EFFECTS OF DIFFERENT INTENSITY LEVELS OF CIRCUIT RESISTANCE TRAINING ON PHYSIOLOGICAL VARIABLES OF YOUNG FEMALE ADULTS IN PLATEAU STATE, NIGERIA

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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA,

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ZARIA, NIGERIA

JULY, 2015

DECLARATION

I hereby declare that this thesis has been written by me and that it is a record of my own research work. It has not been presented in any previous application for higher degree. All quotations and sources of information have been dully acknowledged by means of references.

CERTIFICATION

This thesis titled, "Effect of Different Intensity Levels of Circuit Resistance Training on Body Composition, Resting Blood Pressure and Resting Metabolic Rate of Young Female Adults in Plateau State", by DamueshAyubaAuta, meets the regulations governing the award of Master of Science (MSc.) Degree in Exercise and Sports Science, Department of Physical and Health Education, Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This piece of work is dedicated to:

Ruth Ayuba (Wife)

and

Nanribet and RetnaAyuba (Children),

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Abstract

The purpose of this study was to determine the effects of different intensities of circuit resistance training on body composition, resting blood pressure and resting metabolic rate of young female adults in Plateau state. A pre-test and post-test group research design was used for the study. Thirty (30) young female adult volunteers were randomly assigned into three groups of low, moderate and high intensity to 12 weeks of circuit resistance training (CRT) (LI, n=10, 29.7±3.04; MI, n=10, 28.6±2.12; HI, n=10, 29.3±2.43 years). The low intensity group exercised at 40% 1 repetition maximum while the moderate and high intensity exercised at 50 – 60% 1 repetition maximum. The exercise was conducted 3 times a week and 30 – 40 minutes per session. The variables measured were percent body fat (%BF), waist-to-hip ratio (WHR), lean body mass (LBM), resting systolic blood pressure (SBP), resting diastolic blood pressures (DBP), and resting metabolic rate (RMR). At the end of the 12-week training period, there was a decrease ($p<.05$) in the three CRT groups %BF (LI = -1.8%; MI = -2.4%; MI = -2.9%, (BP) LI = - 6/3, MI = -7/5, HI = -9/6, an increase in LBM (LI = 1.2kg; MI = 3.8kg; HI = 5.1kg), RMR (LI = 34; MI = 81; HI = 112). One way analysis of variance (ANOVA 1) and Scheffe's post hoc tests were used to find out the significance effects on the physiological variables of the participants. And the F-value of %BF, WHR, BMI, LBW, SBP, DBP and RMR were 20.78, 17.23, 2.58, 5.23, 4.25, 4.75 and 5.16 compared to critical value of 2.37 respectively. The results of the study revealed that the different intensities CRT had significant effects on body composition, resting blood pressure and resting metabolic rate of the participants. On the basis of these findings, it was recommended that: young female adults should train more at moderate or relatively high intensity circuit resistance programme. This would go a long way to generally improve their health and fitness.

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ABBREVIATIONS:

1. ACSM: American College of Sports Medicine
2. CRT: Circuit Resistance Training
3. %BF: Percent Body Fat
4. FFM: Fat-Free Mass
5. FM: Fat Mass
6. RMR: Resting Metabolic Rate
7. BMI: Body Mass Index
8. 1RM: 1-Repetition Maximum
9. WHR: Waist-to-Hip Ratio
10. LBM: Lean Body Weight
11. RPE: Rating of Perceived Exertion
12. EPOC: Excess Post exercise Oxygen Consumption
13. ANOVA: Analysis of Variance
14. N: Number of Subjects
15. SBP: Systolic Blood Pressure
16. DBP: Diastolic Blood Pressure
17. DF: Degrees of Freedom
18. HI: High Intensity Group
19. MI: Moderate Intensity Group
20. LI: Low Intensity Group
21. SPSS: Statistical Package for Social Sciences

OPERATIONAL DEFINATION OF TERMS

The technical terms used in this research are defined below in their operational terms:

1. **Body Composition:** The component parts of the body mainly fat mass and fat-free mass.
2. **Fat mass:** The amount of fat a person has measured in kilograms.
3. **Body fat percentage:** The proportion of a person's body that is made up of fat mass.
4. **Lean Body Weight:** The amount of weight that a person has that is not fat weight measured in kilograms. This weight is composed of mainly muscle, but also bone, organ, tissue and connective tissue.
5. **Overweight:** Body weight that has a high amount of fat.
6. **Resting Metabolic Rate:** the minimum amount of calories a person expends per day due to normal processes that are not related to his or her physical activity or thermal effect of food.
7. **Resting Blood Pressure:** The blood pressure of a person at a resting state
8. **Adult Female:** A woman who is at her reproductive stage
9. **Circuit Resistance training:** Different forms of exercises that involves moving a person's joint through its range of motion with an added weight for resistance organized in a circular form

CHAPTER ONE: INTRODUCTION

1.0Background of the Study

Circuit resistance training (CRT) is a great type of training routine that offers a number of benefits, especially for those who have a limited time for workout. Circuit resistance training is the practice of doing exercises with resistance and moving simultaneously from one station to the next with no real break in between exercise. It can be designed to increase muscular strength and power, muscular endurance, flexibility and to a limited extent, cardio-respiratory endurance. However, the physiological effects depend to a large extent on the type of circuit that is set up. For example, a circuit consisting only of weight-resistance exercises produce substantial gains in strength but only minimal gains in cardio-respiratory endurance (Gettman, Ayres, Pollock, and Jackson, 1978; Wilmore,Parr, Girandola, Ward, Vodak, Barstow, Pipes, Romero, and Laslie, 1978).

The physiological effects of circuit resistance training (CRT) onbody composition, resting blood pressure, and resting metabolic rate (RMR) of females have been of great interest to exercise scientists, dieticians, clinicians, coaches, allied sports and health professionals. Since early times, different kind of training programmes that may also be effective in improving health and fitness in females is the circuit resistance training (CRT). Corbin and Lindsey (1994), defined circuit resistance training as a routine of selected weight exercises or activities performed as possible in a sequence at circuitous individual stations.

In recent times, circuit resistance training (CRT) has become a popular and standard practice in research studies and a means to improve health and fitness profiles of females over the course of training. Thus, circuit resistance training is one of the training methods used to improve health and fitness.

Circuit resistance training is being favored by some fitness specialists and coaches in the training and conditioning of athletes and non-athletes, to improve their health and fitness.

Body composition is of great interest to coaches and athletes. Body size influences physical performance in many sports, health and fitness and appearance in women. Body composition consists of absolute and relative amounts of muscle, bone, fat tissues, water, minerals and other components of total body mass (Heyward, 1991). Researchers, in general, refer to body composition in terms of fat percentage (%BF), fat mass (FM) and fat free mass (FFM), with fat free mass as body structures excluding fat mass (Wilmore and Costill, 1994). Weight and body composition are directly related to energy balance. Energy balance is influenced by expenditure from physical activity, recreational and occupational exercises (Heyward, 1991; Jakicic and Otto, 2006). Studies suggest that regular exercise has positive effect on body weight, body composition and aging (Aderson&Jakicic, 2009; Heyward, 1991).A variety of exercise modes benefits body composition, improves health, and enhance exercise performance. Resistance training helps build fat-free mass as well as promoting positive changes in body composition (Ucan, 2013)

Body composition is an important component of physical fitness (Hagsromer, 2007). Body composition is divided into fat mass and fat free mass of the body (Hoeger, 1998, 2002;Musa, Lawal and Sarkinfawa, 2001). And that body fat increases with decreases in lean body mass. The focus of this study, is to find out whether body fat decreases and lean body mass is enhanced. Many young female adults today are very seriously concernedwith their weight as most of them are overweight and obese. There has been, therefore, a growing caloric anxiety around the world as thin standards of beauty and fat ways of living are emerging. People accumulate fat mass when their caloric intake is higher than their caloric

expenditure, although a lot of factors like genetics, metabolism, culture, and lifestyle confound the picture. This is understandable as overweight and obesity constitute a very serious health problem.

Exercise appears to play a critical role in body weight control management (Kraemer, Volek, and Clerk, 1999). It's important to consider the duration, intensity, and type of exercise (especially CRT) that should be recommended for weight loss.

It is more important to consider the way in which fat is distributed in the body than the total body fat to determine the risk of disease. Abdominal fat has been shownto be very closely associated with disease risk like coronary heart disease, hypertension and diabetes. Similarly, the waist-to-hip ratio (WHR) is closely associated with visceral fat. The influence of regional fat distribution on health is related to the amount of visceral fat present in the abdominal cavity (Venkateswarlu, 2011).Regional fat distribution is usually determined in a field setting by using the WHR and young female adults with WHR values of more than 0.85 are at greater risks of health hazards (Skinner, 2005).

Overweight and obese young female adults are at greater risk of cardio vascular disease, hypertension, diabetes, cancer, etc.Venkateswarlu (2011), explained that blood pressure is the forced exerted by blood against the walls of the blood vessel. The pressure is exerted as the blood is carried from the heart to all part of the body in blood vessel. Blood pressure is highest when heart contract during which the blood is pumped into the vessel called arteries. The force is cause by the pumping action of the heart through the arteries (McGlynn, 1999; Katch,McArdle and Katch, 1999). High blood pressure is a killer disease because it does not give any early warning. It increases the risk of heart diseases, stroke and kidney failure (Venkateswarlu, 2011).

Furthermore, a resting metabolic rate (RMR) is the rate at which the human body expended calories in order to maintain normal body processes in a resting state. It measures the number of calories the body requires to maintain itself at rest and it varies with body composition.RMR constitutes approximately 67% of the total body calories expenditure. The remainder of calories expended is through physical activity (23%) and thermal effect of food (10%) (Nieman, 2007), since RMR constitutes such large proportion of the constant amount of energy expended, a potential long term increase could significantly help overweight young female adultsto lose fat mass (FM). A strong correlation existed between RMR and a person's amount of fat free mass (FFM)(Byrne and Wilmore, 2001b). FFM includes the composition of the body muscle, bone, organ, and connective tissue. One of the most efficient ways of increasing FFM is through circuit resistance training. However, studies show that CRT raises RMR significantly more than aerobic training (Dolezal and Potteiger, 1998; Byrne and Wilmore, 2001b).

Although most research studies have examined the effect of endurance exercise on weight loss, CRT has recently become an important component of a successful weight loss programme by helping to preserve FFM and maximizingfat loss (Osterberg&Melby, 2000). Therefore, it is hypothesized that CRT can increase a person's RMR and improve the rate at which FM is lost during exercise and at rest.

RMR is affected not only by body size and age but also by body composition. Muscular individuals have higher RMR than obese individuals of the same weight. This is mainly because fat tissue is less metabolically active than muscle tissue (Venkateswarlu, 2011).

Many people today are engaged in doing things that do not increase energy expenditure, and this may be related to all – mortality such as low quality of life and higher risk of obesity, cardiovascular diseases, low back pain, diabetes and cancer. People accumulate fat mass when their caloric intake is higher than their caloric expenditure. Therefore, theaim of this study was to investigate the effects ofdifferent intensitiesCRT body composition, resting blood pressures and resting metabolic rate of young female adults.

1.1 Statement of Problem

Recent studies as well as a recent report in time magazine (2010) have shown convincingly that aerobic centered exercise provides little advantage in creating real body change. The benefit of exercise are well established but one major barrier for many is time. It has been proposed that short period resistance training could play a role in weight control by increasing resting energy expenditure but the effects if different intensities has not been widely reported.

Circuit resistance training has often been overlooked as a treatment for hypertension, primarily because it is known to elevate diastolic blood pressure during the circuit resistance exercise. However, recent review found that resistance training does not raise blood pressure level significantly (Kelley and Kelley, 2000). It was also reported that circuit resistance training, rather than the traditional repetition strength training, led to a greater reductions in blood pressure. This was likely to be due to the greater number of repetitions and reduced recovery utilized with circuit resistance training. Therefore, there is likely to be greater cardiovascular component to circuit resistance training.

However, there are controversies over whether high, moderate or low intensity exercise is more important for stimulating a decrease in body fat content and blood pressure. But lower exercise intensities work better at reducing blood pressure than higher intensities (Hagberg, Park and Brown, 2000).

Interest has surged in the use of CRT for improving general health and fitness. There is a relationship between body composition, blood pressure and resting metabolic rate. Resting metabolic rate can be influence by body composition (percent body fat and fat-free weight. The variability in RMR is predicted by fat-free mass (Kim and Park, 2003). Also body composition can influence blood pressure.

Unfortunately, findings are not always consistent, and this is likely attributable to differences in training programmes used in different studies, the volume and intensity of the training, the rest interval between the exercises and sets, and the selection of exercise stations can greatly influence the results of any circuit resistance training programme.

