COMPARISON OF TRAINING EFFECTS OF CONTINUOUS AND INTERVAL CIRCUIT TRAINING METHODS

A THESIS

SUBMITTED TO THE JADAVPUR UNIVERSITY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ARTS

By

SK SAHA ALAM

DEPARTMENT OF PHYSICAL EDUCATION

(FACULTY OF ARTS)

JADAVPUR UNIVERSITY

KOLKATA-700032

WEST BENGAL

INDIA

JANUARY, 2024

Dedicated

To

My Parents

Sk Noor Alam

&

Sk Selima Bibi

CERTIFICATE

Certified that the thesis entitled "**Comparison of Training Effects of Continuous and Interval Circuit Training Methods**" submitted by me for the award of the degree of Doctor of Philosophy in Arts at Jadavpur University is based upon my work carried out under the supervision of **Prof. Sudip Sundar Das**, **Department of Physical Education, Jadavpur University,** Kolkata and that neither this thesis nor any part of it has been submitted before for any degree or diploma anywhere / elsewhere.

Countersigned by the supervisor

Dated:

Signature of the Candidate

Dated:

ACKNOWLEDGEMENT

Researcher expresses his heartiest thanks and sincerest gratitude to Professor Sudip Sundar Das, Department of Physical Education, Jadavpur University, Kolkata for his continuous support, valuable guidance, encouragement, suggestion and supervision. His remarkable patience and boundless knowledge that he imparts unto me, It was great privilege and honour to work and study under his precious guidance.

The researcher expresses his gratitude to Dr. Asish Pal, Head of the Department of Physical Education, Jadavpur University, for providing all the facilities and sincere cooperation to complete the study successfully.

Also expresses deepest thanks to all the teachers of the Department of Physical Education, Jadavpur University, for their contribution of whole hearted support, knowledge and cooperation to conduct this study.

The researcher deeply grateful to Prof. A.K Banerjee, Former Vice-chanceller, University of Kalyani and Prof. Shudarsahan Bhoumik Department of Physical Education, Jadavpur University, for theirs worthiest suggestion, endless encouragement and moral support.

The investigator offers his sincere thanks to the vice chancellor, Dean of Arts Faculty, Registrar, Research & Ph.D cell and others members of Jadavpur University for providing opportunity to complete this study.

Special thanks to researcher's father Sk Noor Alam, mother Sk Selima Bibi, wife Asmina Mondal, son Ayat and brother Monirul they always inspired me without their support research work could not be completed.

Researcher extremely grateful to Dr. Birbal Saha, Dr. Bhim chandra Mondal and Dr. Shambhunath Majhi for their valuable encouragement, true support and suggestion.

Highly thanks also go to Dr. Tarun mondal for his precious support, inspiration and valuable opinion to conduct this entire research study.

A lot of heartiest thanks to all of the students (Purulia Cricket Academy) those who were participated without any interest as subjects for this study from purulia district of West Bengal. From the researcher especially thankful to all the members of Purulia Cricket academy for their valuable support by arranged the subjects and ground to smoothly conduct the training protocol.

They were always assisted with researcher to organised training protocol and at the time of data collection.

Sincere thanks to Md Fasihur Rahaman, Headmaster of Nawabpur High Madrasah, Chanditala, Hooghly, for his precious cooperation, encouragement and suggestions during the course of study.

Investigator expresses his sincere thanks to Dr. Nurun Nabi, Dr. Dinabandhu Naskar, Dr. Rajkumar Bauri Dr. Debasis mondal, kallol Ghosh and also those who were attached with him to conduct this research without their supports research work could not be completed.

SK SAHA ALAM

Research Scholar
Department of Physical Education
Jadavpur University

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

ICT = Interval Circuit Training

CCT = Continuous Circuit Training

HST = Harvard Step Test

CG = Control Group

BLA = Blood Lactic Acid

BMI = Body Mass Index

HR = Heart Rate

B/min = Beat(s) per minute

bpm = Beat(s) per minute

Mins = Minute(s)

Mmol/L = Millimole per litter

SD = Standard Deviation

df = Degree of freedom

ANOVA = Analysis of Variance

CD = Critical Difference

LSD = Least Significant Difference

MD = Mean Difference

Sig = Significant

SE = Standard Error

n = Number

Max = Maximum (al)

mm = Millimeter

cm = Centimeter

inch = Inches

h = Hour

kg = Kilogram

mt = Meter

Sec = Second/Seconds

Vo_2 max = Maximum Volume of Oxygen Consumption

CHAPTER- I

INTRODUCTION

1.1 GENERAL INTRODUCTION

1.2 CONCEPT OF HEALTH AND FITNESS

1.3 IMPORTANT OF FITNESS

1.4 EXERCISES FOR HEALTH BENEFIT AND FITNESS

1.5 CONCEPT OF SPORTS TRAINING

1.6 INTERDISCIPLINARY RELEVANCE

1.7 STATEMENT OF THE PROBLEM

1.8 OBJECTIVES OF THE STUDY

1.9 DELIMITATIONS OF THE STUDY

1.10 LIMITATIONS OF THE STUDY

1.11 HYPOTHESIS OF THE STUDY

1.12 SIGNIFICANCE OF THE STUDY

1.13 DEFINITION AND EXPLANATION OF TERMS

CHAPTER-I
INTRODUCTION

1.1 GENERAL INTRODUCTION

Modern education explores various innovations to progress our society. Peoples are more interested on new scientific exploration which can make an advance universe. Globally those who are living in developed countries behind them they have the strong educational structure. So, fundamental need in education is to development of a nation and equally public health as most emergent asset. Public health is closely related with increase the capability of creation and production of realistic materials based on technology. Jerry Morris, an epidemiologist, called physical activity the "best buy" in public health. (MORRIS, 1994). A man as a social member he or she has several responsibilities in the area of family, profession, social work etc. But most of time they have under unsatisfied, depressed, and unhealthy condition, nothing materialized which is the exact necessity on the time. Where physical Activity is the precious base of quality living there, peoples are gradually trend to remain inactive and spending life depending on machine. Since machines are ten times more productive than humans, we rely heavily on them to meet our social and economic needs. Consequently, mental sadness, sedentary lifestyles, and other phenomena lead to a variety of hypo-kinetic disorders and health hazards around the globe. It is the new challenge how the people will start a new journey with healthy life and environment. Not only the inactivity but nutrition and environment are the most effective component to make an efficient healthy life. Human body composed of various systems that allow maintaining a state of homeostasis. We must remember that living a sedentary lifestyle can put a rigid wall in the way of improving our health. It could be social, mental, or physical health. Engaging in different physical or mental activities is necessary to achieve a peaceful life that supports one's profession, daily household chores, leisure activities, social work, and family responsibilities. Nowadays, everyone agrees that training is an essential component of any program that is systematized and grounded in science and serves as a means of achieving the highest level of athletic achievement. Training can be accomplished through many different kinds of methods to improve skill in a range of sports.

The activities involved in the different training modalities have varying durations. Aerobic exercise lasts far longer than anaerobic exercise, which is shorter in duration. Anaerobic workouts typically last under 60 seconds and burn glycogen rapidly caused producing lactic acid. Enhancing the delivery of oxygen to the muscles is the aim of aerobic training. It improves the heart's ability to pump blood and the muscles' capacity to draw oxygen from the blood. It also enhances the efficiency of converting glucose to energy. Every person needs certain physiological parameters, but students especially need them.

Researcher has tried to give as much as possible effort for successful completion of formulated training to solve any kind of problem which needs adequate knowledge about the relevant phenomenon. This knowledge implies to adopt some training or special support of learning. It may be related to sports, general education, mechanics, agriculture, etc. In the field of sports from ancient to modern phenomenon enlighten that gradually some meaningful physical activity established various types of sports and games, equally some activities proved that it can make an active life style for an individual. That types of meaningful activity or games and sports are the very much emphasized how to make today's modern society. It can support maintaining our typical level of physical fitness, managing our weight, lowering our risk of diabetes and heart disease, strengthening our bones and muscles, enhancing our emotional and mental well-being, and enhancing our capacity to carry out everyday tasks. Human life phenomenon tremendously depends up on the internal physiological purpose. Blood pressure, heart rate, body composition, digestive function, nerve function etc are playing a very vital role on overall human body structure and function.

For application of any training program that have to follow some principles which is the most vital for successful accomplishment and production of good result and performance. Important factors for the study include the trainee's identity, performance level, volume and intensity of training, surrounding environment, age and gender of the trainee, and so on.

1.2 CONCEPT OF HEALTH AND FITNESS

Each human being should grow physical fitness intended for a joyful and efficient existing. The completely fit individual has an energetic and cheerful attitude towards living.

Fitness is the man‘s supreme requirement. Physical fitness is the capability to survive a complete and compatible life. It can increase self-confidence and mentally alert of a person. To glowing adjust with changing environment physical fitness is most essential component, which can make a complete synchronization with body and mind. Several research investigations proved that, physical fitness is a central part of the normal growth and development of a man. Clarke and Clarke (1989) found that physical fitness is not a static factor and it varies from individual to individual and in the same person from time to time depending on factors. In the field of physical Education physical fitness is the most valuable term for both teachers and learners (Dutta & Ghosh, 2016). The United States president‘s Council on physical fitness and sports defined the terms physical fitness as the ability to carry out daily task with vigor and alertness, without undue fatigue, with ample energy to enjoy leisure time pursuits and to meet unforeseen emergencies (Clarke, 1971). Physical Fitness can enable to execute on situational demand of our body’s potential. Fitness may be denominate as a state which boosts to do our best and feel the phenomenon. Core concepts of Physical fitness implies the performance and inter relational efficiency of all the systems of human body such as muscular system, blood circulatory system, respiratory system, nervous system, skeletal system etc. Physical fitness is capability to function of a body’s competently and effectively in movement and free time activities. Optimal effectiveness is the key of physical fitness. Normally it implies the ability of an individual to survive most successfully with his or her expectations that builds on the physical, mental, emotional, social and spiritual elements of fitness which are extremely interconnected. To get adequate physical fitness need to involve in a regular physical exercise plan. Therefore, every person should increase sensible practice of exercise that they can improve the quality of living.

1.2.1 Health:

In view of Good health it can simply carry success in a person’s life. A person with an attractive and good body structure may not be healthy or in quality health. Peoples are in modern times, have regarded health as one of the most expensive values in life. Now a days’ Health is considered as one of the most significant values for a human being as well as for nations. So health is primary requirement for every people to uphold the nation advancement. Society is growing gradually with rapid development of industrial sector also. For any working area of profession to every people there most demanded component is physical and mental health. Satisfaction, self control, communicative ability, good habit, precise behavior, and physical

capability these all are under physical and mental health. Those peoples are inactive and poor focused on their own health they always want to consult with doctor for every simple unbalance of body function, this is a sign of unsound conditions in the state. More accurately, health is connected not only with the physiological functioning, but with mental and moral soundness, and spiritual salvation, as well. To improvements of people's health simply require positive thinking about active lifestyle and healthy responses on physical activity. If people truly concentrate on it and want to form a healthy society with responsibility definitely it has become possible to make radical improvements in the health status of people.

In most Western countries an immense consideration to health matters. The best-known studies have been performed by the Swedish professor of religious philosophy (Jeffner, 1997). In his studies Jeffner asked a representative sample of Swedes the questions which are the uppermost values in their lives. A vast majority of peoples put health on top of their lists. The ancient belief of mental health was closely connected to morality and spiritual heath also connected with health science. "A healthy mind in a healthy body" according to interpretations of the concept both are inter related with each other. Thus the concept of health denotes different functions of the human body and mind interconnect harmoniously balanced.

According to World Health Organization thought of health is not only acknowledged that health and illness are fundamentally multi causal, but also shifted the center of attention from a strictly medical viewpoint in which absence of illness was the criteria used to evaluate a person's health status. The World Health Organization developed a holistic concept of health as "a state of complete physical, mental and social well-being and not merely as the absence of disease or infirmity that enables one to lead a social and economically productive life".

1.2.2 Physical Fitness:

Physical fitness is the organic capacity of an individual to accomplish people's regular task in normal life condition. The Physical fitness can be classified into two types; such as a) Health related physical fitness b) Performance related physical fitness.

a) Health Related Fitness

Health related physical fitness components are basically implies to measure our general wellbeing. Physical movement or exercise can able to improve our capabilities in each of these

areas. All the athletes are usually attempted to achieve a sound level of health. Fitness in each area also for general people it is very much important. Scientific and systematic fitness program should include several types of activities and exercises that promote each of these health-related fitness components.

The health-related physical fitness components are as bellow:

Muscular Strength:

Muscular strength is directly connected with force production. Not only in the field of sports but also related with daily activity. Muscular strength is the amount of force that can be applied on muscles against a resistance.

Muscular Endurance:

Endurance is the ability to do any work for longer duration. It depends on nature of work. Thus, muscular endurance is the capability of a muscle or groups of muscles activity against a resistance for a longer period of time.

Body Composition:

Body Composition denotes the quantity of percentage of fat, bones, muscles and other vital parts found within a human body. Generally body composition is classified into percentage of body fat and lean mass weight.

Flexibility:

Flexibility is the ability to move body parts its maximum range of motion around a joint. Superior flexibility in the joints can help to prevent several injuries throughout the stages of life.

Cardiovascular Endurance:

Cardiovascular endurance is also implies to as an aerobic fitness. it is the capability of lungs, heart and blood vessels to supply adequate amount of oxygen as well as nutrients into the cells according to demands of activity over a long period.

b) Performance related physical fitness

Different sports demanding different types of fitness components and level to achieve actual goal. Successfully participate in sports activities there are precious contribution through performance related physical fitness. Regular physical activity or sports movement have a positive influence on health and fitness for athletes as well as for general peoples to lead daily life. Different sports require different performance related fitness. To improvement of

performance related physical fitness several scientific training methods are there in the field of sports. Performance related physical fitness components are as bellow:

Agility:

Agility is the capability to change the body direction rapidly and accurately during in motion. Agility consists with combination of balance, power, speed, and coordination.

Balance:

Balance is the ability to control or maintain the body when stationary or during movement. Example is hand stand in gymnastics.

Reaction time:

Reaction Time refers the ability to how quickly you can respond to a stimulus. Reaction time is implies the combination of mind and body connection. In the field sports reaction time is very essential to execute quality skill.

Coordination abilities:

Coordination is the capability to utilize the human senses among body parts during movements where a man may carry a series of motor task efficiently. Such as hand and eye coordination is require for basketball dribbling.

Speed:

Speed is the ability to move your body or parts of your body as quickly as possible or in short period of time. For quality performance in many sports speed is considered as essential factor to get success.

Power:

Power is the ability to do use maximum force of muscles to move the body or body parts. Power implies the combination of speed and muscular strength.

1.3 IMPORTANT OF FITNESS

Being a physically fit man is important for all the age groups during life cycle. To lead better life activities with satisfaction try to be physically fit. Physical fitness is essential for each and every individual at all stages of life. Towards achieve of physical fitness many physical training methods are available. But all are depends on individual demands. Generally good fitness indicates many benefits in daily lifestyle. These are given below:

i) It ensures the good physical posture with positive body appearance and Enhance muscle tone in human body.

ii) Good physical fitness helps to protect from unintentional injury. Also make assure fast recovery after injury.

iii) When peoples are under exercise and ensure a level of fitness they can maintain their body fat and ideal body weight and enhance the energy level of a person to do any involvement.

iv) A physically fit man can easily reduce depression and anxiety level from changing life cycle.

v) Fitness helps to execute the performance properly and efficiently for a sports person.

vi) It helps to reduce recovery period after complete of vigorous movement and also delayed fatigue. on the other side Promote the functions of heart and lungs in resting position or during activity by using of maximum oxygen in our body.

vii) Sleepless condition is very harmful for everybody but a physically fit man always tries to engage with physical activity and automatically sound sleep is happened for them and as well as Fitness can improve overall health with quality of life and increased life expectancy.

1.4 EXERCISE FOR HEALTH BENEFIT AND FITNESS

In changing scenario in our society to get better and enjoyable life, there require true consciousness about health, hygiene and physical fitness. Physical fitness improves when he/she consciously adopts physical exercise. Physical activity implies as any physical movement created with the help of skeletal muscles that involve energy expenditure. Physical activity is not equal with “exercise”. Exercise is the activity which is planned, structured, and repetitive for the intention of conditioning any part of the body. Also, exercise defined as any physical performed in order to develop or sustain physical fitness and overall health. The many health benefits have been shown due to regular Exercise in many research studies. Similarly present research study conducted with different physical training methods to observe the improvement of physical fitness, anthropometrical and physiological components of human body. These training methods consisted with different types of physical exercises. The people who make exercise as an

essential part of their daily routine they are happier and more efficient than others people. The important of exercise is not only promoting physical health, but also improves emotional stability. Effectiveness of exercises are given below:

i) Exercises always help to promote the Physical and Physiological function of human body.
ii) Exercise can helps to improvement of all the components of Health related Physical Fitness and performance related Physical Fitness.
iii) Systematic physical exercise or activity improves muscles and bones strength of human body.
iv) Some time peoples use the exercise for recreation purpose.
v) Exercise can improve self-Confidence and self-Image to individual life skill.
vi) Various studies have shown that cardiovascular exercise can create new brain cells and improve overall brain performance. As well as Exercises can minimize the probability to attack from health risk.
vii) Exercise helps to reduce stress and anxiety and also reduce the risk of heart diseases.
viii) For preventing obesity to minimize or maintaining the percentage of body fat exercise plays an important role.

1.5 CONCEPT OF SPORTS TRAINING

Commonly the term 'Training' is used as a process of systemic instruction or activity for the purpose of physical, psychological and intellectual improvement. Thought and process of training may vary according to deferent fields. In our society there are so many field or spaces which are connected with our life activity, such as education, sports, technology, industry, health, agriculture etc. To get achievement in each and every sector there require adequate training for execute accurate skill on their specified demands. Similarly in the field of sports for improvement of sports performances there require scientific and systematic training. The term sports training is particularly used in the perspective of athletics, sports and games which could be a training of sports persons, coaches and teachers of physical education. Generally sports' training is the well structured systematic and scientific instruction or activity according to demands of individual capability for the enhancement of sports performance. Sports training implies continuous and designed activity for reach towards actual destination as a true success by execute of skills. Athletes can develop a deeper understanding of their own sport and learn the

importance of maintaining physical and mental well-being through sports training. Sports training is a controlled and planned process that uses content, method, and organizational measures to modify behavior, actability, and complex sports motor performance in order to achieve a goal (Klafs & Arnheim, 1981 & Singh, 1991). A complete sportsman is not complete with physical fitness, skill, tactics and technique but need to possess cognitive functions, personality traits, interest, habits, attitude, emotional stability etc. thus, training is required with systematic and scientific variation for the enhancement of above all these components.

Reaching peak performance in a specific sport is the primary intent of sports training for athletes. In scientific view of sports training present study adopted deferent types of sports training methods to identify the effects on physical fitness, anthropometrical and physiological components.

Aim of Sports Training

Preparing a team or individual athlete for optimal form and performance in a particular sport competition is the goal of sports training. A number of factors are responsible for achieving peak performance with maximum efficiency. Scientifically execute of sports training focuses to reach towards highest efficiency for success.

Principles of Sports Training

Each and every area or field it has hold a particular destination which based on own way of principles. Training means scheduled activity with the help of scientific support for preparation to achieve the goal. In the same way as in sports, basic principles of athletic training are the strong guidance ethics for the trainer, coaches, teachers and sportsmen to formulation, implementation and control of effective sports training programme for athletes or team. Properly use of training principles it should always under consideration on individual ability. After the theoretical analysis about the science of sports training deferent principles were established by many researcher, investigator, educationist etc. (Harre; 1979, Matawejew; 1981, Singh; 1984). Some principles of the sports training are follows- **i)** The continuity of training principle **ii)** Principle of Training Load of Progress **iii)** Principle of Individualization **iv)** Principle of Balance **v)** The Recovery Principle **vi)** Principle of Specificity **vii)** Principle of Variation **viii)** Principle of

Planned & Systematic Training **ix)** Principle of cyclicity and **x)** Principle of Progressive Development etc.

Anthropometrical, Physical fitness and Physiological Components and Sports training

Sports performance highly depends on physical fitness, anthropometrical and physiological components of the human body. Physical fitness splits under two categories: performance-related physical fitness and health-related physical fitness. Health-related physical fitness consists of several elements, including cardiovascular endurance, flexibility, muscular strength, body composition and muscular endurance. But performance related physical fitness refers to things like power, speed, agility, reaction time, balance, and coordination. Generally all the components are very vital for sports performance in competition and for preparation for competition to improve these components basically need a good training programme on basis of individual requirement. Many research studies found that scientific application of sports training methods can improve the physical fitness efficiency ((Sridhar & Maniazhagu, 2018; Prasanna et al., 2020; Rani, 2018; Kumar, 2016; Al-Haliq, 2015; Vinayagamoorthi And Sakthivel, 2014; Cregg, 2013; Babu & Kumar, 2013; Meethal and Najeeb, 2013 & Reddy; 2012).

Physiological components such as heart rate, blood pressure, blood, blood lactic acid etc. these are the essential factor for sports performance. Internal physiological functions are connected with external body movements. Many research studies established that physical training may effective to improve physiological potentiality. Holmgren et al. (1960) and Venkateswarlu (1975) while working on young athletes have shown the reduction of pulse rate due to different training methods. There are significant positive changes due to implication of physical training on blood lactate concentration (Hurley et al, 1984; Bandyopdhyay, 1984 & Connet et al., 1985). Yoshida et al., (1982) studied on healthy male college students and found that endurance training decreased blood lactate content during the sub-maximal exercise significantly. On the other side Richardson & Hardman, (1989) found a significant relationship between blood lactate concentrations with endurance time.

Research findings of a number studies proved that the sports person's anthropometric characteristics are too related with high athletic performances. BMI, Percentage of body fat, Height, Weight, Thigh girth, Calf girth etc. as Anthropometrical components all are very vital for

successfully skill execution. Glick & Kaufmann, (1976) observed lowering of the body weight due to physical training. Adeniran & Toriola (1988) found a result on some school going boys significant reduction of percentage of body fat among the trained comparison with untrained students. Stewart (2021) concluded Jump Squat have positive effects on calf girth. Dixon, (2017) determined the positive relation between the thigh girth ratio and performance in events from 800m-5000m run. Specified training programme can enhance the thigh and calf girth of an athlete's (Saini & Bhardwaj, 2018; Vinu, 2012 & Ashwini, 2017).

Methods of sports training

Sports training is a set timetable designed to help athletes reach their maximum potential by acquiring all necessary components for psychological preparation, technical and tactical requirements and physical fitness. According to Mathew (1981) "Sports training is the basic form of preparation of sportsmen." application of training programme should depend on individualization. An individual difference in consideration is too much precious. Methods of training indicate different ways to improve the specified components. Each methods have there its own aims or destination. The entire duration of training, the sports being played, the athlete's age and gender etc. all influences the method of choice. Therefore, the choice of training methods according to demands is very important in the field of sports. Every method is used for its own speciality, on the basis of individualization which quality or improvement is required for him/her, methods should be selected. There are different training methods in the field of sports training, some methods are discussed below:

Continuous Training

The concept of continuous training was introduced by Dr.V. Aaken for improvement of endurance (Casado et al., 2023). Continuous training is a formation of physical exercise which is performed continuously without any resting period during activity. Suitable Exercises for continuous exercise may include with jogging, walking, running, bench steeping, swimming rope skipping, aerobic dancing etc. There are different ways to conduct continuous training: the Slow Continuous Method, the Fast Continuous Method, and the Slow Fast (Alternate) Continuous Method. Volume of exercise is higher in continuous training method than interval training. This

method develops very high level of endurance ability. Continuous training influences significantly to the increase the level of Vo2 max (Yunus et al., 2019).

Interval Training

Interval training method was introduces by Woldemar Gershler in this method important thing is resting or interval period during exercise (Gibala & Hawley, 2017). Interval training Method is very effective for enhancement the quality of both aerobic and anaerobic capacity for athletes. Also it may helps to improve speed, agility and anaerobic threshold when applied with circuit training set up. (Jatmiko et al., 2023) Resting period is under consideration to calculate the load or progression of load. After workout heart rate in interval period become around 120 b/min then allowed to restart the exercise same as previous. Interval training method is of two types such as extensive interval training method and intensive interval training method. Interval training has long been the cornerstone of athletic fitness programs because it promotes increased calorie burning, strength, speed, endurance, and overall athletic performance (Walke, 2008)**.**

Circuit Training

Circuit training was established by Anderson and Morgan in the year of 1953 (Imanudin et al., 2020). This training method consists with eight to twelve different types of exercises in different station and chosen exercises must be completed in order at specified stations. Specified exercises in station rotate through a circuit. Selection of exercise depends on individualization, type or nature of game and necessity of fitness components. Distance between the stations is very important to implementation of training load. Progression of the load, repetition of exercise and volume of exercise depends on objectives of the training. Circuit training aims to enhance muscular endurance, flexibility, strength, and cardio-respiratory endurance in key muscle groups (Reddy, 2012). In views of different research establishment circuit training can improve the overall performance for an athletes with the help of specified exercises according to athlete's requirement.

Circuit training may be organized by two types of training methods, one is Continuous circuit training and another is Interval circuit training.

Continuous circuit training: This type of circuit training method composed where during the performance there is no permission to take any rest or interval in the way to complete a circuit within specified stations. To conduct the continuous circuit training Low intensity and high volume of exercise should be use.

Interval circuit training: This type of circuit training method adopted the process where during the performance with medium intensity and there are permission to take active rest or interval in the way to complete a circuit within changing the specified stations.

After the reviewed of many related literature for the present study have selected eight different exercises and formed specified training programme following continuous and interval circuit training methods to observe the result of training on anthropometrical, physical fitness and physiological variables.

1.6 INTERDISCIPLINARY RELEVANCE

The study implicates an interdisciplinary approach since the study encompasses the disciplines of sports training, exercise physiology and anthropometry which is also three core branches of Physical Education. The study investigates different anthropometrical, physical fitness and physiological variables as a mark of improving sports training. Hence the relevance and scope of the study can doubtlessly be explained as an interdisciplinary and integrated sports performance pointer. An earnest endeavor was made aware of the prior research conducted in the field, the gaps and weaknesses of the earlier studies, the methodology used and process was carried out by the professional personnel's and literature. A brief summary of review of literature about the related area as searched by the researcher from various sources have been presented in the chapter two. Based on the research conducted in this area, it can be said that not much work has been done so far for the estimation of the assessment of the impact of an interval and continuous training program on physiological, physical fitness, and anthropometric components for 13-16 years students of Purulia district in west Bengal. As such, the approach taken in this study was based on the observation of the effects of two training programs. The experts of the field were formulated the training programs applied by the investigator with the help of number

of assistants to comparison and Investigating the effects of continuous and interval circuit training on physical fitness, physiology, and anthropometric variables.

1.7 STATEMENT OF THE PROBLEM

The investigator was designed to initiate research work related to the evaluation of the impact of 12-weeks training program on various aspects and to measure and determine the Effects of interval and continuous circuit training on anthropometric, physical fitness and physiological parameters. Accordingly, the researcher stated the problem of the study as **"Comparison of Training Effects of Continuous and Interval Circuit Training Methods".**

1.8 OBJECTIVES OF THE STUDY

1. To observe the influence of both continuous and interval circuit training on anthropometrical, physical fitness and physiological variables.
2. To compare the effect of interval circuit training, continuous circuit training and a control group regarding anthropometric variables.
3. To compare the training impact of interval circuit training, continuous circuit training and a control group regarding physical fitness variables.
4. To compare the impact of interval circuit training, continuous circuit training and a control group regarding physiological variables.

1.9 DELIMITATIONS OF THE STUDY

The study has the following delimitations: -

i) Subjects of the present investigation were selected from Purulia Cricket Academy, Purulia district of West Bengal.

ii) Data has been collected from one academy of a particular place of Purulia district of West Bengal.

iii) The subjects' ages were restricted to 13 to 16 years old.

iv) For the purposes of this study, only male subjects were considered.

v) The selected participants were split up into three equal groups: control Group (CG-20), the experimental group - I for Interval Circuit Training (ICT-20) and the experimental group-II for Continuous Circuit Training (CCT-20).

vi) To observe the effect of training the researcher was restricted him into few anthropometrical, physical fitness and physiological variables.

vii) Total twelve weeks could be allotted for the training period, and there could only be three days per week.

1.10 LIMITATIONS OF THE STUDY

The study has the following limitations: -

The study's limitations come from the following factors, over which the researcher did not have control.

i) Despite the use of standard instruments, the researcher could not effort to use the latest sophisticated instruments for collection and analysis of the data.

ii) Due to financial stringency the researcher was bound to cut off so many important anthropometrical and physiological variables for the present study.

iii) Due to inability in initial screening (due to financial limitation) the researcher was unable to select participants from various districts of West Bengal. It might have been more appropriate for the current study to determine the training program's effects.

iv) The time was also the limiting factors for the study.

v) The scholar also did not have any direct control over the life style, food habit and general activity pattern of the subjects.

1.11 HYPOTHESIS OF THE STUDY

The researcher after studied the review of the related literature, formulated the null hypothesis for the present investigation. The null hypothesis set and stated was taken as:

1. There would be no significant influence in any anthropometric variables due to interval circuit training.

2. There would be no significant influence in any anthropometric variables due to continuous circuit training.

3. There would be no significant difference in anthropometric variables among interval circuit training group, continuous circuit training group and control group.

4. There would be no significant influence in any physical fitness variables due to interval circuit training.

5. There would be no significant influence in any physical fitness variables due to continuous circuit training.

6. There would be no significant difference in physical fitness variables among interval circuit training group, continuous circuit training group and control group.

7. There would be no significant influence in any physiological variables due to interval circuit training.

8. There would be no significant influence in any physiological variables due to continuous circuit training.

9. There would be no significant difference in physiological variables among interval circuit training group, continuous circuit training group and control group.

1.12 SIGNIFICANCE OF THE STUDY

This present study would be significantly useful in Physical Education as well as educational sector in the following ways –

i) This study helps to provide adequate knowledge on effect of circuit training on secondary level students.

ii) To find out which type of circuit training is beneficial to improve their anthropometrical, physical fitness and physiological variables.

iii) The result will provide information for future investigation within the disciplines of sports and physical education.

iv) Present study can help to provide knowledge to the sports trainer who also tries to provide perfect training toward sports person.

v) This study can help to general people about physical activity and active life style.

vi) From beginner to advance athletes will get precious motivation and advance movement by this investigation.

1.13 DEFINITION AND EXPLANATION OF TERMS

Sports training:

Sports' training is a structured and regulated procedure that modifies complex sports motor performance, performing ability, and behavior to accomplish a goal through measures of content, methods, and organization. (Martin, 1979)

Interval training:

Interval training is schedule activity which is performed with a specified periods of rest and recovery in between.

Continuous training:

Continuous training is a formation of physical exercise which is performed continuously without any interval period during activity.

Circuit training:

Circuit training is the methods where arranged specified series of exercise performed by athletes one after the other station with a circuit. There may eight to twelve stations in a one circuit.

