	Mean	Std. Error
Whole Body Vibration	16-24 years 25 and above	48.097 49.445	.759 .571
Resistant Training	16-24 years 25 and above	48.213 48.007	1.000 .426
Control	16-24 years 25 and above	45.086 46.021	1.005 .517

Table 17.2 above shows the Estimated Marginal Means of significant interaction effect of treatments and stage of development on the Lean Body Weight (LBW) of University of Ibadan undergraduates. Young adult participants in the whole body vibration group had the highest estimated mean value from this analysis.

Ho5a(iv): There will be no significant interaction effect of treatments and stage of developmenton Percent Body Fat (%BF)of University of Ibadan undergraduates.

Table 17.3: ANCOVA showing the significant interaction effect of treatments and stage of developmenton Percent Body Fat (%BF) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5356.762	6	892.794	159.598	.000	.943
Pretest	4910.002	1	4910.002	877.722	.000	.938
Main Effects:						
Treatment groups	73.910	2	36.955	6.606	.003	.186
Stage of Development	.394	1	.394	.070	.729	.001
Interaction Effects:						
Treatment groups x Stage	1.061	2	.530	.095	.910	.003
of Development	324.454	58	5.594			
Residual	5681.216	64				
Total						

In table 17.3 above, it was observed that there was no significant interaction effect of treatments and stage of development on the Percent Body Fat (%BF)of University of

Ibadan undergraduates ($F_{(6,58)}$ = .095, p>.05, η^2=.003). Null hypothesis was therefore accepted.

Table 17.4: Estimated Marginal Means of significant interaction effect of treatments and stage of developmenton Percent Body Fat (%BF) of University of Ibadan undergraduates.

Treatment	Stageof Development	Mean	Std. Error
Whole Body Vibration	16-24 years	19.819	.905
	25 and above	19.210	.657
Resistant Training	16-24 years	21.311	1.187
	25 and above	21.383	.508
Control	16-24 years	22.617	1.184
	25 and above	22.581	.614

Table 17.4 above shows the Estimated Marginal Means of significant interaction effect of treatments and stage of development on the Percent Body Fat (%BF)of University of Ibadan undergraduates. Treatment had more effect on both adolescent and young adult participants in the resistant group as against participants in the whole body vibration group.

Ho 5b(i): There will be no significant interaction effect of treatments and stage of development on peak expiratory flow (PEF)of University of Ibadan undergraduates.

Table 17.5: ANCOVA showing the significant interaction effect of treatments and stage of development on peak expiratory flow (PEF) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	81.889	6	13.648	16.402	.000	.629
Pretest	1.811	1	1.811	2.177	.146	.036
Main Effects:						
Treatment groups	50.328	2	25.164	30.241	.000	.510
Stage of	1.339	1	1.339	1.609	.210	.027
Development**Interaction**						
Effects:	4.309	2	2.155	2.589	.084	.082
Treatment groups x Stage	48.262	58	.832			
of Development	130.151	64				
Residual						
Total						

In table 17.5above, it was observed that there were no significant interaction effects of treatment and stage of developmenton the peak expiratory flow (PEF)of University of Ibadan undergraduates($F_{(6,58)}$ = 2.589, p>.05, η^2=.082). Null hypothesis was therefore accepted.

Table 17.6: Estimated Marginal Means of significant interaction effect of treatments and stage of developmenton peak expiratory flow (PEF) of University of Ibadan undergraduates

Treatment	Stage of development	Mean	Std. Error
Whole Body Vibration	16-24 years 25 and above	5.271 6.450	.354 .256
Resistant Training	16-24 years 25 and above	5.847 5.627	.457 .197
Control	16-24 years 25 and above	3.390 3.494	.457 .237

Table 17.6above shows the Estimated Marginal Means of significant interaction effects of treatment and stage of development on the peak expiratory flow (PEF)of University of Ibadan undergraduates. The interaction effect of treatment was higher on young adultparticipants in the whole body vibration group.

Ho 5b(ii): There will be no significant interaction effect of treatments and stage of developmenton forced vital capacityFVC of University of Ibadan undergraduates.

Table 17.7: ANCOVA showing the significant interaction effect of treatments and stage of developmenton forced vital capacity (FVC) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	15.949	6	2.658	11.227	.000	.537
Pretest	8.594E-03	1	8.594E-03	.036	.850	.001
Main Effects:						
Treatment groups	10.045	2	5.023	21.213	.000	.422
Stage of development	9.567E-02	1	9.567E-02	.404	.528	.007
Interaction Effects:						
Treatment groups x Stage	.232	2	.116	.489	.616	.017
of development	13.732	58	.237			
Residual	29.681	64				
Total						

In table 17.7above, it was observed that there were no significant interaction effect of treatments and stage of developmenton the FVC of University of Ibadan undergraduates. ($F_{(6,58)}$ = .489, p>.05, η^2=.068). Null hypothesis was therefore accepted.

Table 17.8: Estimated Marginal Means of significant interaction effect of treatments and stage of developmenton forced vital capacity (FVC)of University of Ibadan undergraduates

Treatment	Stage of development	Mean	Std. Error
Whole Body Vibration	16-24 years 25 and above	3.686 3.394	.191 .135
Resistant Training	16-24 years 25 and above	3.750 3.745	.244 .104
Control	16-24 years 25 and above	2.579 2.592	.243 .127

Table 17.8 above shows the Estimated Marginal Means from the analysis of the effect of treatments and stage of development on the forced vital capacity(FVC)of University of Ibadan undergraduates. The estimated marginal mean value for development in the resistant training participants was highest followed by young adult participants in same group and then, the adolescent participants in the whole body vibration group.

Ho 5b(iii): There will be no significant interaction effect of treatments and stage of developmenton forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates.

Table 17.9: ANCOVA showing the significant interaction effect of treatments and stage of development on forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	67.649	6	11.275	.819	.559	.078
Pretest	.703	1	.703	.051	.822	.001
Main Effects:						
Treatment groups	22.656	2	11.328	.823	.444	.028
Stage of Development	2.194	1	2.194	.159	.691	.003
Interaction Effects:						
Treatment groups x Stage	4.333	2	2.166	.157	.855	.005
of Development	798..045	58	13.759			
Residual	865.694	64				
Total						

In table 17.9 above, it was observed that there was no significant interaction effect of treatments and stage of development on the forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates($F_{(6,58)}$ = .157, p>.05, η^2=.005). Null hypothesis was therefore accepted.

Table 18.0: Estimated Marginal Means of significant interaction effect of treatments and stage of development on forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates

Treatment	Stage of Development	Mean	Std. Error
Whole Body Vibration	16-24 years 25 and above	3.338 3.356	1.444 1.029
Resistant Training	16-24 years 25 and above	3.445 4.819	1.865 .796
Control	16-24 years 25 and above	2.271 2.243	1.867 .959

Table 18.0 above showed the Estimated Marginal Means significant interaction effect of treatments and stage of development on forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates. Young adultparticipants in the resistant training group had the highest estimated marginal mean value in the analysis.

Ho 5b(iv): There will be no significant interaction effect of treatments and stage of developmenton Resting heart rate (RHR)of University of Ibadan undergraduates.

Table 18.1: ANCOVA showing the significant interaction effect of treatments and stage of developmenton Resting heart rate (RHR)of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	7158.506	6	1193.084	31.718	.000	.766
Pretest	5651.665	1	5651.665	150.248	.000	.721
Main Effects:						
Treatment groups	62.985	2	31.493	.837	.438	.028
Stage of Development	5.010	1	5.010	.133	.716	.002
Interaction Effects:						
Treatment groups x Stage	348.549	2	174.274	4.633	.014	.138
of Development	2181.709	58	37.616			
Residual	9340.215	64				
Total						

In table 18.1 above, it was observed that there was significant interaction effect of treatments and stage of development on the Resting heart rate (RHR)of University of Ibadan undergraduates($F_{(6,58)}$ = 4.633, $p<.05$, η^2=.138). Null hypothesis was therefore rejected.

Table 18.2: Estimated Marginal Means of significant interaction effect of treatments and stage of development on Resting heart rate (RHR) of University of Ibadan undergraduates

Treatment	Stage of Development	Mean	Std. Error
Whole Body Vibration	16-24 years 25 and above	77.292 85.586	2.377 1.701
Resistant Training	16-24 years 25 and above	79.875 77.290	3.098 1.334
Control	16-24 years 25 and above	82.084 78.474	3.069 1.584

Table 18.2 above shows the Estimated Marginal Means of the significant interaction effect of treatments and stage of development on the Resting heart rate (RHR) of University of Ibadan undergraduates. Treatment had its highest effect on the young adult category in the whole body vibration then followed by the adolescent category in the resistant training group.

Ho 5b(v): There will be no significant interaction effect of treatments and stage of development on Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates.

Table 18.3: ANCOVA showing the significant interaction effect of treatments and stage of developmenton Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5271.863	6	878.644	13.512	.000	.583
Pretest	4105.859	1	4105.859	63.141	.000	.521
Main Effects:						
Treatment groups	852.188	2	426.094	6.553	.003	.184
Stage of Development	52.227	1	52.227	.803	.374	.014
Interaction Effects:						
Treatment groups x Stage	80.326	2	40.163	.618	.543	.021
of Development	3771.583	58	65.027			
Residual	9043.446	64				
Total						

In table 18.3 above, it was observed that there was no significant interaction effect of treatments and stage of development on the Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates($F_{(6,58)}$ = .618, p>.05, η^2=.021). Null hypothesis was therefore accepted.

Table 18.4: Estimated Marginal Means of significant interaction effect of treatments and stage of development on Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates

Treatment	Stage of Development	Mean	Std. Error
Whole Body Vibration	16-24 years 25 and above	97.574 100.914	3.086 2.241
Resistant Training	16-24 years 25 and above	110.360 108.602	4.039 1.764
Control	16-24 years 25 and above	103.698 108.708	4.085 2.109

Table 18.4 above shows the Estimated Marginal Means of the significant interaction effect of treatments and stage of development on the Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates. Adolescent in the resistance training categoryhad

the highest estimated mean, followed by their young adultcounterparts and then the young adultparticipants in the whole body vibration treatment group.

Ho 5b(vi): There will be no significant interaction effects of treatment and stage of developmenton Diastolic Blood Pressure (DIAST B.P)of University of Ibadan undergraduates.

Table 18.5: ANCOVA showing the significant interaction effect of treatments and stage of developmenton Diastolic Blood Pressure (DIAST B.P) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	2311.427	6	385.238	7.246	.000	.428
Pretest	1815.105	1	1815.105	34.139	.000	.371
Main Effects:						
Treatment groups	189.144	2	94.572	1.779	.178	.058
Stage of Development	.169	1	.169	.003	.955	.000
Interaction Effects:						
Treatment groups x Stage	29.231	2	14.616	.275	.761	.009
of Development	3083.711	58	53.167			
Residual	5395.138	64				
Total						

In table 18.5above, it was observed that there was no significant interaction effect of treatments and stage of development on the Diastolic Blood Pressure (DIAST B.P)of University of Ibadan undergraduates($F_{(6,58)}$ = .275, p>.05, η^2=.009). Null hypothesis was therefore accepted.

Table 18.6: Estimated Marginal Means of significant interaction effect of treatments and stage of development on Diastolic Blood Pressure (DIAST B.P) of University of Ibadan undergraduates

Treatment	Stage of Development	Mean	Std. Error
Whole Body Vibration	16-24 years 25 and above	70.738 68.574	2.790 2.024
Resistant Training	16-24 years 25 and above	73.836 73.819	3.657 1.603
Control	16-24 years 25 and above	73.048 74.855	3.663 1.910

Table 18.6 above shows the Estimated Marginal Means of the significant interaction effect of treatments and stage of development on the Diastolic Blood Pressure (DIAST B.P)of University of Ibadan undergraduates. Participants in the resistant training group had a higher estimated mean value than others in the other treatment group.