Despite decades of research into the effects of CRT on fat metabolism, there is still no clear understanding on how exercise helps to regulate FM. Although, exercise can improves the capacity of muscle to oxidize fat, which can lead to weight reduction. This study therefore, is to investigate the effect of different intensity levels of CRT programme has on fat oxidation.

The effects of CRT on blood pressure are varied due largely to differences in study design and exercise intensity which suggests that more research is necessary to clearly understand the role of CRT in blood pressure and weight management. Unfortunately, because of conflicting studies, the effects of different intensity levels of CRT on body composition, blood pressure, and RMR in young female adults is still unclear. Therefore,

the thrust of this study is to find outthe effects ofdifferent intensity levels of CRT on body composition, blood pressure, and RMR in young female adults.

1.3 Research Questions

In the light of the purpose of the study, the following research questions were raised for this study:

1. What are the effects ofdifferent intensity levels of CRT on body composition of young adult female adults?
2. What are the effects ofdifferent intensity levels of CRT onresting blood pressure of young adult female adults?
3. What are the effects ofdifferent intensity levels of CRT on resting metabolic rate of young adult female adults?

1.4 Purpose of the Study

The main purpose of this study was to determine the physiological effects of different intensity levels of CRT on body composition, resting blood pressure, and resting metabolic rate in young females in PlateauState. Therefore, the thrust of this study was to determine the effects of different intensity levels of CRT on body composition, blood pressure, and RMR inyoung females in Plateau State.

This training programme will be more time effective by alternating two or more resistance exercises that subjects worked different muscle groups of body parts (upper body, trunk and lower body) alternately called circuit resistance training. This CRT programme for women was designed to achieve desired curves such as tone arms, narrow waist and proportioned hips. CRT programme for women emphasize the lower body because women store fat in the hips and thigh, while working on the upper body tone

arms and sculpts the torso. The programme also targets the abdominal region where fat is also accumulated.

Specifically, this study was to assessed and compare:

a. Theeffects of different intensity levels ofCRT on body composition ofyoung female adults.
b. The effects of different intensity levels of CRT on blood pressure ofyoung female adults.
c. The effects of different intensity levels of CRT on resting metabolic rate of young female adults.

1.5 Hypotheses

For the purpose of this investigation, the following null hypotheses were formulated and tested.

Major hypothesis

There are no significant effects of different intensity levels of circuit resistance training on body composition, resting blood pressure and resting metabolic rate ofadult young females in Plateau State.

Sub-hypotheses

1. There is no significant effects of different intensity levels of circuit resistance training on body composition of adult young females in Plateau State.
2. There is no significant effects of different intensity levels of circuit resistance training on blood pressure of adult young females in Plateau State.
3. There is no significant effects of different intensity levels of circuit resistance training on resting metabolic rate of adult young females in Plateau State.

1.6 Significance of the Study

The present study was designed to determine the effects of different intensity levels of circuit resistance training on body composition, resting blood pressure and resting metabolic rate of young females in Plateau State.

This research would be of great significance in the field of sport medicine, education, health, sports, engineering and economic of our dynamic society. The results would be beneficialto coaches, physical educators, exercise and sports scientists, physical fitness specialists, health professionals as well as females interested in circuit resistance training programmes with the knowledge and skills required to successfully plan such programmes.

This study would serve students of exercise and sport science, physical and health educationists and other related field as reference guide in creating CRT programmes. It wouldbe of help to students taking exercise and sport science and other related courses to identify the best training method to use. Fitness and exercise specialists found the information on CRT useful in sensitizing women on fitness issues. The result on this CRT programme would aid women in making informed decisions on fitness and weight reduction issues. Young femaleswith well informed decisions would promote their fitness and health status, the fitness of their families and that of the community in general.

The study would also be of help to physical and health education teachers to have deeper understanding of CRT. By this study, teachers, fitness instructors, coaches, exercise and sport science specialist would come up with easier and more powerful programmes to improve health, fitness and sport performance. The study would be of great help for females who have tight schedule and may be able to dedicate their time for this short duration

exercise, thereby producing significant improvement and greater adherence to training programme for health and fitness.

The results of this study unveiled those resistance exercise beliefs by females that had over the years, subjected females to health and fitness disadvantage as females have always been victim of cultural and traditional ways of life beliefs. Exposure to such training would influence young females to resist those "old life's tale"(beliefs that cannot be proved scientifically) that negatively affect their health and fitness and imbibe acceptable fitness exercises that would promote the body health and fitness.

In the same vein, the outcome of the study would aid young females to take informed decisions against fallacious beliefs about CRT exercise during their fitness programme, as most of these beliefs are "old fashion" and cannot be authenticated.

The result of the study added to the pool of existing researches, and serve as reference materials for exercise specialists, fitness instructors, physical educators and health educators when they are planning workshops or seminars for their clients. The study would also benefit and help future researchers as their guide. It can also open in development of this study.

1.7 Delimitation of the Study

The study was conducted in KatonRikkos community in Jos metropolis of PlateauState. The researchfocused on the effects of different intensities CRT programmes on body composition, resting blood pressure, and resting metabolic rate of young femalesadults between the ages; 18 to 35 years who's BMI were between 25.0 and 29.9 $kg/m^2$of adult females in Plateau State.

The research was conducted in a fitness gym where the equipment and space for indoor wereavailable. The research period lasted for twelve (12) weeks. The research was also limited to the effects of low, moderate and high intensity levels of CRT on percent body fat, waist circumference, hip circumference, waist-to-hip ratio, lean body weight, resting blood pressure and resting metabolic rate of young females in Plateau State.

1:8 Limitations of the Study

In this study the researcher did not have control on the climatic condition and other family affairs. The subjects' previous physical activity was not controlled. Therefore, the researcher did not actually have the knowledge of what type of physical activity the subjects were participating prior to the training programmes. The subjects were recruited only within PlateauState.

The researcher did not have control on the diet of the subjects. However, since they live in the same climatic environment and of similar socio-economic status, it was assumed that their diets were similar. There was no personalized nutritional guideline to the participants.

1. Subjects were recruited from KatonRikkos community in Jos metropolis. The subjects of this study were volunteers and therefore were already motivated and looking for exercise benefits. This type of self-motivated individual may not truly represent the entire population.

2. Bias also existed in the sampling. There was geographical bias due to subjects selected were all young female adults and from KatonRikkos community in Jos metropolis.

3. The research was conducted on young female adults which lasted for 12 weeks. The 12 weeks was not enough for the researcher to observe all the physiological effects on their body. It would be better if was done in a longer time.

4. The number of the subjects decreased as the research progressed, as a result of lack of commitment and dropout, this made the population of the experimental group small.

5. The instruments used for the measurements might not provide accurate information because of some mechanical, technical or human error, weather condition, psychological factors and other magnetic materials.

6. It was unavoidable that in the process of this study, certain decree of subjectivity could be found. It would have been a sort of more objectivity if it was measured by more experienced technicians

CHAPTER TWO

2.0 Review of Related Literature

2.1Introduction

Literature on the effect of different intensity circuit resistance training on body composition, resting blood pressure, and resting metabolic rate of young females in Plateau State. A few of them are from Nigeria, but a great number of them are found in countries other than Nigeria. To guide this study, the review of related literature was presented under the following heading:

1. The concept of circuit resistance training
2. Effects of circuit resistance training on body composition
3. Effects of circuit resistance training on blood pressure
4. Effects of circuit resistance training on Resting metabolic rate

The chapter covered the concept of circuit resistance training, effects of circuit resistance training on body composition, effects of circuit resistance training on resting blood pressure, and effects of circuit resistance training on resting metabolic rate. The study's main topic is how different intensity levels of circuit resistance training will affect a females' body composition, resting blood pressure and resting metabolic rate.

2.1 Concept of Circuit Resistance Training

Circuit resistance training is a very popular methodology of fitness programme because it allows join together cardiovascular and strength training. There is an unlimited number of ways to organize a circuit workout. Studies have shown that mixing a resistance

training regimen with cardiovascular element will increase metabolism, therefore, burning fat and building muscle.

Corbin,Welk, Corbin, Welk and Sidman, (2008), explained that CRT consists of the performance of high repetitions of an exercise with low to moderate resistance, progressing from one station to another, performing different exercise at different stations. The stations are usually placed in a circle to facilitate movement. CRT typically used about 20 to 25 reps against a resistance that is 30 to 40 percent of 1RM for 45 seconds. 15 seconds of rest is provided while changing stations. 10 stations are used, and the participant repeats the circuit 2 to 3 times (sets). The amount of resistance used is based on a percentage of 1 Repetition Maximum (1RM) – the maximum amount of resistance or weight one can lift at once.

Circuit resistance training is a type of physical activity meant to increase muscular strength and endurance through application of weight or resistance on a muscles group through its range of motion. Increasing interest surrounds the use of circuit resistance training as part of a general health and fitness exercise programme. Indeed, many health-related benefits can be obtained from circuit resistance training. The American college of sports medicine has included resistance training in its recommendations for a general health fitness programme (ACSM, 1998).

Circuit resistance training is now recognized as important event for non-athletes who seek the health-related benefits of exercise. It was considered inappropriate for women and researches to discovered strength and endurance are beneficial to all. In recent years, considerable interest has focused on training for women and the widespread use of circuit resistance training by women either for sport or for health-related benefits. However, women may not be able to achieve peak values as high as those attained by men. This difference in

strength is attributed primarily to muscle size differences related to differences in anabolic hormones (Corbin, et al, 2008).

There is a common misconception about physical fitness concerns women in resistance or strength training. Because of the increase in muscle mass typically seen in men, some women think that a resistance or strength training programme will result in their developing large musculature. In recent years, improve body appearance has become the rule rather than the exception for women who participate in resistance training programmes.

The successful application of the overload principle as applies to resistance training necessitates the manipulation of intensity (load), frequency and duration (number of repetitions, sets and rest periods). Of these variables, intensity appears to have the greatest effect on the outcome of the programme. There is as inverse relationship between the load (weight) that can be lifted and the number of repetitions that can be performed. There is no single combination of repetitions and sets that produces the best results; rather the ideal number of sets is determined in both muscular strength and differences. To elicit improvement in both muscular strength and endurance, the American Collage of Sport Medicine recommends that a minimum of one set of 8-12 repetitions be performed with each muscle group's 2-3 daysweek-1. It may be more appropriate for women or sedentary individuals to perform 10-15 reps per muscle group.

The length of rest periods between exercise set is also related to the overload placed on muscles. If endurance is the primary goal, shorter (less than 30 seconds) rest periods should be used between sets (Fleck and Kraemer, 1987).

The frequency of circuit resistance training varies with the goals and training status of the individual. The American Collage of Sport Medicine currently recommends that

strengthening exercise should be 2-3 times a week to achieve the health related benefits of such exercises (ACSM, 1998b).

The duration – the amount of time spent in the weight room – will largely be determined by the number of repetitions, the sets and the number of different exercise performed. The average duration is 20-30 minutes per session, although many people spend more time than that. The training volume for resistance exercise is equal to the total amount of weights lifted in the training session and can be calculated as number of sets multiplied by the number of repetitions multiplied by the load (Baechle, 2000).

The principle of individualization states that responses to exercise vary among individuals because of factors unique to individual. In terms of resistance training, these factor include age, body size and type, initial strength and perhaps most importantly, genetic makeup (including fiber type distribution).

Carlyn (2011), explained that circuit resistance training is an exercise programme that has one on a circuit of exercises, completing one type of exercise and then moving along a series of exercises without taking breaks in between. It is incorporated into a variety of fitness and weight loss goals. CRT provides cardiovascular and body building exercises to give one an all-round workout. Programmes for women are designed to achieve desired curves such as tone arms a narrow waist and proportioned hips.

Circuit resistance training is a great type of training routine that offers a number of benefits, especially for those who have a limited time for workout. Circuit resistance training is the practice of doing exercises with resistance and moving simultaneously from one station to the next with no real break in between exercise. Circuit resistance training may be designed to increase muscular strength and power, muscular endurance, flexibility and to a

limited extent, cardio-respiratory endurance. However, the physiological effects depend to a large extent on the type of circuit that is set up. For example, a circuit consisting only of weight-resistance exercises produce substantial gains in strength but only minimal gains in cardio-respiratory endurance (Corbin, Welk, Corbin, Welk, and Sidman, 2012).

CRT is an effective exercise for building muscular endurance and cardiovascular endurance (Corbin et al., 2008). Although an increase in cardio-respiratory endurance can and does result from circuit training especially when cardio-respiratory activities are included in the stations, the magnitude of the increase is generally not as great as that from training programmes consisting entirely of aerobic activities.

From the limited research available, one may conclude that circuit resistance training is an effective training technique for altering muscular strength and endurance and to a limited extent, flexibility and cardio-respiratory endurance (Merie and Steven, 1998).