Lactic acid:

The body produces lactic acid as a byproduct when glucose is broken down through the process of glycolysis to generate adenosine tri phosphate in the absence of oxygen.

Muscular Strength:

Muscular strength is directly connected with force production. Not only in the field of sports but also related with daily activity. The amount of force that can be applied to muscles in response to resistance is known as muscular strength.

Muscular Endurance:

Endurance is the ability to work for a long period of time on any task. It depends on nature of work. Therefore, the ability of a muscle or group of muscles to contract for a prolonged amount of time when faced with resistance is known as muscular endurance.

Body Composition:

Body Composition denotes the quantity of percentage of fat, bones, muscles and other vital parts found within a human body. Generally body composition is classified into percentage of body fat and lean mass weight.

Flexibility:

Flexibility is the ability to move anatomical parts through their full range of motion at a joint. Increased joint flexibility can help shield against a variety of injuries at different phases of life.

Cardiovascular Endurance:

Cardiovascular endurance is also implies to as an aerobic fitness. The ability of the heart, blood vessels, and lungs to provide enough oxygen and nutrients to the cells over an extended length of time in accordance with the demands of activity.

Agility:

The ability to quickly and precisely change the body's direction while moving is known as agility. Agility consists with combination of balance, power, speed, and coordination.

Balance:

The capacity to maintain or control one's body while moving or at rest is known as balance. Example is hand stand in gymnastics.

Reaction time:

The ability to react to a stimulus quickly is referred to as reaction time. Reaction time is implies the combination of mind and body connection. In the field sports reaction time is very essential to execute quality skill.

Coordination abilities:

The ability to use one's senses to coordinate various body parts during motions allows a person to perform a variety of motor tasks with efficiency. Such as hand and eye coordination is require for basketball dribbling.

Speed:

The capacity to move your body or specific body parts quickly or in a brief amount of time is known as speed. For quality performance in many sports speed is considered as essential factor to get success.

Power:

Power is the capacity to use the maximum amount of muscle force to move the body or specific body parts. Power implies the combination of speed and muscular strength.

CHAPTER-II

REVIEW OF RELATED LITERATURE

2.1 ACQUISITION OF EVIDENCES

2.2 INCLUSION AND EXCLUSION CRITERIA

2.3 REVIEW OF RELATED LITERATURE ON ANTHROPOMETRICAL VARIABLES

2.4 REVIEW OF RELATED LITERATURE ON PHYSICAL FITNESS VARIABLES

2.5 REVIEW OF RELATED LITERATURE ON PHYSIOLOGICAL VARIABLES

2.6 REVIEW CONCLUSION

CHAPTER-II

REVIEW OF RELATED LITERATURE

Every research investigation needs to start with an in-depth study of the literature related to the problem area. So, understanding of related literature is the fundamental movement to make a clear picture on present research, also helps to make a strong backbone of investigational path. What will be happen and which process should be the most excellent way to seek out a clear answer of an investigation, it is significantly dependent on related literature. History always enriched the present and future. So, area of investigation obviously most of time considerably depend on previous related research. Literatures can more emphasised stability to find actual solution of the research problem. Related literatures, variant researches, reports are generated an essence for the progress of the present investigation. The review of the related literature is very much requisite for the field of any research reflection which in researcher can have perception of the prior work that has been finished. Directly study related literature was very few but researcher given adequate effort to find out stable solution of research problem with the support of several available literature. Various dissertations, PhD theses, books, periodicals, research reports and other related literature preciously conceders as significant dimension to this investigated problem. Selected Related literature flourished a prominent understandingness of the selected problem. Researcher makes scientific focus on what others have done and what remain to be done on the area of curiosity. In recent time fitness, health, sports training, exercise is most popular for every an individual for active lifestyle. Researcher tries to investigate truly, scientifically, ethically and cordially with adequate evidence or the clinch of related literature into centre of attention on sports training and its positive effects. All the literature have won thought or findings but all are related to sports training, fitness, sports performance, exercise, health etc, these all are major indication to stable for this research investigation actually.

2.1 ACQUISITION OF EVIDENCES

Present study a widespread online searching method was used to acquire the study relevance records. The electronic databases- DOAJR (Peer reviewed open access); Pubmed (Biomedical); google Scholar (Scholarly index and bibliography data base); Scopus (Social

science, Health science, physical science and life science); Sodhgonga (UGC Inflibnet); Europe PMC (Biomedical); Mediline (Medicine) etc. were carefully searched for reviewing the related literature.

2.2 INCLUSION AND EXCLUSION CRITERIA

Present study stated a particular research area where have specified objectives of the study. During selection or search related research studies which were not related to the objectives of the study directly excluded from this procedure. For inclusion into present research study as a related literature criteria were followed carefully and focused toward the area of continuous training, interval training, circuit training, interval circuit training, continuous circuit training, physical training and blood lactic acid, training and physical fitness variables, training and physiological variables, training and anthropometrical variables, Harvard step test and lactic acid, stepping and lactic acid, heart rate and lactic acid etc.

2.3 REVIEW OF RELATED LITERATURE ON ANTHROPOMETRICAL VARIABLES

Kim et al. (2018) examined how a 12-week circuit training program affected the risk factors for metabolic syndrome and health-related physical fitness in obese female college students. Two groups were created, one for circuit training and the other for control, with ten people each. For 12 weeks, three times a week, ten different resistance and aerobic exercise types were included in the circuit training program. According to the study's findings, the circuit training group's body weight, body fat percentage, and body mass index were all considerably lower than those of the control group.

Contrò et al. (2017) were carried out a study comparing the influence of various circuit training methods to ascertain which is the best for losing weight and for particular disorders associated to being overweight. A total of forty-five female participants, aged between twenty and fifty, were chosen and separated into three sections. A control group was utilized to compare with each group. For twelve weeks, there was three times a week of training. The findings indicated that the aerobic-tone-aerobic (ATA) group reduced total body mass and body fat more than the other groups. The aerobic-circuit-aerobic (ACA) group significantly lowered body fat,

total body mass, and low-density lipoprotein cholesterol. All circuit protocols are ideal for decreasing total body fat and body mass.

Ucan (2014) examined to determine how circuit-type resistance training affected the bone status and body composition of twenty-eight teenage boys. The fat mass, bone mineral density, total body fat, fat-free mass and bone mineral content was determined by dual-energy X-ray absorptiometry. The findings suggested that twelve weeks of circuit resistance training improved the bone status and body composition of young, moderately active males without changing their body weight.

Bonsu (2015) conducted a study on overweight or obese young women to determine the extent of the Post Exercise Hypotension Response following an acute bout and high intensity Interval Training for six sessions, as well as the effects following two weeks of detraining. For the study, twenty young women offered their time. According to the findings, an acute bout and six sessions of high-intensity interval training caused a notable reduction in BP following exercise. Detraining also had a statistically significant impact regarding diastolic and mean arterial pressure but the diastolic blood pressure went back to levels that were comparable to the starting point.

Romero-Arenas et al. (2013) investigated the circuit training effects with high resistance and contrasted its effects with traditional heavy strength training on measures of cardiovascular fitness, body composition, muscle size, and strength in an older, healthy population. For 12 weeks, a random assignment of twice-weekly training was given to thirty-seven healthy men and women. Lean mass and bone mineral density increased significantly in the experimental groups. Only the high-resistance circuit demonstrated a discernible drop in fat mass. Compared to the control group, this decrease was noticeably larger in the high-resistance circuit. Nothing changed observed for any of the variables in the control group.

Badami & Baragundi, (2017) carried out a study to compare key metrics of cardiopulmonary fitness between students studying physical education (PE) and medical education (ME). A total of 100 students were chosen, with 50 students in each group for physical education and medical education. The means for both groups' height and age did not differ statistically. Subject data has been collected both before and following the Astrand-Ryhming

step test (ARST). Compared to students studying medical education, Students in physical education showed a noticeably greater percentage of recovery in terms of respiratory rate, blood pressure, and pulse rate.

Hottenrott et al. (2012) studied impacts on men's and women's aerobic capacity and body composition who participate in recreational physical activity when continuous endurance training was compared with high-intensity training. Heart rate was meticulously recorded and aerobic power was measured during a strenuous treadmill test. Running enthusiasts who engage in recreational activities can improve their aerobic fitness with quick, intense endurance training sessions lasting roughly 30 minutes.

Brock & Legg (1997) were investigated to determine the impact of female recruit training regarding the physical health and muscular strength of the British army. For this study, 73 female participants between the ages of 17 and 23 were chosen. Body weight, Muscular strength, percentage of body fat and some other variables were measured on pre and post-implication of six weeks training program. This study concluded that British recruit training is effective in increasing physical Fitness, fat-free mass and lowering the ratio of body fat.

2.4 REVIEW OF RELATED LITERATURE ON PHYSICAL FITNESS VARIABLES

Prasanna et al. (2020) investigated towards the effect on Speed, Muscular Endurance and Cardio Respiratory Endurance along with university students by Continuous and Interval training method. Selected age group was 18 to 25 years old, total 45 university students were haphazardly chosen for this study. Three groups of samples were created using continuous training, interval training, and control groups. Pre and post tests were recorded for this study. This study found that significantly positive improvement in Speed, Muscular Endurance and Cardio Respiratory Endurance when comparing the experimental groups to the control group.

Khan et al. (2019) investigated the effects of continuous, moderate-intensity training methods combined with interval training on aerobic capacity. For a six-week endurance training regimen consisting of three weekly sessions of walking on a treadmill for thirty minutes each, forty young, healthy samples were assigned at random. Measurements were made of blood pressure, heart rate at rest, respiratory rate at rest, and Vo2 max. Vo2 max improved significantly

for both of groups. Following six weeks of training, in both groups, the resting heart rate, blood pressure, and respiratory rate were reduced. According to this study, both groups' aerobic capacity (Vo2max) significantly improved.

Moch & Wahjuni (2019) investigated the difference of continuous and interval training toward maximum V̇o2 max increase. The study made use of randomized group with pre test and post test design. 40 persons were chosen randomly as sample with the use of purposive sampling. Samples were separated into two different groups with continuous and interval training groups. Vo2 max was determined using the experiment's pre- and post-tests. The study concluded continuous and interval training influences significantly toward the Vo2 max increase. Finally concluded there is no significant deference between continuous and interval trainings toward the Vo2 max increase.

Adling & Bangar (2017) were a study carried out to determine how aerobic training affects particular physiological and physical parameters. Thirty male students between the ages of eighteen and twenty-one were chosen at randomly for the investigation. Two equal groups were formed at random from all of the students. Over the course of eight weeks, fifteen students in one group participated in aerobic exercises five days per week, while the control group formed with fifteen students. The pre-test was used to gather data before training, and the post-test was used to gather data following eight weeks of aerobic exercise instruction. The results showed that aerobic training can help with improving resting heart rate, vital capacity, muscular endurance, and cardio-respiratory endurance.

Benda et al. (2015) were conducted a thorough comparison of the effects on cardiovascular structure and function, physical fitness, and quality of life of patients with heart letdown between continuous and high intensity interval training. 29 patients in total were chosen as a sample. Each experimental group carried 10 students and 9 students were for control group. Total 12-weeks of continuous training and high intensity interval training activity allotted for experimental groups. Data was taken before and after the experiment. The findings revealed that the specified training significantly improved the physical fitness parameters, but no differences were observed between high intensity interval training and continuous training.

Al-Haliq (2015) finished a study examining how a circuit training program might improve university students' physical fitness levels. There were thirty students in total, fifteen of whom were male and fifteen of whom were female. The investigator designed the examinations to evaluate the fitness parameters based on the Physical Fitness Course participants. Data from before and after were noted. After post-test measurements, it was found that the participants' level of physical fitness had clearly improved.

Kumar (2016) did a research investigation to determine how to improved male university students' motor skills by circuit training. A total of sixty boys in the 18–25 age range were chosen to be the subjects. A purposeful division of the subjects into experimental and control groups was made. Each group consists with 30 students. Experimental group was performed for 8-weeks of circuit training program on the other side the control group only engaged in the regular curriculum activities; they received no additional training. Study was adopted t-test to find out the statistical significances. The investigation's findings showed that the subjects' speed, leg power, arm power, and agility were all significantly increased by circuit training.

Moses et al. (2015) aimed to investigate how students' cardiovascular characteristics in Ibadan, Nigeria, were affected by both continuous and intermittent training exercises. 180 primary school students were selected by Systematic random sampling and divided by three groups such as continuous exercise, interval exercise and the control groups. Each group carried 60 students. The experimental groups involved in twelve weeks of trainings. The cardiovascular variables were measured pre and post training condition. The result denotes that continuous and interval training exercises have significant effects on heart rate functioning of the primary school students.

Vinayagamoorthi & Sakthivel (2014) were investigated how a selected group of high school students' physical and physiological characteristics were influenced by cardiac circuit training. 16 to 18 years old 30 kabaddi players were selected to conduct this study. Equal numbers of students were allocated randomly into control and experimental groups. The group conducting experimentation where received specific cardiac circuit training for six weeks, three days a week. Muscular strength and endurance, speed, agility, breath holding capacity, and VO2

max were tested both before and after. Found the result that there was significant improvement for experimental group after six weeks of training.

Babu & Kumar (2014) conducted a study to determine how football players' speed and coordination were affected by continuous running, Fartlek training, and interval training. Sixty intercollegiate athletes, ages 18 to 24, were selected at randomly. All the players were divided into four separate groups by Continuous training, Fartlek training, Interval training and control group. Data from both before and after the experimental phase were recorded. After the outcome of the investigation exposed that there was positive improvement in speed and Coordination for experimental groups while compared with control group.

Chittibabu & Akilan (2013) were searched to assess the outcome of 24 male high school basketball players those who received basketball-specific endurance circuit training designed to improve heart rate and endurance ability. A control group and a circuit training group were equally divided among the chosen players. Prior to and following training, pre- and post-tests were conducted. As per the research outcomes, resting heart rate, peak heart rate and the aerobic capacity showed notable differences in between the two groups.

Kumar (2013) investigated on the effect of circuit training on cardiovascular endurance of high school boys. 96 school students were selected as the subjects for this study. Each subject's pre-test pulse rate was recorded following a three-minute modified Harvard step test. Based on their heart rates, they were carefully split into two equal groups of forty-eight individuals each. After complete of six weeks training, the pulse rate was again recorded for both of groups. According to the study, the experimental group's cardio-vascular endurance improved as a result of the circuit training regimen.

Babu & Kumar (2013) were carried out an investigation about the effect of circuit training exercises on thirty female sprinters in the 14–17 age range. Random sampling method was use to select the sample from entire population. Circuit training programme was implemented for six weeks and three days in a week on experimental group. To evaluate of sprinting ability 100 meters run was selected. Data from pre- and post-tests were gathered prior to and following the implementation of the training. Result showed there was significant difference between pre test and post test score.

Mayorga-Vega et al. (2013) were observed the impacts of a circuit program of exercise on cardiovascular and muscular endurance. For this study age group of 10 to 12 students were randomly selected and there were 35 students specified to the experimental group and 37 students to the control group. Eight weeks training programme performed for two day a week. Data from the pre- and post-tests were carefully recorded for a number of chosen variables. After implementation the training program the results reflected that the circuit training program can enhance and sustain both muscular and cardiovascular endurance among the students.

Mazoochi et al. (2013) carried out a research to find out the influence of an interval and continuous training procedure on various cardio-respiratory characteristics in athletes. Total 24 sports persons were selected and distributed into three different groups. Each group carried 8 students. Different training methods have been developed in the area of sports training and uses with support of actual base of physiology. Pre and post test data was recorded on experiment. Findings of the study showed the considerable effects of interval and continuous training on respiratory parameters.

Reddy (2012) compared the performance measures of 60 boys students from Scheduled Tribe / Scheduled Caste (ST/SC) and non- ST/SC category using circuit training methods. Thirty SC/ST and thirty non-SC/ST students were chosen. 30 Students those who are under ST/SC they were separated within three comparable groups: the Control Group (CG), Interval Circuit Training (ICT), and the Continuous Circuit Training (CCT) Groups. Similar to before separation, more thirty without ST/SC students were divided among three groups. For eight weeks, CCT and ICT students received training three days a week. According to the investigation, interval circuit training methods showed statistically significant speed improvements in the case of SC/ST exclusively. For the continuous circuit training method, SC/ST boys' 800 M performance increased as well. Boys from Scheduled Caste/Scheduled Tribe and non-Scheduled Caste/Scheduled Tribe are generally better at the 800m (endurance), standing broad jump (leg strength), and shuttle run (agility) through the continuous and intermittent circuit training program.

2.5 REVIEW OF RELATED LITERATURE ON PHYSIOLOGICAL VARIABLES

Chatterjee & Thukral et al. (2017) constructed a study with the goal of analyzing the muscle activity during two widely used step tests. The Queen's College Step Test (QCST) and the Harvard Step Test (HST) were used to estimate maximal aerobic capacity (Vo2 max) and determine cardiovascular fitness. On the other side electromyography provides to access the physiological and electrical responses during muscular activity. Eight students of a university in total were chosen for this investigation. The level of contraction of the muscles in the right and left legs significantly increased during HST. When comparing the frequency domain during HST to the QCST, which predicted the possibility of fatigue, there was an insignificant decrease. According to the study's findings, the musculoskeletal system is subjected to greater strain by HST than by QCST, making it the preferred method for assessing physical fitness under field conditions.

Adling & Bangar (2017) were composed an investigation to determine how aerobic exercise affects a subset of physical and physiological traits in a group of thirty male students, ages 18 to 21. For the purpose to conduct this study, subjects were first randomly selected, and then they were again randomly assigned to experimental and control groups. For eight weeks, every week for five days, the experimental group worked out aerobically. Pre-test results were obtained prior to training, and post-test results were obtained following an eight-week aerobic exercise program. The study's findings showed a significant distinction between the pre- and post-test results for the experimental group on resting heart rate and vital capacity.

Roy et al. (2014) consisted of a study to determine the female athletes' anaerobic threshold levels for various running distances. Ten female athletes in the age range of 22 to 24 were chosen as the study's subjects. The blood lactate level, speed over various distances, and resting heart rate were the variables that were chosen. The subjects completed an extensive interval training programme that was scheduled for eight weeks. Data were gathered both before and after the training. Increased blood lactate accumulation has been found to differ significantly between the pre- and post-training phases for various gradual running distance increases, including 250, 300, 350, and 400 meters. Regarding the training effect, however, there was a decrease in blood lactate accumulation (250 mt. -1.98%, 350 mt. -.30%, and 400 mt. -1.39%),

with the exception of 300 mt. (which increased by 2.66%), but these were not statistically significant at the same running distance following the extensive interval training.

Bhavsar et al. (2014) carried out a study to see how music and varying musical tempos affect the amount of time needed for recovery after moderate exercise, since there isn't much data on the subject. Thirty male and thirty female volunteers participated in three days of isotonic exercise, which is the Harvard Step Test. On the first day, the volunteers were left in silence, on the second, they listened to slow music, and on the third day, they were given fast music. Blood pressure and pulse rate were within the parameters that were measured at regular intervals. The study came to the conclusion that music speeds up post-exercise recovery and that slow music relaxes people more than fast or no music at all. It also found that recovery times were unaffected by gender and personal musical preferences.

Miller et al. (2014) examined how a high-intensity circuit training (HICT) method influenced obese, sedentary men's physiological health. Over the course of four weeks, eight obese males participated in specified training method, that included for three sessions of thirty minutes each week for training and six hours of exercise overall. Blood pressure, Heart rate, time to completion, total work (TW), rating of perceived exertion, and measurements of body composition were taken before, during, and after training. Measurements were also made on fasting blood samples prior to, during, and following the HICT program. It was found that a high-intensity circuit-training (HICT) program that accounted for only six hours of total exercise significantly improved the biochemical, physical, and body composition characteristics of sedentary obese males.

Chittibabu & Akilan (2013) investigated to determine how Basketball-specified endurance circuit training method affected the heart rates and aerobic capacities of high school male students those who were basketball players. Total twenty-four students were chosen and they were split into two groups at random: specified circuit training group and control group, each group carried twelve students. The variables included heart rate at rest, heart rate at peak, etc. The study's findings showed a significant difference in resting heart rate and peak heart rate between control group and experimental group.

Vescovi et al. (2011) were studied on the effects of sex, age, swim stroke, and race distance on blood lactate [BLA] following competitive swimming events and to create a workable model based on recovery swim distance to maximize the removal of blood lactate. Blood lactic acid [BLA] from 100 swimmers who finished in the finals of the Canadian Swimming Championships was examined retrospectively after the event. Throughout the active recovery, blood lactic acid [BLA] was also measured on a regular basis. To assess the relationship between post-race blood lactic acid [BLA] and independent variables, generalized estimating equations were employed. According to the study's findings, post-race blood lactic acid [BLA] was lowest after 50 and 1500 m races and highest after 100–200 m events. The impact of age on post-race blood lactic acid [BLA] was minimal. Results show that elite swimmers have similar levels of blood lactate [BLA] after a swim, and that age has little bearing on this level in competitive swimmers between the ages of 14 and 29.

Richardson & Hardman (1989) were investigated to see if reference blood lactate concentrations measured during stepping exercises could be utilized as a means of determining an endurance index. During stepping for ten untrained males, the classic endurance fitness metric, maximal oxygen uptake (Vo2 max), and the unique correlations between blood lactate concentration and sub-maximal Vo2 were determined. These findings demonstrated that oxygen uptake and percent Vo2 max at a reference blood lactate concentration can be measured using a sub-maximal step test. Percent Vo2 max for this set of participants, however, showed only a weak relationship with endurance at a blood lactate concentration of 4 mM.

Cal (1973) conducted this study to find out how an interval bench stepping training program affected the metabolic energy mechanisms of ten male participants, ranging in age from 18 to 35. Specifically, the energy produced via the aerobic, alactacid and lactacid mechanisms, was compared before and after a seven-week program of interval bench stepping. The study was composed of three periods: pre-testing, training and post testing. The findings of the research determined seven weeks of interval training method has no effect on maximal alactic capacity. A seven-week interval training program has no effect on maximal lactic capacity. Interval training for seven weeks can result in a significant increase in maximal oxygen consumption.

Chaloupka & Charles (1972) formed a study about the impact of two maintenance programs following eight weeks of interval training on physiological component. Eleven subjects were selected for this study and eight weeks program of interval training consisting of three workouts per week on a motor driven treadmill. The selected physiological variables were: blood lactic acid concentration, resting, exercise and recovery heart rates, maximal oxygen consumption, sub maximal oxygen consumption, physical work capacity, maximum ventilation, maximum muscular power and lean body mass. On the basis of result concluded that both frequencies of interval bench stepping (once per week and once every two weeks) are capable of maintaining a training effect in some variables for as long as sixteen weeks following the cessation of training. He suggested however, that an interval bench stepping frequency of once per week is more beneficial to the maintenance process than a frequency of once every two weeks.

2.6 REVIEW CONCLUSION

The researcher reported all of the reviews in three major categories such as anthropometrical, physical fitness and physiological variables. Circuit training, interval training and continuous training are the strong concept in the field of sports training and many research investigations have been conducted on these areas. It appears that there are lacks or scarcity of literature on continuous circuit training and interval circuit training related research. In the present research an attempt to be taken to fill this gape. On the basis of researcher's observations, several research investigations came into viewed related with this research study directly as well as associated indirectly. Many of them how to promote health status with adequate fitness level on physical, mental and social aspect a related literature in this study. Some research investigations supported this research study with sports training which can help to promote performance of an athlete. In generally physical training also helpful for every individual for our society. Healthy general people and also efficient athlete is the best valuable asset for a growing country. Researcher attempted to emphasise on elaboration of actual concept of sports training and how to implication it for the performance for a sports person. Uncountable investigations were established on sports training to promote precious concept for athlete and coaches. Modern concept of sports training enriched to maintain and progress of sports status for every country. Researchers have very belief with these supported all the reviews of related literatures; this

research investigation may prosper a new thought to society. It also belief that improvement of anthropometrical, physical and physiological components of sports person as well as a general people, continuous and interval circuit training programs are very much important.

The study investigates different anthropometrical, physical fitness and physiological variables as a mark of improving sports training. Hence the relevance and scope of the study can doubtlessly be explained as an interdisciplinary and integrated sports performance pointer. A sincere effort was made to learn about previous research on the topic, its shortcomings and gaps, the methodology employed, and the steps taken by experts and academics. A brief summary of review of literatures about the related areas as searched by the researcher from various sources which have been discussed above. As therefore, the current investigation was designed to start research on the estimation of effect of 12 weeks of proposed scientific training program formulated by expert to determine and compare the impact of interval and continuous circuit training on anthropometric, physical fitness and physiological variables. After carefully studied the related literatures, the researcher found research gape about the study of continuous and interval circuit training methods. Also a very few number of study yet been done on it. Therefore the researcher entitled a study as **"Comparison of Training Effects of Continuous and Interval Circuit Training Methods".**

CHAPTER-III

METHODOLOGY

3. INRTODUCTION

3.1 SELECTION OF THE SUBJECT

3.2 SECTION OF THE VRIABLES

3.3 THE DESIGNE OF THE STUDY

3.4 TRAINING PROGRAMME

3.5 CRITERION MEASURES

3.6 INSTRUMENT RELIABLITY

3.7 TESTER COMPETENCY

3.8 ADMINISTRATION OF THE TEST

3.9 STATISTICAL PROCIDURE ADOPTED FOR ANALYSIS OF THE DATA

CHAPTER-III

METHODOLOGY

3. INTRODUCTION

Methodology is an important, systematic and theoretical analysis of the methods based on particular principles applied in the field of research investigation. This method was used by the researcher to comparison of training effects of continuous and interval circuit training methods. Since this study was investigational in nature as it deals with the comparison among three non-manipulative independent group variables, it falls under the area of experimental types of research.

In this chapter the procedure followed and methodologies were used for the present investigation have been described. It included Selection of the subject, Section of the variables, experimental design, Training programme, Criterion measures, Instrument reliability, Tester competency, Administration of the test and the methods for statistical analysis of the data have been explained.

3.1 SELECTION OF THE SUBJECTS

This study involved a total of sixty boys (N = 60) as subjects. The subjects were randomly selected after medical screening from purulia cricket academy, Purulia district of West Bengal. Subjects in the research were between the ages of 13 to 16 years. They all were under skill practices on pre beginner section and joined at Purulia Cricket academy for one to three months only. Lottery method was use to conduct simple random sampling process, there all the students got an equal opportunity to select for the study. Homogeneity was tested based on their personal data and performance in the initial stage. For present study, after sixty (60) boys were chosen as subjects and they were distributed into three equal groups using a simple random grouping technique, each group was consisted of twenty (N= 20) students. The experimental groups were intervened through scientifically structured continuous circuit training and interval circuit training program separately for twelve weeks whereas the control group was free from intervention of any kind of structured training program. Groups that were formulated for the study namely as Interval Circuit Training (ICT), Continuous Circuit Training (CCT) and Control

Group (CG). All groups were engaged in their regular academic activities and maintain their regular food habits which was not under the control of the researcher. Thus, the effect of uncontrolled variables was tried to nullify by using the expected changes of the control group.

3.2 SELECTION OF THE VARIABLES

The intention of such selection was to determine a group of variables that will make the best relevant for the model so that accurate predictions can be develop. Researcher studied the many scientific literatures regarding to various training methods related to continuous training effect and interval training effect on a circuit training set up. After reviewed the literatures and discussed with professional coaches, expert and supervisor researcher selected following variables in three heads namely anthropometric, Physical fitness and Physiological. BMI is a reliable indicator of a person's health. Sports and medical professionals can quickly identify health risks by using BMI and considered as an important variable of the study. Apart from BMI, Body-weight, percentage of body fat, calf girth, thigh girths were also considered. Building lean body mass promotes in the development of strength and power. Muscle size is related to power and strength. Therefore, an increase in lean body mass allows the athlete to exert more force in a specified period of time. From this standpoint researcher has considered percentage of body fat as an important marker of the study. Participants in circuit training may generally perform a high number of repetitions for each exercise. This means utilizing particular muscles fibers to help sustain the exercise, over time and enable longer exercise sessions without causing fatigue, allowing to use muscles longer time and more effectively, but it depends upon the amount of lactic acid concentration in blood and its tolerance capacity on exercise. So, researcher considered lactic acid concentration and heart rate as significant variables for this study. In a circuit training set up exercises tangled were of high mandate to perform against resistance for a long and with speed which are inevitable that effect on muscular system and cardio respiratory system. From this perspective researcher considered Speed, Agility, Flexibility, Leg explosive strength and Cardio respiratory fitness as physical fitness variable of the study. Taking into considerations of the criteria, feasibility, variability of instrument and relevance to the present experimental study, the above mention variables were selected.

3.2.1. Anthropometric Variables:

Following parameters were identified as an important component for sports performer. From the area of anthropometrical perspective following parameters were considered.

3.2.1. a. BMI

3.2.1. b. Body-weight

3.2.1. c. Percentage of body fat

3.2.1. d. Calf girth

3.2.1. e. Thigh girths

3.2.2. Physical Fitness Variables:

Following parameters were identified as an essential component for sports performer. From the area of physical fitness perspectives following parameters were considered.

3.2.2. a. Speed

3.2.2. b. Agility

3.2.2. c. Flexibility

3.2.2. d. Leg explosive strength

3.2.2. e. Cardio respiratory Endurance

3.2.3. Physiological Variables:

Following parameters were identified as an essential component for sports performer. On view of Physiological perspectives of human body following parameters were considered.