Ho 5b(vii): There will be no significant interaction effects of treatment and stage of developmenton PEAK VO_2 of University of Ibadan undergraduates.

Table 18.7: ANCOVA showing the significant interaction effect of treatments and stage of development on PEAK VO_2 of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5962.667	6	993.778	14.407	.000	.598
Pretest	2456.386	1	2456.386	35.610	.000	.380
Main Effects:						
Treatment groups	1980.378	2	990.189	14.355	.000	.331
Stage of	.458	1	.458	.007	.935	.000
Development**Interaction**						
Effects:	182.725	2	91.362	1.324	.274	.044
Treatment groups x Stage	4000.873	58	68.981			
of Development	9963.541	64				
Residual						
Total						

In table 18.7 above, it was observed that there was no significant interaction effect of treatments and stage of development on the PEAK VO_2 of University of Ibadan undergraduates ($F_{(6,58)} = 1.324$, $p>.05$, $\eta^2=.044$). Null hypothesis was therefore accepted.

Table 18.8: Estimated Marginal Means of significant interaction effect of treatments and stage of development on PEAK VO_2 of University of Ibadan undergraduates

Treatment	Stage of Development	Mean	Std. Error
Whole Body Vibration	16-24 years 25 and above	38.159 43.073	3.184 2.304
Resistant Training	16-24 years 25 and above	37.100 36.373	4.162 1.783
Control	16-24 years 25 and above	26.981 22.168	4.160 2.147

Table 18.8 above shows the Estimated Marginal Means of the significant interaction effect of treatments and stage of development on the PEAK VO_2 of University of Ibadan undergraduates. Young Adultwhole body vibration participants had the highest estimated mean value from the analysis.

Ho 6a(i): There will be no significant interaction effects of gender and stage ofdevelopment on Arm Strength of University of Ibadan undergraduates.

Table 19.5: ANCOVA showing the significant interaction effects of gender and stage of developmenton Arm Strength of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	8754.119	4	2188.530	24.188	.000	.617
Pretest	1330.596	1	1330.596	14.706	.000	.197
Main Effects:						
Gender	1986.705	1	1986.705	21.957	.000	.268
Stage ofDevelopment	76.732	1	76.732	.848	.361	.014
Interaction Effects:						
Gender x Stage	109.449	1	109.449	1.210	.276	.020
ofDevelopment	5428.896	60	90.482			
Residual	14183.015	64				
Total						

In table 19.5 above, it was observed that there was no significant interaction effects of gender and stage ofdevelopment on the Arm Strength of University of Ibadan undergraduates($F_{(4,60)}$ = 1.210, p>.05, η^2=.020). Null hypothesis was therefore accepted.

Table 19.6: Estimated Marginal Means of significant interaction effect of gender and stage of development on Arm Strength of University of Ibadan undergraduates.

Gender	Stage ofdevelopment	Mean	Std. Error
Male	16-24 years	59.280	5.628
	25 and above	52.467	2.197
Female	16-24 years	37.601	2.947
	25 and above	38.230	1.889

Table 19.6 above shows the Estimated Marginal Means of the significant interaction effects of gender and stage ofdevelopment on the Arm Strength of University of Ibadan undergraduates. Male adolescent participants had a better estimated mean value than their young adult counterparts and then followed by female young adult participants.

Ho6a(ii): There will be no significant interaction effects of gender and stageof development on Body mass index of University of Ibadan undergraduates.

Table 19.7: ANCOVA showing the significant interaction effects of gender and stage of development on Body mass index of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	360.295	4	90.074	14.396	.000	.490
Pretest	187.891	1	187.891	30.031	.000	.334
Main Effects:						
Gender	20.466	1	20.466	3.271	.076	.052
Stageof Development	33.487	1	33.487	5.352	.024	.082
Interaction Effects:						
Gender x Stageof	.105	1	.105	.017	.897	.000
Development	375.398	60	6.257			
Residual	735.693	64				
Total						

In table 19.7 above, it was observed that there was no significant interaction effects of gender and stageof development on the Body mass index of University of Ibadan undergraduates($F_{(4,60)}$ = .017, p>.05, η^2=.000). Null hypothesis was therefore accepted.

Table 19.8: Estimated Marginal Means of significant interaction effect of gender and stage of development on Body mass index of University of Ibadan undergraduates.

Gender	Stageof Development	Mean	Std. Error
Male	16-24 years 25 and above	22.780 24.715	1.444 .556
Female	16-24 years 25 and above	24.301 26.467	.729 .496

Table 19.8 above shows the Estimated Marginal Means of the significant interaction effects of gender and stageof development on the Body mass index of University of

Ibadan undergraduates. Treatments had a better effect among male adolescentparticipants.

Ho 6a(iii): There will be no significant interaction effects of gender and stage of development on Lean Body Weight (LBW) of University of Ibadan undergraduates.

Table 19.9: ANCOVA showing the significant main and interaction effects of gender and stage of development on Lean Body Weight (LBW) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5619.658	4	1404.914	254.498	.000	.944
Pretest	3451.361	1	3451.361	625.208	.000	.912
Main Effects:						
Gender	1.799	1	1.799	.326	.570	.005
Stage of Development	5.072	1	5.072	.919	.342	.015
Interaction Effects:						
Gender x Stage of	6.282	1	6.282	1.138	.290	.019
Development	331.220	60	5.520			
Residual	5950.878	64				
Total						

In table 19.9 above, it was observed that there was no significant interaction effects of gender and stage of development on the Lean Body Weight (LBW) of University of Ibadan undergraduates($F_{(4,60)}$ = 1.138, p>.05, η^2=.019). Null hypothesis was therefore accepted.

Table 20.0: Estimated Marginal Means of significant interaction effect of gender and stage of development on Lean Body Weight (LBW) of University of Ibadan undergraduates.

Gender	Stage of Development	Mean	Std. Error
Male	16-24 years 25 and above	46.268 47.946	1.379 .566
Female	16-24 years 25 and above	47.691 47.602	.709 .485

Table20.0 above shows the Estimated Marginal Means of the significant interaction effects of gender and stage of developmenton the Lean Body Weight (LBW) of University of Ibadan undergraduates. It was observed that young adultmale participants had a better estimated mean than other categoriesin the analysis.

Ho 6a(iv): There will be no significant interaction effects of gender and stageof developmenton Percent Body Fat (%BF)of University of Ibadan undergraduates.

Table 20.1: ANCOVA showing the significant interaction effects of gender and stage of developmenton Percent Body Fat (%BF) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5258.173	4	1314.543	186.441	.000	.926
Pretest	3305.422	1	3305.422	468.807	.000	.887
Main Effects:						
Gender	.183	1	.183	.026	.873	.000
Stage of Development	1.380E-03	1	1.380E-03	.000	.989	.000
Interaction Effects:						
Gender x Stage of	2.291	1	2.291	.325	.571	.005
Development	423.043	60	7.051			
Residual	5681.216	64				
Total						

In table 20.1above, it was observed that there wasno significant interaction effects of gender and stageof development on the Percent Body Fat (%BF)of University of Ibadan undergraduates ($F_{(4,60)}$ = .325, p>.05, η^2=.005). Null hypothesis was therefore accepted.

Table 20.2: Estimated Marginal Means of significant interaction effect of gender and stage of development on Percent Body Fat (%BF) of University of Ibadan undergraduates.

Gender	Stage of Development	Mean	Std. Error
Male	16-24 years	21.529	1.568
	25 and above	20.982	.630
Female	16-24 years	20.823	.786
	25 and above	21.344	.555

Table 20.2 above shows the Estimated Marginal Means of the significant interaction effects of gender and stageof development on the Percent Body Fat (%BF)of University of Ibadan students. Adolescent male participants had a better estimated mean value then followed by young adultsin the female category.

Ho 6b(i): There will be no significant interaction effects of gender and stageof developmenton Peak Expiratory Flow (PEF) of University of Ibadan undergraduates.

Table 20.3: ANCOVA showing the significant interaction effects of gender and stage of developmenton Peak Expiratory Flow (PEF) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	80.682	4	20.170	19.231	.000	.562
Pretest	67.630	1	67.630	64.479	.000	.518
Main Effects:						
Gender	.294	1	.294	.281	.598	.005
Stage of Development	.525	1	.525	.501	.482	.008
Interaction Effects:						
Gender x Stage of	2.114	1	2.114	2.016	.161	.033
Development	62.932	60	1.049			
Residual	143.613	64				
Total						

In table 20.3above, it was observed that there wasno significant interaction effects of gender and stageof development on the Peak Expiratory Flow (PEF) of University of Ibadan undergraduates ($F_{(4,60)}$ = 2.016, p>.05, η^2=.033). Null hypothesis was therefore accepted.

Table 20.4: Estimated Marginal Means of significant interaction effect of gender and stage of developmenton Peak Expiratory Flow (PEF) of University of Ibadan undergraduates.

Gender	Stage of Development	Mean	Std. Error
Male	16-24 years 25 and above	5.456 4.680	.604 .217
Female	16-24 years 25 and above	4.733 4.998	.302 .198

Table 20.4 above shows the Estimated Marginal Means of the significant interaction effects of gender and stageof development on the Peak Expiratory Flow (PEF) of University of Ibadan undergraduates. Adolescent male participants had the highest estimated mean value followed by female young adult participants from the analysis.

Ho 6b(ii): There will be no significant interaction effects of gender and stageof developmenton ForcedVital Capacity (FVC) of University of Ibadan undergraduates

Table 20.5: ANCOVA showing the significant interaction effects of gender and stage of development on Forced Vital Capacity (FVC) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	19.718	4	4.930	33.571	.000	.691
Pretest	14.011	1	14.011	95.416	.000	.614
Main Effects:						
Gender	1.672E-02	1	1.672E-02	.114	.737	.002
Stage of Development	.103	1	.103	.701	.406	.012
Interaction Effects:						
Gender x Stage of	.167	1	.167	1.139	.290	.019
Development	8.810	60	.147			
Residual	28.528	64				
Total						

In table 20.5above, it was observed that there wasno significant interaction effects of gender and stageof development on the ForcedVital Capacity (FVC) of University of Ibadan undergraduates ($F_{(4,60)}$ = 1.139, p>.05, η^2=.019). Null hypothesis was therefore accepted.

Table 20.6: Estimated Marginal Means of significant interaction effect of gender and stage of development on Forced Vital Capacity (FVC) of University of Ibadan undergraduates.

Gender	Stage of Development	Mean	Std. Error
Male	16-24 years 25 and above	2.886 2.854	.228 .086
Female	16-24 years 25 and above	2.690 2.948	.114 .076

Table 20.6 above shows the Estimated Marginal Means of the significant interaction effects of gender and stageof development on the ForcedVital Capacity (FVC) of University of Ibadan undergraduates. Female young adult participants had the highest estimated mean followed by the adolescent male participants from the analysis.

Ho 6b(iii): There will be no significant interaction effects of gender and stage of development on forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates.

Table 20.7: ANCOVA showing the significant interaction effects of gender and stage of development on forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates.

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	11.331	4	2.833	.199	.938	.013
Pretest	5.752E-	1	5.752E-02	.004	.950	.000
Main Effects:	02					
Gender		1	.678	.048	.828	.001
Stage of Development	.678	1	1.462	.103	.750	.002
Interaction Effects:	1.462					
Gender x Stage of		1	2.060	.145	.705	.002
Development	2.060	60	14.239			
Residual	854.363	64				
Total	865.694					

In table 20.7above, it was observed that there were significant interaction effects of gender and stage of development on the forced expiratory volume in Ist second ($FEV._{1)}$ of University of Ibadan undergraduates($F_{(4,60)}$ = .145, p>.05, η^2=.002). Null hypothesis was therefore accepted.