2.3 Effects ofCircuit Resistance Training on Body Composition

Body composition is of great interest to coaches and athletes. Body size influences physical performance in many sports, health and fitness and appearance in women. Body composition consists of absolute and relative amounts of muscle, bone, fat tissues, water, minerals and other components of total body mass (Heyward, 1991). Researchers, in general, refer to body composition in terms of fat percentage (%BF), fat mass (FM) and fat free mass (FFM), with fat free mass as body structures excluding fat mass (Wilmore and Costill, 1994). Weight and body composition are directly related to energy balance. Energy balance is influenced by expenditure from physical activity, recreational and occupational exercises (Heyward, 1991; Jakicic and Otto, 2006).Body composition is an important component of physical fitness (Hagsromer, 2007). Body composition is divided into fat mass and fat free

mass of the body (Hoeger, 1998; Musa, et al; 2001). Hoeger, (1988, opined that one of the common misconception about resistance training related to female is due to the increase in muscle mass commonly seen in male, many female feel that, resistance training are counterproductive because the will make them look muscular and less feminine. While the quality of muscle in male and female is the same, endocrinology differences will not allow female to achieve the same muscle (hypertrophy) size as male (Hoeger, 1988).

According to Gunen (2012), there are several different procedures for determining percent body fat. The most common techniques are: (a) hydrostatic or underwater weighing (b) bioelectrical impendence (c)skin fold thickness, and girth measurement.Bioelectric impendence analysis ranks quite favorably for accuracy and has overall ranking similar to those of skin folds measurement techniques.It is based on measuring resistance to current flow. Hands or feet are place on the electrodes or plates and low doses of current are passed through the body. This is because muscle has greater water content than fat; it is a better conductor and has less resistance to current.Measurement or estimates of relative body fat based on bioelectric impendence highly correlate with body fat measurement obtained through hydrostatic weighing (r= .90-.94) (Corbin, 2008; Werner and Sharon, 2007).

Hoeger, (1988), viewed percent body fat as both referring to fat and nonfat components of the human body. The fat component is usually referred to as fat mass or percent body fat. The nonfat component is referred to as lean body mass. The proper way to determine ideal body weight is through body composition, that is, by finding out what percent of total body weight is fat, and what amount is lean tissue. Once the fat percent is known, ideal weight can be calculated from ideal body fat, or recommended amount. That body fat decreases and lean body mass is enhanced in trained subjects. Circuit resistance

training programmes can increase fat-free mass and decrease the percentage of body fat. One of the outstanding benefits of resistance exercise, as relates to weight loss, is the positive impact of increasing energy expenditure during the exercise session and somewhat during recovery, and inmaintaining or increasing fat-free body mass as well as encouraging the loss of fat and body weight (Young &Steinhard, 1995).Shilstone, (2007), found that six weeks of high intensity circuit resistance training exercises could lose an average of 6lbs. of fat and gained an average of 10lbs. of lean muscle tissue. If one has limited time or injury that can prevent his/her from doing vigorous cardiovascular exercises, circuit resistance exercise can accomplish more in a short time and can see faster and greater results than if one worked only on muscle groups. 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, Freck, Triplett, & Kraemer, 1991).

Goodarzi and Kumar (2012), revealed that resistance training is more effective to decrease waist-to-hip ratio (WHR). Volume in resistance training is equal to the total workload, which is directly proportional to the energy expenditure of the workout. A finding highlighted resistance training that the energy expenditure following the higher total volume workouts appears to be higher, compared to other forms of exercise, and thus, further contributes to weight loss.

Few studies showed that the dietary intake of adult women was judged to improve as a result of their participation in a strength training programme (Tucker, 1996). Also, older women who strength trained three times per week for 16 weeks at 67% of 1 RM showed increase in strength and muscle area and a decrease in intra-abdominal adipose tissue (Treuth, 1995). Elderly women who participated in 18 weeks of intensive strength training

increase leg muscle mass and decrease intramuscular fats as measured by computer tomography (Sipila, 1994).Schuenke, Mikat, and McBride, (2002), demonstrated a circuit resistance training programme, made used of heavy weight, short rest periods and lasted 30 minutes, was able to stimulate increase fatburning for 48 hours after the workout. Melanson,Sharp, Seagle, Danahoo, Grunwald, Peters, Hamilton, Hill, (2005) concluded that exercise improves fat metabolism in muscle but does not increase 24 – hour's fat oxidation.Hawely, (1998), stated that low intensity exercises strongly stimulate lipolysis from peripheral adiposities, while the rate of fat oxidation is highest during moderate activities.

Paolin,Pacelli, Bargossi, Marcolin, Guzzinati, Neri, Bianco, and Palma, (2010), compared the effects of distinct protocols of fitness training on body composition, strength and blood lactate. There were forty participants (aged 50 – 65) randomly assigned to groups, circuit-low intensity group or to one of the three exercise treatment groups: Endurance group, Circuit –low intensity group and Circuit high intensity group. The groups exercised three times per week, 50 minute per session for 12 weeks. The results indicated that among the three groups high intensity groups showed the greatest reduction in body weight, percent body fat mass and waist line. The results of the 12 weeks different intensities of circuit resistance training programme concluded that high intensity exercise combined with endurance training in the circuit training technique is more effective than endurance training alone or low intensity circuit training in improving body composition.

Agbonlahor, Agwubike, Ikhioya, andOsagiede, (2009), compared the effect of moderate and high intensity resistance training on the body composition of overweight women (BMI=25-29.9Kg/m^2). A total of twenty (20) sedentary women were randomized into

two equal groups: the moderate intensity exercise group and the high intensity exercise group. The result of the study indicated that high intensity resistance training had more impact on the percent body fat and lean body weight of the participant than the moderate intensity resistance training programme. After the 12 weeks of training intensity resistance was more effective in improving body composition than moderate intensity resistance training.

Byrner,Ullrich, Sauers, Donley, Hornsby, Kolar, and Yeater, (1997, 1999), ran a 15-week investigation with subjects (women aged 18 to 34) engaging in exercise four times a week. The study was designed to compare continuous running aerobics exercise at low intensity (heart rate around 132 beats/min) and high intensity (heart rate around 163/min), with sessions lasting approximately 40 to 45 minutes for both groups. It was found that under the high-intensity aerobic exercise the percent body fat dropped from 27+7.0 to 22+4.0% ($p<0.05$), while in low-intensity group the reduction of 22+6 to 21+6% was not significant ($p>0.05$). He then concluded that the high-intensity physical exercise resulted in a significant percent of fat reduction even with no caloric restriction.

Circuit resistance training programmes can increase fat free mass and decrease the percentage of body fat. One of the outstanding benefits of resistance exercise, as it relates 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 (Young and Steinhard, 1995). It is more likely that body composition is affected and controlled by resistance training programmes using the larger muscle group and greater total volume (Stone, 1991). Volume in resistance training is equal to the workload, which is directly proportional to the energy expenditure of the work

bout. Total volume is determined by 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 load. For example, three sets of 12 repetitions with 50lbs would be expressed 3 x 12 x 50 = 1,800lbs 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.

Ferreira, Medeiros, Nicioli, Nunes, Shiguemo, Prestes, Verzola, Baldissera and Perez, (2010), a study was conducted to analyze the effects of CRT on FFM, FM and cytokine responses in sedentary women, 39.71 $\pm$3.8 years old (n=14). The protocol consisted of 3 sessions/week of circuit resistance training of 9 stations with alternating muscle groups. In each session, the subjects performed the circuit 2 times with a set of 8 – 12 maximal repetitions in each station, during 10 weeks. The body composition was analyzed at the end of the training; there was an increase in the FFM and a decrease in the FM, and no alterations of cytokines. These results showed that the proposed CRT improved body composition in women.

The ratio of waist-to-hip (WHR) is considered risky if it is greater than 0.80 for women. It is good to look at waist-to-hip ratio (WHR) and body mass index (BMI) together. WHR looks at the proportion of fat store on the body around the waist and hip. Most people store their body fat in two ways: around the middle and around the hips. Excess fat in the abdominal region poses a greater health risk than excess fat in the hip and thigh and is associated with a high risk of high blood pressure, diabetes, early onset of heart disease, and

certain types of cancer (American Dietetic Association, 2011). Storing fat centrally is particularly unhealthy.

Increasingly, scientific study of the body shape shows that whilst being overweight is certain bad for health, it may not matter where the weight is held; it had been thought that fat stored centrally was worsethan fat distributed elsewhere, such as the arms or hips, but recent evidence now suggests there is an increased if one is overweight or obese, no matter what one's shape is. A WHR of 0.7 for women has been shown to correlate strongly with their general health and fertility. Women with the 0.7 range have optimal levels of estrogen and are less susceptible to major diseases. While women with high WHR (0.80 or higher) have significantly lower pregnancy rates than women with lower WHRs (0.70-0.79), independent of their BMIs (Lassek and Gaulin, 2012). It was also found that a child's performance in cognitive tests correlated to their mother's waist-to-hip ratio, a proxy for how much fat she stores on her hip. Children whose mothers had wide hips and a low waist hip ratio scored highest. Lassek and Gaulin (2012),suggested that fetuses benefit from hip fat, which contains long chain polysaturated fatty acids, critical for the development of the fetus's brain. Singh (1993) argued that the WHR was a more consistent estrogen marker than the burst-waist ratio.

Physical activity and exercise training bring about beneficial changes that limit the progression of metabolic syndrome, with or without changes in total body weight and composition (Buemann and Tremblay, 1996; Welk and Blair, 2000). Westcott, (2007), provided an alternative conditioning programme for over fat men and women who cannot successfully complete a 1.5 mile run consisting of a 25 – minute strength training circuit 3 days a week produced significant improvement in all the assessment categories. The circuit

strength training programme consisted of 10 weight stack resistance machines (squat, press, leg curl, leg extension, chest press, seated now, shoulder press, pull down, triceps press, biceps curl and abdominal crunch) interspersed with 10 stationary bikes. Each resistance exercise was performed for 60 seconds of stationary cycling; taking 5 seconds transition time from station. After 12 weeks of supervised training, participants decrease their mean abdominal girth by 3.5cm, increased their mean 1- minute push – ups by 7.1 repetitions, and increased their mean 1 – minute abdominal crunches by 5.8 repetitions.

2.4 Effects ofCircuit Resistance Training on Resting Blood Pressure

Conservation 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). However, in 1983 the World Health Organization recommended the use of non-pharmacological approaches as a primary and adjunctive treatment for high blood pressure (World Health Organization, 1983). Of non-pharmacological approaches exercise is considered one of the most promising (Wallace, 2003). The role of exercise in the treatment of high blood pressure is supported by the AmericanCollege of Sports Medicine (ACSM) and American Heart Association.

Abah, Venkateswarlu,Chado and Gunen, (2011), found that there was a significant relationship between blood pressure and body composition. That BMI had a significant correlation with blood pressure, while correlation of waist circumference and blood pressure was proportional. Excess body fat is often associated with increased blood pressure and as such weight loss is often recommended as means of decreasing blood pressure. However, the reduction in blood pressure that occur following exercise treatment is not associated with

reduction body weight (ACSM, 1993) and therefore exercise does reduce blood pressure through reduction in body fat weight.The reduction in blood pressure following training is believed to be primarily due to:

1. Increase number of tiny blood vessels (capillaries) that transport blood to muscles and organs.
2. Opening of capillaries at rest causing improved blood flow.
3. Drop in heart rate at rest
4. A reduction in resistance to blood flow in the peripheral blood vessels – due primarily to relaxation of the blood vessels at rest.
5. A reduction in the levels of catecholamine's (stress hormones) in the blood. Stress hormones have constrictive effect on blood vessels.

During a resistance exercise out, systolic and diastolic blood pressure may show dramatic increases, which suggest that caution should be observed in persons with cardiovascular disease (Stone, 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 in the contraction (Fleck, 1988). More dynamic forms of resistance training such as circuit resistance training that involves moderate resistance and high repetition with short rests are associated with reductions in blood pressure.

In another study, Monteiro, (2008) compared two circuit training protocols: combine circuit training and circuit resistance training, and discovered that combine circuit training elicits a higher relative and absolute Vo_2 max and energy expenditure values than circuit resistance training for women. It was concluded that combine circuit training seems adequate

to produce cardiovascular improvements and greater energy expenditure than circuit resistance training for females.

Studies have shown decreases in diastolic blood pressure (Harris and Holly, 1987). No change in blood pressure (Hagberget al., 1984). The effects of circuit resistance on blood pressure are varied due largely to differences in study design, which suggests that more research is needed to clearly understand the role of resistance training in blood pressure management.