3.2.3. a. Blood lactic acid

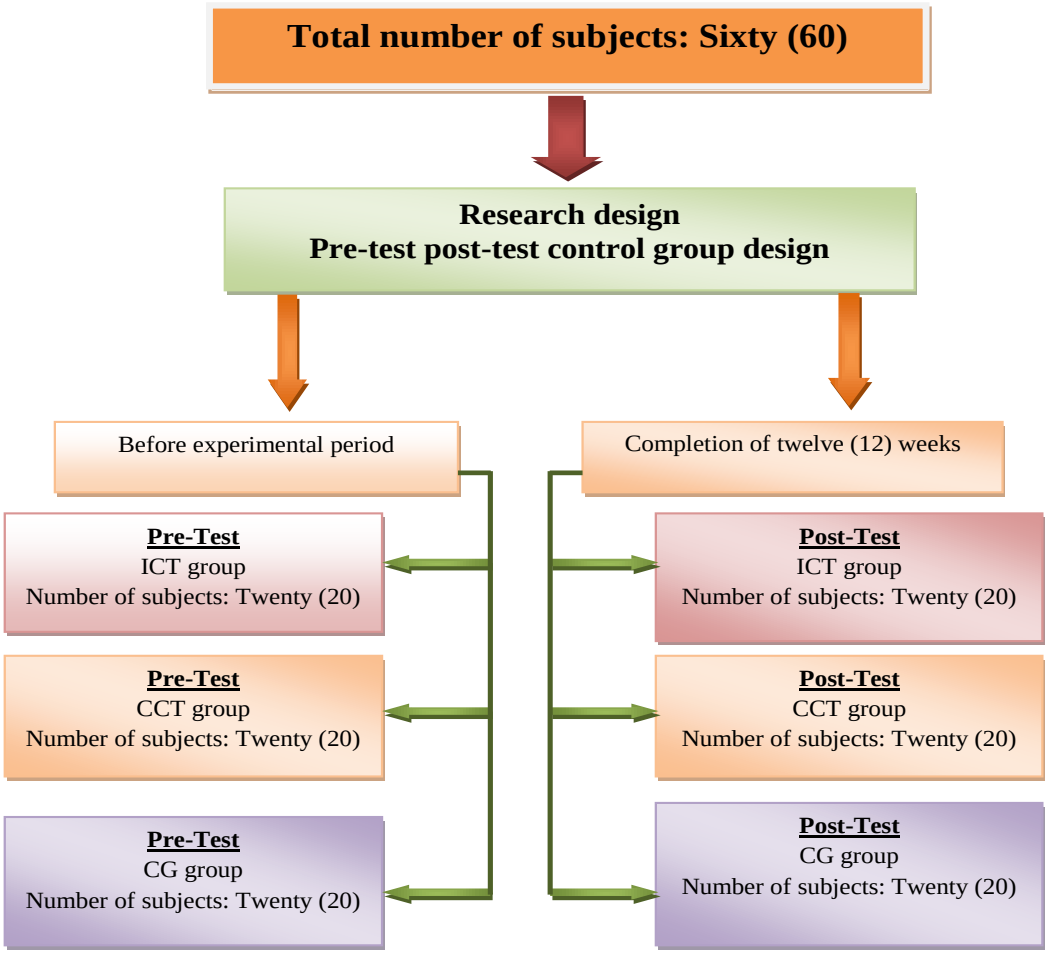
3.2.3. b. Heart rate

3.3 THE DESIGNE OF THE STUDY

The research was designated as an experimental design with a pre-test and post-test. The experimental setup for the present study included sixty subjects (N = 60). Sixty (60) subjects in total were randomly assigned to three groups (ICT, CCT, and CG), each with twenty (20) subjects. The two experimental groups in this study were the Continuous Circuit Training group (CCT), the Interval Circuit Training group (ICT) and another was Control group (CG). Both of experimental Groups underwent circuit training following continuous and interval method respectively for twelve (12) weeks, three (3) days in a week. The CG they were stopped from participating in specified training methods but involved in their regular routine schedule of the academy of cricket skill practices. Before and after the training, each subject underwent testing on selected variables.

The study was under experimental type of research and for this investigation pre-test post-test control group design was applied.

Flow chart of experimental design



3.4 TRAINING PROGRAMME

Experimental group- I (ICT) trained on interval circuit training method whereas experimental group-II (CCT) trained by continuous circuit training method and group- III (CG) was in under control. The researcher have reviewed the several research literature regarding the effects on the human body of both continuous and interval circuit training methods (Reddy, 2012; Pan, 1999 & Themistocleous et al., 2021). After reviewed the researcher discussed with fitness trainer, coaches, exercise expert and supervisor and selected the training methods along with specific exercises. There were eight stations with the same eight physical exercises for both the interval circuit training and the continuous circuit training methods, these are given bellow:

STATIONS	EXERCISE NAME	DURATION OF EXERCISE / DISTANCE
1	**SPOT JUMP**	30 SECONDS
2	**PUSH UPS**	30 SECONDS
3	**HIGH KNEE**	20 SECONDS
4	**SIT UPS**	1 MINUTE
5	**BOX JUMP**	30 SECONDS
6	**SQUAT THRUST**	1 MINUTE
7	**SHUTTLE RUN**	4 X 10 METERS
8	**STEP UPS**	1 MINUTE

At first 7 minutes warming up activity with jogging, shuffling and stretching was mandatory for both of groups. Whereas the stations for the experimental groups I (ICT) and II (CCT) were similar, the recovery times and procedures for changing between the stations differed. Although the interval circuit training group took two minutes of active rest before restarting the circuit, the continuous circuit training group did not have a recovery period. Those who were in interval circuit training method they were involved with slow jogging from one station to another station and those who were in continuous circuit training they carried normal walking from one station to another station. Every day, both experimental groups performed a total of three circuits (3-Sets). One instructor was allotted, where situated starting and finishing line those who access stopwatch and whistle. One instructor had been observed over all circuit activities. For each

performer was a peer who guided individual score sheet and a stop watch. Training was performed three days a week. Training continued for twelve weeks in total. Group III served as the control group (CG), which only engages in their regular activities on a daily basis. Both of experimental groups performed on circuit according to their maximum individual effort and capacity. First four weeks followed the load 70 % of their maximum capacity. After completion of first four weeks researcher again recorded maximum capacity of the students and fifth to eight weeks followed the progression of load 75 % of their maximum capacity. Again same as before determined the maximum capacity and ninth to twelve weeks followed the progression of load 80 % of their maximum capacity.

Twelve weeks Training Schedule for Interval Circuit Training Group

Group Name - ICT (Interval Circuit Training)		Total students : 20			
Total Number of circuit- 03		**Rest interval after one circuit / 01- Set:** **2 Minutes active rest**		Total time for a session- (3- Circuit / 3-Sets) : 21 minutes approximately	
Warm-up Time: 7 minutes		Activity schedule sheet: Each students followed won individual activity sheet			
One station to next station distance covered: by Jogging					
Sl. No	**Name Of Exercise**	**Duration Of Exercise / Distance**	**% of intensity for 1 – 4 Weeks**	**% of intensity for 5 – 8 Weeks**	**% of intensity for 9 – 12 Weeks**
1	Spot Jump	30 Seconds	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity
2	Push Ups	30 Seconds	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity
3	High Knee	20 Seconds	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity
4	Sit Ups	1 Minute	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity
5	Box Jump	30 Seconds	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity
6	Squat Thrust	1 Minute	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity
7	Shuttle Run	4 X 10 Meters	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity
8	Step Ups	1 Minute	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity

Twelve weeks Training Schedule for Continuous Circuit Training Group

Group Name - CCT (Continuous Circuit Training)			Total students : 20		
Total Number of circuit-03		**Rest interval after one circuit / 01- Set: No rest**	Total time for a session (3 Circuit / 3-Sets): 19 minutes approximately		
Warm-up Time: 7 minutes		Activity schedule sheet: Each students followed won individual activity sheet			
One station to next station distance covered: by normal walking					
Sl. No	**Name Of Exercise**	**Duration Of Exercise / Distance**	**% of intensity for 1 – 4 Weeks**	**% of intensity for 5 – 8 Weeks**	**% of intensity for 9 – 12 Weeks**
1	Spot Jump	30 Seconds	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity
2	Push Ups	30 Seconds	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity
3	High Knee	20 Seconds	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity
4	Sit Ups	1 Minute	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity
5	Box Jump	30 Seconds	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity
6	Squat Thrust	1 Minute	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity
7	Shuttle Run	4 X 10 Meters	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity
8	Step Ups	1 Minute	70 % of maximum capacity	75 % of maximum capacity	80 % of maximum capacity

3.5 CRITERION MEASURES

The following parameters were measured through-

PERSONAL DATA		
Variables	**Method/technique used**	**Unit of Measurement**
Age	Age was recorded from the register of Academy.	Years
Height	Height was measured by measuring tape.	Meter (mt)

ANTHROPOMETRICAL VARIABLES		
Parameters	**Method/technique used**	**Unit of Measurement**
BMI (Body Mass Index)	Weight (kg) / Height (m^2)	Kg/m^2
Body weight	Standard Weighing machine	Kilogram (Kg)
percentage of Body fat (%)	Slim guide Skin fold calipers (Jackson & Pollock, 1978)	Percentage (%)
Calf girth	Steel tape	Inches (inch)
Thigh girth	Steel tape	Inches (inch)

PHYSICAL FITNESS VARIABLES		
Parameters	**Method/technique used**	**Unit of Measurement**
Speed	50 yards dash (AAHPER, 1976)	Sec
Agility	4 x 10m shuttle run (AAHPER, 1976)	Sec
Leg explosive strength	Standing broad jump (AAHPER, 1976)	Meter (mt)
Cardio Respiratory Endurance	Harvard Step test (Brouha, Lucien , 1943)	B/min
Flexibility	Sit-and-reach test (Modified) (Johnson & Nelson, 1982)	Inches (inch)

PHYSIOLOGICAL VARIABLES		
Parameters	**Method/technique used**	**Unit of Measurement**
Lactic acid concentration	Harvard step test (Brouha, Lucien , 1943) & Lactate Pro Analyzer (Arkary Global Business, Inc, Kyoto, Japan), Serial No. 2601657 (Tanner, et al., 2010; Baldari, et al.,2009; Pyne, Boston, et al., 2000)	Mmol/L
Heart rate	Harvard step test (Brouha, Lucien , 1943) [Electronic Digital stop watch, bench (ht.20 inches) & Metronome]	B/min

3.6 INSTRUMENT RELIABLITY

The instruments were used in the study, digital weighing machine, stopwatch, skin fold caliper, Steel measuring tape etc. were manufactured by reputed concerns and are being widely used for similar measuring purposes and moreover the physical education department at Jadavpur University in Kolkata was the source of these instruments. Thus, the instruments used in the present study for the same measurement purposes were deemed as reliable enough as guaranteed by the manufacturer and experts.

3.7 TESTER COMPETENCY

For the purpose of collecting data the help of the professional colleagues and teachers of the investigator were taken. These personnel had more than 5 to 10 years of expertise in the field of physical education in many universities of West Bengal and also having wide research experience in the area of physical education & sports especially in sports training, Kinanthropometry and Physiology related topic of the present research study. They were also given a short orientation/practice well before the data was collected. Thus, it could be assumed that the testers were competent and reliable enough for the said purpose.

3.8 ADMINISTRATION OF THE TEST

3.8.1. PERSONAL DATA

3.8.1.1. Age

Age of the subject was recorded in completed years and it was noted according to their date of birth. In this study age ranged of the subjects were 13 to 16 years based on their academy records.

3.8.1.2. Body weight

Purpose: To determine the individual's body weight.

Equipments: Standard Weighing machine and score sheet.

Procedure: The subjects were in minimum clothing without any footwear. Instructed to Subject`s weight should be evenly distributed on both feet and stand straight with forward looking. The Standard Weighing machine was used to measure the body weight with sufficient lighting surface where conducted the measurement. The Investigator was recorded on proper observation.

Scoring: The weight was recorded to the nearest kilograms. Each Individual weight was recorded as the score.

3.8.1.3. Height (Steel tape)

Purpose: To measure the body stature of the subject.

Equipments: Standard Steel or cloth tape and score sheet.

Procedure: A person's height is measured when they are standing, from their vertex to the floor. The individual was instructed to stand straight on the ground without shoes and heel together with looking forward. Individual Height was noted in Meter (mt) used by Standard Steel or cloth tape.

Scoring: Each Individual height in meter was recorded as the score.

3.8.2. ANTHROPOMETRICAL VARIABLES

3.8.2.1. BMI (Body Mass Index) (Height and Weight ratio)

Purpose: To measure the Body Mass in Relation to height.

Equipments: Steel or cloth tape was used to measure the height and Standard Weighing machine was used to measure the weight.

Procedure: BMI was composed by measurement of height and weight ratio of an individual. BMI was calculated from the following formula: BMI (Body Mass Index) = Weight (in kg) / Height^2 (in meter)

Scoring: According to height and weight ratio each individual BMI was calculated with the help of above specified formula. Calculated value was recorded as the score.

3.8.2.2. Percentage of Body fat (%): (Jackson and Pollock Calliper Method)

Purpose: To measure the level of individual's percentage of body fat.

Equipments: Skin fold calliper, Score sheet.

Procedure: The Jackson and Pollock based on the thickness of three different skin fold measurement, i.e., i) Chest, ii) Abdomen, and iii) Thigh gives an estimate of body fat percentage of an individual. Calliper used by Finger was two inch apart and pinch the skin of specified location and used skin fold calliper. Recorded the thickness of specified location in millimetre (mm). Actual area of skin fold measurement described below:

i) Chest: One half the distances between the anterior axillary line and the nipple.

ii) Abdomen: One inch to the right of the navel.

iii) Thigh: On the anterior middle of the thigh, midway between the inguinal and knee.

Scoring: Based on the Jackson and Pollock data table total percentage (%) fat for measurement at three locations in millimetre (mm) for men age range up-to 27 years individual numerical value was established. On the basis of total fat percentage of three locations According to Jackson and Pollock data table obtained a score which was recorded for an individual.

3.8.2.3. Calf girth (Steel tape)

Purpose: To measure the calf circumference of individual subject.

Equipments: Steel or cloth tape, score sheet.

Procedure: Instructed to subject straight stand with the feet parallel to each other. The point of maximal calf circumference was identified and the measurement of circumference taken with great care.

Scoring: The measurement of calf circumference was recorded to the nearest inches as the score of individual subject.

3.8.2.4. Thigh girth (Steel tape)

Purpose: To measure the Thigh circumference of individual subject.

Equipments: Steel or cloth tape, score sheet.

Procedure: Instructed to subject straight stand with the feet parallel to each other. The point of maximal thigh circumference was identified and the measurement of circumference taken with great care.

Scoring: The measurement of thigh circumference was recorded to the nearest inches as the score of individual subject.

3.8.3. PHYSICAL FITNESS VARIABLES

3.8.3.1. Speed (50 Yard Dash) (AAPHER Youth Fitness Test, 1976)

Purpose: This test was used to measure the minimum time required for students to complete 50 yards or running speed of the performer.

Equipments: Measuring tape, stopwatches, clapper, whistle, white dust and 75 yards running space in length with starting line and finishing line. Distance from starting line to finishing line was 50 yards.

Procedure: Students start from a standing position (hands cannot touch on the ground). Front foot of the performer must be behind the starting line. The Starting commands were “On your

mark", Set and sound by clapper. On the sound of clapper students ran 50 yards as fast as possible across the finish line.

Scoring: The score was the elapsed time from clapper sound to crosses the finish line with torso which recorded by second. The nearest tenth of a second as the score for 50 yard dash.

3.8.3.2. Agility (4 x 10m shuttle run) (AAPHER Youth Fitness Test, 1976)

Purpose: To measure the change of direction of the body.

Equipments: To organize this test used equipments were Two wooden blocks for each runner (each block should measure 10 x 5 x 5 cm),measuring tape, two stopwatches, clapper, whistle, white dust and 25meter running space in length marked with a starting line and finishing line. Distance from starting line to finishing line was 10 meter.

Procedure: Two parallel lines are marked 10 meters apart on the ground surface. The two wooden blocks are placed on the line and the students were asked to start from the back of the second line. On the signal "Ready" the performer places their front foot behind the starting line. After the command "Go!" performer runs to the blocks, picks one up, runs back to the starting line and places the block on or behind the starting line, then runs back and picks up the second block which performer carries back across the starting line. Two trials are performed.

Scoring: Two attempts are performed for each performer. Some rest Allowed between two trails. Better time Recorded of the two trails to the nearest tenth of a second as the score of the test.

3.8.3.3. Leg explosive strength (standing broad jump) (AAPHER Youth Fitness Test, 1976)

Purpose: To measure the explosive strength of the legs.

Equipments: jumping peat, white dust, measuring tape, score sheet and few assistants.

Procedure: Pupils stands slightly apart with the feet parallel to each other and the toes just behind the starting line mark. Preparatory to jumping, the performer bends the knees and swings the arms to forward drive and the performer attempts to jump as far forward as possible. There three attempts were allowed.

Scoring: The score is the distance in meters between the starting line and the nearest point where any part of the subject's body touches the pit. Three trials were permitted, and then the best performance was recorded as the score.

3.8.3.4. Cardio Respiratory Endurance (Harvard Step test)

Purpose: To measure the Cardio respiratory endurance of the subjects.

Equipments: stepping bench (ht.20 inches), Metronome, Stopwatch and assistant.

Procedure:

- The body was erect when the subject steps on to the bench.
- For five minutes, the person on the bench moves up and down at a pace of thirty steps per minute (every two seconds) or unless he feel that he must stop before then because of exhaustion.
- With a "GO" order from the assistant, the subject begins the test and the stopwatch is turned on.
- The assistance person assures the athlete keeps up the necessary pace in steps per minute.
- After five minutes or complete of test assistant takes the subject's pulse rate for 1 to 1$^{1}/_{2}$, 2 to 2$^{1}/_{2}$, 3 to 3$^{1}/_{2}$ minutes.

Scoring: Obtained score was computed with this formula:

PEI = Duration of exercise in seconds x 100 / 2 x sum of pulse counts in recovery.

3.8.3.5. Flexibility (Modified Sit-and-Reach test)

Purpose: Measuring the improvement of the legs' hamstring muscles' extension, back flexion, and hip flexion.

Equipments: yardstick, tape and score sheet.

Procedure: After aligning the yardstick's 15-inch mark with a line on the ground, secure the ends of the stick with tape. Sliding his seat back beyond the yardstick's zero end, he took a seat and aligned his heels with the near edge of the 15-inch mark. Reach forward slowly and touch the tips of both hands as far down the stick as you can, keeping your knees locked and your heels no wider than five inches apart.

Scoring: The score was calculated from the three best trials, each measured to the closest quarter of an inch.

3.8.4. PHYSIOLOGICAL VARIABLES

3.8.4.1. Blood lactic acid (BLA)

Test: Blood lactate test

Purpose: To measure the blood lactate levels**.**

Equipments: Lactate Pro Analyzer, Strips, Lancet, Stopwatch.

Procedure: To measure Blood lactate level Harvard Step test was used. For each individual blood lactate has been taken in four phases. At first taken blood in resting position before Harvard step test, second time after complete stepping immediately taken the blood, third time seven minutes after activity and at last fifteen minute after activity taken blood sample. The blood samples were collected from each student's fingertip. Blood lactate level was measured through lactate pro analyzer (arkray global business, inc, kyoto, japan).

Scoring: After blood test result in number according to lactate analyser was recorded as the score.

3.8.4.2. Heart rate (HR)

Equipments: Electronic Digital stop watch, bench (ht.20 inches) & Metronome.

Procedure: previously instructed to every subject about heart rate measurement. Heart rate was taken by five (5) phases. Such as in resting HR, HR Before activity, HR After Immediate activity, HR after seven (7) minutes of activity and HR after fifteen minutes (15) of activity.

Resting HR:

The subject's resting heart rate was measured at the beginning of the morning. No food substance was taken by the students before the test. They were informed to rest completely for thirty minutes prior to having their heart rates taken. In complete relaxed condition resting heart rate was taken.

HR before Exercise :

After the warm up in active rest situation just before the start of Harvard step test heart rate was taken very carefully.

HR After Immediate of Exercise:

Just after complete Harvard step test immediately subject was seated and the heart rate was taken.

HR After completion of seven (7) minutes of Exercise:

In sitting position during rest after seven minutes of Harvard step test again heart rate was taken.

HR After completion of fifteen (15) minutes of Exercise:

Same as before position after fifteen minutes of Harvard step test heart rate was taken.

Scoring: Heart rate was taken and recorded as beat/ minute (bpm) for each subject.

3.9 STATISTICAL PROCIDURE ADOPTED FOR ANALYSIS OF THE DATA

The methods of statistics stated below were applied to analyze the data in accordance with the established hypotheses and study objectives:

1. Mean, SD and ‘t’ test was calculated for the score on the pre and post test. Each variable separately and are presented in tabular form in the chapter-IV.
2. For comparison among post test score among means of each parameters within three group’s analysis of variance (one way ANOVA) was used. For determine the exact location of difference among three groups least significant difference (LSD) was applied as a Post Hoc test.

The level of significance for the study was set at the.01 and .05 levels which were deemed reasonable for the study.

The data obtained through assessment of interval circuit training, continuous circuit training and control group have been statistically analyzed by adopting the standard statistical methods.

CHAPTER-IV

RESULT AND DISCUSSION

4. INTRODUCTION

4.1 PERSONAL DATA

4.2 ANTHROPOMETRICAL VARIABLES

4.2.1 BMI

4.2.2 BODY WEIGHT

4.2.3 PERCENTAGE OF BODY FAT(%)

4.2.4 CALF GIRTH

4.2.5 THIGH GIRTH

4.3 PHYSICAL FITNESS VARIABLES

4.3.1 SPEED

4.3.2 AGILITY

4.3.3 LEG EXPLOSIVE STRENGTH

4.3.4 CARDIO RESPIRATORY ENDURANCE

4.3.5 FLEXIBILITY

4.4 PHYSIOLOGICAL VARIABLES

4.4.1 HEART RATE

4.4.2 BLOOD LACTIC ACID

CHAPTER-IV
RESULTS AND DISCUSSION

4. INTRODUCTION

The data were collected according to specific procedures which are shown in chapter number- III and are presented in this chapter adopting standard statistical procedures. The results are presented in tabular forms as well as in graphical structure. All the data were gathered from two 'states' where one was before starting the training programme and the other was after completion of 12 weeks of training programme.

The pre and post-test scores of mean and SD for each parameter of Interval Circuit Training (ICT), Continuous Circuit training (CCT), & Control Group (CG) are presented first. Then also presented 't' test calculated result of each group's pre and post-test means to observed the impact of training. To compare the training influence among the post-test mean scores of three groups the Analysis of Variance (One-way ANOVA) was calculated. To find the significant difference among the means of three (CCT, ICT & CG) groups also Least Significant Difference (L.S.D) Post-hock test was computed and are presented along with the 'F' value.
Results are presented and discussed under three major aspects such as

1. Anthropometrical variables, 2. Physical fitness variables and 3. Physiological variables

4.1 PERSONAL DATA

Table no. 1. Mean and SD of personal data of the subjects

Variables	Groups	Mean	SD
Age (Yrs)	**ICT**	14.35	0.988
	CCT	13.75	0.638
	CG	13.85	0.745
Weight (Kg)	**ICT**	52.60	9.511
	CCT	48.50	6.117
	CG	51.05	4.058
Height (Cm)	**ICT**	1.596	0.050
	CCT	1.554	0.059
	CG	1.579	0.049

The mean and SD of age, weight and height are presented in table number 1. It appears from the table that the Mean and SD of age for ICT, CCT & CG groups were 14.35 ± 0.988, 13.75 ±

0.638 & 13.85 ± 0.745. The Mean and SD of weight for three (ICT, CCT & CG) groups were 52.60 ± 9.511, 48.50 ± 6.117 & 51.05 ± 4.058. Similarly, Mean and SD of height for ICT, CCT & CG groups were 1.596 ± 0.050, 1.554 ± 0.059 & 1.579 ± 0.049. From the result of the personal data it may safely be stated that the subjects of three (ICT, CCT & CG) different groups accepted for the study were of homogenous in nature.

4.2. ANTHROPOMETRICAL VARIABLES

To measure the anthropometrical dimension a number of tests for specified anthropometrical parameters have been considered such as BMI, body weight, percentage of body fat (%), calf girth and thigh girth and the results of the tests are reflected accordingly.

4.2.1. BMI (BODY MASS INDEX)

Body Mass Index is the measurement of the amount of body fat and lean body mass. Weight in kilograms divided by the individual's height in meters squared provides their body mass index (BMI). So, BMI is used to define adult anthropometric height and weight characteristics. Also it is appropriate determine to screening for obesity with health status. A healthy BMI level would be 18.5 – 24.9 (Holmes & Racette, 2021). Standard BMI equation is very essential requirement for sports personalities. To maintain standard level of BMI various types of exercise has an important role. In present study the training schedule adopted specified circuit training with various exercises. Procedure to calculate BMI discussed in chapter III and test has been conducted before and after the training. The results are shown here.

Table 2: Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on BMI (Body Mass Index).

Parameter	Groups	N	df	Pre-test			Post-test			t- value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
BMI (Body Mass Index)	ICT	20	19	20.57	3.09	.691	20.51	2.44	.546	.389
	CCT	20	19	20.07	2.06	.461	20.32	1.63	.364	-1.95
	CG	20	19	19.54	4.15	.929	20.79	.898	.200	-1.36

Significant at 0.05 level* *(Table value 2.093, df-19).*** ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no.2 that the mean and standard deviation (Mean ± SD) values of BMI on pre-test and post test of three (ICT, CCT & CG) groups were 20.57± 3.09, 20.07± 2.06, 19.54± 4.15and 20.51± 2.44, 20.32± 1.63, 20.79 ± .89 respectively. The result also presented in graphical structure in figure no. 1. In table no. 2 showed that the t- values of three (ICT, CCT & CG) groups were .389, -1.959 and -1.369. According to obtain t-value of each group between pre test and post test it was statistically not significant at 0.05 level since the table value 2.093 for the df 19 which was higher than the obtained value.

Fig.1. Graphical representation among the Mean and SD of three groups of pre test and post test on BMI (Body Mass Index).

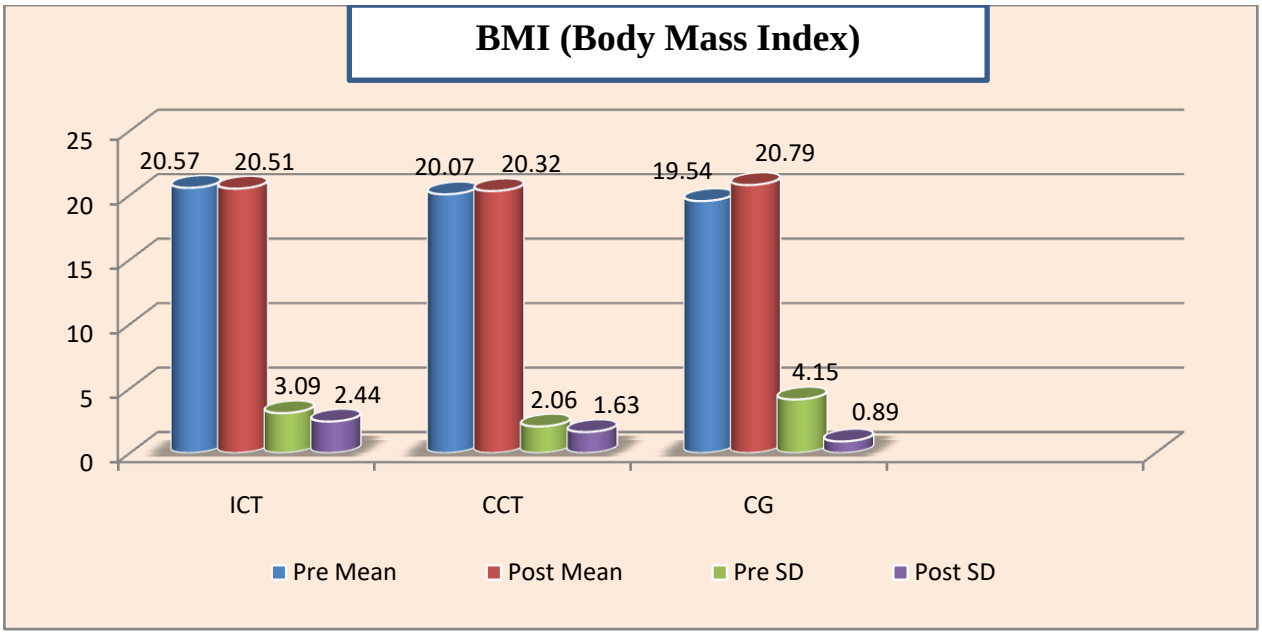


Table: 3. Inferential statistics with 'ANOVA' on BMI (Body Mass Index) of interval circuit training, continuous circuit training & control group on post test score.

Parameter	Source of Variation	Sum of Squares	df	Mean Square	F	Sig
BMI (Body Mass Index)	Between groups	2.236	**2**	1.118	.355	.702
	Within groups	179.348	**57**	3.146		

***significant at 0.05 level, F** $_{(2, 57)}$ **=3.15** ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-3 analysis of variance (One-way ANOVA) was computed on **post test mean** of three (ICT, CCT & CG) groups, the observed 'F' value of BMI was .355 that was statistically not significant at 0.05 level as it is lesser than table value of ***3.15.*** Thus, indicating insignificant differences among the three groups.

Discussion on BMI:

Present study showed that BMI was not changed significantly among three groups after the implication of specified circuit training programme. Similar results were found from the findings of other research reports (Azad et al., 2011); (Aboshkair et al., 2023) (Seo et al., 2021); & (Ouerghi et al., 2017). However, compared to the continuous circuit training (CCT) and interval circuit training (ICT) groups, the BMI level was slightly higher in the control group (CG). Therefore those who are not attained to any kind of physical activity they were gradually move under high ratio of BMI level. Globally, the occurrence of overweight and obesity has increased at shocking rate throughout the world for inactive and unorganized life style. (Blair et al., 2010) reported that the most common and significant health issues connected with physical inactivity and obesity or increased BMI.

This study signified that level of BMI was slightly decreased for CCT and ICT groups. It implies that physical training have positive effect on BMI. (Bansode & Singh, 2022) revealed that there were significant impact of Functional activities on BMI of Sedentary Students. (khodanpur, 2010) discovered Programs involving physical exercise have measurable effects on body weight, BMI, and free fat mass, but not on fat mass.

Usually, physical activity increases muscle mass while decreasing body fat. Wherein (Badami & Baragundi, 2017) studied young men between the ages of 18 and 25 who had lower levels of fat mass. These subjects' body weight and BMI increased as a result of increased muscle mass and decreased fat mass following physical training. Azad, et al. (2011) were documented a reduction in BMI for students who received physical training. (Kim et al., 2018) found a study where for 12 weeks, circuit training significantly reduced BMI and showed relative effect between the groups.

Regular bodily activity has been positively correlated with a productive life and is essential for maintaining good health. (Nudri et al., 2009) reported by a study to maintain Body Mass Index involved in sports, exercise and sedentary activities have an important role. BMI was significantly associated with moderate physical exercise concluded by (Kazmi et al., 2022). It also supports the findings of the current investigation.

Therefore, observations of the present research findings are closely related with other researchers. Present study was composed by continuous and interval circuit training methods. The current investigation's findings revealed that there were no appreciable differences between the three groups. Comparatively interval and continuous circuit training was better effects than control group (CG) on BMI. (Russomando et al., 2020) reports that when comparing the beneficial effects of high intensity interval training and moderate intensity continuous training protocols, no significant interaction was found, suggesting that both protocols had comparable effects on all parameters examined. Considering the overall analysis, the study's outcome and the preparation of the research results of other researchers concluded that both types of circuit training programme can change BMI positively or may not be change significantly due to nature of training as well as duration of total training period. Present findings are in consonance with the other researchers, stated above.

4.2.2 BODY WEIGHT (kg)

In sports, body weight refers to the interpretation of mass measurements which stated in the units of mass, like as kilograms (kg). Ideal body weight is a range that tells you whether your weight is in proportion to your height and gender (Goldsmith, 2018). Body weight is a very important component to distinguish both athletes and ordinary people from each other. Physical Exercises can support maintaining body weight in accordance with height ratios. In the area of sports and sports training body weight is the precious factor to implement the training protocol. The influence of training on the body weight has been studied by many researchers and also the present study too. The details of the test procedure are discussed in chapter III and the test has been used before and after the training. The results are shown here.