Table 20.8: Estimated Marginal Means of significant interaction effect of gender and stage of development on forced expiratory volume in Ist second ($FEV._{1)}$ as a of University of Ibadan undergraduates.

Gender	Stage of Development	Mean	Std. Error
Male	16-24 years	3.295	2.192
	25 and above	3.214	.810
Female	16-24 years	3.089	1.123
	25 and above	4.024	.730

Table 20.8 above shows the Estimated Marginal Means of the significant interaction effects of gender and stage of development on the forced expiratory volume in Ist second ($FEV._{1)}$of University of Ibadan undergraduates. Analysis of gender and stage of development shows that female young adult participants had the highest estimated mean value and then followed by male adolescent participants.

Ho 6b(iv): There will be no significant interaction effects of gender and stage of development on Resting heart rate (RHR) of University of Ibadan undergraduates.

Table 20.9: ANCOVA showing the significant interaction effects of gender and stage of development on Resting heart rate (RHR) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	6578.295	4	1644.574	35.727	.000	.704
Pretest	5935.096	1	5935.096	128.934	.000	.682
Main Effects:						
Gender	69.339	1	69.339	1.506	.224	.024
Stage of Development	.715	1	.715	.016	.901	.000
Interaction Effects:						
Gender x Stage of	11.006	1	11.006	.239	.627	.004
Development	2761.920	60	46.032			
Residual	9340.215	64				
Total						

In table 20.9 above, it was observed that there were no significant interaction effects of gender and stage of development on the Resting heart rate (RHR)of University of Ibadan undergraduates($F_{(4,60)}$ = .239, p>.05, η^2=.004). Null hypothesis was therefore accepted.

Table 21.0: Estimated Marginal Means of significant interaction effect of gender and stage of development on Resting heart rate (RHR) of University of Ibadan undergraduates.

Gender	Stage of Development	Mean	Std. Error
Male	16-24 years 25 and above	82.330 80.853	3.924 1.481
Female	16-24 years 25 and above	78.179 79.046	2.021 1.312

Table 21.0above shows the Estimated Marginal Means of the significant interaction effects of gender and stage of development on the RHR of University of Ibadan undergraduates.

Ho 6b(v): There will be no significant interaction effects of gender and stageof developmenton Systolic Blood Pressure of University of Ibadan undergraduates.

Table 21.1: ANCOVA showing the significant interaction effects of gender and stage of developmenton Systolic Blood Pressure of University of Ibadan Students

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	4368.067	4	1092.017	14.014	.000	.483
Pretest	3646.326	1	3646.326	46.794	.000	.438
Main Effects:						
Gender	53.949	1	53.949	.692	.409	.011
Stage of Development	74.437	1	74.437	.955	.332	.016
Interaction Effects:						
Gender x Stage of	1.341	1	1.341	.017	.896	.000
Development	4675.379	60	77.923			
Residual	9043.446	64				
Total						

In table 21.1above, it was observed that there wasno significant interaction effects of gender and stageof development on the Systolic Blood Pressure of University of Ibadan undergraduates ($F_{(4,60)}$ = .017, p>.05, η^2=.000). Null hypothesis was therefore accepted.

Table 21.2: Estimated Marginal Means of significant interaction effect of gender and stage of development on Systolic Blood Pressure of University of Ibadan undergraduates.

Gender	Stage of Development	Mean	Std. Error
Male	16-24 years 25 and above	105.164 107.835	5.213 1.850
Female	16-24 years 25 and above	102.076 105.570	2.551 1.714

Table 21.2 above shows the Estimated Marginal Means of the significant interaction effects of gender and stageof development on the Systolic Blood Pressure of University of Ibadan undergraduates. Male Young Adult participants had a higher estimated mean value from the analysis, followed by female young adultsand male adolescent participants respectively.

Ho 6b(vi): There will be no significant interaction effects of gender and stageof developmenton Diastolic Blood Pressure of University of Ibadan undergraduates.

Table 21.3: ANCOVA showing the significant interaction effects of gender and stage of development on Diastolic Blood Pressure of University of Ibadan Students

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	2029.245	4	507.311	9.043	.000	.376
Pretest	1906.440	1	1906.440	33.984	.000	.362
Main Effects:						
Gender	20.513	1	20.513	.366	.548	.006
Stage of Development	.935	1	.935	.017	.898	.000
Interaction Effects:						
Gender x Stage of	3.228	1	3.228	.058	.811	.001
Development	3365.894	60	56.098			
Residual	5395.138	64				
Total						

In table 21.3 above, it was observed that there wasno significant interaction effects of gender and stageof development on the Diastolic Blood Pressure of University of Ibadan undergraduates ($F_{(4,60)}$ = .058, p>.05, η^2=.001). Null hypothesis was therefore accepted.

Table 21.4: Estimated Marginal Means of significant interaction effect of gender and stage of adolescent on Diastolic Blood Pressure of University of Ibadan undergraduates.

Gender	Stage of Development	Mean	Std. Error
Male	16-24 years 25 and above	72.986 73.962	4.338 1.562
Female	16-24 years 25 and above	72.019 71.729	2.167 1.445

Table 21.4 above shows the Estimated Marginal Means of the interaction effects of gender and stageof development on the Diastolic Blood Pressure of University of Ibadan undergraduates. The analysis indicated that young adultscategory of the male participants had a higher estimated marginal mean value than other categories in the study.

Ho 6b(vii): There will be no significant interaction effects of gender and stageof developmenton Peak VO_2 of University of Ibadan undergraduates.

Table 21.5: ANCOVA showing the significant interaction effects of gender and stage of developmenton PEAK VO2 of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	4860.147	4	1215.037	38.041	.000	.717
Pretest	2990.718	1	2990.718	93.634	.000	.609
Main Effects:						
Gender	101.448	1	101.448	3.176	.080	.050
Stage of Development	151.432	1	151.432	4.741	.033	.073
Interaction Effects:						
Gender x Stage of	40.744	1	40.744	1.276	.263	.021
Development	1916.430	60	31.941			
Residual	6776.577	64				
Total						

In table 21.5above, it was observed that there wasno significant interaction effects of gender and stageof development on the PEAK VO2 of University of Ibadan undergraduates ($F_{(4,60)}$ = 1.276, p>.05, η^2=.021). Null hypothesis was therefore accepted.

Table 21.6: Estimated Marginal Means of significant interaction effect of gender and stage of development on Peak VO_2 of University of Ibadan undergraduates

Gender	Stage of Development	Mean	Std. Error
Male	16-24 years 25 and above	37.279 30.671	3.292 1.309
Female	16-24 years 25 and above	31.119 29.014	1.714 1.129

Table 21.6 above shows the Estimated Marginal Means of the significant interaction effects of gender and stageof development on the PEAK VO2of University of Ibadan undergraduates. Male adolescent participants had the highest estimated marginal mean value followed by adolescent female participants and then other categories of participants from the analysis.

Ho 7a(i): There will be no significant 3-way interaction effect of treatments, gender and stage ofdevelopment on Arm Strength of University of Ibadan undergraduates.

Table 22.3: ANCOVA showing the 3-way interaction effect of treatments, gender and stage of development on Arm Strength of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	12228.425	11	1111.675	30.144	.000	.862
Pretest	1817.812	1	1817.812	49.291	.000	.482
Main Effects:						
Treatment	2652.591	2	1326.296	35.963	.000	.576
Gender	970.772	1	970.772	26.323	.000	.332
Stage ofDevelopment	2.602	1	2.602	.071	.729	.001
2-way Interaction						
Effects:	361.329	2	180.665	4.899	.011	.156
Treatment x Gender	6.275	2	3.137	.085	.919	.003
Treatment x Stage	50.314	1	50.314	1.364	.248	.025
ofDevelopment						
Gender x Stage	74.627	1	74.627	2.024	.161	.037
ofDevelopment	1954.591	53	36.879			
3-way Interaction	14183.015	64				
Effects:						
Treatment x Gender x						
Stage ofDevelopment						
Residual						
Total						

In table 22.3above, it was observed that there was no 3-way interaction effect of treatments, gender and stage ofdevelopment on the Arm Strength of University of Ibadan undergraduates($F_{(11,53)} = 2.024$, $p>.05$, $\eta^2=.037$). Null hypothesis was therefore accepted.

Table 22.4: Estimated Marginal Means of 3-way interaction effect of treatments, gender and stage of development on Arm Strength of University of Ibadan undergraduates.

Treatment	Gender	Stage ofDevelopment	Mean	Std. Error
Whole Body Vibration	Male	16-24 years	67.926	6.080
		25 and above	60.101	2.332
	Female	16-24 years	43.246	2.668
		25 and above	48.271	2.495
Resistant Training	Male	16-24 years	53.149	4.437
		25 and above	54.142	1.981
	Female	16-24 years	39.296	4.298
		25 and above	39.013	1.970
Control	Male	16-24 years	000.000	000.000
		25 and above	33.845	2.813
	Female	16-24 years	31.425	3.101
		25 and above	32.574	1.923

Table 22.4 above shows the Estimated Marginal Means of 3-way interaction effect of treatments, gender and stage ofdevelopment on the Arm Strength of University of Ibadan undergraduates. Male adolescent participants in the whole body vibration group had the highest estimated marginal mean value from the results above.

Ho 7a(ii): There will be no significant 3-way interaction effect of treatments, gender and stageof development on Body mass indexof University of Ibadan undergraduates.

Table 22.5: ANCOVA showing the 3-way interaction effect of treatments, gender and stage of development on Body mass index of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	448.137	11	40.740	13.093	.000	.731
Pretest	263.368	1	263.368	84.639	.000	.615
Main Effects:						
Treatment	12.250	2	6.125	1.968	.150	.069
Gender	6.095	1	6.095	1.959	.167	.036
Stage of Development	11.443	1	11.443	3.677	.061	.065
2-way Interaction						
Effects:	8.482	2	4.241	1.363	.265	.049
Treatment x Gender	6.846	2	3.423	1.100	.340	.040
Treatment x Stage of						
Development	.712	1	.712	.229	.634	.004
Gender x Stage of						
Development			1.198	.385	.538	.007
3-way Interaction	1.198	1				
Effects:	164.918	53	3.112			
Treatment x Gender x	613.055	64				
Stage of Development						
Residual						
Total						

In table 22.5 above, it was observed that there was no 3-way interaction effect of treatments, gender and stageof development on the Body mass indexof University of Ibadan undergraduates($F_{(11,53)}$ = .385, p>.05, η^2=.007). Null hypothesis was therefore accepted.

Table 22.6: Estimated Marginal Means of 3-way interaction effect of treatments, gender and stage of developmenton Bodymass index of University of Ibadan undergraduates

Treatment	Gender	Stage of Development	Mean	Std. Error
Whole Body Vibration	Male	16-24 years 25 and above	24.429 26.263	1.764 .685
	Female	16-24 years 25 and above	26.757 28.386	.750 .722
Resistant Training	Male	16-24 years 25 and above	28.338 27.535	1.247 .553
	Female	16-24 years 25 and above	28.448 28.239	1.252 .545
Control	Male	16-24 years 25 and above	000.000 27.621	000.000 .794
	Female	16-24 years 25 and above	25.937 28.474	.883 .562

Table 22.6 above shows the Estimated Marginal Means of 3-way interaction effect of treatments, gender and stageof development on the Body mass indexof University of Ibadan undergraduates.Male adolescentsin the whole body vibration had a better estimated mean value from the analysis.

Ho 7a(iii): There will be no significant 3-way interaction effect of treatments, gender and stage of development of University of Ibadan students on Lean Body Weight (LBW)as an of University of Ibadan undergraduates.