The magnitude of the cardiovascular response to circuit resistance exercise depends on the intensity of the load and the number of repetitions performed. As expected cardiovascular responses are greater when heavier loads are lifted, assuming the number of repetitions is held constant (Fleck, 1988; Fleck and Dean, 1987). For example, when subjects performed 10 repetitions of three different weights (light, moderated and heavy); blood pressure was highest at the completion of the heaviest set (Westcott and Howes, 1983). Systolic blood pressure increased while diastolic pressure does not change significantly with any of the sets. There is disagreement about the diastolic blood pressure response to circuit resistance exercise, some authors report an increase and other report no change (Fleck, 1988;Fleck and Dean, 1987; Westcott and Howes, 1983)

A recent meta-analysis that included 320 male and female subjects (182 exercise, 138 control) also examined the effects of chronic resistance training on resting systolic blood pressure and diastolic blood pressure in normotensive and hypertensive adults (Kelley, 2000). In general, the resistance training programmes following the guidelines recommended by the ACSM, 1998. Statistically significantly decreases of approximately 3mmHg were found for both SBP and DBP categories as a result of progressive resistance training.

Willey (1992), examined the effects of static (isometric) exercise training on resting SBP and SBP. In one trial, resting SBP by approximately 15mmHg as a result of four, 2-minute static handgrip contraction performed 3d.wk-1 for 8 weeks. Contractions were performed at 30% of maximal effort with a 3- minute rest between contractions, was performed 5d.wk-1 for 5 wks. Statistically, significant reduction of approximately 10 and 9mmHg were reported for resting SBP and DBP, respectively.

Ray and Carrasco (2000), examined the effects of four, 3- minute bouts of static handgrip exercise at 30% of maximal voluntary contraction performed 4xwk-1 in nornmotensive adults. Statistically, significant reductions of approximately 5mmHg were reported for resting DBP with no statistically significant reduction observed for resting SBP. The limited evidence available suggests static exercise reduces blood pressure in adults with elevated blood pressure.

Westcott (2007), examined the effects of an entire circuit of strength exercise on the participants' blood pressure readings. One hundred men and women performed one set of 8 – 12 reps to muscle fatigue on a typical 11 – station circuit weight stack machines. The result revealed that their mean blood pressure measured within one minute of completing the 11-station strength circuit was 117mmHg systolic and 65 mmHg diastolic. Basically, their post exercise blood pressure readings were the same as their pre-exercise readings, indicating excellent cardiovascular systems adaptations to a standard circuit strength training session.

More recently, another study examined participants' blood pressure response to a standard circuit strength training session over a 10 week exercise programme. A 140 men and women had their blood pressure measured before and within one minute after completing a 10 – station circuit of weight stack machines during the third, sixth, and ninth week of the

programme, the post exercise systolic pressure decreased about 1mmHg during the third - week workout, almost 3mmHg during the sixth - week workout, and approximately 5mmHg during the ninth – week workout.

These findings suggested positive and progressive cardiovascular system adaptations to standard strength training sessions with respect to systolic blood pressure. Nonetheless, over the 10- weeks training period, the programme participants recorded a 6.3mmHg mean reduction in resting systolic blood pressure and 2.2mmHg mean reduction in resting diastolic blood pressure. The beneficial changes in the subjects resting blood pressure reading are similar to thousands of men and women who have participated in a basic circuit strength training programmes.

Another recent review found that resistance training does not raise blood pressure level significantly (Kelley and Kelley, 2000). This review also reported that circuit resistance training, rather than the traditional repetition strength training, led to greater reductions in blood pressure. This was likely to be due to the greater number of repetitions, and reduce recovery, utilized with circuit resistance training. Therefore, there is likely to be greater cardiovascular component to circuit resistance training. Lower exercise intensities (<70% Vo_2 max~65-70%HR Max) work better at reducing blood pressure than higher intensities (Hagberg et al., 2000)

2.5 Effects ofCircuit Resistance Training on Resting Metabolic Rate

Resting metabolic rate is the lowest rate of energy expenditure that can sustain life measured after an overnight sleep in the laboratory under optimal conditions of quit, rest, and relaxation (Wilmore and Costil, 1994). RMR is a form of metabolism measurement that measures the amount of energy used by the body in a relaxed and rest state (Speakman, Krol,

and Johnson (2004). It measures the number of calories the body requires to maintain itself at rest. BMR and RMR are essentially the same measurement with a different preparation. To measure a BMR, the subject must fast over night for a period of 12 – 14 hours before the test is administered. RMR only requires 4 – 5 hours fasting period that does not have to be completed overnight (Nieman, 2007).

RMR accounts for approximately 60-75% of TDEE and represents the energy requirements of vital body functions. Seventy five and eighty percent (75-80%) of variability in RMR is predicted by fat-free mass (Speakman,Danahoo and Selman, 2004). Other variation in study topics includes resistance training versus aerobic training, intensity levels and very low calories diets. The purpose of this review of literature was to determine the effects of 12 weeks of circuit resistance training on RMRs among a group of overweight subjects.

There is evidence that the insidious process of muscle atrophy, resting metabolic rate, and fat accumulation may be reversed through regular resistance exercise. A study with 1,644 previously inactive adults and older adults showed an average lean (muscle) weight gain 3.1lbs (assessed by skin fold calipers and ultrasound technology) after 10 weeks of circuit resistance strength training (Wescott&Winett 2006). Other studies have reported similar lean weight gains accompanied by 7% to 8% increases resting metabolic rate.

Dolezal and Potteiger (1998), examined the changes on basal metabolic rate, body composition, VO2 Max, muscular strength and urinary urea nitrogen execration through 10 weeks of concurrent resistance and aerobic training. The subjects included 30 active males, ages 20±1.6 years that were randomized into a resistance only, endurance only or a combined resistance and endurance training group. The result of the study indicated a significant

increase in basal metabolic rate in the resistance only group from 7613.3±968.7 to 8090.8±951.2K/DAY. Adversely there was a significant decrease in basal metabolic rate in the endurance training group from 7231.2±554.1 to 7029.7±666.4KJ/day. The changes in resting metabolic rate were consistent with changes in FFM (Dolezal and Potteiger, 1998). The subjects did not include overweight participants or females. This study is more applicable for healthy males rather than obese population.

A related study that emphasized the intensity of exercise also compared the RMR of aerobic and resistance training subjects. The 12 weeks study by Broeder,Burrhus, Svanenik, and Wilmore (1992b) compared the effects of high intensity endurance programme to a high intensity resistance training programme on RMR. There were 47 male subjects randomly assigned to a control group, resistance or endurance training group. The result of the study indicated that intervention proved to create significant differences in RMR ($P<0.050$). However, the post training data for fat free mass for the resistance training group (65.9±2.6Kg) indicated significant differences from its pretreatment data (65.8±2.4Kg) and from the post treatment value in the endurance training group (64.7±2.2Kg) (Broeder, 1992b). The study indicates that the resistance training group increased in fat free mass significantly over the control and the endurance groups. However, the results did not indicate a significant change in RMR for the resistance training group. Perhaps the study was not long enough in duration to effect caloric expenditure rates.

Byrne and Wilmore (2001a) focused not only on the intensity but also different modes of exercise and their effects on RMR. The relationship between different levels of resistance and aerobic exercise intensities were studied. The study included 61 women between the ages of 18 and 46 years, who were grouped as untrained, moderately trained or

highly trained or aerobic or resistance exercise. Subjects were grouped directed towards the subjects' workout routines. The results of the study indicated that there were no differences in RMR between aerobically and resistance trained subjects (P.05). There was a trend, however for the subjects' RMR to increase as the intensity training levels increased (Byrne and Willmore, 2001a). The characteristic is probably due to a high amount of fat free mass in the highly trained group compared to both the moderately trained and the untrained groups. As the groups' amount of FFM mass increase in RMR was observed (P.05). The untrained group had a FFM of 44.5±0.9 Kg, the moderately trained group had 47.6±0.9Kg and the highly trained had 69.8±0.8Kg of FFM (Byrne and Willmore, 2001a). Therefore, according to statistics and the fact that resistance training has more bearing on FFM than endurance exercise, resistance training is the logical mode of exercise that may influence metabolic rates.

Hunter,Byrne, Sikikul, Fernandez, Zukerman, Darnell, and Gower, (2008), observed resistance training as a means of increasing energy expenditure among men and women. The purpose of the study was to examine the effects of a 26 weeks resistance training programme on resting energy expenditure among older adults. The subjects included 15 males and females whose ages ranged from 61 – 70 years. The results of the 26 weeks resistance training programme concluded that resting energy expenditure significantly increased from 5388±520 to 5753±560KJ/day with a current significantly increase in FFM from 50.0±10.1 to 52.0±10.7Kg (Hunter et al. 2008). This study suggests that an increase in FFM will increase a person's RMR. However, there are limitations of this study in regards to application in obese adults. The subjects in this study were of older adults.

Osterberg and Melby (2000), examine the effect of acute resistance exercise of post exercise O_2 consumption and resting metabolic rate in young women. The subjects participated consist of 7 females with an average age of 27 years – 66 inch height and 141.5 weight (pounds) and body fat of 18.3%, ten different exercises of 5 sets- 10 to 15 repetitions in 4 minutes. The exercises include bench press, bent –over row, leg extension, leg military press, sit-ups, biceps curl, triceps extension; lungs and lateral raise. The result revealed that average RMR was 4.2% higher 16 hours following exercise when compared to the pre-workout RMR. The authors concluded that intense resistance training produces modest, but prolonged elevation of post exercise and metabolic rate in women.

Holtom, (1999) have shown that a high intensity, intermittent, high-intensity weight training appears to have the greatest effect on EPOC. Also, it appears that resistance training produces greater EPOC responses that aerobic exercise (Burleson, 1998). (Melby, 1993; Laforgia, 1997) an individuals who perform high volume (2-5 sets of 10 to 15 repetitions at 60 – 70% 1-RM) resistance exercise will see minimal weight management benefits from EPOC (Osterberg and Melby, 2000).

2.5 Summary

Circuit resistance training is a type of physical activity meant to increase muscular strength and endurance through application of weight or resistance on a muscle group through its range of motion. The use of resistance training has become part of a general health and fitness exercise programme. Indeed, many health-related benefits can be obtained from circuit resistance training.

Studies have shown that mixing resistance training regimen with cardiovascular element will increase metabolism, therefore burning fat and building muscle. Researches

have shown that circuit resistance training programmes can increase fat-free mass, decrease percentage of body fat and waist-to-hip ratio.Bryner et al. (1997, 1999) ran a 15-week investigation with subjects (women aged 18 to 34) engaging in exercise four times a week. The study was designed to compare continuous running aerobics exercise at low intensity (heart rate around 132 beats/min) and high intensity (heart rate around 163/min), with sessions lasting approximately 40 to 45 minutes for both groups. It was found that under the high-intensity aerobic exercise the percent body fat dropped from 27+7.0 to 22+4.0% ($p<0.05$), while in low-intensity group the reduction of 22+6 to 21+6% was not significant ($p>0.05$). He then concluded that the high-intensity physical exercise resulted in a significant percent of fat reduction even with no caloric restriction.

Evidence indicates that circuit resistance training programmes reduces risk of diseases.Many studies have also shown that circuit resistance training has a long term effect on blood pressures by reducing it especially in normal and hypertensive individuals. A 140 men and women had their blood pressure measured before and within one minute after completing a 10 – station circuit of weight stack machines during the third, sixth, and ninth week of the programme, the post exercise systolic pressure decreased about 1mmHg during the third - week workout, almost 3mmHg during the sixth - week workout, and approximately 5mmHg during the ninth – week workout.

But some studies have shown no changes in blood pressures. The effects of circuit resistance training on blood pressures are varied due largely to differences in study design. The magnitude of the cardiovascular response to CRT depends on the intensity of the load and the number of repetitions performed.

Also, studies have shown that circuit resistance training aids in weight loss over time by increasing the fat-free mass (FFM) and resting metabolic rate (RMR) in overweight and obese subjects.Hunter et al. (2008) observed resistance training as a means of increasing energy expenditure among men and women. The purpose of the study was to examine the effects of a 26 weeks resistance training programme on resting energy expenditure among older adults. The subjects included 15 males and females whose ages ranged from 61 – 70 years. The results of the 26 weeks resistance training programme concluded that resting energy expenditure significantly increased from 5388±520 to 5753±560KJ/day with a current significantly increase in FFM from 50.0±10.1 to 52.0±10.7Kg (Hunter et al. 2008). Most results revealed that circuit resistance training is a logical mode of exercise that may influence resting metabolic rate in individuals.

CHAPTER THREE

3.0 Research Methodology

3.1 Introduction

The purpose of this study was to investigate the effects oflow, moderate and high intensities of circuit resistance training on percent body fat, waist-to-hip ratio, lean body weight, body mass index,resting blood pressure and resting metabolic rate of young females in Plateau State. This chapter presents the research design, population, sample and sampling techniques, instrument for data collection, procedures for data collection and statistical techniquesused for this research work.