Table: 4. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on Body weight (kg).

Parameter	Groups	N	df	Pre-test			Post-test			t-value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
Body weight (kg)	ICT	20	19	52.60	9.51	2.126	52.40	7.86	1.758	.48
	CCT	20	19	48.50	6.11	1.367	49.10	5.19	1.160	1.87
	CG	20	19	51.05	4.05	.907	51.90	4.05	.905	3.10*

Significant at 0.05 level (Table value 2.093, df-19). I.C.T= Interval Circuit Training group, C.C.T= Continuous Circuit Training group, C.G= Control group.

It appears from the table no.4 that the mean and standard deviation (Mean ± SD) values of Body weight on **pre-test and post test** of three (ICT, CCT & CG) groups were 52.60 ± 9.51, 48.50± 6.11, 51.05± 4.05 and 52.40 ± 7.86, 49.10 ± 5.19, 91.90 ± 4.05 respectively. The result also presented in graphical format in figure no. 2. In the table no. 4 showed that the t- values of three (ICT, CCT & CG) groups were, .48, 1.87 and 3.10. t- value of control group (CG) was statistically significant at 0.05 level since the table value 2.093 for the df 19 which was lower than the obtained value. Wherein t-value of interval circuit training group (ICT) and continuous circuit training group (CCT) was statistically not significant at 0.05 level since the table value was higher than the obtained value.

Fig.2. Graphical representation among the Mean and SD of three groups of pre test and post test on body weight (kg).

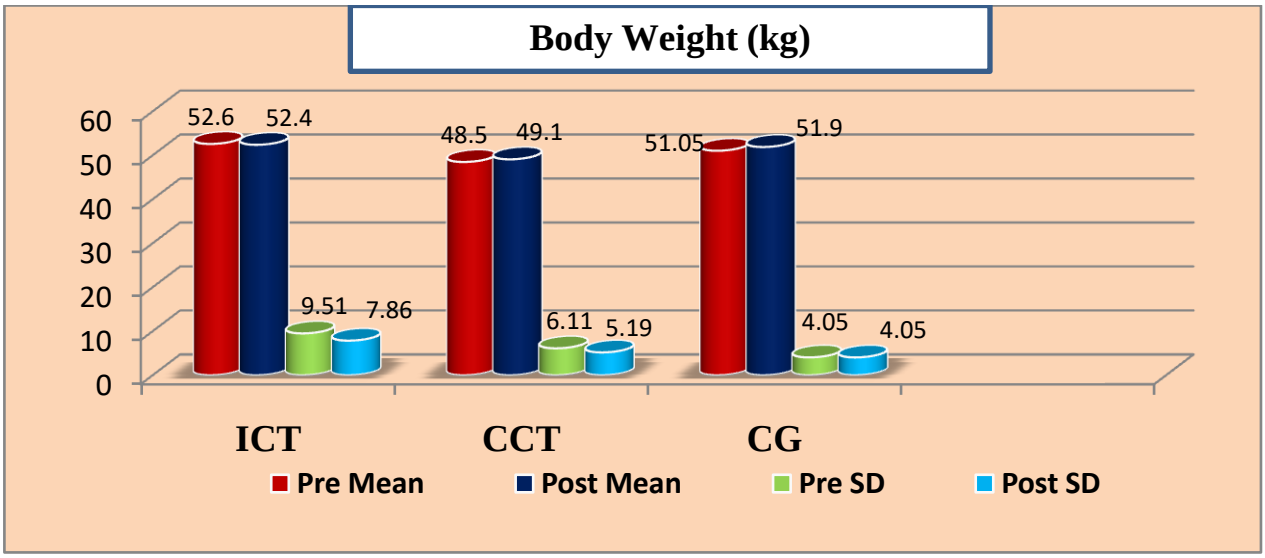


Table: 5. Inferential statistics with 'ANOVA' on body weight of interval circuit training, continuous circuit training & control group on post test score.

Parameter	Source of Variation	Sum of Squares	df	Mean Square	F	Sig
Body weight	Between groups	126.533	**2**	63.267	1.805	.174
	Within groups	1998.400	**57**	35.060		

significant at 0.05 level, F0.05** $_{(2, 57)}$ **=3.15

In table-5 analysis of variance (One-way ANOVA) was computed on **post test mean** of three (CCT, ICT & CG) groups, the observed 'F' value of body weight was 1.805 which was statistically not significant at 0.05 level as it is lesser than table value of 3.15, thus indicating insignificant differences among the three groups.

Discussion on Body Weight:

Present study reflected that the Body weight was slightly decreased in case of interval circuit training (ICT) group. Many studies consistent with present study, Öner et al., (2021), Kim et al., (2018), Jakicic, (2009), Badami (2013), Alahmadi, (2014) Das, (1995) have found significant decreased of body weight by physical training program. Vale et al., (2020) reported that one of the ways to save time in your weight management programme is interval training. Physical exercises demand adequate oxygen supply into cell. Excessive requirement of energy some time our body loses fat. As such loses excess fat due to the high calorie cost of the actual training session (Hottenrott et al., 2012). Loses of fat may be the cause of weight loss. The result of the study indicated that the Body weight was slightly gained in case of continuous circuit training (CCT) and control groups (CG). Regarding effect of training on weight change was observed among the several researchers wherein, (Brock & Legg, 1997; Shaw et al., 2022 Lesinski et al., 2016 & Van Etten et al., 1994) found significant increase of mass or body weight due to physical training program. According to Badami (2013), adults who are not physically active or who are not fit enough are at risk of developing obesity. On the other hand Swift et al., (2014) found no change in body weight by physical training and according to Meckel et al., (2011) due to insufficient physical training body weight was not control for physical education students .

Therefore the observations of the present study, findings were closely related with other research investigations. Based on the study's findings, conclusions can be drawn that body weight may be altered due to influence of training, depending on the nature of the training regimen.

4.2.3 Percentage of Body Fat (%)

A human body is made up of many different components. Some of major components are bone, muscles, organs and fat. Everybody is concerned about it when they think about their health and fitness. Specific amount of fat is required to conduct physiological function smoothly. In present study the training schedule adopted contained specified circuit training with various exercises. Body fat is an important health related physical fitness component. Excessive fat percentages have a definite influence on quality of fitness. Therefore assessment of fat percentage has been considered as an index of fitness. According to training implementation body fat was assessed and analyzed. The details of the test procedure are discussed in chapter III and test has been used before and after the training. The results are shown here.

Table: 6. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on percentage of body fat (%).

Parameter	Groups	N	df	Pre-test			Post-test			t-value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
Percentage of Body Fat (%)	ICT	20	19	14.24	7.14	1.59	13.24	6.70	1.498	3.84*
	CCT	20	19	12.89	4.85	1.08	12.02	4.65	1.042	5.42*
	CG	20	19	14.46	4.96	1.11	15.46	4.84	1.083	7.38*

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no.6 that the mean and standard deviation (Mean ± SD) values of Percentage of Body Fat on **pre-test and post test** of three (ICT, CCT & CG) groups were 14.24 ± 7.14, 12.89 ± 4.85, 14.46 ± 4.96 and 13.24 ± 6.70, 12.02 ± 4.65, 15.46 ± 4.84 respectively. The result also presented in graphical structure in figure no. 3. It was understandable that a distinct difference appeared in the mean value between the pre-test and post-test of each group which apparently reflected in the t- value. In table no. 6 showed that the

t- values of three (ICT, CCT & CG) groups were 3.84, 5.42 and 7.38. t- Value of interval circuit training (ICT), continuous circuit training group (CCT) and control group (CG) were statistically significant at 0.05 level since the table value 2.093 for the df 19 which was lower than the obtained value.

Fig.3. Graphical representation among the Mean and SD of three groups of pre test and post test on Percentage of Body Fat (%).

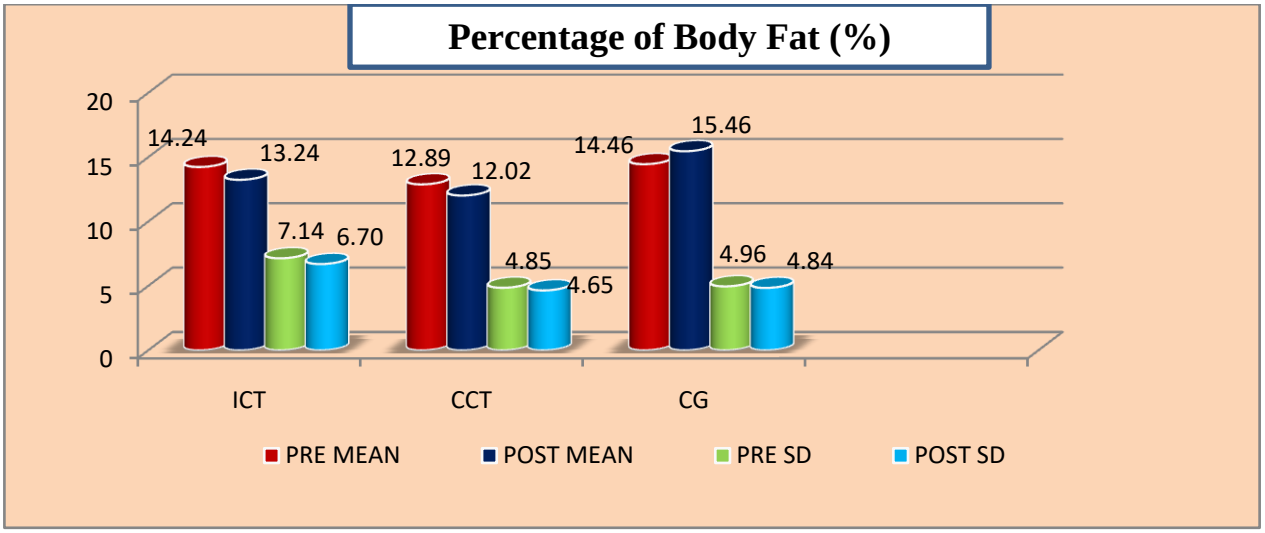


Table: 7. Inferential statistics with 'ANOVA' on Percentage of Body Fat (%) of interval circuit training, continuous circuit training & control group on post test score.

Parameter	Source of Variation	Sum of Squares	df	Mean Square	F	Sig
Percentage of Body Fat (%)	Between Groups	121.669	**2**	60.835	2.026	.141
	Within Groups	1711.913	**57**	30.034		

significant at 0.05 level, $F_{(2, 57)}$ ***=3.15*** ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-7 analysis of variance (One-way ANOVA) was computed on **post test mean** of three (ICT, CCT & CG) groups, the observed 'F' value of Percentage of Body Fat is 2.026 which was statistically insignificant at 0.05 level as it is lesser than table value of *3.15*. Thus implies no significant differences among the three groups.

Discussion on Percentage of Body Fat (%):

Present study exposed that there was a notable decline in the percentage of body fat (%) after implication of specified circuit training programme, whereas significantly enhanced body

fat percentage for control group (CG). Reduction of body fat following training had been observed by a number of researchers where Kim, (2018); Maillard, (2018); Contrò, (2017); Miller, et al.,(2014); Arenas, et al., (2013) and Hottenrott, (2012) were stated that to have change in human body. They were established with the aim of a systematic training program of 3-4 days a week with exercise intensity of 80-90% of maximum heart rate and duration of 30 to 40 minutes in a day is necessary to reduce the percentage of body fat significantly. Also present study formed the training schedule more or less in a same direction to reduce the body fat percentage.

On the other side percentage of body fat has been increased for control group. In this study control group (CG) was under observation they were participated with only daily activity and reflected that significant enhanced body fat percentage. Inactive life may be the cause of grow fat. Similar results were found from the findings of other research reports. (Kim et al., 2018 & Romero-Arenas et al., 2013) This investigation displayed about in comparison among three different groups, there was insignificant on body fat percentage. Whereas control group (CG) evident that percentage of body fat increased than other two groups.

Vale et al., (2020) reported Interval training is an effective strategy for weight loss among overweight or obese individuals. Therefore the observations of the present research exploration findings are closely related with other researcher. Analysis the result of the study and the other investigators establishment of the research findings concluded that both types of circuit training programme can decreased or maintain of percentage of body fat. Kim (2018) reported that a 12-week circuit training program might be useful for enhancing physical fitness and preventing metabolic disorders. Present findings are in consonance with the other researchers, stated above.

4.2.4 CALF GIRTH (Inches)

In human anatomy, the back side of the lower leg is known as the calf. The calf muscle that consists of two largest muscles in this compartment, attaches to the heel through the Achilles tendon. Girths are measurements of circumference taken at typical body locations according to anatomy. The measurement of the circumference of the lower leg is called the calf girth. Lee et al. (2022) signifies when walking or running, the calf muscle is essential to the physical

movement of stepping on the ground and forward motion. In the discipline of sports and training for it to change the body location or in performance for various sports lower leg or calf muscles plays an important role. Saiyed et al. (2015) concluded that calf girth and hamstring flexibility may contribute to a higher vertical jump. Many research investigations proved various exercises such as spot jump, box jump, squat thrust etc. can improve quality of calf muscles and girth of calf muscles. In present study the physical training schedule adopted specified circuit training with several lower limb exercises for students to observe how training affects the calf muscles. The details of the calf girth measurement are discussed in chapter III and test has been used before and after the training. The results are shown here.

Table: 8. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on calf girth (inch).

Parameter	Groups	N	df	Pre-test			Post-test			t-value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
Calf Girth (inch)	ICT	20	19	12.93	2.07	.463	13.31	2.14	.481	3.09*
	CCT	20	19	12.17	1.13	.255	12.77	1.28	.286	5.64*
	CG	20	19	12.6	1.90	.427	12.85	1.57	.351	1.87

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no.8 that the mean and standard deviation (Mean ± SD) values of Calf Girth on pre-test and post test of three (ICT, CCT & CG) groups were 12.93 ± 2.07, 12.17 ± 1.13, 12.6 ± 1.90 and 13.31 ± 2.14, 12.77 ± 1.28, 12.85 ± 1.57 respectively. The result also presented in graphical structure in figure no. 4. It was understandable that a distinct difference appeared in the mean value between the pre-test and post-test of interval circuit training (ICT) group and continuous circuit training (CCT) group. In table no.8 showed that the t- values of three (ICT, CCT & CG) groups were 3.09, 5.64 and 1.87. t-value of interval circuit training ((ICT) group and continuous circuit training (CCT) group was statistically significant at 0.05 level since the table value 2.093 for the df 19 which was lower than the obtained value. Wherein t- value (1.87) of control group (CG) was statistically not significant at 0.05 level since the table value was higher than the obtained value.

Fig.4. Graphical representation among the Mean and SD of three groups of pre test and post test on Calf Girth (inch).

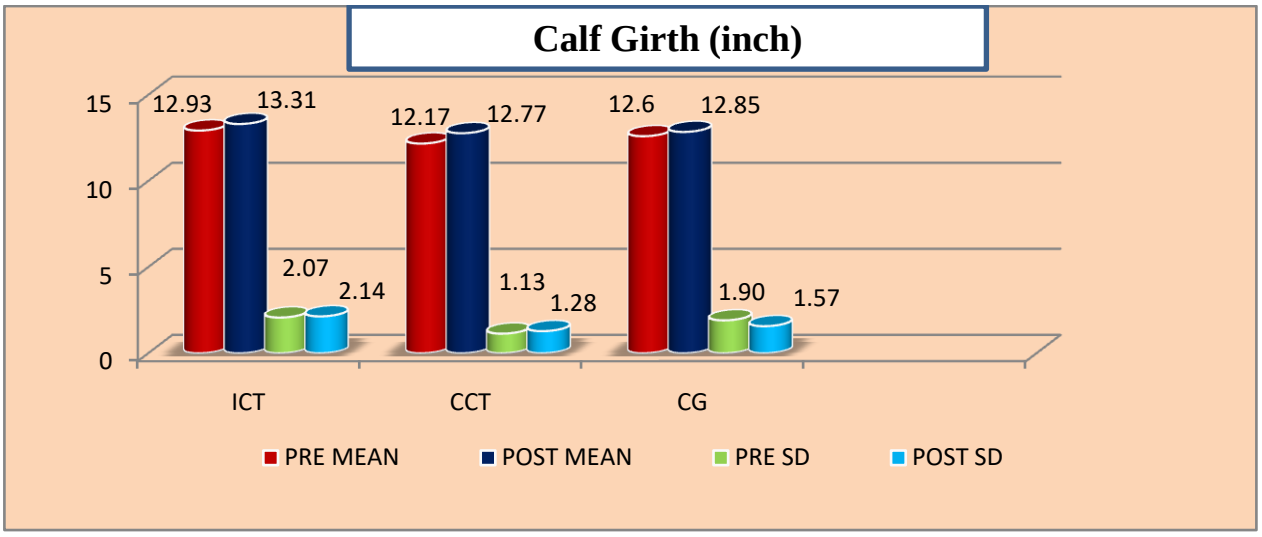


Table: 9. Inferential statistics with 'ANOVA' on Calf Girth of interval circuit training, continuous circuit training & control group on post test score.

Parameter	Source of Variation	Sum of Squares	df	Mean Square	F	Sig
Calf Girth	Between Groups	3.356	**2**	1.678	.576	.565
	Within Groups	166.106	**57**	2.914		

***significant at 0.05 level, F0.05** $_{(2, 57)}$ **=3.15** ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-9 analysis of variance (One-way ANOVA) was computed on **post test mean** of three (ICT, CCT & CG) groups, the observed 'F' value of Calf Girth is .576 which was statistically not significant at 0.05 level as it is lesser than table value of ***3.15.*** Thus indicating not significant differences found among the three (ICT, CCT & CG) groups.

Discussion on Calf Girth:

Anthropometry has become a significant field in sports today. In human anatomy, the back of the lower leg is called the calf. This muscle always preciously useful for maximum physical movement and in the area of many sports (Mahesh et al., 2017). Present study showed that Calf Girth was significantly enhanced after the implication of specified circuit training programme for each group. Where comparatively among the three groups less changes observed on control group. More or less similar results were found from the findings of other research reports by

(Saini & Bhardwaj, 2018) and (Ashwini, 2017). During work out of upper leg muscles it deals with calf muscles as well and it is an integral part of many physical movements. In this present study specified circuit training program adopted by several jump and step moving exercises such as Spot Jump, High Knee, box Jump, Squat Thrust, Steps up etc. (Stewart, 2010) concluded Jump Squat have positive effects on calf girth. It also supports the findings of the current investigation.

Therefore the observations of the present research findings are closely related with other researchers. Analysis the result of the study and the other investigators establishment of the research findings concluded that both types of circuit training programme can improve calf girth and control group have not significantly changes after twelve weeks of duration. Present findings are in consonance with the other researchers, stated above.

4.2.5 THIGH GIRTH (Inches)

Girths are measurements of circumference taken at typical body locations according to anatomy. The measurement of the circumference of the upper leg is called the thigh girth. When sitting, stepping, jumping, walking, running, or performing other physical activities, the thigh muscle is essential. Regarding the sports and exercise to change the direction of body or in sports performance thigh girth and muscles plays an important role. Many research investigations proved various exercises such as squat thrust, depth jump, high knee etc can improve quality of Thigh muscles and girth of Thigh. In present study the physical training schedule adopted specified circuit training with several lower limb exercises for students to view the impacts of training on thigh muscles. The details of the thigh girth measurement are discussed in chapter III and test has been used before and after the training. The results are shown here.

Table: 10. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on Thigh Girth (inch).

Parameter	Groups	N	df	Pre-test			Post-test			t-Value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
Thigh Girth (inch)	ICT	20	19	17.77	2.76	.618	18.17	2.47	.554	2.74*
	CCT	20	19	17.02	1.36	.304	17.82	1.33	.297	8.10*
	CG	20	19	18.17	2.45	.549	18.47	2.04	.458	1.71

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no.10 that the mean and standard deviation (Mean ± SD) values of Thigh Girth on pre-test and post test of three (ICT, CCT & CG) groups were 17.77 ± 2.76, 17.02 ± 1.361, 18.17 ± 2.45 and 18.17 ± 2.47, 17.82 ± 1.33, 18.47 ± 2.04 respectively. The result also presented in graphical structure in figure no. 5. It was understandable that a distinct difference appeared in the mean value between the pre-test and post-test of interval circuit training (ICT) group and continuous circuit training (CCT) group which apparently reflected in the t- value. In table no. 10 showed that the t- values of three (ICT, CCT & CG) groups were 2.74, 8.10 and 1.71. t-value of interval circuit training ((ICT) group and continuous circuit training (CCT) group was statistically significant at 0.05 level since the table value 2.093 for the df 19 which was lower than the obtained value. Wherein t- value (1.71) of control group (CG) was statistically not significant at 0.05 level since the table value was higher than the obtained value.

Fig. 5. Graphical representation among the Mean and SD of three groups of pre test and post test on Thigh Girth (inch).

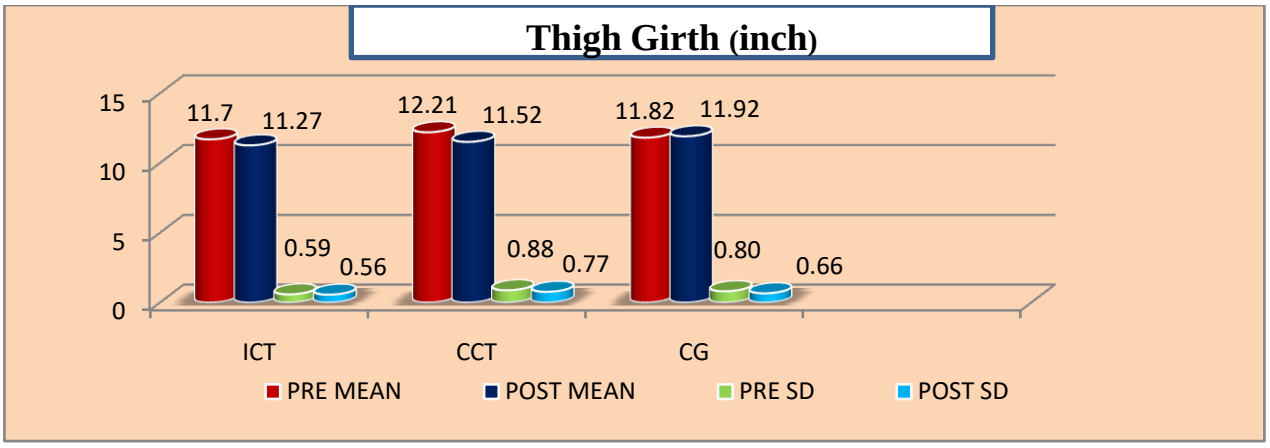


Table: 11. Inferential statistics with 'ANOVA' on Thigh Girth of interval circuit training, continuous circuit training & control group on post test score.

Parameter	Source of Variation	Sum of Squares	df	Mean Square	F	Sig
Thigh Girth	Between groups	4.233	**2**	2.117	.525	.174
	Within groups	230.013	**57**	4.035		

***significant at 0.05 level, F0.05** $_{(2, 57)}$ **=3.15** ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group**.**

In table-11 analysis of variance (One-way ANOVA) was computed on post test mean of three groups, the observed 'F' value of Thigh Girth is .525 which was statistically insignificant at 0.05 level as it is lesser than table value of ***3.15.***

Discussion on Thigh Girth:

Anthropometry is very important in the world of sports these days. The measurement around the middle of the thigh is called the thigh girth. Thigh circumference formed by many muscles such as satorious, rectus femoris, adductor longus, vastus lateralis etc. Thigh muscles are always involved maximum physical movement and in the area of many sports. Dixon (2017) determined the positive relation between the thigh girth ratio and performance in events from 800m-5000m run. In this study specified circuit training program adopted by several jump and step moving exercises such as High Knee, Box Jump, Squat Thrust, Step Ups etc. which are very effective to improve the quality of thigh muscles and girth.

Present study showed that Thigh Girth was significantly enhanced after the implication of specified circuit training programme for first two groups. Where comparatively among the three groups less changes observed on control group (CG). More or less similar results were found from the findings of other research reports by Saini & Bhardwaj (2017), and Vinu (2012). Systematic and organized station wise circuit training method is a tremendous way to enhancing general strength and muscles gain. Present study conducted an organized circuit training schedule which was for 12 weeks and three days per week to identify the effect of training on thigh girth. Similarly Vinu (2012) a twelve-week circuit training program conducted three days a week resulted in a notable improvement in thigh circumference. Therefore it can justify the outcome of the current investigation.

As a result the observations of the present research findings are strongly connected with other researcher. Analysis the result of the study and the other investigators research findings concluded that both types of circuit training programme can improve Thigh girth and control group have also positive effect but lesser then physical training groups. Present findings are in consonance with the other researchers, stated above.

4.3 PHYSICAL FITNESS VARIABLES

To measure the physical fitness dimension a number of tests for specified physical fitness parameters have been considered and the results of the tests are reflected accordingly.

4.3.1 SPEED (Sec)

Speed is the ability to do a quick movement in a minimum time. It is an important motor fitness component of human body. Rapidity or speed has a major impact on a sporting gesture's effectiveness and situational efficiency. Speed is one of the important parameter that is very influential for field performance (Yıldız et al., 2018).In sports, speed denotes the capacity to perform under specific circumstances in which the highest possible reaction and movement speeds are dependent on cognitive processes, implying neuromuscular abilities (Domenico & D'isanto, 2019). Ability of explosive strength is being integrated for improvement of speed. Explosive strength can be improved by many exercises such as spot jump, squat thrust, depth jump etc. The present study implemented a specified circuit training program with interval and continuous form where selected such types of exercises in deferent stations with progressive increment of load was maintained view to improvement of speed ability. 50 yard dash was considered as a measure of speed, the details of the test procedure are discussed in chapter III and test has been used before and after the training. The results are shown here.

Table: 12. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on Speed (sec).

Parameter	Groups	N	df	Pre-test			Post-test			t-Value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
Speed (sec)	ICT	20	19	8.26	1.00	.225	7.45	.64	.144	7.66*
	CCT	20	19	8.31	.77	.172	7.61	.65	.146	6.29*
	CG	20	19	8.50	1.10	.247	8.99	1.42	.319	-3.29*

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no.12 that the mean and standard deviation (Mean ± SD) values of speed on pre-test and post test of three (ICT, CCT & CG) groups were 8.26 ± 1.00, 8.31 ± .77, 8.50 ± 1.10 and 7.45 ± .64, 7.61 ± .65, 8.99 ± 1.42 respectively. The result also presented in graphical format in figure no. 6. It was understandable that a distinct difference appeared in the

mean value between the pre-test and post-test of each group which apparently reflected in the t-value. In table no.12 showed that the t- values of three (ICT, CCT & CG) groups were 7.66, 6.29 and -3.29. t-value of interval circuit training (ICT) group, continuous circuit training (CCT) group and control group (CG)was statistically significant at 0.05 level value 2.093 since the table for the df 19 which was lower than the obtained value.

Fig.6. Graphical representation among the Mean and SD of three groups of pre test and post test on Speed (sec).

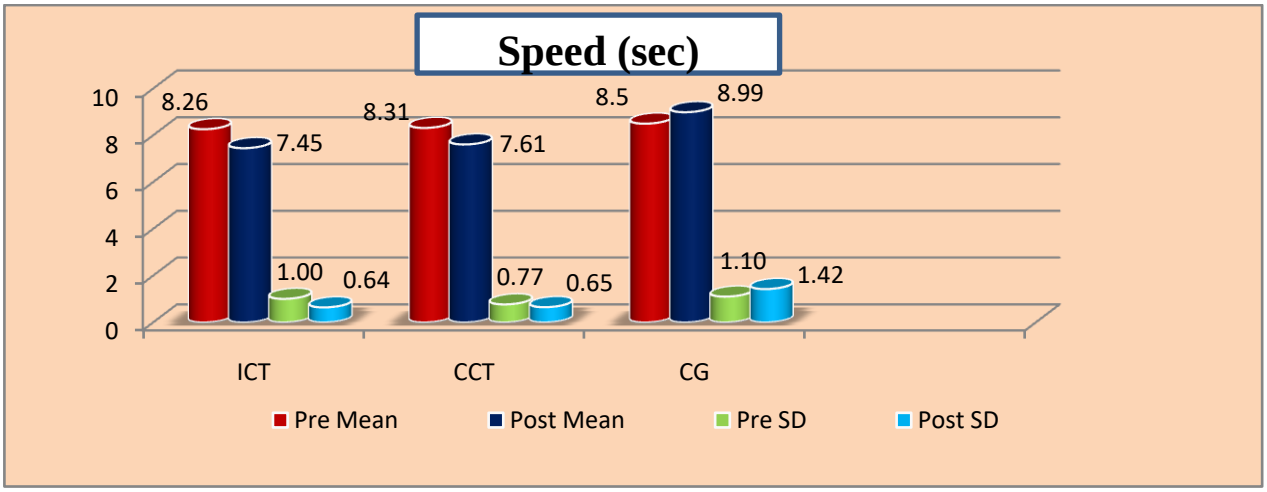


Table: 13. Inferential statistics with 'ANOVA' and critical difference on Speed of interval circuit training, continuous circuit training & control group on post test score.

Parameter	Source of Variation	df	F - value	Sig	Intra group	MD	CD
Speed	Between group	2	14.90*	.000	CCT-ICT	.157	.691
	Within group	57			ICT-CG	1.536*	
					CG-CCT	1.379	

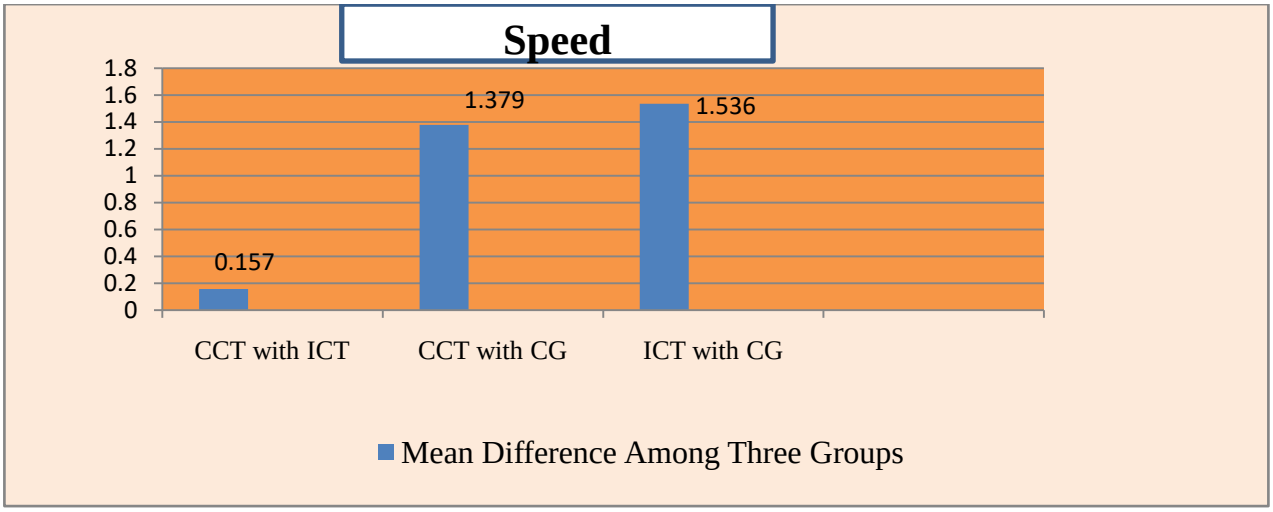
***significant at 0.05 level, F** $_{(2, 57)}$ =3.15.* ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-13 analysis of variance (One-way ANOVA) was computed on post test mean of three experimental groups, the observed 'F' value of Speed is 14.90 which was statistically significant at 0.05 level as it is higher than table value of ***F*** $_{(2, 57)}$ ***=3.15.***

To determine the exact location where the differences occur among three groups for speed Post-Hoc test (LSD test) was used. Among the three paired of MD between the ICT & CG and CG & CCT were found statistically significant, since MD of 1.536, & 1.379 were higher than CD

(.691)at 0.05 level. Whereas MD was found not significant in case of CCT with ICT group at 0.05 level of confidence. The mean differences also presented in graphical structure in figure no. 7.