Table 22.7: ANCOVA showing the 3-way interaction effects of treatment, gender and stage of development on Lean Body Weight (LBW) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5736.800	11	521.527	129.116	.000	.964
Pretest	2715.828	1	2715.828	672.366	.000	.927
Main Effects:						
Treatment	80.519	2	40.260	9.967	.000	.273
Gender	8.098	1	8.098	2.005	.163	.036
Stage of Development	11.195	1	11.195	2.772	.102	.050
2-way Interaction						
Effects:	1.326	2	.663	.164	.849	.006
Treatment x Gender	11.321	2	5.661	1.401	.255	.050
Treatment x Stage of Development	12.587	1	12.587	3.116	.083	.056
Gender x Stage of	3.995E-02	1	3.995E-02	.010	.921	.000
Development	214.078	53	4.039			
3-way Interaction	5950.878	64				
Effects:						
Treatment x Gender x Stage of Development						
Residual						
Total						

In table 22.7above, it was observed that there was significant 3-way interaction effect of treatments, gender and stage of developmenton the Lean Body Weight (LBW) of University of Ibadan undergraduates ($F_{(11,53)}$ = .010, p<.05, η^2=.000). Null hypothesis was rejected.

Table 22.8: Estimated Marginal Means of 3-way interaction effect of treatments, gender and stage of development on Lean Body Weight (LBW)of University of Ibadan undergraduates

Treatment	Gender	Stage of Development	Mean	Std. Error
Whole Body Vibration	Male	16-24 years	45.392	2.168
		25 and above	49.301	.891
	Female	16-24 years	48.599	.860
		25 and above	49.446	.832
Resistant Training	Male	16-24 years	46.816	1.422
		25 and above	47.939	.639
	Female	16-24 years	49.675	1.425
		25 and above	48.072	.638
Control	Male	16-24 years	000.000	000.000
		25 and above	46.454	.910
	Female	16-24 years	45.151	1.017
		25 and above	45.837	.653

Table 22.8above showed the Estimated Marginal Means from the 3-way interaction effect of treatments, gender and stage of development on the Lean Body Weight (LBW) of University of Ibadan undergraduates. Female adolescent in the resistant training group, had the highest estimated marginal mean value from this analysis.

Ho 7a(iv): There will be no significant 3-way interaction effect of treatment, gender and stageof development on Percent Body Fat (%BF)of University of Ibadan undergraduates.

Table 22.9: ANCOVA showing the 3-way interaction effect of treatment, gender and stage of development on Percent Body Fat (%BF) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5364.300	11	487.664	81.555	.000	.944
Pretest	3088.927	1	3088.927	516.582	.000	.907
Main Effects:						
Treatment	62.692	2	31.346	5.242	.008	.165
Gender	1.982	1	1.982	.332	.567	.006
Stage of Development	.923	1	.923	.154	.696	.003
2-way Interaction						
Effects:	4.034	2	2.017	.337	.715	.013
Treatment x Gender	1.900	2	.950	.159	.854	.006
Treatment x Stage of						
Development	.705	1	.705	.118	.733	.002
Gender x Stage of						
Development	.482		.482	.081	.778	.002
3-way Interaction		1				
Effects:	316.916		5.980			
Treatment x Gender x		53				
Stage of Development	5681.216					
Residual		64				
Total						

In table 22.9above, it was observed that there was no significant interaction effect of treatments, gender and stageof development on the Percent Body Fat (%BF)of University of Ibadan undergraduates($F_{(11,53)}$ = .081, p>.05, η^2=.002). Null hypothesis was therefore accepted.

Table 23.0: Estimated Marginal Means of 3-way interaction effect of treatments, gender and stage of development onPercent Body Fat (%BF) of University of Ibadan undergraduates

Treatment	Gender	Stage of Development	Mean	Std. Error
Whole Body Vibration	Male	16-24 years 25 and above	20.733 19.698	2.480 .982
	Female	16-24 years 25 and above	19.592 18.674	1.039 1.040
Resistant Training	Male	16-24 years 25 and above	22.098 21.522	1.751 .827
	Female	16-24 years 25 and above	20.619 21.298	1.729 .770
Control	Male	16-24 years 25 and above	000.000 22.072	000.000 1.095
	Female	16-24 years 25 and above	22.591 22.794	1.225 .787

Table 23.0 above shows the Estimated Marginal Means from the 3-way interaction effect of treatments, gender and stageof development on the Percent Body Fat (%BF)of University of Ibadan undergraduates. Male and female young adultparticipants in the resistant training group had a more improved estimated mean value than other categories of participants from the analysis.

Ho 7b(i): There will be no significant 3-way interaction effect of treatments, gender and stage of development on peak expiratory flow (PEF)of University of Ibadan undergraduates.

Table 23.1: ANCOVA showing the significant 3-way interaction effect of treatments, gender and stage of development **on peak expiratory flow (PEF) of University of Ibadan undergraduates**

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	87.794	11	7.981	9.987	.000	.675
Pretest	1.017	1	1.017	1.273	.264	.023
Main Effects:						
Treatment	49.864	2	24.932	31.197	.000	.541
Gender	1.040	1	1.040	1.302	.259	.024
Stage of Development	1.158E-03	1	1.158E-03	.001	.970	.000
2-way Interaction						
Effects:	.592	2		.371	.692	.014
Treatment x Gender	1.712	2	.296	1.071	.350	.039
Treatment x Stage of	4.358	1	.856	5.453	.023	.093
Development			4.358			
Gender x Stage of	1.275	1		1.596	.212	.029
Development	42.357	53	1.275			
3-way Interaction	130.151	64	.799			
Effects:						
Treatment x Gender x Stage of Development						
\Residual						
Total						

In table 23.1above, it was observed that there wasno significant 3-way interaction effect of treatment, gender and stage of developmenton peak expiratory flow (PEF)of University of Ibadan undergraduates($F_{(11,53)}$ = 1.596, p>.05, η^2=.029). Null hypothesis was therefore accepted.

Table 23.2: Estimated Marginal Means of 3-way interaction effect of treatments, gender and stage of development onPeak expiratory flow (PEF) of University of Ibadan undergraduates

Treatment	Gender	Stage of Development	Mean	Std. Error
Whole Body Vibration	Male	16-24 years 25 and above	7.055 6.195	.895 .351
	Female	16-24 years 25 and above	4.943 6.720	.375 .366
Resistant Training	Male	16-24 years 25 and above	6.136 5.523	.634 .274
	Female	16-24 years 25 and above	5.578 5.749	.632 .270
Control	Male	16-24 years 25 and above	0.000 3.200	.000 .400
	Female	16-24 years 25 and above	3.381 3.656	.448 .285

Table 23.2 above shows the Estimated Marginal Means from the 3-way interaction effect of treatments, gender and stage of development on the peak expiratory flow (PEF)of University of Ibadan undergraduates. It was observed that adolescence and young adultmale and female participants in the whole body vibration had the highest estimated mean values from this analysis.

Ho 7b(ii): There will be no significant 3-way interaction effect of treatments, gender and stage of development on Forced vital capacity of University of Ibadan undergraduates.

Table 23.3: ANCOVA showing the significant 3-way interaction effect of treatments, gender and stage of development on forced vital capacity (FVC) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	17.217	11	1.565	6.656	.000	.580
Pretest	.116	1	.116	.492	.486	.009
Main Effects:						
Treatment	6.990	2	3.495	14.863	.000	.359
Gender	.219	1	.219	.931	.339	.017
Stage of Development	.264	1	.264	1.122	.294	.021
2-way Interaction						
Effects:	.774	2	.387	1.647	.202	.059
Treatment x Gender	.184	2	9.212E-02	.392	.678	.015
Treatment x Stage of	6.120E-03	1	6.120E-03	.026	.872	.000
Development						
Gender x Stage of	.156	1	.158	.673	.416	.013
Development	12.463	53	.235			
3-way Interaction	29.681	64				
Effects:						
Treatment x Gender x						
Stage of Development						
\Residual						
Total						

In table 23.3above, it was observed that there wasno 3-way interaction effect of treatment, gender and stage of developmenton the forced vital capacity(FVC)of University of Ibadan undergraduates ($F_{(11,53)}$ = .673, p>.05, η^2=.013). Null hypothesis was therefore accepted.

Table 23.4: Estimated Marginal Means of 3-way interaction effect of treatments, gender and stage of development onForced vital capacity (FVC) of University of Ibadan undergraduates.

Treatment	Gender	Stage of development	Mean	Std. Error
Whole Body Vibration	Male	16-24 years	3.888	.491
		25 and above	3.331	.183
	Female	16-24 years	3.618	.205
		25 and above	3.453	.199
Resistant Training	Male	16-24 years	6.691	.349
		25 and above	3.816	.147
	Female	16-24 years	3.823	.345
		25 and above	3.683	.146
Control	Male	16-24 years	0.000	.000
		25 and above	2.988	.228
	Female	16-24 years	2.583	.243
		25 and above	2.409	.154

Table 23.4 above shows the Estimated Means from the 3-way interaction effect of treatments, gender and stage of development on the forced vital capacity(FVC)of University of Ibadan undergraduates.Adolescent male participants in the resistant training group had the highest estimated marginal mean value from the analysis presented above.

Ho 7b(iii): There will be no significant 3-way interaction effect of treatments, gender and stageof development on Forced Expiratory Volume in Ist second (FEV.1)of University of Ibadan undergraduates.

Table 23.5: ANCOVA showing the significant 3-way interaction effect of treatments, gender and stage of development on Forced Expiratory Volume in Ist second(FEV.1) of University of Ibadan undergraduates.

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	15.802	11	1.437	12.175	.000	.716
Pretest	9.342	1	9.342	79.176	.000	.599
Main Effects:						
Treatment	2.642E-02	2	1.321E-02	.112	.894	.004
Gender	3.060E-02	1	3.060E-02	.259	.613	.005
Stage of Development	1.928E-02	1	1.928E-02	.163	.688	.003
2-way Interaction Effects:	.164	2	8.218E-02	.697	.503	.026
Treatment x Gender	.264	2	.132	1.120	.334	.041
Treatment x Stage of Development	.199	1	.199	1.684	.200	.031
Gender x Stage of Development	.120		.120	1.013	.319	.019
3-way Interaction		1				
Effects:	6.253		.118			
Treatment x Gender x		53				
Stage of Development	22.055					
Residual		64				
Total						

In table 23.5above, it was observed that there was no significant 3-way interaction effect of treatments, gender and stageof development on the Forced Expiratory Volume in Ist second (FEV.1)of University of Ibadan undergraduates($F_{(11,53)}$ = 1.013, p>.05, η^2=.019). Null hypothesis was therefore accepted.

Table 23.6: Estimated Marginal Means of 3-way interaction effect of treatments, gender and stage of development onForced Expiratory Volume in Ist second (FEV.1) of University of Ibadan undergraduates.

Treatment	Gender	Stage of Development	Mean	Std. Error
Whole Body Vibration	Male	16-24 years	2.739	.348
		25 and above	2.329	.136
	Female	16-24 years	2.366	.145
		25 and above	2.607	.141
Resistant Training	Male	16-24 years	2.523	.246
		25 and above	2.616	.106
	Female	16-24 years	2.486	.243
		25 and above	2.664	.104
Control	Male	16-24 years	000.000	000.000
		25 and above	2.503	.158
	Female	16-24 years	2.548	.174
		25 and above	2.402	.116

Table 23.6 above shows the Estimated Means from the 3-way interaction effect of treatments, gender and stageof development on the Forced Expiratory Volume in Ist second (FEV.1)of University of Ibadan undergraduates. From this analysis, it was observed that male adolescent participants in the whole body vibration group had the most improved estimated mean value than others.

Ho 7b(iv): There will be no significant 3-way interaction effect of treatment, gender and stage of development on Resting heart rate (RHR)of University of Ibadan undergraduates.