3.2 Research Design

In order to achieve the purpose of this study, apre-test and post-test experimental research was usedto find out the effects of three different intensity levels of circuit resistance training on body composition, blood pressure and resting metabolic rate of young female adults.

3.3 Population of the Study

The Population of this study consisted of all young female adults in KatonRikkos community within Jos metropolisof Plateau State.The total population of young female adults were 456 (INEC, 2010). Thepopulation of the subjects were between the ages of 20 and 35 years.

3.4 Sample and Sampling Technique

Thirty young female adults within KatonRikkos community in Jos metropolisvolunteered to participate in this study and were randomly assigned to three

groups (low, moderate and high intensity). All thesubjects were informed of the purpose of the study, completed a medical history form, and signed a written consent form.

The sample of the study comprised of thirty (30) young female adults. Gwani (2009), opined that the type of research determines the number or percentage of the population to be used. Based on this, since the study was experimental, 30 young females constituted the sample for the study because the researcher felt that the sample size was adequate and manageable in an experimental research such as this one.

The procedure that the researcher employed in assigning groups into different intensities CRT was by chances. The selected young female adults were selected and further randomly assigned to three different training groups: low-intensity CTR group (LI), moderate-intensity CRT group (MI), and high-intensity CRT group (HI).The study used LI (N = 10), MI (N = 10), and the HI (N = 10). Eachgroup performed the same volume of CRT but at different intensity. There was no need of a control group, only three groups were used and exposed to the different intensity CRT programme. This helped to sustain the interest and full participation of the groups. The training programme lasted for 12 weeks. All measurements took place under laboratory conditions. All subjects were informed of the purpose of the study, completed a medical history form, and signed a written consent form. Participants were instructed to refrain from eating or drinking within two hours of the training and to empty their bladder before measurements were taken.

3.5 Research Instruments

The instruments used for this research were as follows:

1. **Stop watch** – The professional quartz timer (digital sport timer, ENCO KK-5853), Made in China was used for timing during the CRT exercises.

2. **Stadiometer** (GULFLEX Medical scientific England, RGZ-120), Made in England was used in measuring the weights and heights of the subjects.
3. **Blood pressures monitor** (OMRON MX2 Basic – OMRON HEALTHCARE Co. Ltd.) was used for assessing the resting blood pressure of the subjects.
4. **A universal gym machines** –A complete universal gym machines of 12 stations of resistance exercises (TROJAN) made in Germanywas used for the different intensity levels of circuit resistance training programmes arranged in a circular form.
5. **A Trojan pursuit computer monitor** (BC – 28115) – An exercise bike (Trojan pursuit computer monitor) was used to measure the fat percent of the subjects.
6. **Magnetic upright exercise bike** – Model: 1300. Made in China was used for warm-up exercise.

3.6 Description of the Tests

3.6.1 Height

Height was measured using the stadiometer. The height was measured to the nearest centimeter (0.5cm) with subjects in their minimal sport wears and without shoes. They were directed to stand with the back against the standing meter rule with feet together. The back of the feet (heels), buttocks, shoulders, and the back of the head touching the meter rule looking straight ahead. This was to ensure that the body wasas straight as possible. The measurement was taken and recorded. Each subject was assessed twice and the average computed.

3.6.2Weight

In measuring the weight of the subjects, a stadiometer was placed on a level, hard and uncarpeted floor. Before each measurement, the scale was adjusted at zero in order to weigh

accurately. Subjects were instructed to remove heavy clothes, shoes (in light clothing and no footwear), and any heavy accessories.They were asked to step on the scale and remain motionless in the middle of the scale platform with feet slightly apart and the body weight must be distributed equally on both feet, with arms relaxed and hanging down loosely at the sides of the body. The scale was very sensitive to movement and any movement would change the weight measurement. Therefore, subjects were instructed to stand very still or motionless in order to weigh accurately.

3.6.3 Body Mass Index (BMI)

This measures the weight in relation to the height. BMI equals a person's weight in kilograms (kg) divided by the height in meters squared (m^2). BMI was calculated using the standard formula: weight (kg)/height (m^2) and was used to evaluate health status according to World Health Organization (Santos, et al; 2008). For example, a woman with a weight 74kg and a height of 1.63m would have a BMI calculated as $74kg/1.63m^2 = 27.4kg/m^2$.

3.6.4Waist-to-Hip Ratio (WHR)

The waist and hip circumferences were measured with a standard measuring tape (capacity: 150 centimeters) following the guidelines recommended in the Anthropometric Standardization Reference Manual (Lohman, et al; 1988 in Mcreary, et al; 2006; Hivert, et al; 2007) and according to procedures described by Venkateswarlu (2007).

Waist Circumference:A tape measure was placed around the bare abdomen of the subjects at the belly button, just above the hip bone and it was ensured that the tape was snuggled, but did not compress the skin, and was parallel to the floor. Subjects were asked to relax and exhale. The waist circumference was taken and recorded in centimeters (cm) to one decimal place (Dudeja, et al; 2001 and Finer, 2006).

Hip Circumference:Hip circumference was measured at the greatest, posterior protuberance of the buttocks or the widest point of the buttocks, and read at the side. It was recorded to the nearest centimeters (0.5cm) for body composition assessment (fat distribution patterns).

WHR is the ratio of the waist circumference to the hip circumference. This ratio was determined by dividing the waist circumference by the hip circumference. WHR = Waist circumference (cm)/Hip circumference (cm).For example, a woman with a WC of 96cm and a HC of 110cm, her WHC will be 0.87. Waist-to-hip ratio between 0.80 – 0.90 were considered safe (Centre for Disease Control and Prevention).

3.6.5Percent Body Fat (%BF)

Body fat measurement was computed by using a Trojan exercise bike computer monitor (body analyzer). The subjects were directed one after the other to place the palms of their hands on both of the contact pads, and the personal data (gender, weight, height and age) of the subjects were imputed into the machine by the researcher. The monitor thenautomatically analyzed the data and displayed the fat percent, BMI, and RMR on the screen or LCD of the subject.

The bioelectric impendence analysis ranks quite favorably for accuracy and has overall ranking similar to those of skin folds measurement techniques. It is based on measuring resistance to current flow. Hands or feet are place on the electrodes or plates and low doses of current passed through the body. This is because muscle has greater water content than fat; it is a better conductor and has less resistance to current. Measurement or estimates of relative body fat based on bioelectric impendence highly correlate with body fat measurement obtained through hydrostatic weighing (r= .90-.94) (Corbin, et al, 2008; Werner and Sharon, 2007).

3.6.6Resting Blood Pressures (BP)

The systolic and diastolic blood pressures were taken with an automatic blood pressure monitor (Omron Automatic Digital Blood Pressure Monitor) endorsed by American Heart Association, model: MX2 Basic, according to the procedures of the British Hypertension Society (O'Brien,et al; 2002).Subjects were comfortably seated and relaxed.The cuff of the monitor waswrapped evenly and snugly around the bare left arm at heart height or level, 2.5 cm above the site of the bronchial pulsation. Measurement was done automatically using the control functions (START button) mark the onset of the inflation with a buzzing sound. On pressing the start button, the unitinflated and deflated the cuff automatically by increasing the pressure and gradually decreasing the pressure. At the end, the resting systolic and diastolic blood pressure values were displayed showing blood pressure and heart rate alternately. Hereafter, the screen displayed the three readings (systolic, diastolic and the heart rate) which was then recorded in the entry chart. During measurement subjects sat still,did not move and talk. Phones and other magnetic materials were kept far away during measurements. The blood pressure was recorded in mmHg. The pre-tests and post-tests were measured same time of the day and place.

3.6.7 Resting Metabolic Rate (RMR)

RMR was estimated using a prediction equation of Katch, McArdle and Katch formula: RMR = 370 + [21.6 x lean body weight in kg] (Katch,McArdleand Katch, 1999).Calculating RMR was based on body fat percentage. Since the body fat percentage of a subject was known, to find the lean body weight using body fat percentage. The weight of the subject was multiplied by the body fat percentage and divided by 100. Then the value obtained was subtracted from the total body weight of the subject. For example, a subject

who weighed 70kg and a body fat percentage of 25 i.e. 70 x 25 = 1,750/100 = 17.5kg of weight coming from fat. Then17.5kg - 70kg = 52.5kg of lean body weight. The LBW is then substituted in the equation (Katch-McArdle and Katch formula) as RMR = (LBW x 21.6) + 370 = (52.5 x 21.6) + 370 = 1504 calories (Coleman, 2011).This formula takes into accountincrease or decrease in lean body mass into consideration. Therefore, theformula was used for RMR could be determined based on lean body mass because they are related (Byrne and Willmore, 2001a). RMR is one of the main components of energy expenditure and more muscles increases it. RMR is actually one major factor affecting our daily calories requirement. Therefore, for the purpose of this study, lean body weight was a very important variable that wasused in calculating the RMR of the subjects.

3.7 Training protocols

Table 3.7.1: Showing circuit resistance training programme with different exercise stations and intensity.

Exercise	Low intensity training group	Moderate intensity training group	High intensity training group
Leg press	3 *$_{20}$ (40% 1RM), 3 min	3 *$_{15}$(50% 1RM) 3min	3 *$_{10}$(60% 1RM),3 min
Bench press	3 *$_{20}$ (40% 1RM), 3 min	3 *$_{15}$(50% 1RM) 3min	3 *$_{10}$(60% 1RM), 3 min
Bent-knee sit-up	3 *$_{20}$ (40% 1RM), 3 min	3 *$_{15}$(50% 1RM) 3min	3 *$_{10}$(60% 1RM), 3 min
Lat pulls	3 *$_{20}$ (40% 1RM), 3 min	3 *$_{15}$(50% 1RM) 3min	3 *$_{10}$(60% 1RM), 3 min
Hanging knee raises	3 *$_{20}$ (40% 1RM), 3 min	3 *$_{15}$(50% 1RM) 3min	3 *$_{10}$(60% 1RM), 3 min
Knee extensions	3 *$_{20}$ (40% 1RM), 3 min	3 *$_{15}$(50% 1RM) 3min	3 *$_{10}$(60% 1RM), 3 min
Biceps curl	3 *$_{20}$ (40% 1RM), 3 min	3 *$_{15}$(50% 1RM) 3min	3 *$_{10}$(60% 1RM), 3 min
Knee flexion	3 *$_{20}$ (40% 1RM), 3 min	3 *$_{15}$(50% 1RM) 3min	3 *$_{10}$(60% 1RM), 3 min
Triceps extensions	3 *$_{20}$ (40% 1RM), 3 min	3 *$_{15}$(50% 1RM) 3min	3 *$_{10}$(60% 1RM), 3 min
Upright – rowing	3 *$_{20}$ (40% 1RM), 3 min	3 *$_{15}$(50% 1RM) 3min	3 *$_{10}$(60% 1RM), 3 min

Set, *Repetition (Resistance), Rest between sets

After completing the pre-test measurements, the three CRT groups participated for 12 weeks at 3 days per week in resistance exercise. The resistance training was a circuit training model that included 10 exercises. Thetraining protocol is presented in the table above and

shows thedifferent intensities CRTand reflected as the set, resistance, and rest interval, duration and number of repetitions. The exercises were performed on a universal gym machines with 10 stations: leg press, bench press, lat pulls, bent-knee sit-up, hanging knee raises, knee extensions, biceps curl, knee flexion, triceps extensions, and upright rowing, were completed within 10 minutes. The reason resistance exerciseswere usedinstead of body weight exercises, which are common in many circuit-training routines, was possible for the researcher to control the loading levels or the intensities of the training. Each training session began with 5 – 10 minutes warm-up and ended with a cool-down exercises during each training sessions. They also performed stretching exercises(triceps stretch, quadriceps stretch, side stretch, body rotation, knee-to-chest stretch, and back extension stretch) when taking transition time from station to station and between circuit sets.

The circuit resistance training exercises at the various stations consisted mainly of weight resistance exercise (universal gym machines) and they emphasized on the upper-body, lower body and abdominal region, alternating between upper and lower body exercises, so that while arms are recovering the legs were working. The machines had variable resistance which required less time to set by quickly using a selector pin to change resistance. The sequence of exercises were arranged in a clockwise so that no two consecutive stations of exercises involving same muscle group's follow each other i.e. alternative exercise for arms, legs, trunk, and between flexor and extensor muscle groups. There was 15 seconds rest interval of stretches (sit-and-reach stretch, triceps stretch, quadriceps stretch, side stretch, body rotation, knee-to-chest stretch, and back extension stretch) between stations.