Fig.7. Graphical representation of mean difference among three groups of post test on Speed.



Discussion on Speed:

Speed abilities are commonly not improved directly but indirectly by improving the many components on which the speed performance depends. These components are explosive strength, flexibility, motor ability, technique etc. Bandyaopadhyay (1988) found improvement in running speed among young boys through rope skipping. In present study formed a training schedule to improve strength, flexibility, agility, coordination etc. This attempt was indirectly influenced the speed ability. Present study showed that Speed was significantly improved after the implication of specified circuit training programme for Interval and Continuous Circuit Training Group but significantly decreased the speed ability observed on control group. Similar results were found from the findings of other research reports (Krishna , 2020; Rani, 2018; Kumar, 2016; Vinayagamoorthi & Sakthivel, 2014; Cregg, 2013; Babu & Kumar, 2013 and Reddy, 2012). It has been proved the specified training can improved the speed ability. Harre (1982) and Fox (1975) have shown that running speed may be improved through training. Dintiman (1964) used weight training as supplement to conventional sprint training and found significant improvement in running speed. Nunney (1960) found improvement in speed by circuit training method.

According to Bandyaopadhyay (1992), running speed can be increased if the training is highly targeted for the desired outcome and lasts for at least eight to ten weeks. Similarly this research study conducted training protocol for 12 weeks and three days per week in a systematic way where selected depth jump, spot jump, high knee, squat thrust, step up etc. (Permana et al., 2022) & (Huang et al., 2023) found that exercises like box jumps or various types of jumping activity are an excellent way to build speed and explosive strength.

Therefore the observations of the present research findings are closely connected with other investigated research. Based on a thorough analysis of the study's results as well as those of other researchers, it can be concluded that while both CCT and ICT circuit training programs may increase speed, the control group's speed ability those who did not participate in any physical training may have decreased. Shekhawat & Chauhan (2021) found that regular Circuit training performed enhances muscular strength as well as speed ability. Present findings are in consonance with the other researchers, stated above.

4.3.2 AGILITY (Sec)

The capacity to quickly and precisely change our body's direction while it is actively moving is known as agility. It necessitates a combination of speed, strength, balance and coordination. Agility considers being a complex motor ability compound of different abilities, such as explosiveness, reaction speed, dynamic balance etc. (Verkhoshansky, 1996 and Sabin & Marcel, 2016). Agility as performance related component of physical fitness it is very essential requirement for sports performances. The benefit of agility not only for sports performance but also improves our daily movement. Circuit training can help build it in addition to strength, endurance, and speed. The development of particular abilities needed for sports can be utilized in circuit training, a very popular and effective organizational method of physical exercise (Rani, 2018). In present study the training schedule adopted contained specified circuit training with progressive increment of load to improve agility. Shuttle run was considered as a measure of agility, the details of the test procedure are discussed in chapter III and test has been used before and after the training. The results are shown here.

Table: 14. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on agility (Sec).

Parameter	Groups	N	df	Pre-test			Post-test			t-Value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
Agility (Sec)	ICT	20	19	11.70	.59	.132	11.27	.56	.126	8.34*
	CCT	20	19	12.21	.88	.197	11.52	.77	.172	5.28*
	CG	20	19	11.82	.80	.180	11.92	.66	.148	-1.07

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, C.G= Control group.

It appears from the table no.14 that the mean and standard deviation (Mean ± SD) values of agility on pre-test and post test of three (ICT, CCT & CG) groups were 11.70 ± 0.59, 12.21 ± 0.88, 11.82 ± 0.80 and 11.27 ± 0.56, 11.52 ± 0.77, 11.92 ± 0.66 respectively. The result also presented in graphical format in figure no. 8. It was understandable that a distinct difference appeared in the mean value between the pre-test and post-test of each group which apparently reflected in the t- value. In table no. 14 showed that the t- values of three (I.C.T, C.C.T & C.G) groups were 8.34, 5.28 and -1.07. t-value of interval circuit training (ICT) group and continuous circuit training (CCT) group was statistically significant at 0.05 level since the table value 2.093 for the df 19 which was lower than the obtained value. Wherein t- value (-1.07) of Control Group (CG) was statistically not significant at 0.05 level since the table value was higher than the obtained value.

Fig.8. Graphical representation among the Mean and SD of three groups of pre test and post test on Agility (Sec).

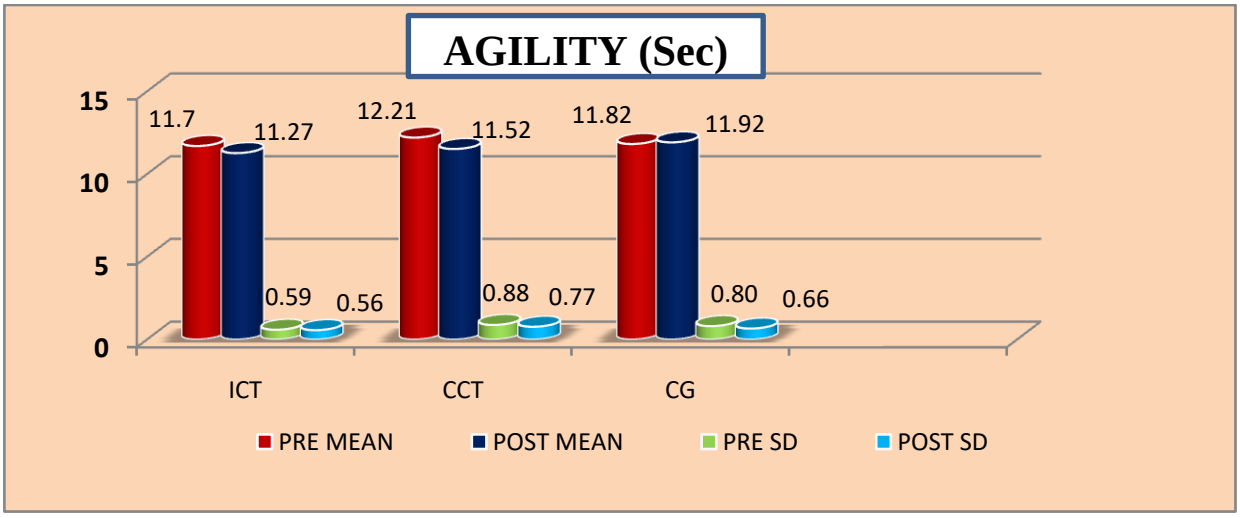


Table: 15. Inferential statistics with 'ANOVA' and critical difference on agility of interval circuit training, continuous circuit training & control group on post test score.

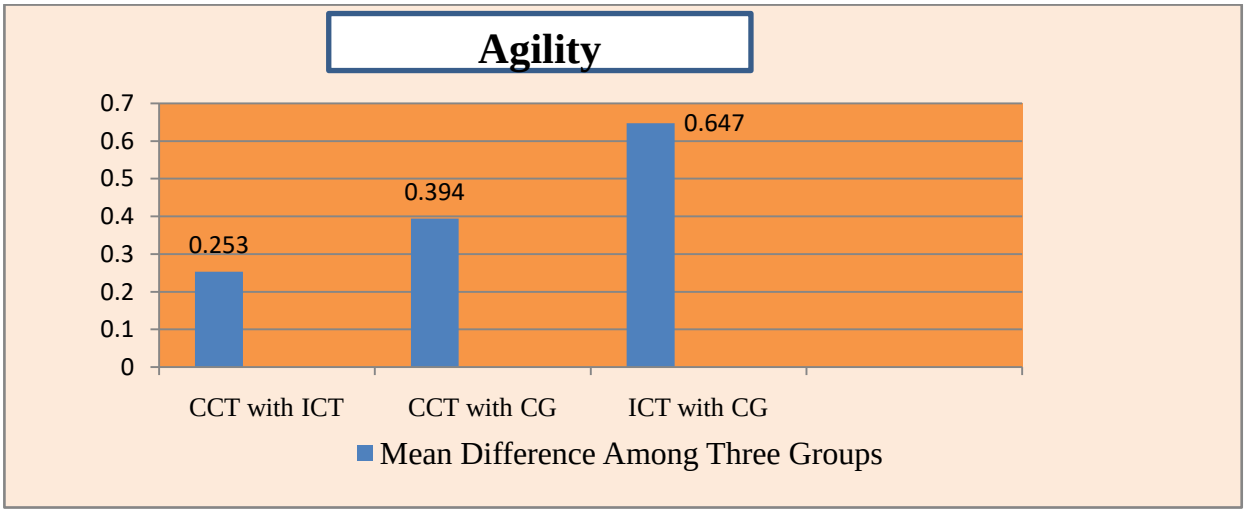
Parameter	Source of Variation	df	F - value	Sig	Intra group	MD	CD
agility	Between group	2	4.729*	.013	CCT-ICT	.25300	.424
	Within group	57			ICT-CG	.64750*	
					CG-CCT	.39450	

***significant at 0.05 level, F** $_{(2, 57)}$ =3.15.* ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-15 analysis of variance (One-way ANOVA) was computed on **post test mean** of three groups, the observed 'F' value of Agility is 4.729 which was statistically significant at 0.05 level as it is greater than table value of ***3.15.***

To determine the exact location where the differences occur among three groups for agility Post-Hoc test (LSD test) was used. Among the three paired of MD between the ICT & CG were found statistically significant, since MD of .6475 was higher than CD (.424) whereas, MD of CG with CCT was nearly significant but MD was found not significant in case of CCT with ICT at 0.05 level of confidence. The mean differences also presented in graphical structure in figure no. 9.

Fig.9. Graphical representation of mean difference among three groups of post test on Agility.



Discussion on Agility:

Present study showed that Agility was significantly improved after the implication of specified circuit training programme for Interval and Continuous Circuit Training Group but no significant changes observed on control group. Similar results were found from the findings of other research reports (Reddy, 2014; Kumar, 2014; Vinayagamoorthi and Sakthivel, 2014; Kumar, 2016; Rani, 2018; Sornalingam, 2012 & Vallimurugan et al., 2022). Agility is the capacity to rapidly change one's direction and position of the body and it is influenced by strength, speed, and flexibility. Shekhawat & Chauhan (2021) found that Regular circuit training improves muscular strength, speed, flexibility, and cardio-vascular fitness; the development of these motor skills may have helped to the development of agility.

Mishra, (2015) and Pandey et al., (2015)) said that explosive strength is the most dominating variable for the improvement of the agility of an individual. In present research study the training programme used, had specified station wise exercises such as spot jump, box jump, high knee and squat thrust these can improve the leg explosive strength. Đošić (2016) found that significant relationships between explosive strength and agility jumping performance of athletes. Different sports training methods is usually used to get better physical fitness and standards performance of athletes. Circuit training, interval training, continuous training, interval circuit training, continuous circuit training, etc. are some of these various training formats. The circuit training is considered as a very important part of the training program. Not only for general fitness but it used for motor fitness also it concluded by Al-Haliq (2015) and also an established circuit training method helps to improve components of fitness such as agility, flexibility and strength. There were differences in the aspects, principles, and outcomes of the various training methods.

Present research study was composed by interval and continuous circuit training procedures. The results of the study showed that there was a considerable degree of deference among the three groups. Comparatively interval circuit training (ICT) was better effects than continuous circuit training (CCT) on agility. After the completion of specified training program there interval circuit training (ICT) and continuous circuit training (CCT) were better than the control group (CG). Reddy (2014) discovered that there are notable differences between the

impact of interval and continuous circuit training methods on shuttle run agility, with ICT being superior to CCT. It also provides justification for the current research study's findings.

Therefore the observation of the present research investigations findings are closely related with other researchers. After analyzing the study's results and those of other researchers, it can be indicated that both types of circuit training programme (CCT & ICT) can improve agility and interval circuit training method is better than continuous circuit training method for agility improvement. Present findings are in consonance with the other researchers, stated above.

4.3.3 LEG EXPLOSIVE STRENGTH (mt)

The maximum force or tension that a muscle is able to generate during a single attempt is known as its muscular strength. Having muscular strength will ensure that you have the strength to conduct daily life activity smoothly. Similarly in the area of sports or sports training during the change of physical movement or activity leg explosive strength is the very essential factor. Leg explosive strength is the ability of lower limb act against the maximum resistance with speed in a single effort. Strength seems to improve when sufficient tension is applied to the muscles contractile system. The physiological principles on which strength development depend is overload principles. Overload training leads to adaptation in the muscles according to the specific types of training (Das, 1995). In present study composed with progression of load on individual capability with specific exercises such as box jump, high knee, spot jump, squat thrust and stepping. These all exercises have positive benefit to improve leg explosive strength. Reddy (2012) Step ups for feet & legs, Squat thrust, Lean back Squat for legs etc included these exercises with circuit training to observed effect on leg explosive strength. In present study the training schedule adopted contained specified circuit training with progressive increment of load to improve leg explosive strength. Standing broad jump was considered as a measure of leg explosive strength, the details of the test procedure are discussed in chapter III and test has been used before and after the training. The results are shown here.

Table: 16. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on leg explosive strength (mt).

Parameter	Groups	N	df	Pre-test			Post-test			t- Value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
Leg Explosive Strength	ICT	20	19	1.77	.20	.045	1.89	.21	.049	11.46*
	CCT	20	19	1.66	.22	.050	1.78	.22	.051	11.29*
	CG	20	19	1.63	.16	.036	1.63	.15	.034	1.01

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no.16 that the mean and standard deviation (Mean ± SD) values of leg explosive strength on **pre-test and post test** of three (ICT,CCT & CG) groups were 1.77 ± .20, 1.66 ± .22, 1.63 ± .16 and 1.89 ± .21, 1.78 ± .22, 1.63 ± .15 respectively. The result also presented in graphical structure in figure no. 10. It was understandable that a distinct difference appeared in the mean value between the **pre-test and post-test** of ICT and CCT group which apparently reflected in the t- value. In table no.16 showed that the t- values of three (ICT, CCT & CG) groups were 11.46, 11.29 and 1.011. t-value of interval circuit training (ICT) group and continuous circuit training (CCT) group was statistically significant at 0.05 level since the table value 2.093 for the df 19 which was lower than the obtained value. Wherein t- value (1.011) of control group (CG) was statistically not significant at 0.05 level since the table value was greater than the obtained value.

Fig.10. Graphical representation among the Mean and SD of three groups of pre test and post test on leg explosive strength (mt).

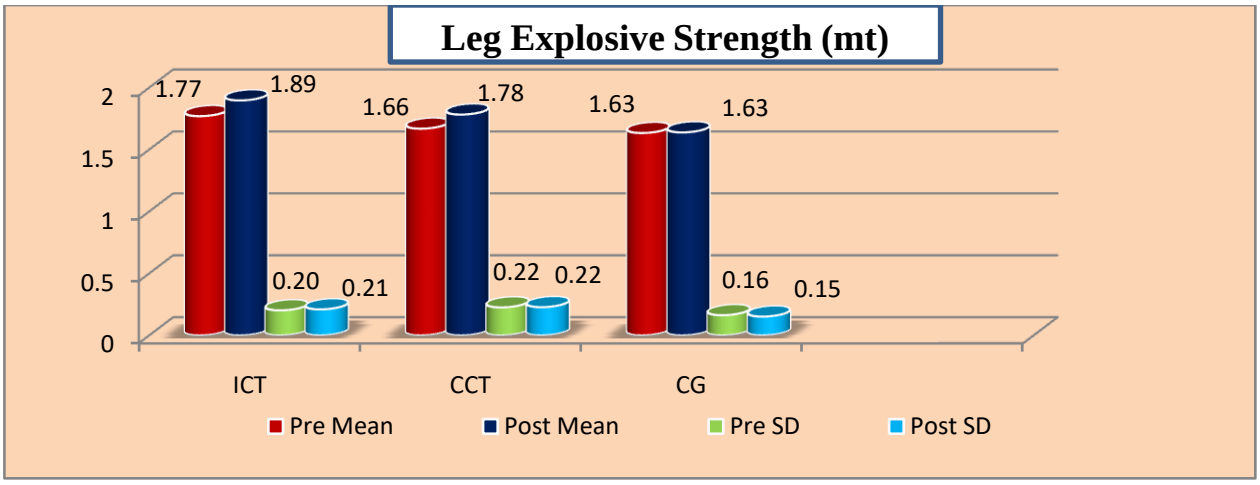


Table: 17. Inferential statistics with 'ANOVA' and critical difference on Leg Explosive Strength of interval circuit training, continuous circuit training & control group on post test score.

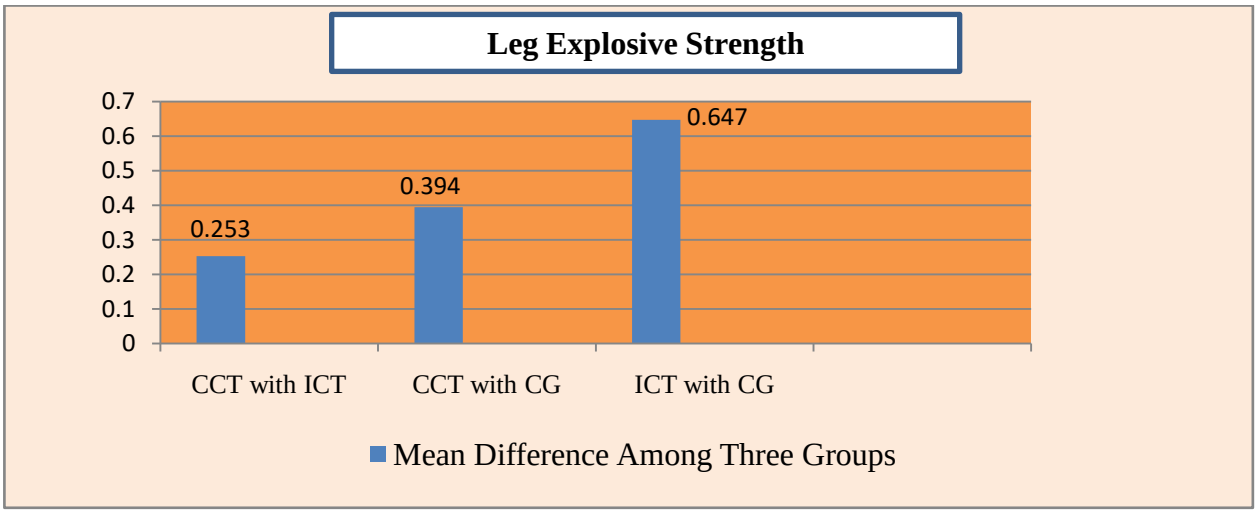
Parameter	Source of Variation	df	F - value	Sig	Intra group	MD	CD
Leg Explosive Strength	Between group	2	8.129*	.001	CCT-ICT	.114	0.128
	Within group	57			ICT-CG	.258*	
					CG-CCT	.143*	

***significant at 0.05 level, F** $_{(2, 57)}$ =3.15.* ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-17 analysis of variance (One-way ANOVA) was computed on **post test mean** of three groups, the observed 'F' value of leg explosive strength is 8.129 which was statistically significant at 0.05 level as it is greater than table value of ***3.15.***

To determine the exact location where the differences occur among three groups for leg explosive strength Post- Hoc test (LSD test) was used. Among the three mean differences between the ICT & CG and CG & CCT were found statistically significant, since MD of .258 & .143 were higher than CD (0.128) at 0.05 level. Whereas MD was found not significant in case of CCT with ICT group at 0.05 level of confidence. The mean differences also presented in graphical structure in figure no. 11.

Fig.11. Graphical representation of mean difference among three groups of post test on leg explosive strength.



Discussion on Leg explosive strength:

The results of this study's analysis revealed that Leg explosive strength was significantly enhanced after the implication of specified circuit training programme through 12 weeks but no significant changes observed on control group. Kumar (2016), Reddy (2014), Sakthivel (2014), Meethal and Najeeb (2013), Al-Haliq (2015) & Sutha (2020) have particularly found improvement in leg explosive strength with the help of following training. Present research investigation did compare with three groups in respect of leg explosive strength after specified training, here comparatively no changes observed for control group which is similar findings with Vadivel and Maniazhagu (2022) they were found Due to both the training have improved the muscular strength but no development was identified in control group. Shekhawat & Chauhan (2021) found that the Circuit training performed on a regular basis in a systematic way it can enhances muscular strength, speed and flexibility. On the other hand (Sarkar, 2013) determined that explosive strength and strength endurance showed a significant improvement, but training needs to be methodical, planned, and scientific. According to each person's capacity, the current study used a particular circuit training method that was implemented for a period of twelve weeks, three days per week. As a result, the results of this study agree with those of previous investigations.

Present study assembled the circuit training methods with progression of load on individual capability with specific exercises such as box jump, high knee, spot jump, squat thrust, stepping etc. These all exercises effective to improve leg explosive strength. Reddy (2012), Step ups for feet & legs, Squat thrust, Lean back Squat for legs etc included as exercises with circuit training to observed effect on leg explosive strength and found the result, there was significant enhanced leg explosive strength.

Therefore the observation of the present research investigations findings are closely related with other researcher. Analysis the result of the study and the other investigators establishment of the research findings concluded that specified circuit training programme can improve leg explosive strength but insignificant changes observed for control group. Present findings are in consonance with the other researchers, stated above.

4.3.4 CARDIO RESPIRATORY ENDURANCE

Cardio respiratory endurance is a key component of physical fitness throughout the life as well as in the field of sports or physical movement. Cardio respiratory fitness (CRF) is the ability of the respiratory and circulatory systems to supply oxygen to mitochondria for the production of energy required during physical activity (Raghuveer et al., 2020). Smith (2023) reported "The greater your cardio respiratory endurance, the longer and harder you can push yourself during a workout or athletic event," Aerobic activity is the first step towards testing your cardio, respiratory, and cardiovascular endurance. Participating in cardiovascular and pulmonary exercise can help your muscles receive enough oxygen for the production of energy is included in this category. Like interval training and long-distance running, for example.

In present study the training schedule adopted specified continuous and interval circuit training with progressive increment of load to improve cardio respiratory endurance. Harvard step test was considered as a unique method to measurement of cardio respiratory endurance, the details of the test procedure are discussed in chapter III and test has been used before and after the training. The results are shown here.

Table: 18. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on Cardio Respiratory Endurance

Parameter	Groups	N	df	Pre-test			Post-test			t-Value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
Cardio Respiratory Endurance	ICT	20	19	77.12	5.19	1.162	81.44	5.52	1.236	23.83*
	CCT	20	19	79.87	3.44	.769	88.01	6.79	1.518	9.58*
	CG	20	19	78.09	6.52	1.458	78.04	6.48	1.450	.188

Significant at 0.05 level (Table value 2.093, df-19). I.C.T= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no.18 that the mean and standard deviation (Mean ± SD) values of Cardio Respiratory Endurance on **pre-test and post test** of three (ICT, CCT & CG) groups were 77.12 ± 5.19, 79.87 ± 3.44, 78.09 ± 6.52 and 81.44 ± 5.52, 88.01 ± 6.79, 78.04 ± 6.48 respectively. The result also presented in graphical structure in figure no. 12. It was understandable that a distinct difference appeared in the mean value between the **pre-test and**

post-test of CCT and ICT groups which apparently reflected in the t- value but not significant difference observed for CG. In table no. 18 showed that the t- values of three (ICT, CCT & CG) groups were 23.83, 9.58 and .18. t-value of interval circuit training (ICT) group and continuous circuit training (CCT) group was statistically significant at 0.05 level since the table value 2.093 for the df 19 which was lower than the obtained value. Wherein t- value (.18) of control group (CG) was statistically not significant at 0.05 level since the table value was higher than the obtained value.

Fig.12. Graphical representation among the Mean and SD of three groups of pre test and post test on Cardio Respiratory Endurance

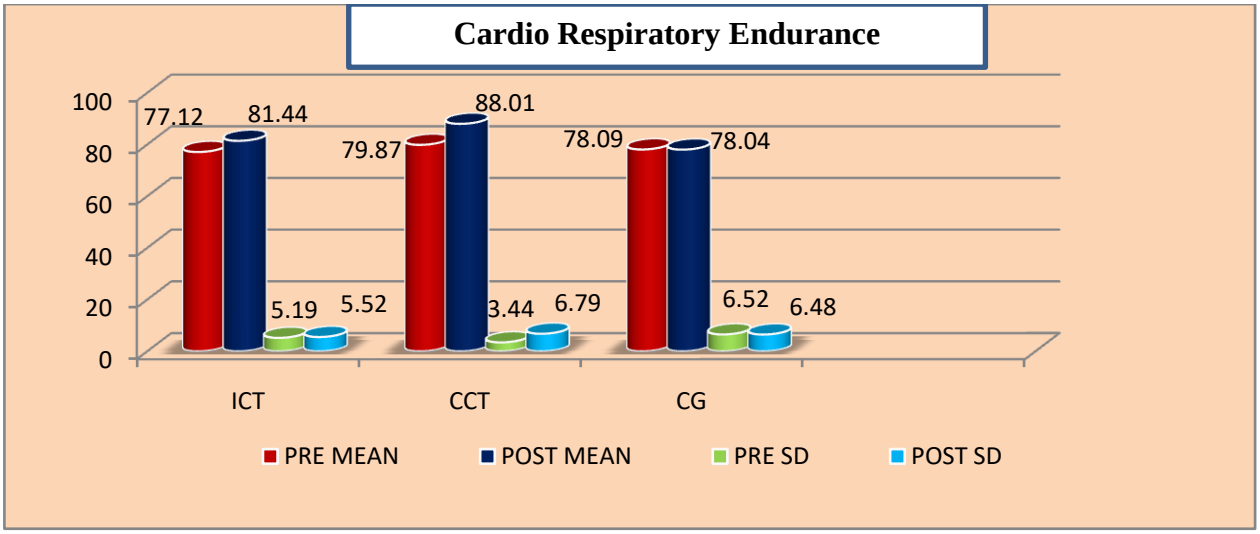


Table: 19. Inferential statistics with 'ANOVA' and critical difference on Cardio Respiratory Endurance of interval circuit training, continuous circuit training & control group on post test score.

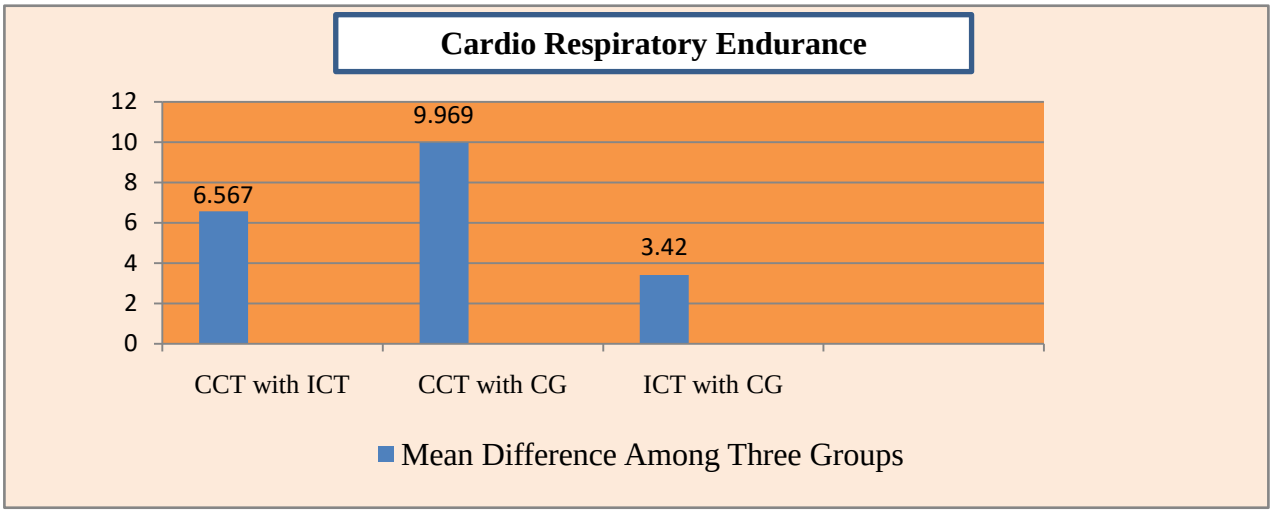
Parameter	Source of Variation	df	F - value	Sig	Intra group	MD	CD
Cardio Respiratory Endurance	Between group	2	12.97*	.000	**CCT – ICT**	6.567*	3.97
	Within group	57			**ICT – CG**	3.420	
					CG – CCT	9.969*	

***significant at 0.05 level, F** $_{(2, 57)}$ =3.15.* ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-19 analysis of variance (One-way ANOVA) was computed on **post test mean** of three groups, the observed 'F' value of cardio respiratory endurance is 12.97 which was statistically significant at 0.05 level as it is higher than table value of ***3.15.***

To determine the exact location where the differences occur among three groups for cardio respiratory endurance Post- Hoc test (LSD test) was used. Among the three mean differences between the CCT & ICT and CG & CCT were found statistically significant, since MD of 6.567 & 9.969 were higher than CD (3.97) at 0.05 level. Whereas MD was found not significant in case of ICT with CG at 0.05 level of confidence. The MD also presented in graphical structure in figure no. 13.

Fig.13. Graphical representation of mean difference among three groups of post test on Cardio Respiratory Endurance



Discussion on Cardio Respiratory Endurance:

Present study reflected about Cardio Respiratory Endurance was significantly enhanced after the implementation of specified circuit training programme but no significant changes noticed on control group. Some related research studies were observed, from the findings of many other researchers ((Hryvniak et al., 2021; Krishna, 2020; Yunus et al., 2018; Adling & Bangar, 2016; Khan et al., 2015; Koubaa et al., 2013 & Venkatseswarul, 2010) concluded that cardio respiratory fitness improved through interval and continuous training methods. (Yue et al., 2022) suggested Interval training three times per weeks for more than 12 weeks resulted in the largest improvement in cardio respiratory fitness. In this study those who are under control they were stand in more or less in same point on cardio respiratory fitness. Adling & Bangar (2016)

came to the conclusion that pre and post-test results for cardiopulmonary endurance showed no appreciable change in the control group. Present study implies that continuous circuit training (CCT) method was slightly more effective than interval training method for Cardio respiratory endurance. Sundar et al. (2020) found continuous training was little more effective than interval method. According to Khan et al. (2015), for young peoples and healthy individuals increasing aerobic capacity can be achieved through both continuous and interval training. Yunus et al. (2018) concluded no significant differences between influences of interval and continuous trainings toward VO2 max increase. On the other side Koubaa et al. (2013) showed a study where continuous training to be beneficial for maintaining cardiovascular fitness.