Table 23.7: ANCOVA showing the significant 3-way interaction effect of treatments, gender and stage of development on Resting heart rate (RHR) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	7523.226	11	683.930	19.950	.000	.805
Pretest	5544.933	1	5544.933	161.741	.000	.753
Main Effects:						
Treatment	158.014	2	79.007	2.305	.110	.080
Gender	91.053	1	91.053	2.656	.109	.048
Stage of Development	1.804	1	1.804	.053	.819	.001
2-way Interaction						
Effects:	250.474	2	125.237	3.653	.033	.121
Treatment x Gender	102.820	2	51.410	1.500	.233	.054
Treatment x Stage of	12.153	1	12.153	.355	.554	.007
Development						
Gender x Stage of	11.687	1	11.687	.341	.562	.006
Development	1816.989	53	34.283			
3-way Interaction	9340.215	64				
Effects:						
Treatment x Gender x						
Stage of Development						
\Residual						
Total						

In table 23.7above, it was observed that there wasno significant interaction effect of treatments, gender and stage of development on the Resting heart rate (RHR)of University of Ibadan undergraduates($F_{(11,53)}$ = .341, p>.05, η^2=.006). Null hypothesis was therefore accepted.

Table 23.8: Estimated Marginal Means of 3-way interaction effect of treatments, gender and stage of development onResting heart rate (RHR) of University of Ibadan undergraduates.

Treatment	Gender	Stage of Development	Mean	Std. Error
Whole Body Vibration	Male	16-24 years 25 and above	88.701 89.344	5.856 2.264
	Female	16-24 years 25 and above	74.895 81.177	2.467 2.462
Resistant Training	Male	16-24 years 25 and above	79.091 77.047	4.149 1.842
	Female	16-24 years 25 and above	79.749 77.963	4.188 1.765
Control	Male	16-24 years 25 and above	0.000 77.652	.000 2.619
	Female	16-24 years 25 and above	81.990 78.905	2.930 1.852

Table 23.8 above shows the Estimated Means of the 3-way interaction effect of treatments, gender and stage of developmenton Resting heart rate (RHR)of University of Ibadan undergraduates.Young Adultmale whole body vibration participants had the highest estimated marginal mean, followed by their adolescent counterparts and then young adultfemalesin the whole body vibration group.

Ho 7b(v): There will be no significant 3-way interaction effects of treatment, gender and stage of development Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates.

Table 23.9: ANCOVA showing the significant 3-way interaction effect of treatments, gender and stage of development Systolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	5542.193	11	503.836	7.627	.000	.613
Pretest	3688.825	1	3688.825	55.839	.000	.513
Main Effects:						
Treatment	886.493	2	443.246	6.710	.003	.202
Gender	5.033E-02	1	5.033E-02	.001	.978	.000
Stage of Development	81.576	1	81.576	1.235	.271	.023
2-way Interaction						
Effects:	29.287	2	14.643	.222	.802	.008
Treatment x Gender	136.400	2	68.200	1.032	.363	.037
Treatment x Stage of Development	81.200	1	81.200	1.229	.273	.023
Gender x Stage of	101.662	1	101.662	1.539	.220	.028
Development	3501.253	53	66.061			
3-way Interaction	9043.446	64				
Effects:						
Treatment x Gender x Stage of Development						
\Residual						
Total						

In table 23.9above, it was observed that there wasno significant 3-way interaction effect of treatments, gender and stage of development Systolic Blood Pressure (SYST B.P)of University of Ibadan undergraduates($F_{(11,53)}$ = 1.539, p>.05, η^2=.028). Null hypothesis was therefore accepted.

Table 24.0:Estimated Marginal Mean of 3-way interaction effect of treatments, gender and stage of developmentSystolic Blood Pressure (SYST B.P) of University of Ibadan undergraduates

Treatment	Gender	Stage of Development	Mean	Std. Error
Whole Body Vibration	Male	16-24 years 25 and above	91.148 104.684	8.214 3.072
	Female	16-24 years 25 and above	98.600 96.490	3.343 3.333
Resistant Training	Male	16-24 years 25 and above	111.016 108.912	5.846 2.451
	Female	16-24 years 25 and above	109.666 108.356	5.774 2.575
Control	Male	16-24 years 25 and above	000.000 109.284	.000 3.758
	Female	16-24 years 25 and above	103.750 108.379	4.124 2.571

Table 24.0 above shows the Estimated Means from the 3-way interaction effect of treatments, gender and stage of development Systolic Blood Pressure (SYST B.P)of University of Ibadan undergraduates. Analysis indicates thatadolescent male participants in the resistant training group had the highest estimated marginal mean value followed by their female adolescent counterparts respectively.

Ho 7b(vi): There will be no significant 3-way interaction effect of treatments, gender and stage of developmentDiastolic Blood Pressure (DIAST B.P)of University of Ibadan undergraduates.

Table 24.1: ANCOVA showing the significant 3-way interaction effect of treatments, gender and stage of development Diastolic Blood Pressure (DIAST B.P) of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	2588.092	11	235.281	4.442	.000	.480
Pretest	1893.137	1	1893.137	35.744	.000	.403
Main Effects:						
Treatment	199.970	2	99.985	1.888	.161	.067
Gender	16.580	1	16.580	.313	.578	.006
Stage of Development	.291	1	.291	.006	.941	.000
2-way Interaction						
Effects:	52.113	2	26.056	.492	.614	.018
Treatment x Gender	42.610	2	21.305	.402	.671	.015
Treatment x Stage of	34.262	1	34.262	.647	.425	.012
Development						
Gender x Stage of	54.654	1	54.654	1.032	.314	.019
Development	2807.046	53	52.963			
3-way Interaction	5395.138	64				
Effects:						
Treatment x Gender x						
Stage of Development						
\Residual						
Total						

In table 24.1above, it was observed that there wasno significant 3-way interaction effect of treatments, gender and stage of developmentDiastolic Blood Pressure (DIAST B.P)of University of Ibadan undergraduates($F_{(11,53)}$ = 1.032, $p>.05$, η^2=.019). Null hypothesis was therefore accepted.

Table 24.2: Estimated Marginal Means of 3-way interaction effect of treatments, gender and stage of developmentDiastolic Blood Pressure (DIAST B.P) of University of Ibadan undergraduates

Treatment	Gender	Stage of Developmentt	Mean	Std. Error
Whole Body Vibration	Male	16-24 years 25 and above	69.167 72..860	7.343 2.774
	Female	16-24 years 25 and above	70.747 63.494	2.995 3.028
Resistant Training	Male	16-24 years 25 and above	74.537 74.157	5.147 2.197
	Female	16-24 years 25 and above	72.852 73.867	5.173 2.310
Control	Male	16-24 years 25 and above	000.000 75.056	.000 3.342
	Female	16-24 years 25 and above	73.223 74.515	3.658 2.305

Table 24.2 above shows the Estimated Means from 3-way interaction effect of treatments, gender and stage of developmentDiastolic Blood Pressure (DIAST B.P)of University of Ibadan undergraduates. Male adolescentsand young adults in the resistant training had the highest estimated mean value from the analysis above.

Ho 7b(vii): There will be no significant 3-way interaction effect of treatments, gender and stage of developmentPeak $VO_2$of University of Ibadan undergraduates.

Table 24.3: ANCOVA showing the significant 3-way interaction effect of treatments, gender and stage of developmentPeak VO_2 of University of Ibadan undergraduates

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta^2
Corrected Model	7643.317	11	694.847	15.872	.000	.767
Pretest	728.541	1	728.541	16.642	.000	.239
Main Effects:						
Treatment	2000.337	2	1000.169	22.846	.000	.463
Gender	920.878	1	920.878	21.035	.000	.284
Stage of Development	63.684	1	63.684	1.455	.233	.027
2-way Interaction						
Effects:	464.632	2	232.316	5.307	.008	.167
Treatment x Gender	89.528	2	44.764	1.023	.367	.037
Treatment x Stage of	115.033	1	115.033	2.628	.111	.047
Development						
Gender x Stage of	.382	1	.382	.009	.926	.000
Development	2320.223	53	43.778			
3-way Interaction	9963.541	64				
Effects:						
Treatment x Gender x						
Stage of Development						
\Residual						
Total						

In table 24.3above, it was observed that there wasno significant interaction effect of treatments, gender and stage of developmentPeak $VO_2$of University of Ibadan undergraduates ($F_{(11,53)}$ = .009, p>.05, η^2=.000). Null hypothesis was therefore accepted.

Table 24.4: Estimated Marginal Means of 3-way interaction effect of treatments, gender and stage of developmentPeak $VO_2$of University of Ibadan undergraduates

Treatment	Gender	Stage of Development	Mean	Std. Error
Whole Body Vibration	Male	16-24 years 25 and above	58.213 50.590	6.694 2.518
	Female	16-24 years 25 and above	33.475 34.151	2.802 2.732
Resistant Training	Male	16-24 years 25 and above	44.958 40.644	4.695 2.127
	Female	16-24 years 25 and above	28.029 33.025	4.766 2.024
Control	Male	16-24 years 25 and above	0.000 21.920	.000 3.065
	Female	16-24 years 25 and above	26.464 22.623	3.316 2.108

Table 24.4 above shows the Estimated Means from the 3-way interaction effect of treatments, gender and stage of development PEAK $VO_2$of University of Ibadan undergraduates. Major effect of treatment was observed first among adolescentsand young adult participants in the whole body vibration, then adolescents and young adult resistant training participants respectively from the analysis.

Summary of the results

(i) Arm strength was significant ($F_{(3,61)}$ = 33.908, p<.05, η^2=.526) . Post-hoc analysis shows that the direction of significance was between whole body vibration and control (p= .001) and between resistance training and control (p= .005) respectively. Participants in the WBV had a higher mean value of 52.711 while resistance training participants had 46.205; gender was also significant ($F_{(2,62)}$ = .000, p<.05, η^2=.307).

(ii) Body mass index (bmi) was significant ($F_{(3,61)}$ = 28.321, p<.05, η^2=.481). Post-hoc analysis in shows that the direction of significance was between whole body vibration and control (p= .000) and between resistance training and control (p= .012) groups respectively. Participants in the resistance training group had a higher mean value of 25.233while WBV group had 23.015; Stage of adolescent ($F_{(2,62)}$ = 5.315, p<.05, η^2=..079) was significant too.

(iii) Lean body weight (LBW) was significant ($F_{(3,61)}$ = 12.231, p<.05, η^2=.286) with WBV having a higher mean value of 48.951 than resistance training with 48.04.

(iv) Percent body fat (%BF) ($F_{(3,61)}$ = 9.364, p<.05, η^2=.235) was significant with resistance training having a higher mean value of 21.378[a]than WBV 19.421.

(v) Peak expiratory flow rate (PEF) ($F_{(3,61)}$ = 41.918, p<.05, η^2=.579) was significant. Post-hoc analysis shows that the direction of significance was between whole body vibration and control (p= .000) and between resistance training and control (p= .000) group respectively. Participants in the WBV with had a higher mean value of 6.053while resistance training participants had 5.652 respectively.

(vi) Forced vital capacity (FVC) ($F_{(3,61)}$ = 32.960, p<.05, η^2=.519) was significant and a post-hoc analysis shows that the direction of significance was between whole body vibration and control (p= .000) and between resistance training and control (p= .000) respectively. Resistance training participants had a higher mean value of 3.748 while WBV participants had 3.491respectively.

(vii) Forced expiratory volume in 1st second (FEV_1) ($F_{(3,61)} = 2.323$, $p>.05$, $\eta^2=.071$) was not significant.