Intensity for the different groups were determined by selecting a load equating to about 40% for LI, 50% for MI, and 60% for HI group of their 1-RM with minimal rest interval between sets. The groups and the intensities were determined by calculating the percentage of one repetition maximum (% 1RM) as follows: the low-intensity of 3 sets, 20 reps at 40% 1-RM max (40% 1RM), moderate-intensity of 3 sets, 15 reps at 50% 1-RM max (50% 1RM), and the high-intensity of 3 sets, 10 reps at 60% 1-RM max (60% 1RM). In this study, the three groups lifted different relative loads and completed the different amount of work, so they could be compared.

Borg's RPE scale (6 to 20) was also used in monitoring the intensity of the various exercises of the different groups. The selected exercise intensities were between an RPE of 10 to 11 (light) for low- intensity, 12 to 13 (somewhat hard) for moderate-intensity and an RPE of 14 to 16 (hard) for high-intensity group. Maximum numbers of repetitions for the various exercises were taken to muscular failure.A Rating of Perceived Exertion (RPE) was used in monitoring the exercise intensity of the training groups. And subjects were subjectively rated on how hard they felt when they were exercising (lifting the weights). Their feelings were reflecting the total amount of exertion and fatigue, combining all sensations and inner feelings of physical stress, effort, and fatigue. The RPE scale gave a quantitative identification of the feeling of fatigue. The training sessions lasted for 30 minutes and for 3 alternating days(Monday, Wednesday, and Friday per week). The exercises were performed with the Trojan universal Gym machines.All workouts sessions were supervised by the researcher and with the help of three (3) assistants who also provided sometechnical assistance, motivation, advice and encouragement to the subjects. The

groupsperformed different intensity of CRT programme for the 12 weeks,and were requested not to change their eating patterns during the period of the training.

Furthermore, subjects always warmed-up prior to each training session. The warmed-upconsisted of five minutescycling of low intensity on a cycle ergo meter, followed by a three minutes of static stretching. The warmed-up procedure was held constant throughout all the testing sessions. All the pretests wereconducted one week before the exercise training period. In this session, after 5-minutes warmed-up, 3-5 1RM attempts were performed with two minutes of rest between each attempt. After each repetition, the weight was increased by 2.5-10kg for each repetition until failure; the final weight to be lifted is the 1RM (Cotterman, 2005), then 60%, 50% and 40% of 1RM was selected for the loadsused for the HI, MI and LI group. After three weeks of training, the subjects' 1RM loads were measured again in order to determine their loads for the next three weeks continuously.

3.8 Procedure for Data Collection

The purpose of the study was to find out the effects of different intensity levels of circuit resistance training on body composition, blood pressure, and resting metabolic rate of adult females in Plateau State. Young female adults in KatonRikkos Community within Jos metropolis of Plateau state volunteered and came to Jos Christian Mission International (JCMI) Recreation Centre for test and were tested by the following sequence for all the groups:

- Measurement of blood pressure
- Recording of weight
- Measurement of height
- Analysis of percent body fat

- Waist circumference
- Hip circumference

These tests were conducted in the morning preceding the commencement of training.

The researcher explained to the participants the details concerning the 12 weeks training pogrammes. Only those who volunteered were screened for the study.Measurements were taking on two different occasions: before the initiation of training T_1 (pre-test), and after completion of the 12 weeks circuit resistance training T_2 (post-test) was conducted on their physiological variables.

The researcher with the research assistants carried the pre-test and the post-test on the dependent variables which were recorded according to training groups. Three days were used for the pre-test, a day for a particular group. After the pre-test, the researcher described to the subjects in details all activities and procedures that would be involved during the training programmes to the various groups. A day was scheduled for each group to familiarize themselves with their training programme.

At the end of the 12 weeks the subjects in the different groups were tested (posttest), the researcher with the research assistants conducted another test (posttest) on the subjects. The tests were administered to the training groups by the researcher and one research assistants in each group. During the post test the research assistants were repositioned to eliminate test bias. The scores of the measurements were collected on the spot.

3.9 Research Control

The following conditions were observed:

1. The researcher ensured that all measurements conducted on the same day and time to ensure equaltesting conditions for all subjects.

2. The purposes of each test item were explained to the subjects before the commencement of the test and exercise training programme.
3. The time and place for the commencement of the test range from 6.00am to 9.00am or 4.00pm to 6.00pm each test and training day, because this was the time of the day that is more convenient to exercise and the temperature was suitable for physical activity.
4. Subjects were advised to have their meal as normal during the training period.
5. All subjects were encouraged to wear sport outfit that were appropriate for the test and training conditions.
6. All trainings were preceded by ten (10) minute warm-up.

3.8.1 Researcher Assistance:

Physical and health education teachers, medical students and fitness instructors served as research assistants for this research. They were given adequate instructions by the researcher on the purposes of each test item and protocol involved. This was to guide them in their evaluation of different parameters of the subjects assigned to them. They were involved in recordings, taking measurements, supervision of participants during the training sessions.

3.9 Statistical Techniques:

Description statistics wasto calculate mean and standard deviation (mean$\pm$ SD). While One Way Analysis of Variance (ANOVA 1) was used to test hypotheses, for there were three levels of independent variable (low, moderate and high intensity circuit resistance training) on percent body fat, body mass index, waist-to-hip ratio, lean body weight, resting blood pressure and resting metabolic rate of young female adults.The decision to reject or retained the null hypothesis was made at an alpha level of 0.05.AScheffe post-hoc test

wasfurther used to locate where the differences occurred between the groups.The statistical software (SPSS 20.0 version) was used to analyze the data collected.

CHAPTER FOUR

4.0 Results and Discussion

4.1 Introduction

This chapter presents and discusses the findings of the study, which was to investigate the effects of different intensity levels of circuit resistance training on percent body fat, body mass index, waist-to-hip ratio, lean body weight, resting blood pressure and resting metabolic rate of young femaleadults in Plateau State. The findings were based on analysis of data obtained fromthirty (30) subjects who successfully completed 12 weeks of different intensitycircuit resistance training. The result presented useddescriptive statistics, one way analysis of variance (ANOVA 1) and Scheffepos hoc test in the chapter.

4.2 Results

Before presenting the results according to the research questions and null hypotheses, the information on the demographic characteristics of the subjects are presented in table 4.2.1

Table 4.2.1: Range, Means and Standard Deviation of Demographic characteristics of subjects

		N	Mean	SD	Range
Age (yrs.)	Low	10	29.7	3.04	20-34
	Moderate	10	30.1	2.12	23-35
	High	10	29.3	2.97	21-34
Body weight (kg)	Low	10	72.5	2.30	62-80
	Moderate	10	69.4	2.64	60-79
	High	10	70.2	3.14	61-81
Height (cm)	Low	10	163.4	2.54	157-170
	Moderate	10	164.2	2.68	155-168
	High	10	163.6	2.59	156-167

The result shows that the age of the different groups ranged from 20-34, 23-35, 21-34 years with mean and standard deviation of 29.7 $\pm$ 3.04, 30.1 $\pm$2.12, 29.3 $\pm$ 2.97 for the low, moderate and the high intensity group respectively, while the height range 157-170, 155-168, 156-167cm with 163.4 $\pm$2.54, 164.2 $\pm$2.68,163.6 $\pm$2.59cm for the low, moderate and high intensity as mean and standard deviation respectively.It was also found that thebody

weightranged from62-80, 60-79, 61-81kg with mean and standard deviation of 72.5± 2.30kg, 69.4 ± 2.64kg,70.2 ± 3.14kg for low, moderate and high intensity group respectively.The age, standing height and the body weight revealed no much variation among the subjects.

Table 4.2.2: The means, standard deviation and mean difference of different intensities circuit resistance training on the physiological variables of young female adults

		Pre test		**Post test**		**Diff**
Variable	**Intensity Group**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Diff.**
%BF	Low	30.6	3.50	24.5	1.92	-6.1
	Moderate	31.4	3.67	24.2	2.71	-8.2
	High	32.3	3.07	23.4	.85	-8.8
WHR	Low	.85	.01	.84	.01	-.01
	Moderate	.84	.01	.82	.01	-.02
	High	.84	.01	.81	.01	-.03
BMI	Low	27.3	1.64	25.7	1.46	-1.0
	Moderate	27.9	1.93	26.8	1.66	-1.6
	High	27.9	1.50	27.1	1.48	-1.8
LBW	Low	50.5	2.99	51.3	3.55	1.2
	Moderate	50.1	2.97	53.9	3.39	3.8
	High	50.8	3.08	55.9	3.57	5.1
SBP	Low	112	9.71	106	7.90	-6.0
	Moderate	115	7.79	108	7.37	-7.0
	High	120	6.81	111	6.48	-9.0
DBP	Low	80	7.74	77	6.87	-3.0
	Moderate	78	5.36	73	3.58	-5.0
	High	79	2.71	73	2.35	-6.0
RMR	Low	1451	64.66	1485	81.17	34
	Moderate	1453	63.89	1534	73.74	81
	Highs	1466	66.50	1578	77.04	112

Table 4:2:2 shows the descriptive statistics of the effects of different intensities CRT on the subjects assessed variables. The table presented the pre training, post training and post training difference means and standard deviation for the three groups (low, moderate and high intensity) for %BF, WHR, BMI, LBW, SBP, DBP and RMR of the subjects. The mean difference of pre training and post training was calculated for the groups in %BF, WHR, BMI, SBP, and DBP and the result gives amean difference (reduction) in %BF, WHR, BMI,

SBP, and DBP in all the groups with scores of -6, -8.2, -8.8;-.01, -.02, -.03;-1.0, -1.6, -1.8;-6, -7, -9; and-3, -4, -5 respectively. The result also gives a mean difference (increase) in LBW and RMR after the training. A standard deviation scores of the %BF, WHR, BMI, LBW, SBP, DBP and RMR were calculated for pre and post training respectively. The high intensity group shows high reduction in %BF (-8.8), WHR (-.03), BMI (-1.8), SBP (-9), and DBP (-5) compared to other groups.Therefore, there is significanteffects of low, moderate, and high intensity of CRT after 12 weeksof training.

TEST OF HYPOTHESES

Major Hypothesis

There is no significance effects of different intensity levels of circuit resistance training on body composition, resting blood pressure and resting metabolic rate of young female adults in Plateau State.

Sub-Hypothesis I

There are no significance effects of different intensity levels of circuit resistance training on body composition of young female adults in Plateau State.

Table 4.2.3: One-way analysis of variance (ANOVA 1) for the significance effects of different intensities circuit resistance training on body composition of young female adults.

Variable	Source	SS	DF	MS	F	P. Sig.
Percent body fat	Between groups	836.81	5	167.36	20.78**	.000
	Within groups	434.83	54	8.05		
	Total	1271.64	59			
Waist-to-hip ratio	Between groups	.011	5	.002	17.23**	.000
	Within groups	.007	54	.000		
	Total	.017	59			
Body mass index	Between groups	33.46	5	6.69	2.58**	.003
	Within groups	140.19	54	2.60		
	Total	173.66	59			
Lean body weight	Between groups	269.44	5	55.89	5.23**	.001
	Within groups	556.53	54	10.31		
	Total	825.96	59			

F (5, 54) = 2.37, P ≤ 0.05** = significant

The summary of ANOVA on the significance of the difference in body composition variables of the three exercise groups. The result on percent bodyfat, waist-to-hip ratio, body mass index, lean body weight shows a calculated F-values of 20.78, 17.23, 2.58, 5.23 are greater than the tab- value of 2.37 at 0.05 level of significance with 4 and 54 degrees of freedom. This means that there are significance effects of different intensities CRT on the body composition of young female adults. Therefore, the null hypothesis of no significance effects of different intensities CRT on the body composition of the young female adults was rejected. The significance of the F ratio therefore called for post-hoc analysis. The Scheffe's S-test was used to further determine the source of the difference. The summary result for the post-hoc analysis is presented in table 4.2.4, 4.2.5, 4.2.6 and 4.2.7.

4.2.4: Summary of Scheffe's post hoc test Results for differences in the Effectson the percent body fat of young female adults

Group	**N**	**Subset for alpha = .05**	
		1	2
1. High-post	10	23.4	
2. moderate-post	10	24.2	
3. low-post	10	24.5	
4. high-pre	10		30.6
5. moderate-pre	10		31.4
6. low-pre	10		32.3
Sig.		.986	.888

Uses Harmonic Means Sample Size = 10.00

The summary of Scheffe's post hoc test result shows that there is a significant difference between the pretest scores and posttest scores. This indicates that there was significant effects on the %BF of all the groups. Therefore, the different intensities CRT had training effects on percent body fat of the young female adults,and the significance decrease became evident after 12 weeks of training.