Therefore the observation of the present research investigations findings are closely related with other research reports. Analysis the result of the study and the other investigators establishment of the research findings concluded that both types of circuit training programme may improve Cardio Respiratory Endurance and continuous circuit training (CCT) method is better than interval circuit training method for enhance Cardio Respiratory Endurance. Present findings are in consonance with the other researchers, stated above.

4.3.5 FLEXIBILITY (Inches)

When a joint or muscle is capable to move through its whole range of motion, it is said to be flexible. The soft tissues that surround a joint always have an impact on its range of motion. Such as joint capsules, tendons, ligaments, and muscles. Over time, a lack of movement and stretching, particularly when combined with activity, can cause a soft tissue shortening brought on by fatigue. Good flexibility helps to performance, posture, promotes higher movement economy, prevents body misalignments, balance and also decreases several injury risks. Flexibility is very essential factor for athletes because it helps to boost up their performance as well as need for every general people to do daily life movement. It is an important health related physical fitness component for human body. In present study the training schedule prepared by specific exercises with in the mode of continuous and interval circuit training program to observe the effects of specified training programme on flexibility. Modified sit & reach test was considered as a measure of flexibility, the details of the test procedure are discussed in chapter III and test has been used before and after the training. The results are shown here.

Table: 20. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on Flexibility.

Parameter	Groups	N	df	Pre-test			Post-test			t Value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
Flexibility	ICT	20	19	18.07	1.29	.288	20.15	1.59	.355	16.32*
	CCT	20	19	18.10	1.11	.250	20.12	1.41	.316	13.75*
	CG	20	19	18.05	1.45	.326	17.95	1.34	.301	.72

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no.20 that the mean and standard deviation (Mean ± SD) values of Flexibility on **pre-test and post test** of three (ICT, CCT & CG) groups were 18.07 ± 1.29, 18.10 ± 1.11, 18.05 ± 1.45 and 20.15 ± 1.59, 20.12 ± 1.41, 17.95 ± 1.34 respectively. The result also presented in graphical structure in figure no. 14. It was understandable that a distinct difference appeared in the mean value between the **pre-test and post-test** of CCT and ICT group which apparently reflected in the t- value. In table no.20 showed that the t- values of three (ICT, CCT & CG) groups were 16.32, 13.75 and .721. t- value of interval circuit training (ICT) group and continuous circuit training (CCT) group was statistically significant at 0.05 level since the table value 2.093 for the df 19 which was lower than the obtained value. Wherein t- value (.72) of control group (CG) was statistically not significant at 0.05 level since the table value was greater than the obtained value.

Fig.14. Graphical representation among the Mean and SD of three groups of pre test and post test on Flexibility.

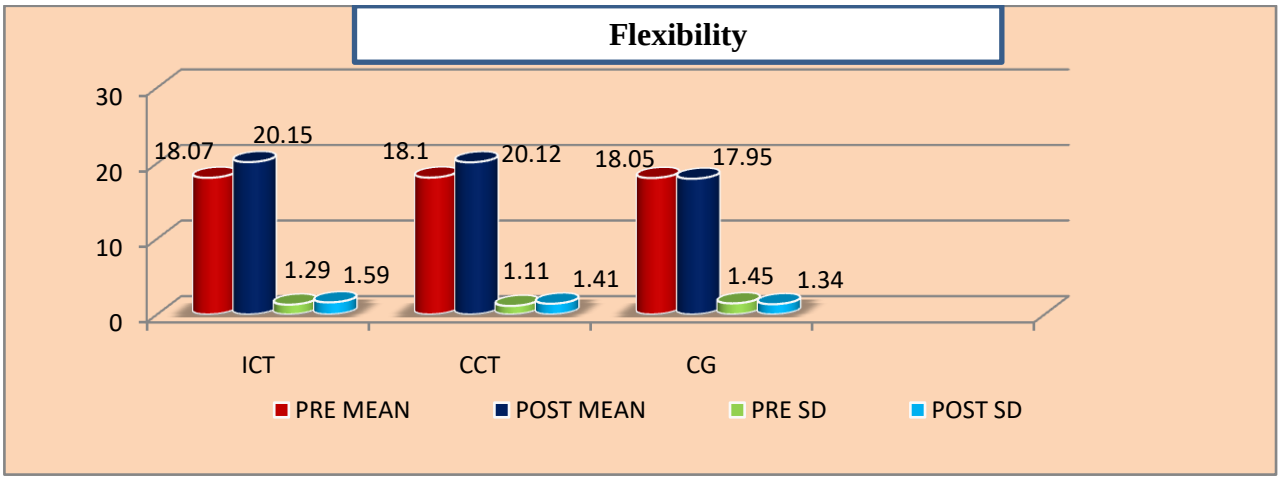


Table: 21. Inferential statistics with 'ANOVA' and critical difference on Flexibility of interval circuit training, continuous circuit training & control group on post test score.

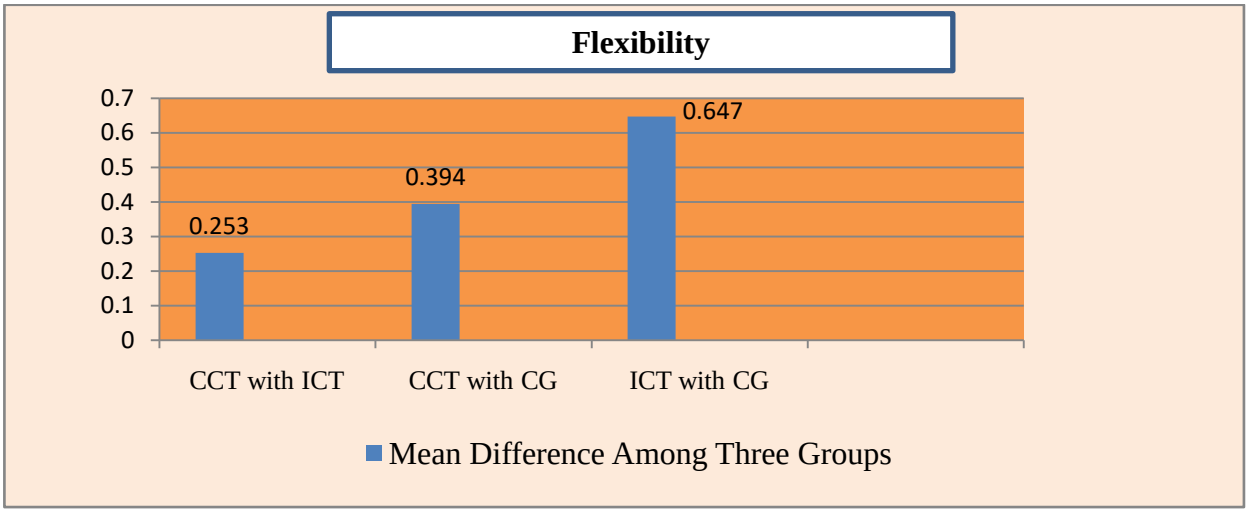
Parameter	Source of Variation	df	F - value	Sig	Intra group	MD	CD
Flexibility	Between group	2	15.099*	.000	**CCT – ICT**	.025	.919
	Within group	57			**ICT – CG**	2.200*	
					CG – CCT	2.175*	

***significant at 0.05 level, F** $_{(2, 57)}$ =3.15.* ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-21 analysis of variance (One-way ANOVA) was computed on **post test mean** of three groups, the observed 'F' value of flexibility is 15.099 which was statistically significant at 0.05 level as it is greater than table value of ***3.15.***

To determine the exact location where the differences occur among three groups for flexibility Post- Hoc test (LSD test) was used. Among the three mean differences between the ICT & CG and CG & CCT were found statistically significant, since MD of 2.200 & 2.175 were higher than CD (.919) at 0.05 level. Whereas mean difference was found not significant in case of CCT with ICT group at 0.05 level of confidence. The mean differences also presented in graphical structure in figure no. 15.

Fig.15. Graphical representation of mean difference among three groups of post test on Flexibility



Discussion on Flexibility:

There are true relationship between flexibility and athletic performance. To improve flexibility specific stretching exercises and increased muscles and joint temperatures is very effective. Fox & Mathews (1981) have denotes that flexibility can be improved through appropriate training but it is very specific to the joint involved and types of stretching exercise. Moreover, it is specific to the sports skills and aids the performance. Present investigation showed that flexibility was significantly enhanced after the implication of both types of specified circuit training programme but no significant changes observed on control group. It has been observed from the conclusions of various researchers that flexibility may improved through specified circuit training methods (Dhiman, 2022; Jadhav, 2020; Nonye Ujuagu, 2020; Dharuman, 2020; Shitaneh, 2019; Rani, 2018). This study was conducted circuit training with interval and continuous mode for 12 weeks and three days per week. Mohanakrishanan (2018) found that interval training can improve flexibility. On the other side, Girinathan and Lillypuspam (2019) were administered a training for 12 weeks and just thirty minutes a day, especially three days a week for the entire twelve-week period. There were found that interval and continuous training both can enhance flexibility but Interval training was considerably improved than Continuous training. It also upholds this research study.

Therefore the observation of the present research findings are closely related with other research reports. Analysis the result of the study and the other investigators establishment of the research findings concluded that both types of circuit training programme can improve flexibility but not significant difference observed between them (ICT & CCT). Present findings are in consonance with the other researchers, stated above.

4.4 PHYSIOLOGICAL VARIABLES

To measure the physiological dimension a number of tests for specified physiological parameters have been considered and the results of the tests are reflected accordingly.

4.4.1. HEART RATE (bpm)

The heart rate is defined as the number of heart beats per minute. There have a closely relation between physical movement and physiological changes. Heart rate variability of an athlete depends on training load, types of exercise, athletics condition, age etc. The

cardiovascular structure and function of heart is generally controlled by pathways of the autonomic nervous system that are sympathetic and parasympathetic. It can simply be determined by ECG. Measurement of basic human physiological state has been considered a most precious aspect of performance evaluation of athletes. The functional status of the body organs should be studied at rest or during movement condition is a medium by which volume of load can be easily calculated and maximum capability may be obtained. From the physiological dimensions as an important component, heart rate was studied and similar aspect was adopted about it. In the aspect of sports different physical training method can improve the efficiency of heart functions. To determine the impact of physical exercises or physical training present study adopted the specified circuit training methods with progressive increment of load to improve function of cardiovascular system which was determined by counting of heart rate per minute.

Harvard step test was administered to assess the changing pattern of heart rate consequence to resting and recovery period. Measurement of heart rate was taken by five states such as resting heart rate, heart rate before activity, heart rate after immediate activity, heart rate after seven minutes of activity and heart rate after fifteen minutes of activity. The details of the test procedure are discussed in chapter III and test has been used before and after the training.

4.4.1. a. RESTING HEART RATE

Reasonably low resting heart rate means higher level of fitness in athletes who are under physical training or an exercise program, but in general people low resting heart rate implies unfit and unhealthy condition. As a result, measuring resting heart rate is a useful method to measure fitness and is undoubtedly a good way to estimate cardiac stroke volume. The results are shown here.

Table: 22. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on Resting Heart Rate.

Parameter	Groups	N	df	Pre-test			Post-test			't' Value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
Resting Heart Rate	ICT	20	19	73.25	1.55	.347	70.20	1.54	.345	13.65*
	CCT	20	19	72.50	1.46	.328	68.20	1.90	.427	11.83*
	CG	20	19	73.05	1.87	.419	73.40	1.69	.379	1.67

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no. 22 that the mean and standard deviation (Mean ± SD) values of Resting Heart Rate on **pre-test and post test** of three (ICT, CCT & CG) groups were 73.25 ± 1.55, 72.50 ± 1.46, 73.05 ± 1.87 and 70.20 ± 1.54, 68.20 ± 1.90, 73.40 ± 1.69 respectively. The result also presented in graphical structure in figure no. 16. It was understandable that a distinct difference appeared in the mean value between the **pre-test and post-test** of CCT and ICT groups which apparently reflected in the t- value but not significant difference observed on control group (CG). In table no. 22 showed that the t- values of three (ICT, CCT & CG) groups were 13.65, 11.83 and 1.67. t-value of interval circuit training (ICT) group and continuous circuit training (CCT) group was statistically significant at 0.05 level since the table value 2.093 for the df 19 which was lower than the obtained value. Wherein t- value (1.67) of control group (CG) was statistically not significant at 0.05 level since the table value was greater than the obtained value.

Fig.16. Graphical representation among the Mean and SD of three groups of pre test and post test on Resting Heart Rate.

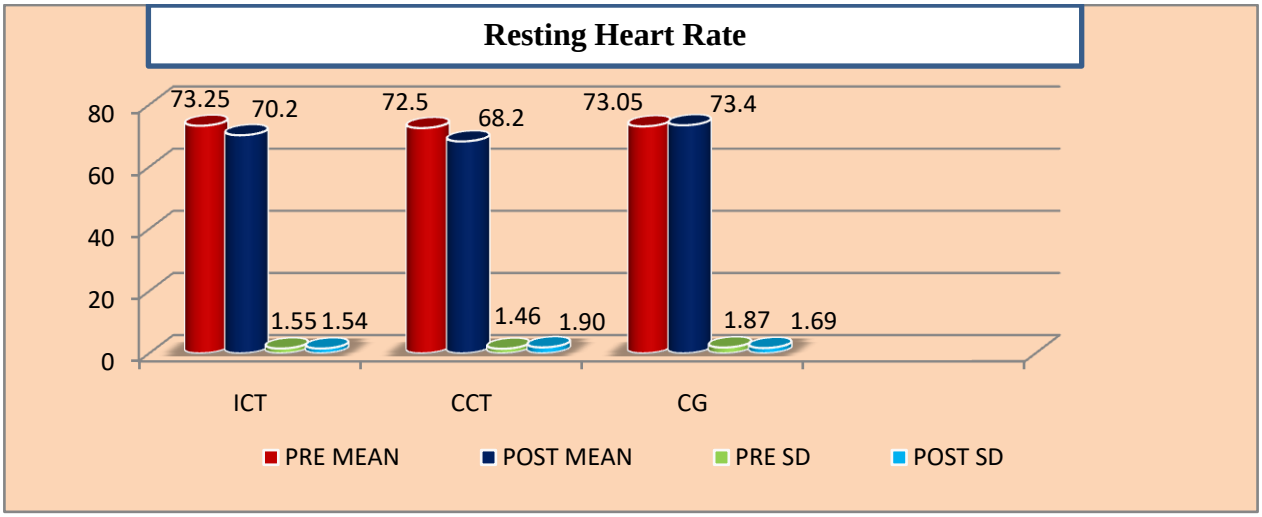


Table: 23. Inferential statistics with 'ANOVA' and critical difference on Resting Heart Rate of interval circuit training, continuous circuit training & control group on post test score.

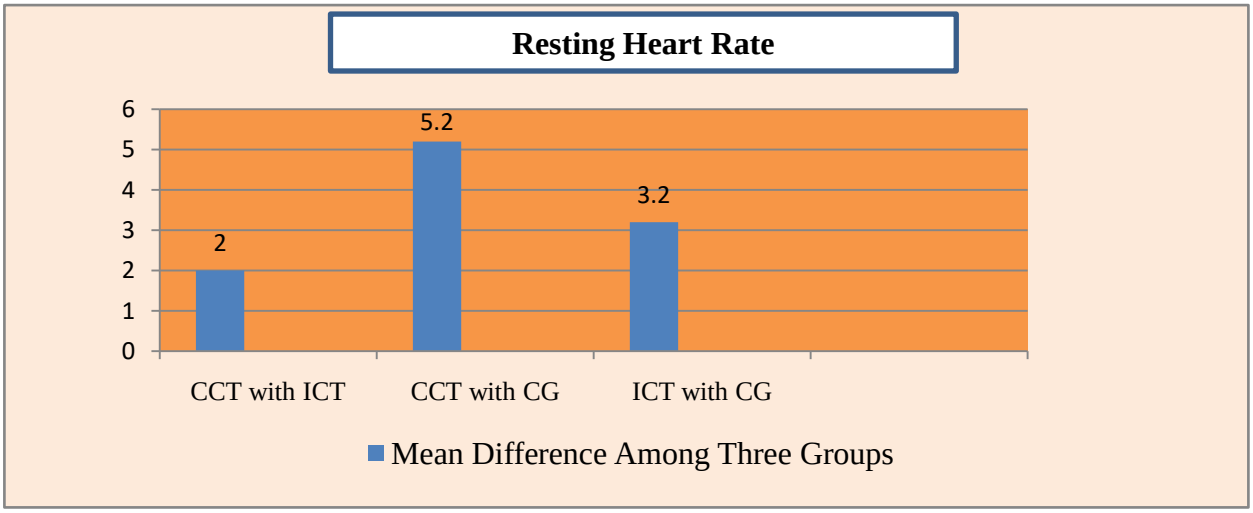
Parameter	Source of Variation	df	F - value	Sig	Intra group	MD	CD
Resting Heart Rate	Between group	2	46.355*	.000	**CCT – ICT**	2.000*	1.08
					ICT – CG	3.200*	
	Within group	57			**CG – CCT**	5.200*	

***significant at 0.05 level, F** $_{(2, 57)}$ =3.15.* ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-23 analysis of variance (One-way ANOVA) was computed on **post test mean** of three groups, the observed 'F' value of resting heart rate is 46.355 which was statistically significant at 0.05 level as it is greater than table value of ***3.15.***

To determine the exact location of difference among three groups for resting heart rate Post- Hoc test (LSD test) was used. Among the three paired of MD between the CCT & ICT, ICT & CG and CG & CCT were found statistically significant, since MD of 2.000, 3.200 & 5.200 were higher than CD (1.08) at 0.05 level. The MD also presented in graphical structure in figure no. 17.

Fig.17. Graphical representation of mean difference among three groups of post test on Resting Heart Rate



4.4.1.b. HEART RATE BEFORE EXERCISE

Harvard step test was precisely conducted as a Physical activity. For Present study heart rate was measured just before the starting of Harvard step test. The details of the test procedure are discussed in chapter III and test has been used before and after the training. The results are shown here.

Table: 24. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on Heart rate before exercise.

Parameter	Groups	N	df	Pre-test			Post-test			't' Value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
Heart rate before exercise	ICT	20	19	75.50	1.76	.394	73.30	1.52	.341	9.78*
	CCT	20	19	75.25	1.61	.362	71.15	1.92	.430	9.30*
	CG	20	19	76.10	1.80	.416	76.40	1.85	.419	1.55

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group**.**

It appears from the table no.24 that the mean and standard deviation (Mean ± SD) values of Heart rate before activity on pre-test and post test of three (ICT, CCT & CG) groups were 75.50 ± 1.76, 75.25± 1.61, 76.10± 1.86 and 73.30 ± 1.52, 71.15 ± 1.92, 76.40 ± 1.87 respectively. The result also presented in graphical structure in figure no. 18. It was understandable that a distinct difference appeared in the mean value between the **pre-test and post-test** of CCT and ICT groups which apparently reflected in the t- value but not significant difference observed on control group (CG). In table no. 24 showed that the t- values of three (ICT, CCT & CG) groups were 9.78, 9.30 and 1.55. t-value of interval circuit training (ICT) group and continuous circuit training (CCT) groups were statistically significant at 0.05 level since the table value 2.093 for the df 19 which was lower than the obtained value. Wherein t- value (1.55) of Control Group (CG) was statistically not significant at 0.05 level since the table value was greater than the obtained value.

Fig.18. Graphical representation among the Mean and SD of three groups of pre test and post test on Heart rate before exercise.

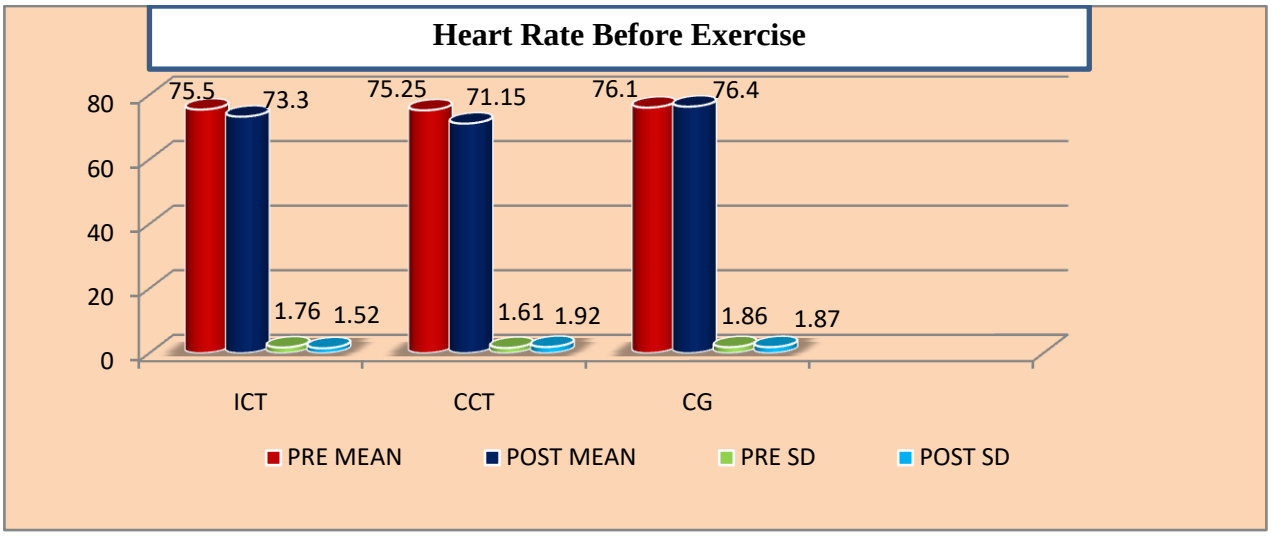


Table: 25. Inferential statistics with 'ANOVA' and critical difference on Heart rate before exercise of interval circuit training, continuous circuit training & control group on post test score.

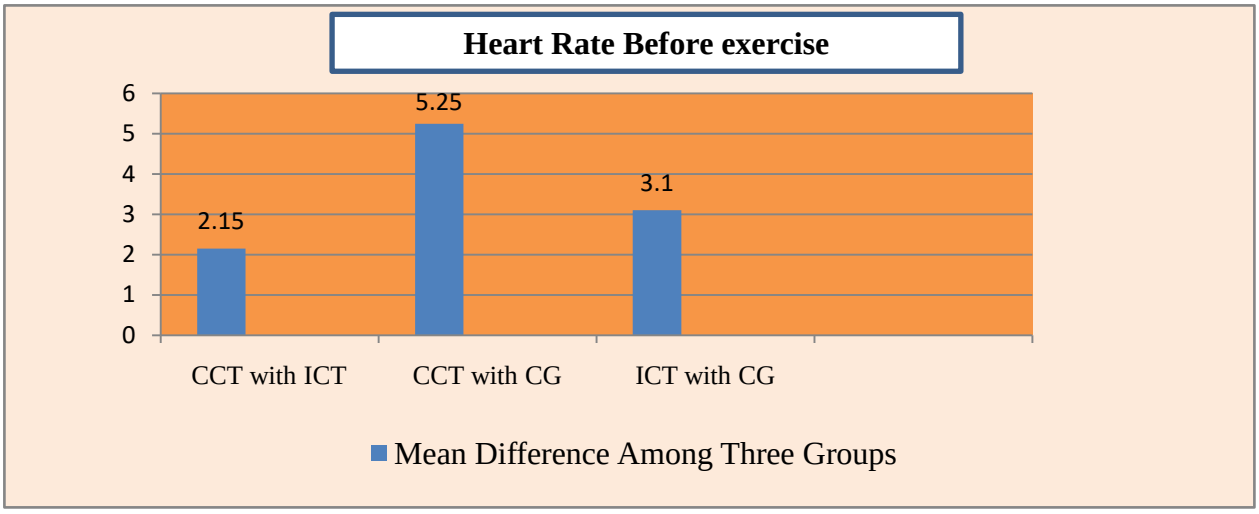
Parameter	Source of Variation	df	F - value	Sig	Intra group	MD	CD
Heart rate before exercise	Between group	2	43.740*	.000	**CCT – ICT**	2.150*	1.128
	Within group	57			**ICT – CG**	3.100*	
					CG – CCT	5.250*	

***significant at 0.05 level, F** $_{(2, 57)}$ =3.15.* ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-25 analysis of variance (One-way ANOVA) was computed on **post test mean** of three groups, the observed 'F' value of Heart rate before activity is 43.74 which was statistically significant at 0.05 level as it is greater than table value of ***3.15.***

To determine the exact location where the differences occur among three groups for resting heart rate before activity Post- Hoc test (LSD test) was used. Among the three paired of MD between the CCT & ICT, ICT & CG and CG & CCT were found significant statistically, since MD of 2.150, 3.100 & 5.250 were higher than CD (1.128) at 0.05 level. The MD also presented in graphical structure in figure no. 19.

Fig.19. Graphical representation of mean difference among three groups of post test on Heart rate before exercise



4.4.1.c. HEART RATE AFTER IMMEDIATE OF EXERCISE

Certainly stepping exercises can increase the heart rate and physiological functions of organs. Harvard step test was precisely conducted as a Physical exercise to view the effect of exercise on heart rate. For Present study heart rate was measured just after the completion of Harvard step test. The details of the test procedure are discussed in chapter III and test has been used before and after the training. The results are shown here.

Table: 26. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on Heart Rate after immediate of exercise.

Parameter	Groups	N	df	Pre-test			Post-test			't' Value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
Heart Rate after immediate of exercise	ICT	20	19	159.05	5.56	1.244	155.60	5.45	1.22	8.91*
	CCT	20	19	159.00	5.48	1.226	153.15	5.03	1.127	19.40*
	CG	20	19	160.00	4.53	1.013	160.50	4.07	.910	2.12*

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no.26 that the mean and standard deviation (Mean ± SD) values of Heart Rate after immediate of exercise on **pre-test and post test** of three (ICT, CCT & CG) groups were 159.05 ± 5.56, 159.00 ± 5.48, 160.00 ± 4.53 and 155.60 ± 5.45, 153.15 ± 5.03,

160.50 ± 4.07 respectively. The result also presented in graphical structure in figure no. 20. It was understandable that a distinct difference appeared in the mean value between the **pre-test and post-test** of CCT, ICT and CG groups which apparently reflected in the t- value. In table no. 26 showed that the t- values of three (ICT, CCT & CG) groups were 8.91, 19.40 and 2.12. t-value of CCT, ICT and CG groups were statistically significant at 0.05 level since the table value 2.093 for the df 19 which was lower than the obtained value.

Fig.20. Graphical representation among the Mean and SD of three groups of pre test and post test on Heart Rate after immediate of Exercise.

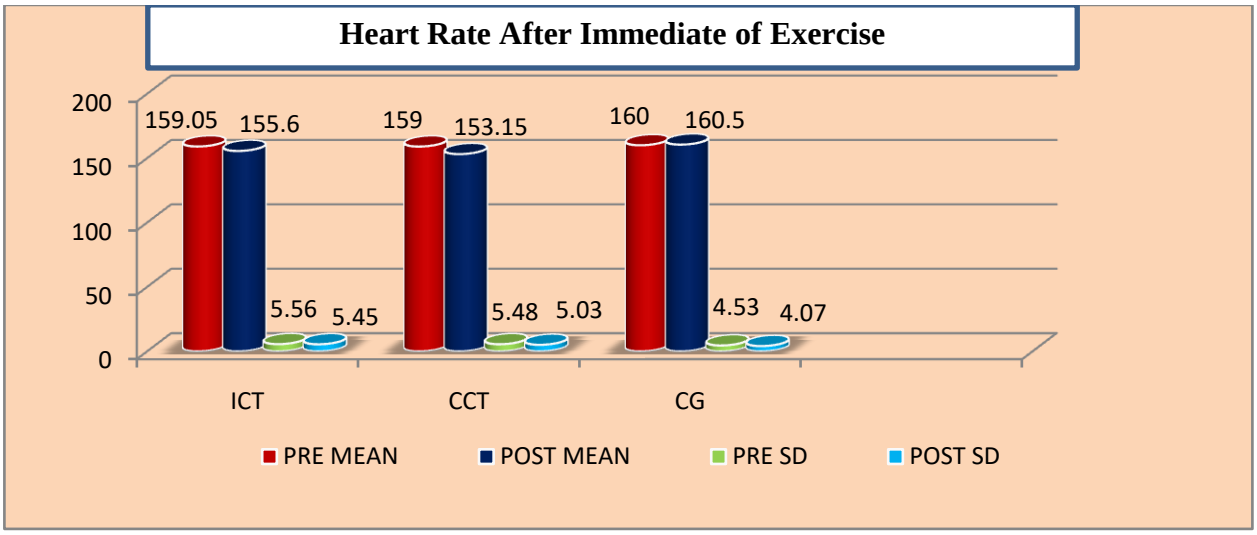


Table: 27. Inferential statistics with 'ANOVA' and critical difference on Heart Rate after immediate of exercise of interval circuit training, continuous circuit training & control group on post test score.