(viii) Resting heart rate ($F_{(3,61)} = 3.451$, $p<.05$, $\eta^2=.102$) was significant, with a post hoc analysis showing that the direction of significance was between whole body vibration and resistance training (p= .033). Gender ($F_{(2,62)} = 1.572$, $p<.05$, $\eta^2=.025$) was significant, two-way interaction effect of treatment and gender ($F_{(6,58)} = 7.419$, $p<.05$, $\eta^2=.204$) and treatment and stage of adolescent ($F_{(6,58)} = 4.633$, $p<.05$, $\eta^2=.138$) were significant respectively.

(ix) Blood pressure (systole) ($F_{(3,61)} = 64.083$, $p<.05$, $\eta^2=.208$) was significant while two-way and three-way interaction effect were not.

(x) Diastole ($F_{(3,61)} = 3.124$, $p<.05$, $\eta^2=.093$) was significant while two-way and three-way interaction effect were not.

(xi) PeakVO_2($F_{(3,61)} = 25.201$, $p<.05$, $\eta^2=.452$) was significant with a post-hoc analysis showing that the direction of significance was between whole body vibration and control (p= .000) and between resistance training and control (p= .000) groups respectively. Mean value for WBV 41.367 was higher than that of the resistance training group 36.476. Gender ($F_{(2,62)} = 17.917$, $p<.05$, $\eta^2=.224$) was also significant, two- way interaction effect of treatment and gender ($F_{(6,58)} = 9.285$, $p<.05$, $\eta^2=.243$) was significant too.

DISCUSSION OF FINDINGS

The benefits of physical activities are well documented with its success attributable to the effectiveness of exercise prescription in manipulating the progression of the resistance stimulus, the variation and the individualization in the programme design; hence, such was the case in this study. Participants who took part in this study were more in their late adolescent stages, having more of females as part of the total number of participants in the study.

The average height of the participants was around 1.6 metres with a weight range value of 46 kilograms to 96 kilograms and a waist circumference measure ranging from 45 centimetres to 97 centimeters respectively. It was also revealed that 37 of the 65 participants were unfit based on findings from the comparison of the data from their anthropometric variable with a standardized fitness norm at the entry point. This had earlier been pointed out in the findings of Ansa, Odigwe and Anah (2001) thatconducted a study among Nigerian adolescents and found out that prevalence level of overweight and obesity were 4% for ages 13-15 years and 3% for ages 16-18 years respectively with higher values among the females.This is also in agreement with the findings of Akinpelu, Oyewole and Oritogun, (2008) whoequally reported prevalentvalues ranging from 0.9% to 2.7%.

The percent body fat norm value table shows that one–third (16 out of 25) of male participants in the age bracket 16-24 years had adequate fitness variable status prior to the training programme while both participants in the 25 years and above age bracket had inadequate fitness variable status for overweight and obesity, prior to the training. It was observed that the number of female participants with adequate percent body fat fitness values when compared with the norm value table was inadequate prior to the training, given that only 10 out of 37 (97.36%) participants within the age bracket 16-24 years had an adequate fitness variable status, while the participantin the 25 years and above age bracket did not possess adequate fitness variable at the entry point.

Furthermore, the peak VO_2performance capacity for male participants when compared to the norm table value as observed at entry point of the training was grossly inadequate. Participants at both age categories did not posses adequate cardiopulmonary fitness performance capacity while the peak VO_2performance capacity for female participants when compared to the norm table value at the entry point of training was inadequate too. It was observed however that their cardiopulmonary fitness performance capacity based on different age category fell below what was expected of each participant captured within the respective age brackets.

Findingfrom this study indicates that there was significant main effect of treatment on arm muscle strength of participants under study. Male participants had a higher estimated mean value than their female counterparts, an indication that gender was a factor to be considered in muscle strength improvement. Several studies had earlier established the fact that resistance training had a capacity of improving the strength of an individual, depending on training indices such as intensity and sessions of training. Findings from de Ruiter, van der Linden, van der Zijden, Hollander, de Haan, (2003) &Da Silva, Nunez, Vaamonde, (2006), found an increase in muscle strength and performance of participants. Findings from this study are in line with those of Bogaerts et al., 2007; Kawanabe et al., (2007); Machado et al., (2010); Tapp and Signorile, 2014), who suggested that WBV exercise could be an alternative exercise modality for eliciting muscle strength in older adults. It has also been established by the findings of Figueroa et al., (2010); Figueroa et al., (2012); Roelants et al., (2004), that there is an improvementin the strength of younger individuals following whole body vibration training. Consequently, the addition of vibration to exercise programmes has been shown to increase strength and power more than exercise programmes without vibration (Kawanabe et al., (2007); Ronnestad, 2004).

The effect of treatment on body mass index of participants was significant in this study. The finding can be corroborated by the submission of Esan, (2010)who affirmed that several investigations had been carried out on the effects of strength training on body weight, lean body weight and percent body fat and concluded that there were both significant and insignificant differences in their findings.

Also, Iro and Amassiatu (2007), Payne and Isaac, (2002) as reported by Ogbe, (2008) established that gender differentials exist in fat deposition pattern. However, gender was not significant from the findings of this study but while comparing the estimated mean value for both gender, it was observed that females had a higher mean value than their male counterparts. Also, stage of adolescents was found to be significant from the results of the study, with those within the late adolescent age bracket having a higher estimated mean value than participants who fell within the early adolescent age bracket. Ogbe, (2008), stated that older persons have higher body fat values even when they possess identical body indices with younger individuals of the same sex. Consequently he further revealed that females are more prone to overweight and obesity than males, stating that significant difference exist between males and females in early adult overweight and obesity presentation. Otinwa and Agbaraji, (2008), submitted that there was drop in the body mass index and body fat percent after six weeks intensive exercise. They further opined while stating Williams (2000) that exercise has been discovered to be an important and favourable adjunction to dietary pharmacological and surgical treatment of obesity. Similarly, Banz et.al, (2003),Pollocket. al, (2000), &Williams et.al, (2007) stated that there were other consensus documents and study reports showing that resistancetraining results in decreases in fat percentage, with the suggestion that this decrease in fat percent indicates a decrease in fat mass.

Peak expiratory flow from this study was found to be significant and this result is consistent with the findings of Nourry et., al (2005) who submitted that the improvements in expiratory flow parameters could be illustrated by one or both causes i.e. an increase in contractility or strength of the expiratory muscle, or alterations in the lung compliance and the balance in airways resistance. They also reported a significant increase in PEF and other variables of healthy prepubescent children after 8 weeks of high-intensity interval running training. Farid et al (2005) also found significant elevation in PEF with other pulmonary parameters. Consequently, treatment was found to have significant main effects on forced vital capacity of participants in this study. This is in line with the observations of Tartibian, Maleki, and Abbasi (2010), who found a significant rise in pulmonary parameters VC, FVC, MVV, FEF 2575%, and FEV1 after a 12-week of wrestling training. However, findings from this study revealed that treatment had no significant main effect on forced expiratory volume in first second of participants under study. Earlier submission made by Quanjer, (1983), posited that age is an unmodifiable risk factor for decreased cardiorespiratory function of an individual.He submitted that after 25 years of age, the average annual decline of FEV_1 will be about 26 ml/year for men and 22 ml/year for women.

However, participants within the late adolescent stage had a higher estimated mean value in their forced expiratory volume in first second measures than their counterparts. This has buttressed the sample characteristics of the participants in this study which indicates that about 79% are in their late adolescence and could be active. Cheng et al, (2003) showed that active persons had a higher FEV_1 than others. Multiple aspects may support improvement of the pulmonary function. Also,muscular imbalances-associated with inactivity causes a restriction in the thorax (Wright, Heck, &Langenkamp, 2003), and so exercise training maybe could have a compensatory effect on this situation; furthermore, reinforcement of the auxiliary respiratory muscle is another effect of regular exercise training (Boeckh-Behrens, Buskies, Loges&Winsen, 2002). It has also been shown in previous studies on asthmatic patients that physical exercise can increase the residual air flow and decrease the ventilation with reinforcement of bronchi expansion during an exercise (Farid, Azad, Atri, Rahimi, Khaledan, Talaei-Khoei, et al. 2005). In addition, improved pulmonary function following exercise training could be due to decreased airway resistance, increased airway caliber, and strengthened respiratory muscles as well as lung and thorax elasticity (Tartibian, Maleki, Abbasi**,** 2010). Resting heart rate was also found to be significant from findings of this study following effect of treatment on cardiopulmonary fitness variables. This is in line with the report of Kravitz, (1996) who submitted that in terms of chronic adaptations, there appears to be a reduction in heart rate following resistance training, which is considered beneficial to participants. However from this study, whole body vibration training had a higher estimated marginal mean value of training effect on participants under study than their counterparts in the resistant training group. In addition to that, Kerschan-Schindl, Grampp, Henk, Resch, et al. (2001) also indicated that wholebody vibration affects the cardiovascular system, which implies a positive effect.

For the effect of treatment on blood pressure, it was discovered that there was significant mean effect of treatment on the systolic blood pressure of participants under study. This finding can be supported with findings from two different studies conducted by

Rittweger, Beller,& Felsenberg(2000) & Just, Kautzsch, Reeg, et al (2001) who reported increases in heart rate, blood pressure, lactate, and oxygen uptake due to whole body vibration exposure. According to the authors, they posited that these outcome parameters are important to know, since they affect muscular fatigue during whole body vibration training. Consequently, both the American Heart Association (AHA) and the American College of Sports Medicine (ACSM) have endorsed the inclusion of resistance training as an integral part of an exercise programme for promoting health and preventing cardiovascular disease (Braith, & Stewart, (2006) and Williams, Haskell, Ades, Amsterdam, Bittner, Franklin, Gulanick, Laing & Stewart, 2007). They pointed out that in a meta-analysis on the effect of resistance training, published in 2005, it was suggested that moderate resistance training could become part of the non-pharmacological intervention strategy to prevent and decrease high blood pressure.

There was significant main effect of treatment in the peak respiratory volume of air of participants in this study. This finding is consisted with those of Rittweger, Ehrig, Just, Mutschelknauss Kirsch & Felsenberg(2002) having investigated the effects of different frequencies and amplitudes of vibration with different external loads on oxygen uptake found an increase of VO_2 proportional to the frequency increase (18, 26 or 34 Hz), stating that each vibration cycle evoked an oxygen consumption of approximately 2.5 Ml 2 kg-1 with 5 mm amplitude. Furthermore, VO_2 increased more than proportionally with amplitudes from 2,5 to 7,5 mm and with an additional load of 40% of the lean body mass attached to the waist, oxygen uptake likewise increased significantly.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

Sedentary lifestyle is associated withobesity, a global epidemic seenas one of the major causes of non-communicable chronic diseases and one of the leading causes of morbidity and mortality in both developed and developing countries. The fundamental cause of obesity and overweight is an energy imbalance between calories consumed and calories expended and many other factors of which the most prominent include physical inactivitylevel. Obesity is associated with less efficient cardiopulmonary function which has a multiplier effect on the general health. The search for a viable alternative training protocol to an existing training module was long overdue. The benefits of conventional training protocol and its importance to the general health of every adolescent are well documented, while the introduction of a new but effective alternative training protocol was novel.

Literature review for this study focused on the conceptual model and theoretical frame work where the study was hinged on and also, an empirical review of several literatures pertaining to the benefits derived by adolescents from the exposure to both the whole body vibration training and resistance training protocols. The study therefore examined the effects of 12 weeks whole body vibration and resistance training exposure on obesity, overweight and cardiopulmonary fitness variables of apparently sedentary University of Ibadan students.

Randomized pretest posttest control group experimental research design which adopted the 3x2x2 factorial matrix was the design for the study and descriptive statistics of mean, standard deviation, percentage and chats were used to analyze the demographic data while the inferential statistics of analysis of co-variance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The two experimental groups were exposed to treatment for a period of 12 weeks while the control group was placed on a placebo of 20 minutes on physical fitness lessons every forthnight.