Table 4.2.5: Summary of Scheffe's post hoc test Results for differences in the Effectson the waist-to-hip ratio of young female adults

Group	N	Subset for alpha = .05	
		1	2
1. High-post	10	.81	
2. Moderate-post	10	.82	
3. Low-post	10	.83	
4. High-pre	10		.84
5. Moderate-pre	10		.84
6. low-pre	10		.85
Sig.		.336	.178

Uses Harmonic Means Sample Size = 10.00

The summary of Scheffe's post hoc test result shows that there is a significant difference between the pretest scores and posttest scores. This indicates that there was significant effects on the waist-to-hip ratio of all the groups. Therefore, the different intensities CRT had training effects on waist-to-hip ratio of the young female adults,and the significance decrease became evident after 12 weeks of training.

Table 4.2.6: Summary of Scheffe's post hoc test Results for differences in the Effectson the body mass index of young female adults

Group	N	Subset for alpha = .05
		1
1. Low-post	10	25.7
2. Moderate-post	10	26.8
3. High-post	10	27.1
4. Low-pre	10	27.3
5. Moderate-pre	10	27.9
6. High-pre	10	27.9
Sig.		.116

Uses Harmonic Means Sample Size = 10.00

The summary of Scheffe's post hoc test result shows that there is a significant difference between the pretest scores and posttest scores. This indicates that there was significant effects on the body mass index of all the groups. Therefore, the different intensities CRT had training effects on body mass index of the young female adults,and the significance decrease became evident after 12 weeks of training.

Table 4.2.7: Summary of Scheffe's post hoc test Results for differences in the Effectson the lean body weight of young female adults

Group	N	Subset for alpha = .05	
		1	2
1. Moderate-pre	10	50.1	
2. Low-pre	10	50.5	
3. High-pre	10	50.8	
4. Low-post	10	51.3	51.3
5. Moderate-post	10	53.9	53.9
6. High-post	10		55.9
Sig.		.244	.079

Uses Harmonic Means Sample Size = 10.00

The summary of Scheffe's post hoc test result shows that there is a significant difference between the pretest scores and posttest scores. This indicates that there was significant effects on the lean body weight of all the groups. Therefore, the different intensities CRT had training effects on lean body weight of the young female adults,and the significance decrease became evident after 12 weeks of training.

Sub-Hypothesis II

There is no significance effects of different intensity levels of circuit resistance training on resting blood pressure of young female adults in Plateau State.

Table 4.2.8: One-way analysis of variance (ANOVA 1) for the significance effects of different intensity levels of circuit resistance training on the resting blood pressure of young female adults.

Variable	Source	SS	DF	MS	F	P. Sig.
Resting systolic	Between groups	1276.68	5	255.34	4.25**	.002
blood pressure	Within groups	3246.30	54	60.12		
	Total	4522.98	59			
Resting diastolic	Between groups	587.55	5	117.51	4.75**	.001
blood pressure	Within groups	1335.70	54	24.76		
	Total	1923.25	59			

$F(5, 54)= 2.37$, $P \leq 0.05$** = significant

The summary of ANOVA on the significance of the difference in body composition variables of the three exercise groups. The result on resting systolic and diastolic blood

pressure shows a calculated F-values of 4.25 and 4.75 are greater than the tab- value of 2.37 at 0.05 level of significance with 4 and 54 degrees of freedom. This means that there are significance effects of different intensities CRT on the resting blood pressure of young female adults. Therefore, the null hypothesis of no significance effects of different intensities CRT on the resting bloodpressure of the young female adults was rejected. The significance of the F ratio therefore called for post-hoc analysis. The Scheffe's S-test was used to further determine the source the difference. The summary result for the post-hoc analysis is presented in table 4.2.9 and 4.2.10.

Table 4.2.9: Summary of Scheffe's post hoc test Results for differences in the Effectson the resting systolic blood pressureof young female adults

Group	**N**	**Subset for alpha = .05**	
		1	2
1. Moderate-pre	10	106	
2. Low-pre	10	108	108
3. High-pre	10	111	111
4. Low-post	10	112	112
5. Moderate-post	10	116	116
6. High-post	10		120
Sig.		.205	.060

Uses Harmonic Means Sample Size = 10.00

The summary of Scheffe's post hoc test result shows that there is a significant difference between the pretest scores and posttest scores. This indicates that there was significant effects on the resting systolic blood pressure of all the groups. Therefore, the different intensities CRT had training effects on resting systolic blood pressure of the young female adults,and the significance decrease became evident after 12 weeks of training.

Table 4.2.10: Summary of Scheffe's post hoc test Results for differences in the Effects on the resting diastolic blood pressureof young female adults

Group	N	Subset for alpha = .05	
		1	2
1. Low-post	10	68	
2. Moderate-post	10	72	
3. High-post	10	73	
4. Low-pre	10		74
5. Moderate-pre	10		76
6. High-pre	10		77
Sig.		.272	.220

Uses Harmonic Means Sample Size = 10.00

The summary of Scheffe's post hoc test result shows that there is a significant difference between the pretest scores and posttest scores. This indicates that there was significant effects on the resting diastolic blood pressure of all the groups. Therefore, the different intensities CRT had training effects on resting diastolic blood pressure of the young female adults,and the significance decrease became evident after 12 weeks of training.

Sub-Hypothesis III

There is no significance effects of different intensity levels of circuit resistance training on resting metabolic rate of young female adults in Plateau State

Table 4.2.11: One-way analysis of variance (ANOVA 1) for the significance effects of different intensity levels of circuit resistance training on the resting metabolic rate of young female adults.

Source	SS	DF	MS	F	P. Sig.
Between groups	131515.33	5	26303.07	5.16**	.001
Within groups	275504.00	54	5101.93		
Total	407019.33	59			

F (5, 54)= 2.37, P ≤ 0.05** = significant

The summary of ANOVA on the significance of the difference in body composition variables of the three exercise groups. The result on resting metabolic rate shows a calculated F-values of 5.16 is greater than the tab- value of 2.37 at 0.05 level of significance with 4 and 54 degrees of freedom. This means that there is significance effects of different intensities CRT on the resting metabolic rate of young female adults. Therefore, the null hypothesis of no significance effects of different intensities CRT on the resting metabolic rate of the young female adults was rejected. The significance of the F ratio therefore called for post-hoc analysis. The Scheffe's S-test was used to further determine the source the difference. The summary result for the post-hoc analysis is presented in table 4.2.12.

Table4.2.12: Summary of Scheffe's post hoc test Results for differences in the Effects on the Resting Metabolic Rateof Young Female Adults

Group	**N**	**Subset for alpha = .05**	
		1	2
1. Low –pre	10	1451	
2. Moderate-pre	10	1453	
3. High-pre	10	1467	
4. Low-post	10	1485	1485
5. Moderate-post	10	1534	1534
6. High-post	10		1578
Sig.		.246	.157

Uses Harmonic Means Sample Size = 10.00

The summary of Scheffe's post hoc test result shows that there is a significant difference between the pretest scores and posttest scores. This indicates that there was significant effects on the resting metabolic rate of all the groups. Therefore, the different intensities CRT had training effects on resting metabolic rate of the young female adults,and the significance decrease became evident after 12 weeks of training.

4.3Discussion

The purpose of this study was to examine the effects of different intensities of CRT on body composition, resting blood pressure and resting metabolic rate of young female adults in Plateau State. The results of hypotheses formulated and tested revealed that there was significance effects of low, moderate and high intensity of CRT on percent body fat, waist-to-hip ratio, body mass index, lean body weight, resting systolic and diastolic blood pressure, and resting metabolic rate in young female adults after 12 weeks of training.

Result of analysis on hypothesis I showed that different intensities CRT had significant effects on %BF, WHR, BMI, and LBW of young female adults in Plateau State. The result showed that different intensityCRT groups showed significant decrease in %Bf, BMI and WHRand significant increase in LBW after a 12-week training programme. The significant decrease in body mass index and waist-to-hip ratio may be attributed to the increase in loss of fat and increase LBW and is in line withComellisen and Fargard, (2005).

Goodarzi and Kumar (2012), revealed that resistance training is more effective to decrease waist-to-hip ratio (WHR).Paolin, (2010), compared the effects of distinct protocols of fitness training on body composition.The results indicated that among the three groups high intensity groups showed the greatest reduction in body weight, percent body fat mass and waist line. The results of the 12 weeks different intensities of circuit resistance training programme concluded that high intensity exercise combined with endurance training in the circuit training technique is more effective than endurance training alone or low intensity circuit training in improving body composition.

Circuit resistance training programmes can increase fat free mass and decrease the percentage of body fat. One of the outstanding benefits of resistance exercise, as it relates 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 (Young and Steinhard, 1995).Ferrera, (2010), a study was conducted to analyze the effects of CRT on FFM, FM and cytokine responses in sedentary women, 39.71 ±3.8 years old (n=14). The protocol consisted of 3 sessions/week of circuit resistance training of 9 stations with alternating muscle groups. In each session, the subjects performed the circuit 2 times with a set of 8 – 12 maximal repetitions in each station, during 10 weeks. The body composition was analyzed at the end of the training; there was an increase in the FFM and a decrease in the FM. These results showed that the proposed CRT improved body composition in women.

The reason of low significant effect of moderate and high intensity circuit resistance training on BMI might be that there wasdecreased body fat but changed in lean body mass of the experimental groups suggested that their lean body mass has been increased following training. It was submitted that the intensity of an exercise is an important component of weight loss intervention and therefore should be commonly included as part of a comprehensive weight loss management programme by helping to preserve fat-free mass (FMM) and maximize fat loss.This suggests that CRT programme can be an effective treatment to reduce abdominal obesity in young overweight female adults. The positive effect of decreasing WHR may help reduce the risk of cardiovascular diseases in the adult population.

The direction of the decrease of the body fat of the subjects for this study shows improvement in health and fitness, as fat, being metabolically inactive tissue, has detrimental effect on health. A reduction of the non-essential adipose tissue in the young female adults is an advantage in decreasing their risk factors for diabetes, coronary artery disease,

hypertension, gallstones, gout, reproductive problems and osteoarthritis, as well as cancer of the breast, colon and uterus.Therefore, the results of this study may be related to this physiological principle, as the results have shown that HI training results in a greater improvement in body composition than the MI and LI training protocols, based on previous studies it was concluded that these results can partially be related to greater carbohydrates being depleted in high-intensity rather than moderate and low-intensity circuit resistance training programmes. It also appears that fat oxidation is enhanced during recovery from circuit resistance exercise as well as other types of high intensity exercise. This serves to spare available carbohydrates for glycogen re-synthesis.

The results of the studyrevealed thatthe hypotheses formulated and tested was rejected. Thedifferent intensities circuit resistance training had significant effect of on the body composition (%BF, BMI, WHR and LBW), of the subjects. Therefore, the results seem justified as it is supportedby other similar studies.

The result on lean body weight is therefore in conformity with the position ofAgbonlahor et al, (2009), Byrne and Willmore, (2001a), Agwubike and Oboh,(2006), Agwubike, (1992), and Hunter, (2000), who supported a significant gain in lean body weight following appropriate anaerobic and circuit resistance training.

It should be emphasized that the amount of lean tissue in the body is much more important in young females than body mass, since lean tissue is metabolically active the more its quantity relative to fat, the more likely will the health and fitness improve. Thus, lean body weight is usually considered to be positively related to good health and fitness, especially in females who have high percentage of fat in the body. A large body component means a large muscle mass and thus, greater muscle strength and endurance which is a vital

fitness component in the life of women. Therefore overweight may or may not be due to increase in body fat. It may also be due to an increase in lean muscle.

The second hypothesis on the effects of different intensities CRT for the period of 12 weeks had significant effects on the resting systolic and diastolic blood pressure of the young female adults in Plateau State. The result showed significance decrease in both resting systolic and diastolic blood pressure after a 12-week circuit resistance training programme. The decrease in blood pressure was due to the significant effects of 12 weeks CRT training. The result is in line with the findings ofAbah J.A. et al., 2011; Willey, 1992;Ray and Carrasco, 2000;Kelley and Kelley, 2000;Hagberg et al., 2000.Abah, J.A. et al., (2011), found that there was a significant relationship between blood pressure and body composition. That BMI had a significant correlation with blood pressure, while correlation of waist circumference and blood pressure was proportional. Excess body fat is often associated with increased blood pressure and as such weight loss is often recommended as means of decreasing blood pressure.Statistically significantly decreases of approximately 3mmHg were found for both SBP and DBP categories as a result of progressive resistance training.

Willey (1992), examined the effects of static (isometric) exercise training on resting SBP and SBP. In one trial, resting SBP by approximately 15mmHg as a result of four, 2-minute static handgrip contraction performed 3d.wk-1 for 8 weeks. Contractions were performed at 30% of maximal effort with a 3- minute rest between contractions, was performed 5d.wk-1 for 5 wks. Statistically, significant reduction of approximately 10 and 9mmHg were reported for resting SBP and DBP, respectively.