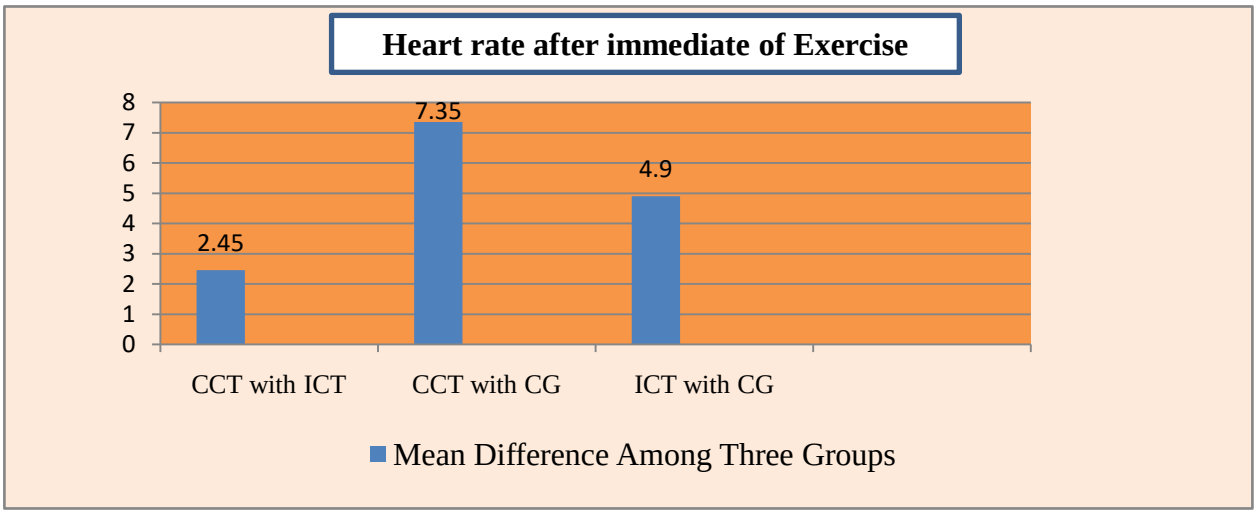
Parameter	Source of Variation	df	F - value	Sig	Intra group	MD	CD
Heart Rate after immediate of Exercise	Between group	2	11.720*	.000	**CCT – ICT**	2.450	3.09
	Within group	57			**ICT – CG**	4.900*	
					CG – CCT	7.350*	

***significant at 0.05 level, F** $_{(2, 57)}$ =3.15.* ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-27 analysis of variance (One-way ANOVA) was computed on **post test mean** of three groups, the observed 'F' value of Heart rate after immediate of exercise is 11.720 which was statistically significant at 0.05 level as it is greater than table value of ***3.15.***

To determine the exact location where the differences occur among three groups for Heart Rate after immediate of exercise Post- Hoc test (LSD test) was used. Among the three paired of mean difference between the ICT & CG and CG & CCT were found statistically significant, since MD of 4. 900 and 7. 350 were higher than CD (3.09) at 0.05 level. Whereas MD was found not significant in case of CCT with ICT group at 0.05 level of confidence. The MD also presented in graphical structure in figure no. 21.

Fig.21. Graphical representation of mean difference among three groups of post test Heart Rate after immediate of Exercise



4.4.1. d. HEART RATE AFTER COMPLETION OF SEVEN MINUTES OF EXERCISE

After the completion of exercise athletes step in under recovery period. All the body organs have come back towards normal condition gradually. In present study after completion of steeping there was a complete rest in setting posture with under observation. After seven minutes of complete rest heart rate was measured again. The details of the test procedure are discussed in chapter III and test has been used before and after the training. The results are shown here.

Table: 28. Pre test and Post test Mean, SD and t-values of continuous circuit training, interval circuit training & control group on HR after completion of Seven Minutes of Exercise.

Parameter	Groups	N	df	Pre-test			Post-test			't' Value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
HR after completion of Seven Minutes of Exercise	ICT	20	19	104.90	2.26	.507	102.05	2.43	.545	10.39*
	CCT	20	19	105.40	2.25	.505	99.35	2.71	.608	17.21*
	CG	20	19	105.80	1.88	.420	105.35	1.49	.335	1.62

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no.28 that the mean and standard deviation (Mean ± SD) values of Heart Rate after completion of Seven Minutes of Exercise on **pre-test and post test** of three (ICT, CCT & CG) groups were 104.90 ± 2.26, 105.40 ± 2.25, 105.80 ± 1.88 and 102.05 ± 2.43, 99.35 ± 2.71, 105.35 ± 1.49 respectively. The result also presented in graphical structure in figure no. 22. It was understandable that a distinct difference appeared in the mean value between the **pre-test and post-test** of CCT and ICT groups which apparently reflected in the t-value but not significant difference observed on control group (CG). In table no. 28 showed that the t- values of three (ICT, CCT & CG) groups were 10.39, 17.21 and 1.62. t-value of interval circuit training (ICT) group and continuous circuit training (CCT) group was statistically significant at 0.05 level since the table value 2.093 for the df 19 which was lower than the obtained value. Wherein t- value (1.62) of Control Group (CG) was statistically not significant at 0.05 level since the table value was greater than the obtained value.

Fig. 22. Graphical representation among the Mean and SD of three groups of pre test and post test on HR after completion of Seven Minutes of Exercise.

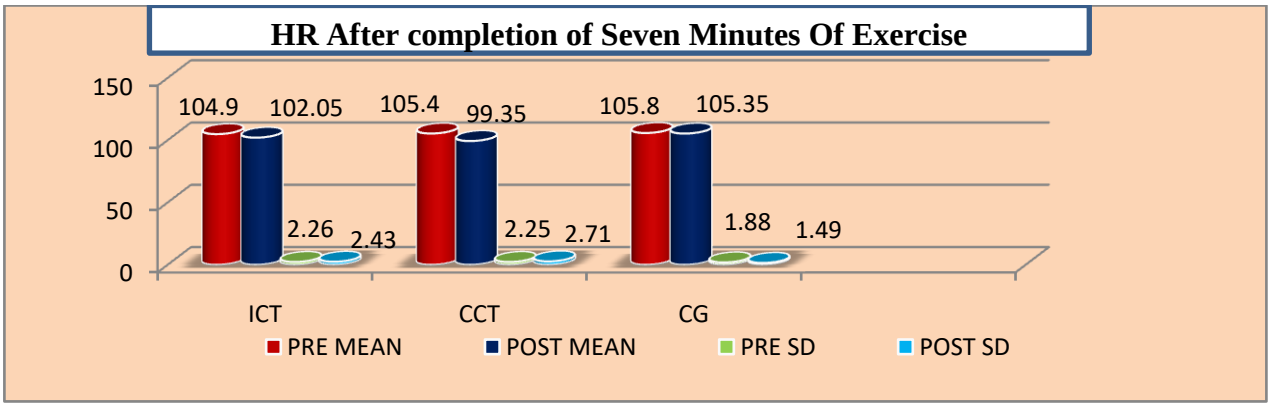


Table: 29. Inferential statistics with 'ANOVA' and critical difference on HR after completion of Seven Minutes of Exercise of interval circuit training, continuous circuit training & control group on post test score.

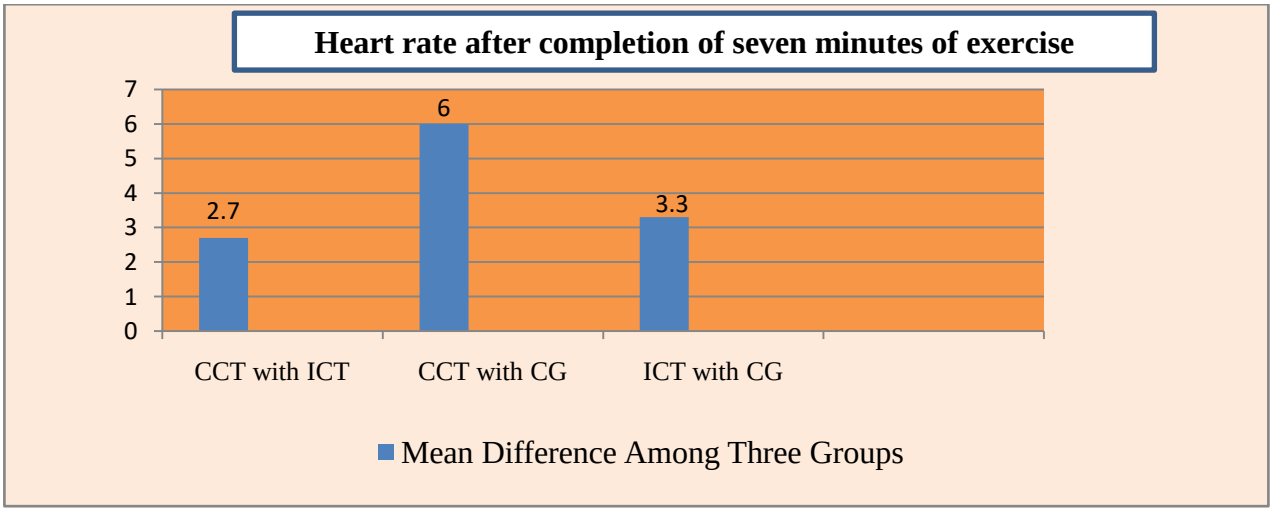
Parameter	Source of Variation	df	F - value	Sig	Intra group	MD	CD
HR after completion of Seven Minutes of Exercise	Between group	2	34.772*	.000	**CCT – ICT**	2.700*	1.44
	Within group	57			**ICT – CG**	3.300*	
					CG – CCT	6.000*	

***significant at 0.05 level, F** $_{(2, 57)}$ =3.15.* ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-29 analysis of variance (One-way ANOVA) was computed on **post test mean** of three groups, the observed 'F' value of Heart Rate after completion of Seven Minutes of Exercise is 34.772 which was statistically significant at 0.05 level as it is greater than table value of ***3.15***.

To determine the exact location where the differences occur among three groups for Heart Rate after completion of Seven Minutes of exercise Post- Hoc test (LSD test) was used. Among the three paired of MD between the CCT & ICT, ICT & CG and CG & CCT were found statistically significant, since MD of 2.700, 3.300 & 6.000 were higher than CD (1.44) at 0.05 level. The MD also presented in graphical structure in figure no. 23.

Fig.23. Graphical representation of mean difference among three groups of post test on Heart Rate after completion of Seven Minutes of exercise.



4.4.1.e. HEART RATE AFTER COMPLETION OF FIFTEEN MINUTES OF EXERCISE

After the completion of stepping exercise (Harvard step test) during recovery period they were taken complete rest in sitting position for absolute fifteen minutes and also students were under observations. At last after fifteen minutes of complete rest heart rate was measured. The details of the test procedure are discussed in chapter III and test has been used before and after the training. The results are shown here.

Table: 30. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on HR after completion of fifteen minutes of exercise.

Parameter	Groups	N	df	Pre-test			Post-test			't' Value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
HR after completion of fifteen minutes of exercise	ICT	20	19	90.10	2.19	.491	86.00	2.57	.575	12.36*
	CCT	20	19	89.25	2.73	.610	84.70	2.61	.585	15.94*
	CG	20	19	89.30	2.22	.497	89.60	2.32	.520	.972

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no.30 that the mean and standard deviation (Mean ± SD) values of Heart Rate after completion of fifteen minutes of exercise on **pre-test and post test** of three (ICT, CCT & CG) groups were 90.10 ± 2.19 , 89.25 ± 2.73, 89.30 ± 2.22 and 86.00 ± 2.57, 84.70 ± 2.61, 89.60 ± 2.32 respectively. The result also presented in graphical structure in figure no. 24. It was understandable that a distinct difference appeared in the mean value between the **pre-test and post-test** of CCT and ICT groups which apparently reflected in the t- value but not significant difference observed on control group (CG). In table no. 30 showed that the t- values of three (ICT, CCT & CG) groups were 12.36, 15.94 and .97. t-value of interval circuit training (ICT) group and continuous circuit training (CCT) group was statistically significant at 0.05 level since the table value 2.093 for the df 19 which was lower than the obtained value. Wherein t- value (.972) of Control Group (CG) was statistically not significant at 0.05 level since the table value was greater than the obtained value.

Fig.24. Graphical representation among the Mean and SD of three groups of pre test and post test on Heart rate after completion of fifteen minutes of Exercise.

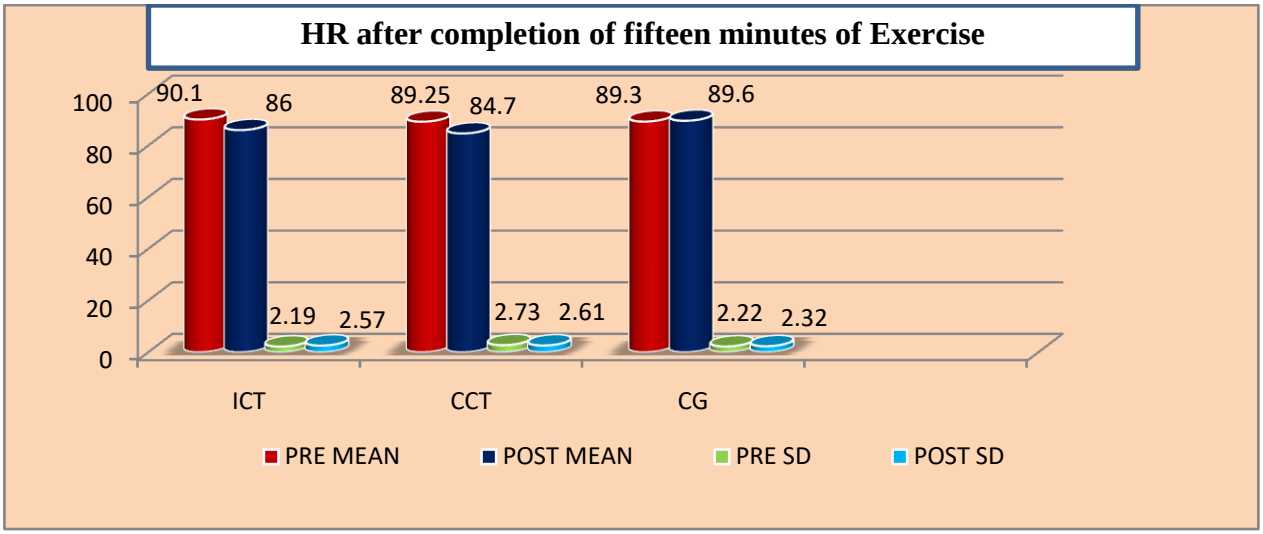


Table: 31. Inferential statistics with 'ANOVA' and critical difference on HR after completion of fifteen minutes of Exercise of interval circuit training, continuous circuit training & control group on post test score.

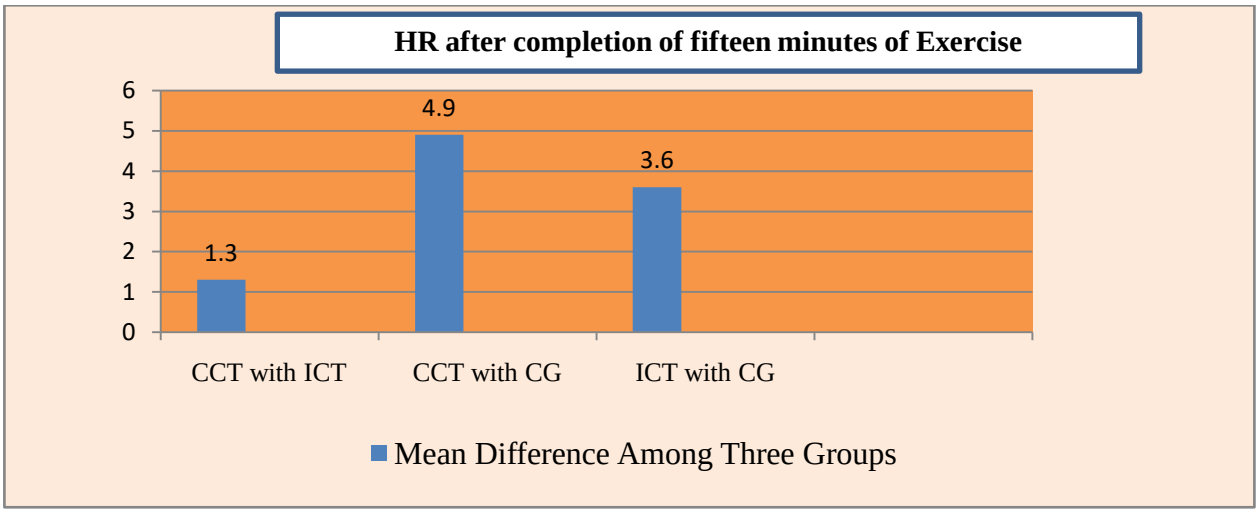
Parameter	Source of Variation	df	F - value	Sig	Intra group	MD	CD
HR after completion of fifteen minutes of Exercise	Between group	2	20.461*	.000	**CCT – ICT**	1.300	1.58
	Within group	57			**ICT – CG**	3.600*	
					CG – CCT	4.900*	

***significant at 0.05 level, F** $_{(2, 57)}$ =3.15.* ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-31 analysis of variance (One-way ANOVA) was computed on **post test mean** of three groups, the observed 'F' value of HR after completion of fifteen minutes of exercise is 20.461 which was statistically significant at 0.05 level as it is greater than table value of ***3.15***.

To determine the exact location where the differences occur among three groups for HR after completion of fifteen minutes of exercise Post- Hoc test (LSD test) was used. Among the three paired of MD between the ICT & CG and CG & CCT was found statistically significant, since MD of 3.600 and 4.900 were higher than CD (1.58) at 0.05 level. Whereas MD was found not significant in case of CCT with ICT groups at 0.05 level of confidence. The mean differences also presented in graphical structure in figure no. 25.

Fig.25. Graphical representation of mean difference among three groups of post test on HR after completion of fifteen minutes of Exercise



Discussion on Heart rate:

Heart rate was measured on five phases to observe the effects of training on heart rate of 13 to 16 years students. Heart rate was measured during resting period, before on set of activity, immediate after activity, after completion of 7 minutes of exercise and after 15 minutes of exercise. Harvard step test was selected as an activity or exercise. After the 12 weeks training decreased the Heart rate after the implication of specified continuous and interval circuit training programme on different (five) states but Control group students' heart rate was more or less same as before. In comparison on five different phases among three groups were significant. In respect of resting heart rate after 12 weeks of training CCT was better than ICT which is significant whereas both of training groups was better than CG which also was significant in Post-Hoc Test. In respect of heart rate before exercise after completion of 12 weeks of training observed the changes same as resting heart rate. In respect of heart rate after immediate exercise after 12 weeks of training CCT and ICT was better than CG which was significant whereas CCT with ICT was not significant in Post-Hoc Test. After 12 weeks of training in respect of heart rate after completion of seven minutes of activity changes observed same as resting heart rate. After 12 weeks of training in respect of heart rate after completion of fifteen minutes of activity CCT and ICT was better than CG which was significant whereas CCT with ICT was not significant in Post-Hoc Test.

Fig.26. Pre test mean of CCT, ICT & CG on heart rate for four phases.

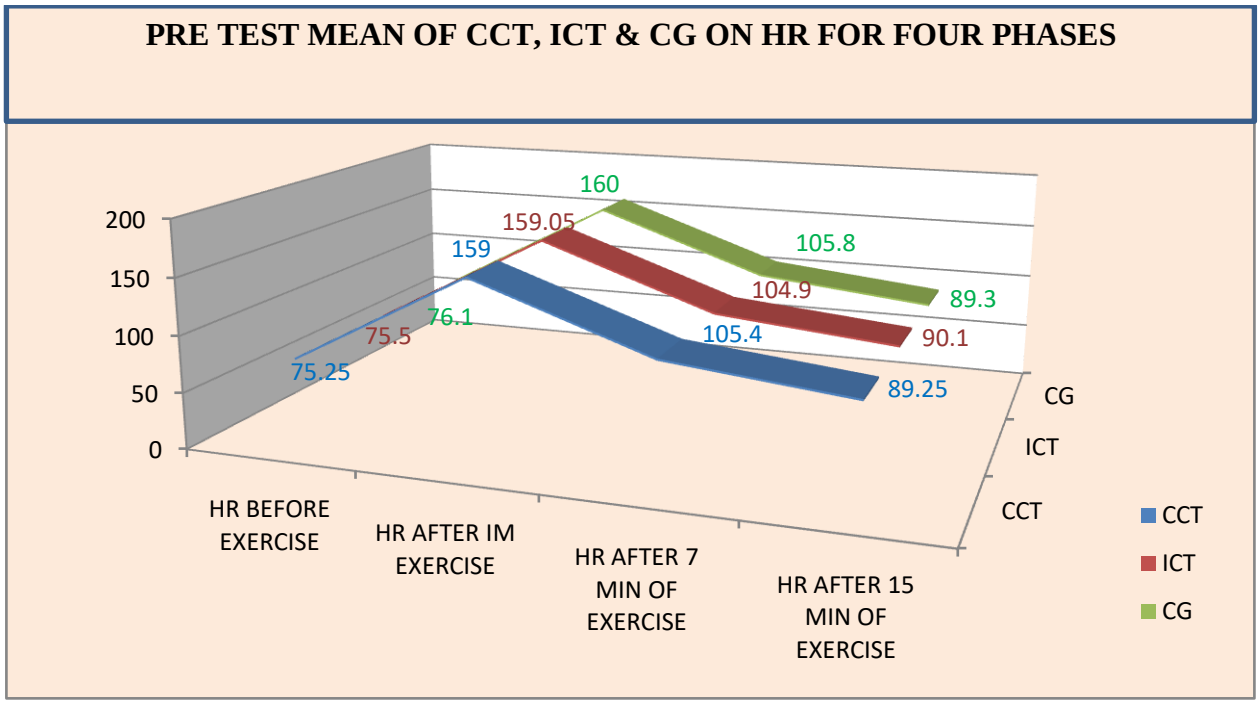
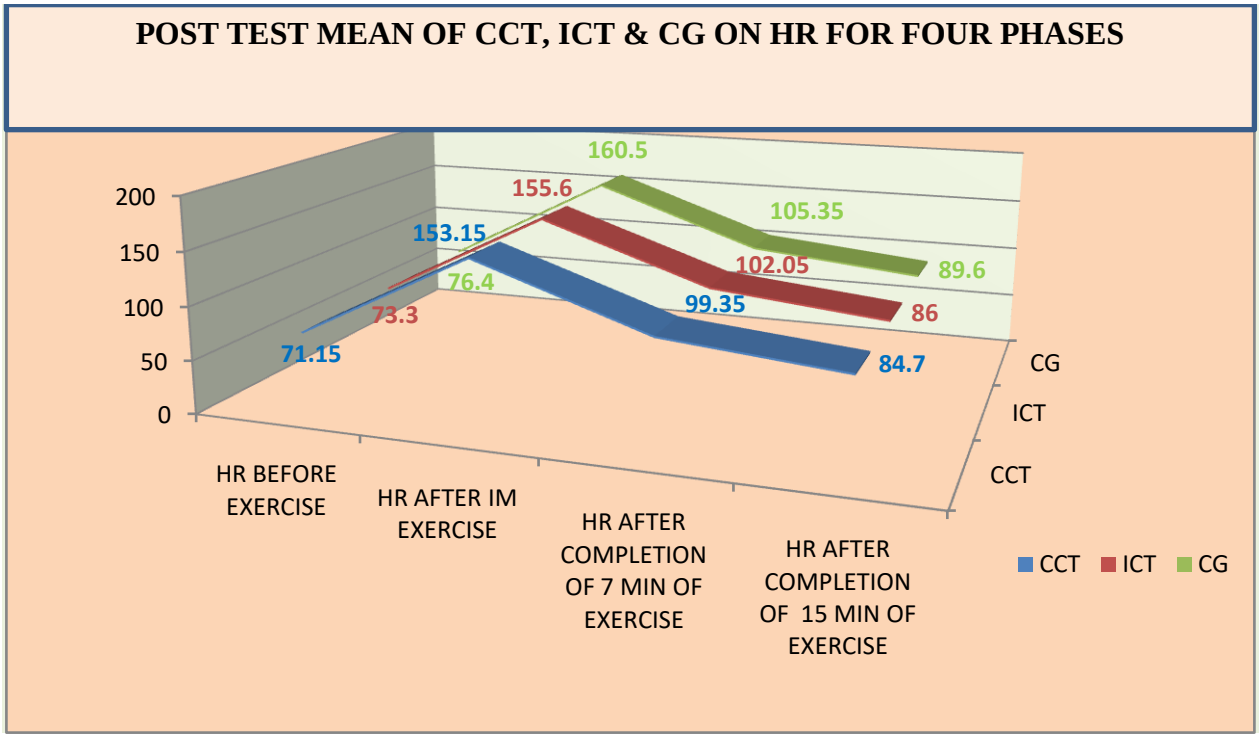


Fig. 27. Post test mean of CCT, ICT & CG on heart rate for four phases



In fact, recording of resting heart rate can be used as an indirect measure of cardiac stroke volume as well as a useful fitness test (Das, 1995). Heart rate variability may observe on those who are under physical training or sports performer. Highly trained athletes resting HR may be as low as 45 bpm (Bramwell & Ellis,1929). Shoenfeld & Kren (1981) found lowest heart rate among marathon runners. Banerjee (1987) found mean resting HR of 60.16 bpm among sate level football payers. Also Malhotra (1973) found resting heart rate between 54 & 60 beats per minute among track and field athletes. Das (1995) stated that the most simple and widely used method of assessing the circulatory functional capability was to measure of the HR at rest, during and after a typical exercise test, on the basis of the response of heart rate the circulatory capacity could then be assessed. In present study accordingly heart rate was recorded at resting condition, after immediate complete of exercise and during recovery period. The majority of research (Khan et al. 2019; Adling and Bangar, 2016; Miller, 2014; Akilan, 2013) shows that exercise causes a considerable decrease in resting heart rates, which is consistent with the results of the current study. However, a small number of studies have found no evidence of a significant drop in pulse rate in response to exercise (Patil, 2012 & Alpert, 1974). After the analysis of result present study observed CCT & ICT both have positive effects to reduction of heart rate but CCT group was slightly better improvement then ICT and CG in the situation of resting period, before Exercise, after immediate complete of Exercise, and after fifteen minutes completes of Exercise. Khan et al, (2019) showed a conclusion on 6 weeks of training intervention for three days per weeks where the reduction of heart rate can be achieved through both Continuous and Interval training. But Daxin Li, (2021) & Khan et al, (2019) were concluded that interval training works better than continuous training at lowering resting heart rate.

Control group was delayed to recover towards normal condition than CCT and ICT groups. Where is in view of total five phases of post test heart rate was higher than training groups. Badami (2012) concluded the pulse rates in resting period, during maximal exercise, and after finishing the Astrand-Ryhming Step Test (ARST) and 5 minutes after ARST physical education students showed considerably lower pulse rates. Students in Physical Education had a higher percentage of heart rate of recovery at five minutes after ARST than students in Medical Education. It also supports the current study's findings. Buchheit et al. (2006), who found that trained men's pulse rates recovered from exercise more quickly. On the other hand comparison between ICT & CG, where ICT group has better improvement in the view of five testing phase

on heart rate. According to previous discussion it is evident that ICT also have positive influence to decrease of heart rate in different phases.

Therefore the observation of the present research investigations findings are closely related with other studies. Analysis the result of the study and the other investigators establishment of the research findings concluded that both types of circuit training programme have positive influence on HR in resting or during recovery period. Training with continuous circuits is superior to training with intervals. Present findings are in consonance with the other researchers, stated above.

4.4.2 BLOOD LACTIC ACID

The body produces lactic acid as a bi-product when glucose is broken down through the process of glycolysis to generate adenosine triphosphate without the presence of oxygen. A metabolic path way of producing energy is basically a chain of chemical responses in the metabolic pathways of glycolysis, breaks down glucose molecules into pyruvate. As stated by Goodwin et al. (2007), when measuring parameters for clinical exercise testing and athlete performance testing, one of the most common ones is blood lactate concentration. It can also be a "normal" physiological reaction to physical exertion. After 30 to 120 seconds of maximal work, peak values of 15 to 25 mm/l can be seen 3 to 8 minutes after exercise. Cardio respiratory efficiency is highly depend upon the amount of lactic acid produces as a result of intense exercise and level of BLA act as an inevitable index of the study. This blood lactic acid also indicated the anaerobic capacity of an individual and in study by measuring these parameters an attempt has been made to assess the metabolic adaptation to different methods of training. Roy et.al, (2014) found that an eight-week program of intensive interval training was beneficial in raising the anaerobic threshold level in the physiological system. This increase in threshold level has a positive effect on sports performance. Researcher observed many related research study where investigators have reported collection of blood samples for lactate analysis between 3 and 5 min after activity (Keskinen et al., 2007; Sawka et al., 1979; McMaster et al., 1989 & Vescovi et al., 2011). While Bonifazi et al., (2000) Peak blood lactic acid was recorded 6–7 minutes following competitive events, which gave the researcher confidence that the blood sample collection time was suitable for observing a rise in BLA following stepping exercise. For present

study Harvard step test as exercise was used. BLA was measured before on set of exercise (Harvard step test), immediate after exercise (HST), after completion of 7 minutes of exercise (HST) and 15 minutes of exercise (HST). The details of the measurement techniques have been discuss in this chapter III and results are presented bellow.

4.4.2. a BLOOD LACTIC ACID BEFORE EXERCISE

In present study the training schedule adopted specified circuit training program with progressive increment of load in order to increase blood lactic acid tolerance. To measure the blood lactic acid Harvard step test was precisely conducted as a Physical activity and blood lactic acid was measured just before the starting of Harvard step test. The details of the test procedure are discussed in chapter III and test has been used before and after the training programs. The results are shown here.

Table: 32. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on BLA before Exercise.

Parameter	Groups	N	df	Pre-test			Post-test			t- Value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
BLA before Exercise	ICT	20	19	1.78	.29	.0658	1.59	.29	.0656	7.32*
	CCT	20	19	1.75	.25	.0559	1.49	.24	.5568	5.98*
	CG	20	19	1.78	.30	.067	1.76	.30	.068	.54

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no.32 that the mean and standard deviation (Mean ± SD) values of BLA before exercise on **pre-test and post test** of three (ICT, CCT & CG) groups were 1.78 ± .29, 1.75 ± .25, 1.78 ± .303 and 1.59 ± .29, 1.49 ± .24, 1.76 ± .30 respectively. The result also presented in graphical structure in figure no. 28. It was understandable that a distinct difference appeared in the mean value between the **pre-test and post-test** of CCT and ICT groups which apparently reflected in the t- value but not significant difference observed on control group (CG). In table no. 32 showed that the t- values of three (ICT, CCT & CG) groups were 7.32, 5.98 and .54. t-value of interval circuit training (ICT) group and continuous circuit training (CCT) group was statistically significant at 0.05 level since the table value 2.093 for the df 19 which was

lower than the obtained value. Wherein t- value (.54) of control group (CG) was statistically not significant at 0.05 level since the table value was greater than the obtained value.

Fig.28. Graphical representation among the Mean and SD of three groups of pre test and post test on BLA before Exercise.

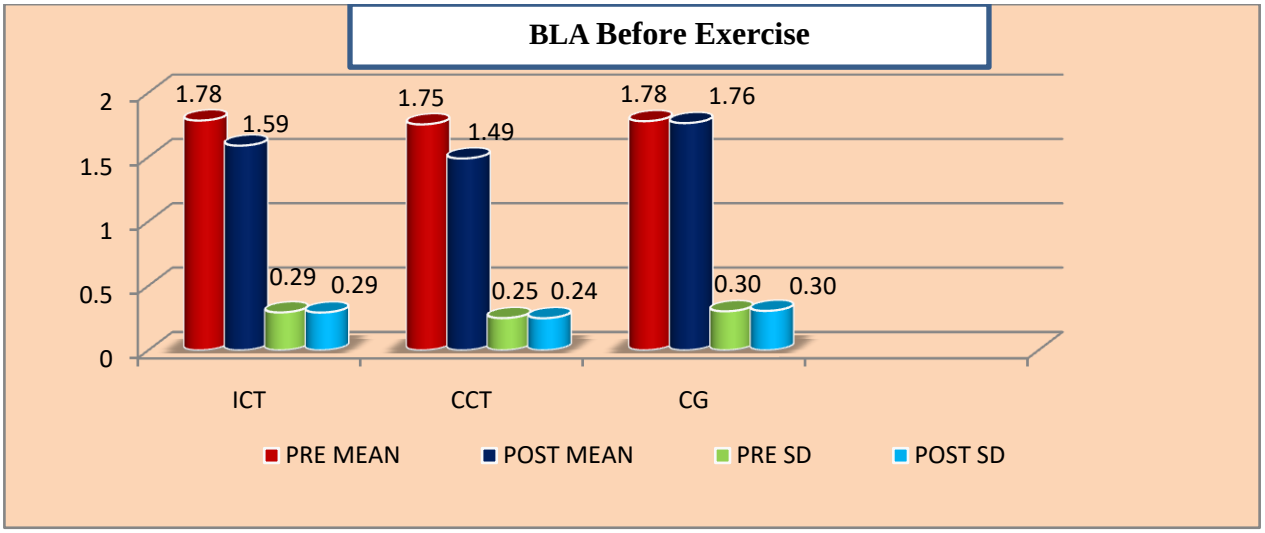


Table: 33. Inferential statistics with 'ANOVA' and critical difference on BLA before Exercise of interval circuit training, continuous circuit training & control group on post test score.