Findings from this study revealed that whole body vibration training had a significant effect on the selected fitness variables of University of Ibadan students. It was however observed that existing conventional training type that was adopted as a second treatment equally had significant impact on the variables of study. Findings showed that treatment had no significant effect on forced expiratory volume in first second in the study. It was also revealed that gender and stage of adolescent were really not significant on some selected fitness variables from the analysis. However, they were observed to have had significant effect on other selected fitness variables of average and peak leg power, arm muscle strength, body mass index, resting heart rate and peak volume of oxygen consumed.

The last chapter focused on the sub-headings of summary, conclusion and recommendations made in the study, contributions to knowledge and suggestions for further studies on the research.

Conclusion

From the findings of this study, the following conclusions were drawn:

(1) Whole body vibration training was more potent in improving the arm strength of participants under study than resistance training. A further observation from the post hoc analysis showed that whole body vibration was a better training techniqueto be adopted in improving arm strength although, resistance training was also seen to have elicited an appreciable effect on the arm strength of participants.The mean value of participants in the whole body vibration also gave credence to this submission to have outweighed that of resistance training participants respectively.

(2) Resistance training was a better technique in improving the body mass index of participants in this study. Participants in the resistance training group had a better mean value as against those in the whole body vibration. However, whole body vibration was equally effective in eliciting an improvement on body mass index given the slight difference that was observed in the mean of participants in both group.

(3) The difference in the potency of the two treatments on lean body weight was very slim however; it was observed that whole body vibration was proven to be a better

option in eliciting required response from training, even better than resistance training technique when considering the mean value of both techniques.

(4) Resistance training was a better technique in improving the percent body fat of participants in this study. Participants in the resistance training group had a better mean value better than those in the whole body vibration. However, whole body vibration was also effective in eliciting an improvement on percent body fat of participants because there was only slight difference observed in the mean of participants in both treatment group.

(5) Treatment had an improvement on peak expiratory flow (PEF). Post-hoc analysis shows that the direction of significance was between whole body vibration and control and between resistance training and control group respectively. It was equally observed that whole body vibration and resistance training had equal contribution based on the finding from the post hoc analysis. However, participants in the whole body vibrationhad a higher mean value above resistance training on participants in the study. Therefore, whole body vibration was a better technique in the improvement of peak expiratory flow.

(6) Resistance training was a better technique in the improvement of forced vital capacity on participants. Post-hoc analysis shows that the direction of significance was between whole body vibration and control and also between resistance training and control group respectively. It was equally observed that whole body vibration and resistance training contributed equally to the improvement of selected variable. However, participants who took partin the resistance training had a higher mean abovethose in the whole body vibration in the study.

(7) Forced expiratory volume in 1^{st} second (FEV_1) was not significant. However, resistance training technique had a better effect on the forced expiratory volume in first second of participants above whole body vibration based on their mean scores. Therefore, resistance training was a better option in eliciting needed improvement on the forced expiratory volume in first second of individuals.

(8) Whole body vibration training was more potent in improving the resting heart rate of participants under study asagainst resistance training. A further observation from the post hoc analysis showed that whole body vibration was a better training

technique to be adopted in improving resting heart rateof individuals. The mean value of participants in the whole body vibration also gave credence to this submission becauseit outweighed that of the resistance training group respectively. Although, resistance training was also seen to have elicited an appreciable effect on the resting heart rate of participants.

(9) Resistance training was a better technique in improving systolicblood pressure of participants in this study. Participants in the resistance training group had a better mean value as against those in the whole body vibration. Resistance training should be adopted while training for an improvement in selected variable on adolescents.

(10) Resistance training was a better technique in improving diastolicblood pressure of participants in this study. Difference in the mean values provided support to this claim that resistance training should be adopted while training for an improvement in diastolicblood pressure of adolescents.

(11) There was improvement in the peak$Vo_2$of participants under study with a post-hoc analysis showing that the direction of significance was between whole body vibration and control and between resistance training and control groups respectively. Whole body vibration was a better training option for the improvement of peak volume of oxygen consumed based on the analysis of this study.

Recommendations

Based on the findings of this study, the following recommendations were made;

- Whole body vibration training should also be adopted especially when the interest is in the area of arm strength improvement due to its potency.
- Resistance training was better and should be preferred for the improvement of body mass index of participants.
- Whole body vibration was better and should be adopted for the improvement of body lean mass as an adjunct to resistance training.
- Resistance training was better in improving percent body fat and should be adopted for better training conditioning.
- A combination of whole body vibration and resistance training should be adopted in improving peak expiratory flow.

- Resistance training was better in the improvement of forced vital capacity on participants and should be adopted during training.
- Resistance training technique was a better option for forced expiratory volume in 1^{st} second and should be adopted during training.
- Whole body vibration training was more potent in improving the resting heart rate and is recommended for conditioning.
- Resistance training was a better technique and should be adopted in the improvement of systolicblood pressure during training.
- Resistance training broughtabout improvementin diastolic blood pressure and is recommended for exercise conditioning.
- Whole body vibration was a better training option for the improvement of peak volume of oxygen consumed and should be advocated fortraining.
- Whole body vibration training should be introduced to various fitness industries, research centers and tertiary institution laboratories to help in promoting wellness and healthy living and curtailing the scourge of sedentary living among persons that are at-risk.

Contribution to Knowledge

Findings from this study have contributed to existing body of knowledge in the following areas;

1. The study has established that whole body vibration training could serve as a viable alternative to conventional training module.
2. Also, outcome of this study has confirmed that training with the vibration machine at a regulated frequency and amplitude was a bail out to conventional aerobic training module in improving selected cardiopulmonary parameters.
3. Resistance training was also effective in bringing about an improvement in selected cardiopulmonary parameters of individuals.

4. It has also been established that gender and age could have some interaction on selected body parameters of individuals.

5. Individuals can engage in exercise work-out with little supervision on the whole body vibration machine and achieve their desired goals within a short period of time without the need to jog around the community.

6. Coaches and other experts in the fitness industry can adopt and adapt the use of whole body vibration to the already existing conventional training techniques for weight management programmes.

Suggestions for Further Study

- Future effort may seek to conduct research on both the paediatric and geriatric populations.

- Times series design can be adopted for a future study to enable researcher monitor rate of improvement in the course of intervention.

- Effect of whole body vibration can also be considered on other physiological and metabolic variables apart from those adopted in this study.

- A combination of whole-body vibration and resistance training may beopted for in order to establish best treatment option.

- Other variables may also be considered to serve as moderators in future study.

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APPENDIX I

CONSENT FORM

Completed in Duplicate:

IRB Research approval number: (ID: 2066)

Title of research: Effects of Whole Body Vibration and Resistance Training on Obesity, Overweight and Cardiopulmonary Fitness Variables of University of Ibadan Undergraduates.

Name: This study is being conducted by **Kelechi David BENSON** of the Department of Human Kinetics and Health Education.

Purpose of research: to investigate the effectsthat whole body vibrationand conventional exercise (resistance training) will have on obesity, overweight and cardiopulmonaryfitness variables of University of Ibadan Undergraduates.

Procedure of research(s): Participants werevolunteers and wererecruited for the study. They were randomly assigned into three groups (two experimental and a control group). Sixty- five participants were recruited for the study. Each participant in the experimental groups underwent either the whole body vibration training or the resistance training in their different groups, while the control group was placed on placebo i.e 20 minutes interactive session on physical activities lessons. In the event of an accident during training, participants were assured that medical attention wereon ground in order to allay any fear that might run through their minds. The researcher ensured that participants' clinic cards were kept close and also, the school's clinic is put in the know of the research work. The researcher's team includedboth physiotherapists and a medical doctor from within and outside the University. These experts assisted throughout the training and data collection process.

Expected duration of research: You are expected to be involved in this research for a period of three months, three times a week and one hour at each contact in the laboratory.

After being briefed by the researcher on the modality of the research, i express my willingness to participate in the research as a participant.

I voluntarily submit myself to the constraints and control of the research procedure, abide strictly by the instructions provided by the research, cooperate fully in the experiment and do my possible best to assist the researcher, collect reliable data for the research.

I …………………………………………… of ……………………………………….
(Name in full) (Name of dept)

N.B. Kindly specify; Cardiovascular ( ) Neuromuscular ( ) Metabolic conditions that would prohibit exercise ( ) Lower-body surgery within the past year ( ), Use of Medications for chronic Cardiovascular or Neuromuscular conditions ( ) and any conditions that made WBV training ill-advised.

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Signature of participant.	Signature of investigator/ witness
Date …………………	Date ………………...

APPENDIX II
DATA SHEET

Serial Number	Name/ID number	
01.	Date	
02.	Tester	
03.	Sex	
04.	Age	
05.	Height(in/m)	
06.	Weight (kg)	
07.	Waist(cm)	
08.	Heart rate	
09.	Systole B.P	
10.	Diastolic B.P	
11.	Peak Vo2	
12.	Muscle Strength	
13.	Flexibility	
14.	BMI	
15.	Percent Body fat	
16.	Lean Body Weight	
17.	Leg Power	
18.	Peak Exp. Flw Rate	
19.	Forced Vit. Cap	
20.	Forced Exp. Vol. 1st Sec.	

SKINFOLD MEASURES				
Sites/measures	Trial 1	Trial 2	Trial 3	Mean Value
Tricep				
Subscapula				
Biceps				
Supraillium				
Thigh				
Calf				

Laboratory Manual for Exercise Physiology by Gregory Haff and Charles Dumke; 2012

COUNTER MOVEMENT JUMP (LEG POWER) FLIGHT TIME		
IST TRIAL	2ND TRIAL	MEAN VALUE

CARDIO-PULMONARY PARAMETERS				
	Trial 1	Trial 2	Trial 3	Mean Value
Peak Exp. Flw Rate				
Forced Vit. Cap				
Forced Exp. Vol. 1st Sec.				

APPENDIX III

12 Minute Run Fitness Test Norm

Age	**Excellent**	**Above Average**	**Average**	**Below Average**	**Poor**
Male 20-29	>2800m	2400-2800m	2200-2399m	1600-2199m	<1600m
Females 20-29	>2700m	**2200-2700m**	1800-2199m	1500-1799m	<1500m
Males 30-39	>2700m	2300-2700m	1900-2299m	1500-1999m	<1500m
Females 30-39	>2500m	2000-2500m	1700-1999m	1400-1699m	<1400m
Males 40-49	>2500m	2100-2500m	1700-2099m	1400-1699m	<1400m
Females 40-49	>2300m	1900-2300m	1500-1899m	1200-1499m	<1200m
Males 50	>2400m	2000-2400m	1600-1999m	1300-1599m	<1300m
Females 50	>2200m	1700-2200m	1400-1699m	1100-1399m	<1100m

Source: Cooper, K.H. (1968), "A means of assessing maximal oxygen uptake," Journal of the American Medical Association, 203:201-204.