Ray and Carrasco (2000), examined the effects of four, 3- minute bouts of static handgrip exercise at 30% of maximal voluntary contraction performed 4 x wk-1 in

nornmotensiveadults. Statistically, significant reductions of approximately 5mmHg were reported for resting DBP with no statistically significant reduction observed for resting SBP. The limited evidence available suggests static exercise reduces blood pressure in adults with elevated blood pressure.These findings suggested positive and progressive cardiovascular system adaptations to standard strength training sessions with respect to systolic blood pressure. Nonetheless, over the 10- weeks training period, the programme participants recorded a 6.3mmHg mean reduction in resting systolic blood pressure and 2.2mmHg mean reduction in resting diastolic blood pressure. The beneficial changes in the subjects resting blood pressure reading are similar to thousands of men and women who have participated in a basic circuit strength training programmes.

Another recent review found that resistance training does not raise blood pressure level significantly (Kelley and Kelley, 2000). This review also reported that circuit resistance training, rather than the traditional repetition strength training, led to greater reductions in blood pressure. This was likely to be due to the greater number of repetitions, and reduce recovery, utilized with circuit resistance training. Therefore, there is likely to be greater cardiovascular component to circuit resistance training. Lower exercise intensities (<70% Vo_2 max~65-70%HR Max) work better at reducing blood pressure than higher intensities (Hagberg et al., 2000)

There were also significant differences between the groups after the course of the study and subjects that participated in LI training programme showed significant decreases in systolic and diastolic blood pressure in relation to the HI and MI groups. This shows that lower intensities of circuit resistance training work better at reducing blood pressure than high and moderate intensities (Hagberg et al,. 2000). The results are in accordance with

previous studies (Harris and Holly, 1987; Willy, 1992; Ray and Carrasco, 2000; Kelly and Kelley, 2000; Hagberg et al,. 2000). The reduction in the blood pressure following circuit resistance training is believed to be primarily due to increase number of tiny blood vessels (capillaries) that transport blood to muscles and organs. Excess body fat is often associated with increased blood pressure, and is believed that the reduction in blood pressure that occurs, following exercise treatment is associated with reduction in body fat (ACSM, 1993).

The third hypothesis on the effects of different intensities CRT for the period of 12 weeks had significant effects on the resting metabolic rate of the young female adults in Plateau State. The result showed significance increase in both resting metabolic rate after a 12-week circuit resistance training programme. There is evidence that the insidious process of muscle atrophy, resting metabolic rate, and fat accumulation may be reversed through regular resistance exercise. A study with 1,644 previously inactive adults and older adults showed an average lean (muscle) weight gain 3.1 lbs (assessed by skin fold calipers and ultrasound technology) after 10 weeks of circuit resistance strength training (Wescott and Winett, 2006). Other studies have reported similar lean weight gains accompanied by 7% to 8% increases resting metabolic rate.

Dolezal and Potteiger (1998), examined the changes on basal metabolic rate, body composition, VO2 Max, muscular strength and urinary urea nitrogen execration through 10 weeks of concurrent resistance and aerobic training. The subjects included 30 active males, ages 20±1.6 years that were randomized into a resistance only, endurance only or a combined resistance and endurance training group. The result of the study indicated a significant increase in basal metabolic rate in the resistance only group from 7613.3±968.7 TO 8090.8±951.2K/DAY.There was a trend, however for the subjects' RMR to increase as the

intensity training levels increased (Byrne and Willmore, 2001a). The characteristic is probably due to a high amount of fat free mass in the highly trained group compared to both the moderately trained and the untrained groups. As the groups' amount of FFM mass increase in RMR was observed (P.05). The untrained group had a FFM of 44.5±0.9 Kg, the moderately trained group had 47.6±0.9Kg and the highly trained had 69.8±0.8Kg of FFM (Byrne and Willmore, 2001a). Therefore, according to statistics and the fact that resistance training has more bearing on FFM that endurance exercise, resistance training is the logical mode of exercise that may influence metabolic rates.The results of the 26 weeks resistance training programme concluded that resting energy expenditure significantly increased from 5388±520 to 5753±560KJ/day with a current significantly increase in FFM from 50.0±10.1 to 52.0±10.7Kg (Hunter et al., 2000). This study suggests that an increase in FFM will increase a person's RMR.Osterberg and Melby (2000), examine the effect of acute resistance exercise of post exercise O_2 consumption and resting metabolic rate in young women.The result revealed that average RMR was 4.2% higher 16 hours following exercise when compared to the pre-workout RMR. The authors concluded that intense resistance training produces modest, but prolonged elevation of post exercise and metabolic rate in women.

An analysis of variance conducted on the resting metabolic rate of pre-test and post-test scores of the different intensityCRT groups, were found to have statistical significant effects. The result showed significant increase in resting metabolic rate after the 12-week circuit resistance training programme. The results is in conformity with the position of Byrne and Willmore, (2001a), Dolezal and potteiger,(1998), Broeder et al., (1992); Hunter, Wetzstein, Fields, Brown and Bamman (2000), who support a significant increase in resting metabolic rate following appropriate anaerobic and resistance training.

CHAPTER FIVE

5.0 Summary, Conclusions, and Recommendations

5.1 Summary

The purpose of this study was to assess the effects of different intensity of circuit resistance training on body composition, resting blood pressure and resting metabolic rate of young female adults in KatonRikkos community of Plateau State. To achieve this purpose, three research questions and null hypotheses were postulated. Thirty (30) young female adult volunteers were randomly assigned into three groups of low, moderate and high intensity to 12 weeks of circuit resistance training (CRT). The low intensity group exercised at 40% 1 repetition maximum while the moderate and high intensity exercised at 50 and 60% 1 repetition maximum respectively. The exercise was conducted 3 times a week and 30 – 40 minutes per session.A pre-test and post-test group research design was used for the study. The participants were tested before and after the 12 weeks CRT on %BF, WHR, BMI, LBW, SBP, DBP, and RMR with different instruments.The data collected were analyzedusing means and standard deviation to answer the three research questions, one-way analysis of variance (ANOVA 1) to test for the significance effects of the different intensities CRT groups, whileScheffe post hoctest was used to locate where difference occur.Based on the study, the following summary of the major findings are:

i. There was a significant decreasein %BF, WHR, BMI, SBP, DBP and a significant increase in LBW of the participants in the three groups as a result of the training effects.
ii. There was a significant decrease in resting SBP and DBP of the participants in the three groups as a result of the training effects.

iii. There was a significant increase in RMR of the participants in the three groups as a result of the training effects.

5.2 Conclusion

Based on the finding of the study, the following conclusions were drawn.

1. There was a significanteffects of different intensity levels of CRT on the %BF, WHR, BMI, and LBW of the young female adults.
2. There was a significant effects of different intensity levels of CRT on the resting systolic and diastolic blood pressure of the young female adults.
3. There was a significant effects of different intensity levels of CRT on the resting metabolic rate of the young female adults.

In conclusion, CRT significantly reduced %BF, WHR, BMI, SBP, DBP, and increased lean body mass and resting metabolic rate of young female adults. The most interesting findings of this study is that the decreasing percent body fat, WHR, BMI positively contribute to the decrease in resting systolic and diastolic blood pressure. While an increase in LBW positively contribute to the increase in RMR of the subjects after 12 weeks of CRT programme. This exercise methodology allows subjects to improve metabolism and, at the same time, muscle mass and resting metabolic rate all of which are promoted as beneficial by many guidelines. In our society today leisure time is lacking and motivation to perform daily exercise is uncommon resulting in low overall levels of daily lifestyle related to physical activity. In this situation a short intense training such as circuit resistancethat enables elevation of resting metabolic rate, that is, increase fat consumption at rest may be an interesting and attractive alternative to time consuming exercise.

5.3 Recommendations

The following recommendations are offered based on the findings of this study:

1. Young female adults should train at moderate or relatively high intensity level of circuit resistance training (intensity between 50 – 60 % max) for 15 – 20 repetitions three times per week. This will go a long way to generally improve their health and fitness.
2. Circuit resistance exercise should form part of a comprehensive weight loss programme, blood pressure management and in preventing obesity and hypertension in young female adults.
3. Follow-up studies are needed to determine if the effect is maintained, increased or decreased in the young female adults.

5.4 Suggestion for Further Study

The following further studies are suggested.

1. Studies on the effect of different intensity of circuit resistance training on other physiological variables be conducted. It is envisaged that such study may provide clue on physiological exercise adaptations of children, male, female and aging.
2. Further studies related to the present study may be carried out on athletes, children, pregnant women, and older women.

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APPENDIX I

Circuit resistance training programme with different exercise stations and intensity:

Exercise	**Low intensity training group**	**Moderate intensity training group**	**High intensity training group**
Leg press	3 $*_{20}$ (40% 1RM), 3 min	3 $*_{15}$(50% 1RM) 3min	3 $*_{10}$(60% 1RM),3 min
Bench press	3 $*_{20}$ (40% 1RM), 3 min	3 $*_{15}$(50% 1RM) 3min	3 $*_{10}$(60% 1RM), 3 min
Bent-knee sit-up	3 $*_{20}$ (40% 1RM), 3 min	3 $*_{15}$(50% 1RM) 3min	3 $*_{10}$(60% 1RM), 3 min
Lat pulls	3 $*_{20}$ (40% 1RM), 3 min	3 $*_{15}$(50% 1RM) 3min	3 $*_{10}$(60% 1RM), 3 min
Hanging knee raises	3 $*_{20}$ (40% 1RM), 3 min	3 $*_{15}$(50% 1RM) 3min	3 $*_{10}$(60% 1RM), 3 min
Knee extensions	3 $*_{20}$ (40% 1RM), 3 min	3 $*_{15}$(50% 1RM) 3min	3 $*_{10}$(60% 1RM), 3 min
Biceps curl	3 $*_{20}$ (40% 1RM), 3 min	3 $*_{15}$(50% 1RM) 3min	3 $*_{10}$(60% 1RM), 3 min
Knee flexions	3 $*_{20}$ (40% 1RM), 3 min	3 $*_{15}$(50% 1RM) 3min	3 $*_{10}$(60% 1RM), 3 min
Triceps extensions	3 $*_{20}$ (40% 1RM), 3 min	3 $*_{15}$(50% 1RM) 3min	3 $*_{10}$(60% 1RM), 3 min
Upright – rowing	3 $*_{20}$ (40% 1RM), 3 min	3 $*_{15}$(50% 1RM) 3min	3 $*_{10}$(60% 1RM), 3 min

Set, *Repetition (Resistance), Rest between sets

APPENDIX II

Department of Physical and Health Education,
Ahmadu Bello University,
Zaria.

Dear Participant,

LETTER OF CONSENT

I am a postgraduate student of the Ahmadu Bello University, Zaria, pursuing a Master of Science (MSc.) Degree in Exercise and Sports Science. I am conducting a research on The Effect of Different Intensity Circuit Resistance Training on Body Composition, Blood Pressure and Resting Metabolic Rate of Women in PlateauState in which you have been selected to participate. The training exercise will be performed in a fitness Gym in JCMI Recreational Centre KatonRikkos, Jos using universal Gym machines.

Details of training programme:

The circuit resistance training procedure involves weight exercises using ten (10) stations of universal gym machines in a circuitous form moving from one station to another in an anti-clockwise order. There will be a short rest interval between the stations and completion of each set of circuit. Stretching exercises will be used during the rest intervals.

- Number of sets of circuit is 3 with rest interval of 3 minutes between sets.
- Number of repetitions per exercise station is 10, 15, and 20 depends on the intensity.
- Number of days per week is three days on alternate days.
- Duration – a training session will last for 30 minutes and the programme will last for a period of 12 weeks (3 months).

There will be pretest and posttest on some body physiological variables such as height, weight, waist and hip circumference, percent body fat, blood pressure, and resting metabolic

rate.During the exercise training programme, certain body physiological changes may occur. And you may also experience some body soreness at the beginning of the training 24 hours or 48 hours after some training sessions especially for the first 2 or 3 weeks of the progamme. However, effort will be made to minimize discomfort and other risks. The result will be used to prescribe safe and sound exercise programme in fitness centers. Your records will be kept strictly confidential unless you consent to release this information.

If you have any question or need additional information, please ask me to explain further.

Your permission to take part in this programme is strictly voluntary. You are free to make your choice.

DECLARATION

I have read this form carefully and I fully understand the training procedure that I will perform and what is expected of me including risks and discomfort. Knowing all these and was having had the opportunity to ask questions that have been answered to my satisfaction. I _____ consented to participate in this training programme.

_____ _____
Signature of Client Date

_____ _____
Signature of Witness Date

_____ _____
Signature of Researcher Date