APPENDIX IV

Normative data for VO2max*(Female (values in ml/kg/min)*

Age	Very Poor	Poor	Fair	Good	Excellent	Superior
13-19	<25.0	25.0 – 30p.9	31.0 - 34.9	35.0 - 38.9	39.0 - 41.9	>41.9
20-29	<23.6	23.6 - 28.9	29.0 - 32.9	33.0 - 36.9	37.0 - 41.0	>41.0
30-39	<22.8	22.8 - 26.9	27.0 - 31.4	31.5 - 35.6	35.7 - 40.0	>40.0
40-49	<21.0	21.0 - 24.4	24.5 - 28.9	29.0 - 32.8	32.9 - 36.9	>36.9
50-59	<20.2	20.2 - 22.7	22.8 - 26.9	27.0 - 31.4	31.5 - 35.7	>35.7
60+	<17.5	17.5 - 20.1	20.2 - 24.4	24.5 - 30.2	30.3 - 31.4	>31.4

Table Reference: The Physical Fitness Specialist Certification Manual, The Cooper Institute for Aerobics Research, Dallas TX, revised 1997 printed in Advance Fitness Assessment & Exercise Prescription, 3rd Edition, Vivian H. Heyward, 1998.p48

Normative data for VO2max (*Male (values in ml/kg/min)*

Age	Very Poor	Poor	Fair	Good	Excellent	Superior
13-19	<35.0	35.0 - 38.3	38.4 - 45.1	45.2 - 50.9	51.0 - 55.9	>55.9
20-29	<33.0	33.0 - 36.4	36.5 - 42.4	42.5 - 46.4	46.5 - 52.4	>52.4
30-39	<31.5	31.5 - 35.4	35.5 - 40.9	41.0 - 44.9	45.0 - 49.4	>49.4
40-49	<30.2	30.2 - 33.5	33.6 - 38.9	39.0 - 43.7	43.8 - 48.0	>48.0
50-59	<26.1	26.1 - 30.9	31.0 - 35.7	35.8 - 40.9	41.0 - 45.3	>45.3
60+	<20.5	20.5 - 26.0	26.1 - 32.2	32.3 - 36.4	36.5 - 44.2	>44.2

Table Reference: The Physical Fitness Specialist Certification Manual, The Cooper Institute for Aerobics Research, Dallas TX, revised 1997 printed in Advance Fitness Assessment & Exercise Prescription, 3rd Edition, Vivian H. Heyward, 1998.p48

APPENDIX V

BODY FAT % MEASUREMENT CHART FOR *MEN*

AGE																		
18-20	2.0	3.9	6.2	8.5	10.5	12.5	14.3	16.0	17.5	18.9	20.2	21.3	22.3	23.1	23.8	24.3	24.9
21-25	2.5	4.9	7.3	9.5	11.6	13.6	15.4	17.0	18.6	20.0	21.2	22.3	23.3	24.2	24.9	25.4	25.8
26-30	3.5	6.0	8.4	10.6	12.7	14.6	16.4	18.1	19.6	21.0	22.3	23.4	24.4	25.2	25.9	26.5	26.9
31-35	4.5	7.1	9.4	11.7	13.7	15.7	17.5	19.2	20.7	22.1	23.4	24.5	25.5	26.3	27.0	27.5	28.0
36-40	5.6	8.1	10.5	12.7	14.8	16.8	18.6	20.2	21.8	23.2	24.4	25.6	26.5	27.4	28.1	28.6	29.0
41-45	6.7	9.2	11.5	13.8	15.9	17.8	19.6	21.3	22.8	24.7	25.5	26.6	27.6	28.4	29.1	29.7	30.1
46-50	7.7	10.2	12.6	14.8	16.9	18.9	20.7	22.4	23.9	25.3	26.6	27.7	28.7	29.5	30.2	30.7	31.2
51-55	8.8	11.3	13.7	15.9	18.0	20.0	21.8	23.4	25.0	26.4	27.6	28.7	29.7	30.6	31.2	31.8	32.2
56 & UP	9.9	12.4	14.7	17.0	19.1	21.0	22.8	24.5	26.0	27.4	28.7	29.8	30.8	31.6	32.3	32.9	33.3

LEAN IDEAL AVERAGE ABOVE AVERAGE

BODY FAT % MEASUREMENT CHART FOR *WOMEN*

AGE																		
18-20	11.3	13.5	15.7	17.7	19.7	21.5	23.2	24.8	26.3	27.7	29.0	30.2	31.3	32.3	33.1	33.9	34.6
21-25	11.9	14.2	16.3	18.4	20.3	22.1	23.8	25.5	27.0	28.4	29.6	30.8	31.9	32.9	33.8	34.5	35.2
26-30	12.5	14.8	16.9	19.0	20.9	22.7	24.5	26.1	27.6	29.0	30.3	31.5	32.5	33.5	34.4	35.2	35.8
31-35	13.2	15.4	17.6	19.6	21.5	23.4	25.1	26.7	28.2	29.6	30.9	32.1	33.2	34.1	35.0	35.8	36.4
36-40	13.8	16.0	18.2	20.2	22.2	24.0	25.7	27.3	28.8	30.2	31.5	32.7	33.8	34.8	35.6	36.4	37.0
41-45	14.4	16.7	18.8	20.8	22.8	24.6	26.3	27.9	29.4	30.8	32.1	33.3	34.4	35.4	36.3	37.0	37.7
46-50	15.0	17.3	19.4	21.5	23.4	25.2	26.9	28.6	30.1	31.5	32.8	34.0	35.0	36.0	36.9	37.6	38.3
51-55	15.6	17.9	20.0	22.1	24.0	25.9	27.6	29.2	30.7	32.1	33.4	34.6	35.6	36.6	37.5	38.3	38.9
56 & UP	16.3	18.5	20.7	22.7	24.6	26.5	28.2	29.8	31.3	32.7	34.0	35.2	36.3	37.2	38.1	38.9	39.5

LEAN IDEAL AVERAGE ABOVE AVERAGE

Some of the participants after the Cooper test in U.I Stadium, Awo

Researcher and one of his assistants taking the blood pressure readings of his participants

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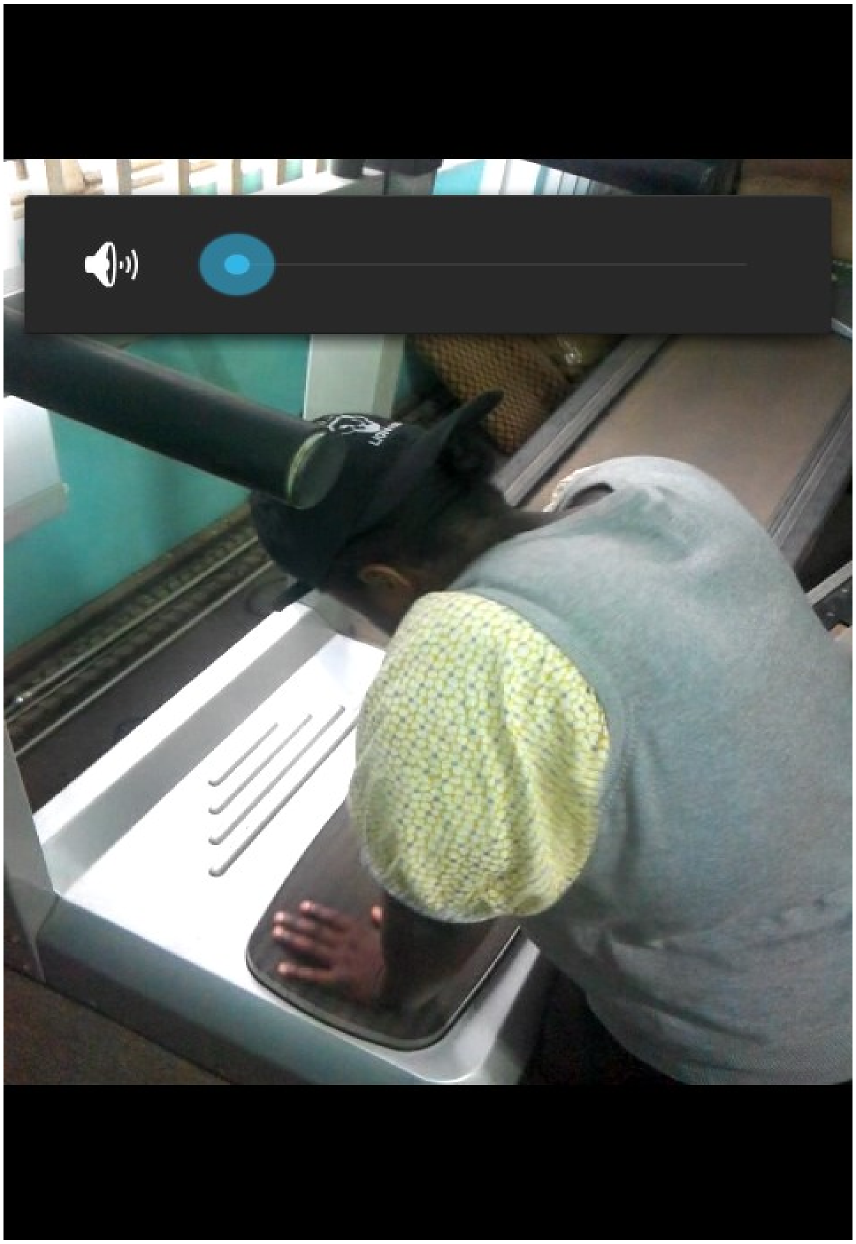
Participants after the Cooper test in U.I Stadium, Awo

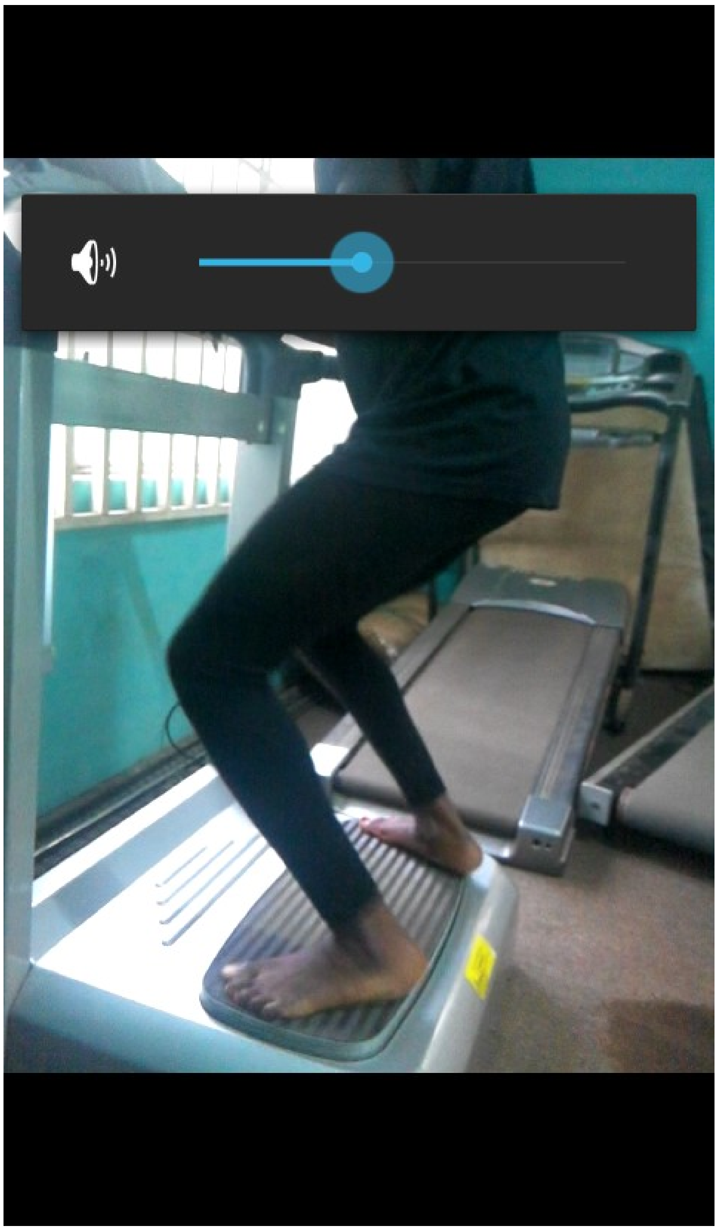
One of the participants placed on the whole body vibration machine



A participants taking session on the whole

A participanttaking session on the multi-gym

A participants taking session on the whole body vibration machine



Researcher wraping the air bag on a participant for blood pressure readings

Researcher monitoring different training sessions on the WBV and the Multi-gym facility

Biceps curl training on the multi-gym facility