Parameter	Source of Variation	df	F - value	Sig	Intra group	MD	CD
BLA before Exercise	Between group	2	4.80*	.252	**CCT – ICT**	0.100	0.180
	Within group	57			**ICT – CG**	0.175	
					CG – CCT	.275*	

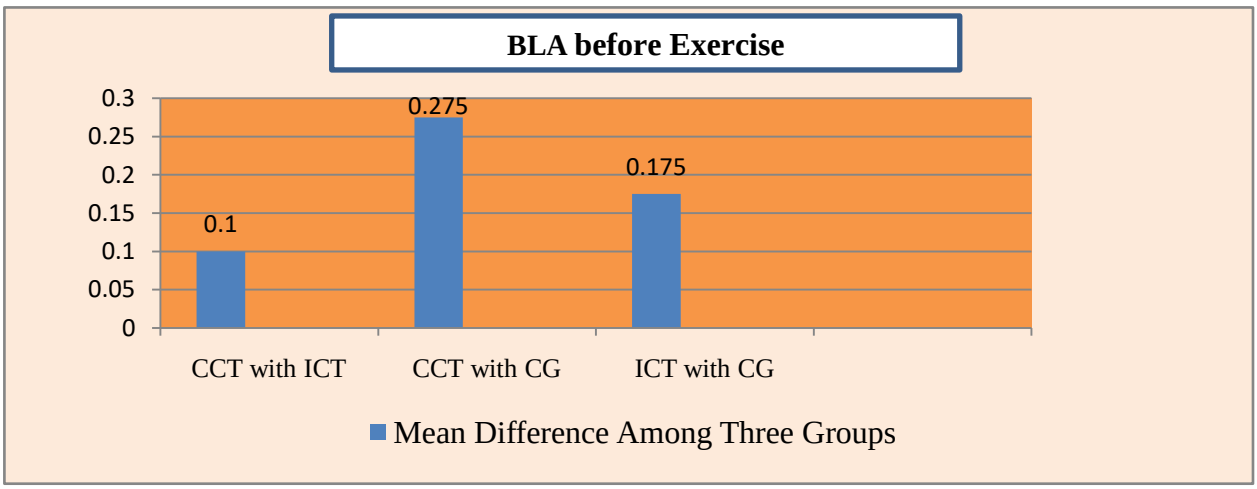
***significant at 0.05 level, F** $_{(2, 57)}$ =3.15.* ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-33 analysis of variance (One-way ANOVA) was computed on **post test mean** of three groups, the observed 'F' value of BLA before exercise is 4.80 which was statistically significant at 0.05 level as it is greater than table value of ***3.15.***

To determine the exact location where the differences occur among three groups for BLA before exercise Post- Hoc test (LSD test) was used. Among the three mean differences between the CCT & CG were found statistically significant, since MD of .275 was higher than CD (0.180) at

0.05 level. Whereas MD was found not significant in case of ICT with CCT and CG with ICT groups at 0.05 level of confidence. The MD also presented in graphical structure in figure no. 29.

Fig.29. Graphical representation of mean difference among three groups of post test on BLA before Exercise



4.4.2.b BLOOD LACTIC ACID AFTER IMMEDIATE OF EXERCISE

In present study the training schedule adopted specified circuit training program with progressive increment of load to improve blood lactic acid tolerance capacity. For measure the lactic acid Harvard step test was precisely conducted as a Physical activity and blood lactic acid was measured just after immediate activity of Harvard step test. The details of the test procedure are discussed in chapter III and test has been used before and after the training. The results are shown here.

Table: 34. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on BLA after immediate of Exercise.

Parameter	Groups	N	df	Pre-test			Post-test			t- Value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
BLA after immediate of Exercise	ICT	20	19	9.80	1.32	.296	8.45	1.24	.279	9.00*
	CCT	20	19	9.75	1.46	.327	8.11	1.23	.275	7.58*
	CG	20	19	9.94	.76	.171	9.95	.76	.170	.073

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no.34 that the mean and standard deviation (Mean ± SD) values of BLA after immediate of exercise on **pre-test and post test** of three (ICT, CCT & CG) groups were 9.80 ± 1.32, 9.75 ± 1.46, 9.94 ± .76 and 8.45 ± 1.24, 8.11 ± 1.23, 9.95 ± .76 respectively. The result also presented in graphical structure in figure no. 30. It was understandable that a distinct difference appeared in the mean value between the **pre-test and post-test** of ICT and CCT groups which apparently reflected in the t- value but not significant difference observed on control group (CG). In table no. 34 showed that the t- values of three experimental (ICT, CCT & CG) groups were 9.00, 7.58 and .073. t-value of interval circuit training (ICT) group and continuous circuit training (CCT) group was statistically significant at 0.05 level since the table value 2.093 for the df 19 which was lower than the obtained value. Wherein t- value (.073) of Control Group (CG) was statistically not significant at 0.05 level since the table value was higher than the obtained value.

Fig.30. Graphical representation among the Mean and SD of three groups of pre test and post test on BLA after immediate of Exercise

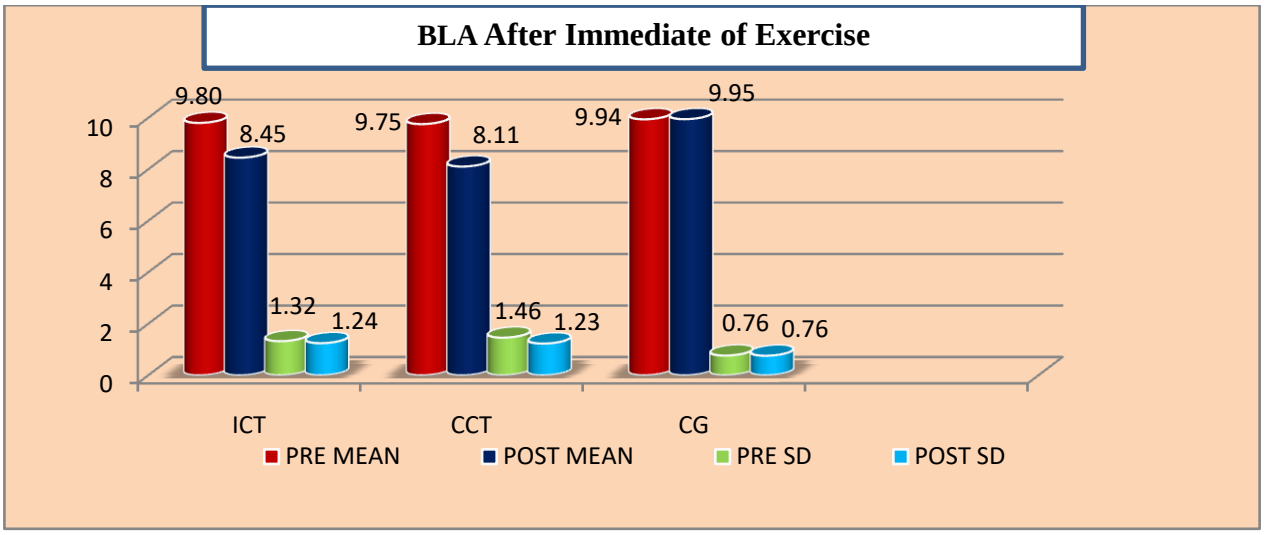


Table: 35. Inferential statistics with 'ANOVA' and critical difference on BLA After immediate of exercise of interval circuit training, continuous circuit training & control group on post test score.

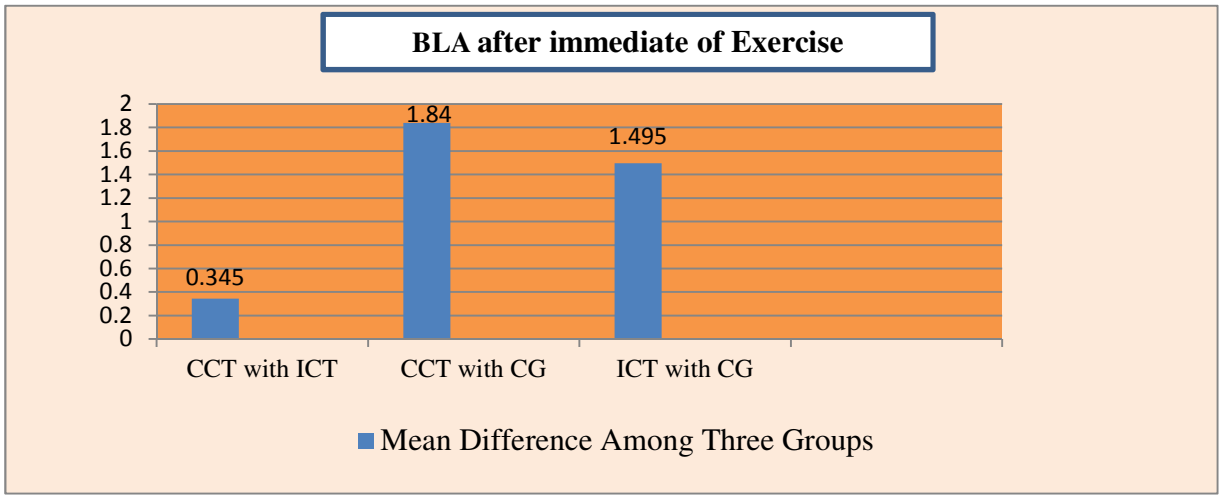
Parameter	Source of Variation	df	F - value	Sig	Intra group	MD	CD
BLA After immediate of Exercise	Between group	2	15.701*	.002	**CCT – ICT**	0.345	.698
	Within group	57			**ICT – CG**	1.495*	
					CG – CCT	1.840*	

***significant at 0.05 level, F** $_{(2, 57)}$ =3.15.* ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-35 analysis of variance (One-way ANOVA) was computed on **post test mean** of three groups, the observed 'F' value of BLA after immediate of exercise is 15.701 which was statistically significant at 0.05 level as it is greater than table value of ***3.15.***

To determine the exact location where the differences occur among three groups for BLA after immediate of exercise Post- Hoc test (LSD test) was used. Among the three mean differences between the ICT & CG and CCT & CG were found statistically significant, since MD of 1.495 and 1.840 were higher than CD (0.698) whereas mean difference was found not significant in case of CCT with ICT group at 0.05 level of confidence. The MD also presented in graphical structure in figure no. 31.

Fig.31. Graphical representation of mean difference among three groups of post test on BLA after immediate of Exercise



4.4.2. c LACTIC ACID AFTER COMPLETION OF SEVEN MINUTES OF EXERCISE

In present study the training schedule adopted specified circuit training program with progressive increment of load to improve lactic acid tolerance capacity. For measure the lactic acid Harvard step test was precisely conducted as a Physical activity and lactic acid was measured after seven minutes of activity. The details of the test procedure are discussed in chapter III and test has been used before and after the training. The results are shown here.

Table: 36. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on BLA after completion of seven minutes of exercise.

Parameter	Groups	N	df	Pre-test			Post-test			t- Value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
BLA after completion of seven minutes of Exercise	ICT	20	19	8.79	1.06	.237	7.51	1.18	.264	9.31*
	CCT	20	19	9.00	.90	.201	7.04	1.03	.231	10.48*
	CG	20	19	9.09	.65	.145	9.19	.67	.150	2.23*

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no.36 that the mean and standard deviation (Mean ± SD) values of BLA after completion of seven minutes of exercise on **pre-test and post test** of three (ICT, CCT & CG) groups were 8.79 ± 1.06, 9.00 ± .90, 9.09 ± .65 and 7.51 ± 1.18, 7.04 ± 1.03, 9.19 ± .675 respectively. The result also presented in graphical structure in figure no. 32. It was understandable that a distinct difference appeared in the mean value between the **pre-test and post-test** of ICT, CCT & CG groups which apparently reflected in the t- value. In table no. 36 showed that the t- values of three (ICT, CCT & CG) groups were 9.31, 10.48 and 2.23. t-value of three (ICT, CCT & CG) groups were statistically significant at 0.05 level, since the table value 2.093 for the df 19 which was lower than the obtained value.

Fig.32. Graphical representation among the Mean and SD of three groups of pre test and post test on BLA after completion of seven minutes of exercise

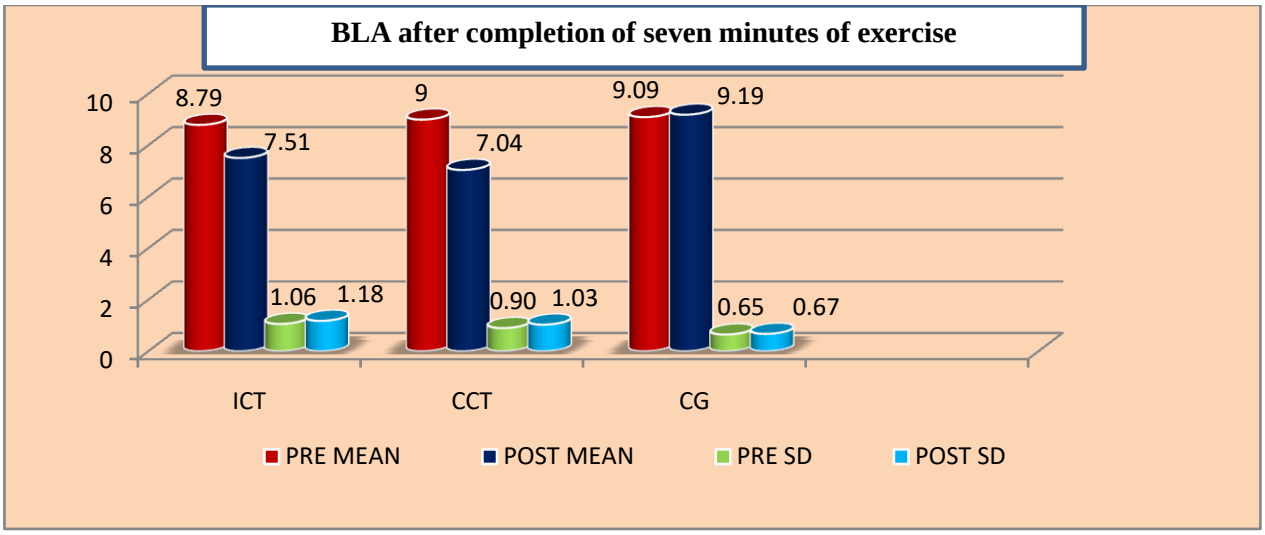


Table: 37. Inferential statistics with 'ANOVA' and critical difference on BLA after completion of seven minutes of exercise of interval circuit training, continuous circuit training & control group on post test score.

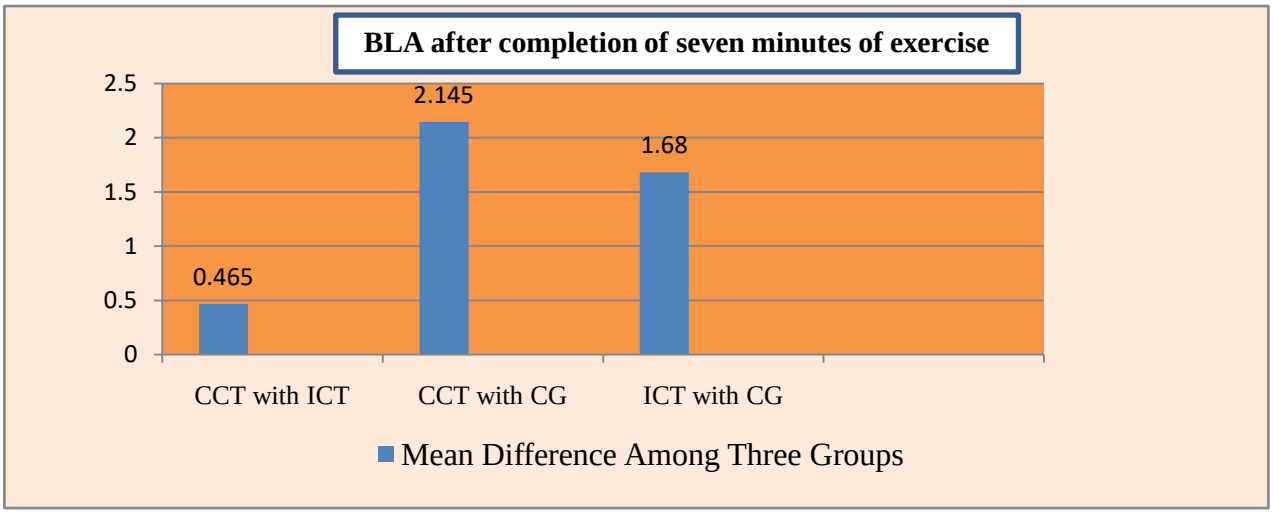
Parameter	Source of Variation	df	F - value	Sig	Intra group	MD	CD
BLA after completion of seven minutes of exercise	Between group	2	26.132*	.005	**CCT – ICT**	0.465	.624
	Within group	57			**ICT – CG**	1.680*	
					CG – CCT	2.145*	

significant at 0.05 level, $F_{(2, 57)} = 3.15$. ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-37 analysis of variance (One-way ANOVA) was computed on **post test mean** of three groups, the observed 'F' value of BLA after completion of seven minutes of exercise is 26.132 which was statistically significant at 0.05 level as it is greater than table value of ***3.15.***

To determine the exact location where the differences occur among three groups for BLA after completion of seven minutes of exercise Post- Hoc test (LSD test) was used. Among the three paired mean difference between the ICT & CG and CG & CCT were found statistically significant, since MD of 1.680 and 2.145 were higher than CD (0.624) at 0.05 level. Whereas MD was found not significant in case of CCT with ICT group at 0.05 level of confidence. The MD also presented in graphical structure in figure no. 33.

Fig.33. Graphical representation of mean difference among three groups of post test on BLA after completion of seven minutes of exercise



4.4.2.d BLOOD LACTIC ACID AFTER COMPLETION OF FIFTEEN MINUTES OF EXERCISE

In present study the training schedule adopted specified circuit training program with progressive increment of load to improve blood lactic acid tolerance capacity. For measure the lactic acid Harvard step test was precisely conducted as a Physical activity and lactic acid was measured after fifteen minutes of exercise. The details of the test procedure are discussed in chapter III and test has been used before and after the training. The results are shown here.

Table: 38. Pre test and Post test Mean, SD and t-values of interval circuit training, continuous circuit training & control group on BLA after completion of fifteen minutes of Exercise.

Parameter	Groups	N	df	Pre-test			Post-test			t- Value
				Mean	SD	Std-Error mean	Mean	SD	Std-Error mean	
BLA after completion of fifteen minutes of Exercise	ICT	20	19	7.84	1.03	.232	6.55	1.07	.239	6.39*
	CCT	20	19	8.00	.89	.200	6.30	.81	.183	10.05*
	CG	20	19	8.09	.61	.137	8.11	.65	.147	.18

Significant at 0.05 level (Table value 2.093, df-19). ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

It appears from the table no.38 that the mean and standard deviation (Mean ± SD) values of BLA after completion of fifteen minutes of exercise on **pre-test and post test** of three (ICT, CCT & CG) groups were 7.84 ± 1.03, 8.00 ± .89, 8.09 ± .61 and 6.55 ± 1.07, 6.30 ± .81, 8.11 ± .65 respectively. The result also presented in graphical structure in figure no. 34. It was understandable that a distinct difference appeared in the mean value between the **pre-test and post-test** of ICT and CCT groups which apparently reflected in the t- value but not significant difference observed on control group (CG). In table no. 38 showed that the t- values of three (ICT, CCT & CG) groups were 6.39, 10.05 and .18. t- value of interval circuit training group (ICT) and continuous circuit training (CCT) groups were statistically significant at 0.05 level since the table value 2.093 for the df 19 which was lower than the obtained value. Wherein t-value (.184) of Control Group (CG) was statistically not significant at 0.05 level since the table value was greater than the obtained value.

Fig.34. Graphical representation among the Mean and SD of three groups of pre test and post test on BLA after completion of fifteen minutes of Exercise

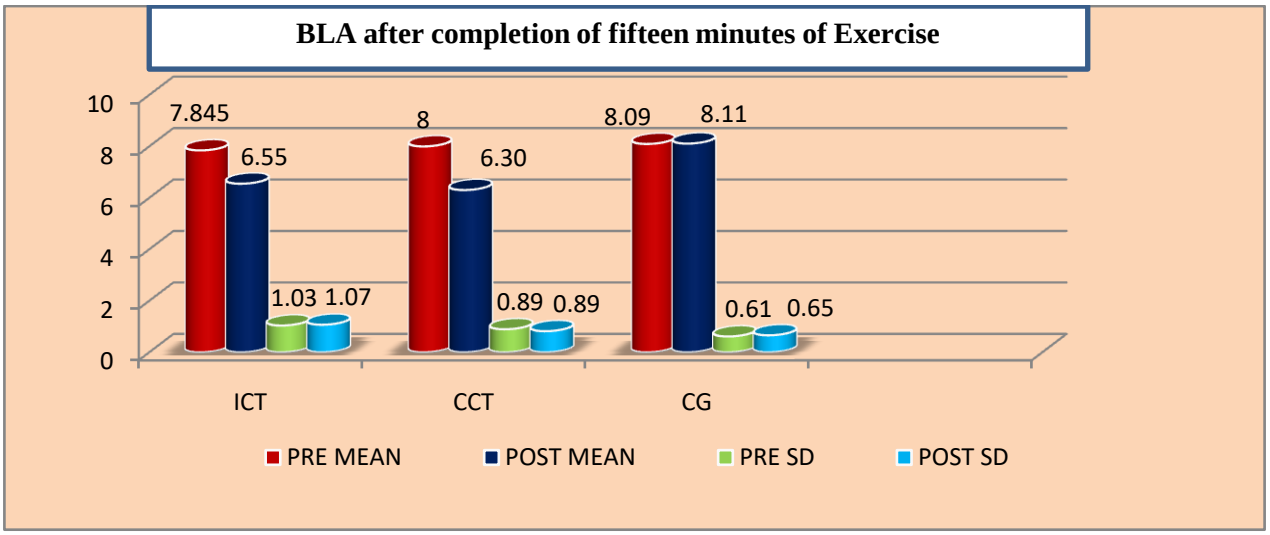


Table: 39. Inferential statistics with 'ANOVA' and critical difference on BLA after completion of fifteen minutes of Exercise of interval circuit training, continuous circuit training & control group on post test score.

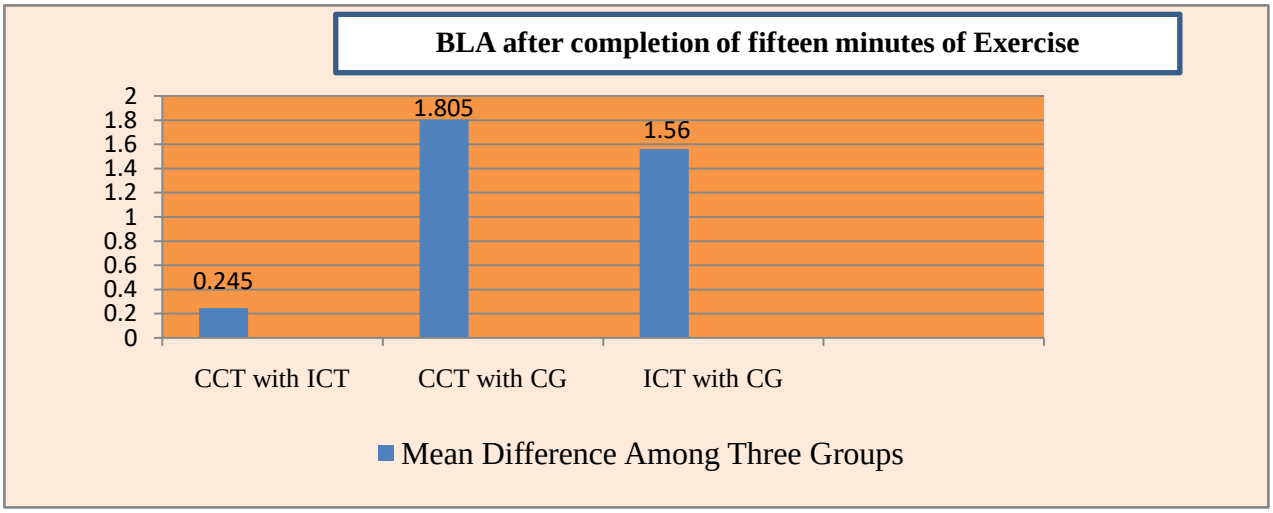
Parameter	Source of Variation	df	F - value	Sig	Intra group	MD	CD
BLA after completion of fifteen minutes of Exercise	Between group	2	25.54*	.000	**CCT – ICT**	0.245*	.173
	Within group	57			**ICT – CG**	1.560*	
					CG – CCT	1.805*	

***significant at 0.05 level, F** $_{(2, 57)}$ =3.15.* ICT= Interval Circuit Training group, CCT= Continuous Circuit Training group, CG= Control group.

In table-39 analysis of variance (One-way ANOVA) was computed on **post test mean** of three groups, the observed 'F' value of BLA after completion of fifteen minutes of exercise is 25.546 which was statistically significant at 0.05 level as it is greater than table value of ***3.15.***

To determine the exact location of difference among three groups for BLA after completion of fifteen minutes of exercise Post- Hoc test (LSD test) was used. Among the three paired of MD between the CCT & ICT, ICT & CG and CG & CCT were found statistically significant, since MD of 0.245, 1.560 & 1.805 were higher than CD (0.624) at 0.05 level. The MD also presented in graphical structure in figure no. 35.

Fig.35. Graphical representation of mean difference among three groups of post test on BLA after completion of fifteen minutes of Exercise



Discussion on Blood Lactic Acid:

BLA was measured on four phases to observe how training affects on lactic acid concentration for 13 to 16 years students. BLA was measured before on-set of exercise, immediate after exercise, after completion of 7 minutes of exercise and after completion of 15 minutes of exercise. Most other researchers have noted that blood samples are collected for lactate analysis between three and five minutes following physical activity (Sawkaet et al., 1979; McMaster et al., 1989; Keskinen et al., 2007 & Vescovi et al., 2011), while Bonifazi et al., (2000) were confident that the blood sample collection time was appropriate to observe an increase in BLA after stepping exercise, as observed peak blood lactic acid around 6-7 minutes after competitive events. For this study researcher was selected Harvard step test as an activity. Similarly Chaloupk (1973) observed the effects of interval training programme on different physiological condition and measured the lactic acid after bench stepping for his research investigation.

Normally after completion of long physical activity muscles goes under fatigue. This research study showed that after complete of Harvard step test all the three groups goes under fatigue because of the buildup of lactic acid in the muscles. Similarly other researchers (Astrand, 1960; & Karlsson & Saltin, 1971) have also shown a slightly higher accumulation of lactic acid during the initial part of the recovery following exhaustion exercise. Research has shown that

completing light exercise instead of resting during the recovery phase can accelerate the removal of LA from blood and muscles after intense to maximal exercise (Belcastro & Bonen, 1975; Hermansen & stensvold, 1972 & Dodd et al., 1984). Physical training can enhance the endurance ability as well as lactic acid tolerance capacity. The performance of young endurance athletes in long-distance running has a positive relationship with their lactic acid tolerance (Kumagai, 1982). Roy et al., (2014) concluded that an eight-week training program has a beneficial effect on the physiological system; For example, improved sports performance is associated with a higher anaerobic threshold level. This research study conducted specified circuit training programme for 12 weeks and 3 days per week. It was conducted to observe the effects of different types of circuit training programme on accumulation of lactic acid in muscles.

After the 12 weeks training decreased the amount of lactic acid after the implication of specified continuous and interval circuit training programme on different (four) states but Control group students' bold lactic acid amount was increase on post test score respectively for each phases. In comparison on four different phases among three groups were significant. In respect of blood lactic acid before exercise after 12 weeks of training CCT was better than ICT but not significant whereas, both of training groups were better than CG where CCT was significantly better than CG in Post-Hoc Test. In respect of blood lactic acid after immediate exercise CCT and ICT was better than CG which is significant whereas CCT with ICT was not significant in Post-Hoc Test. whereas blood lactic acid after seven minutes of exercise have observed changes same as after immediate of activity. At the last phase of lactic acid collection where after fifteen minutes of activity CCT and ICT was better than CG and are significant whereas CCT was better than ICT which was also significant in Post-Hoc Test.

In general a small amount of lactate production occurs during the resting period, suggesting that lactate removal is also necessary to prevent lactate accumulation during rest. The heart, liver, and kidneys' uptake of lactate as metabolic fuel is an important way of lactate removal (Brooks, 1985). In this investigation measured the amount of lactic acid just before of activity at resting position on setting posture where few amount of lactic acid shown for three different groups. According to Fox & Mathews, (1981) that training causes a decrease in the accumulation of lactic acid during a given sub maximal exercise. On the other side Accumulation of Lactic acid depends on intensity and volume of exercise. Views of Mc Ardle et

al., (1991) lactic acid becomes greater as exercise become more intense. Here according to students' maximum capacity training load was calculated and implemented proper intensity and volume of training activity.

Previously discussed present investigation followed particular types of interval and continuous circuit training methods and according to result of this study interval and continuous both of circuit training has positive effects on lactic acid concentration. Equally a research study (Roy, Paul & Bandopadhaya, 2014) found that an appropriate extended interval training program improves the anaerobic threshold level and reduced blood lactate accumulation. And also Gökhan et al (2018) concluded about their study the acute lactic acid accumulation increased quickly when high-intensity interval training was used. We can say that this exercise could be an important part of the lactate tolerance training used to counter fatigue in performance athletes. So, physical training has positive effects on lactic acid accumulation because in this study those who were under control group they losses lactic acid tolerance capability than before after experiment of 12 weeks. For control group students' lactic acid amount was increase on post test score respectively for four phases. When comparing the maximal exercise performance with the ventilator anaerobic threshold, Tripathi and Banerjee (1992) showed that the trained group's aerobic status was superior to the untrained groups.

Fig.36. Pre test mean of CCT, ICT & CG on heart rate for four phases.

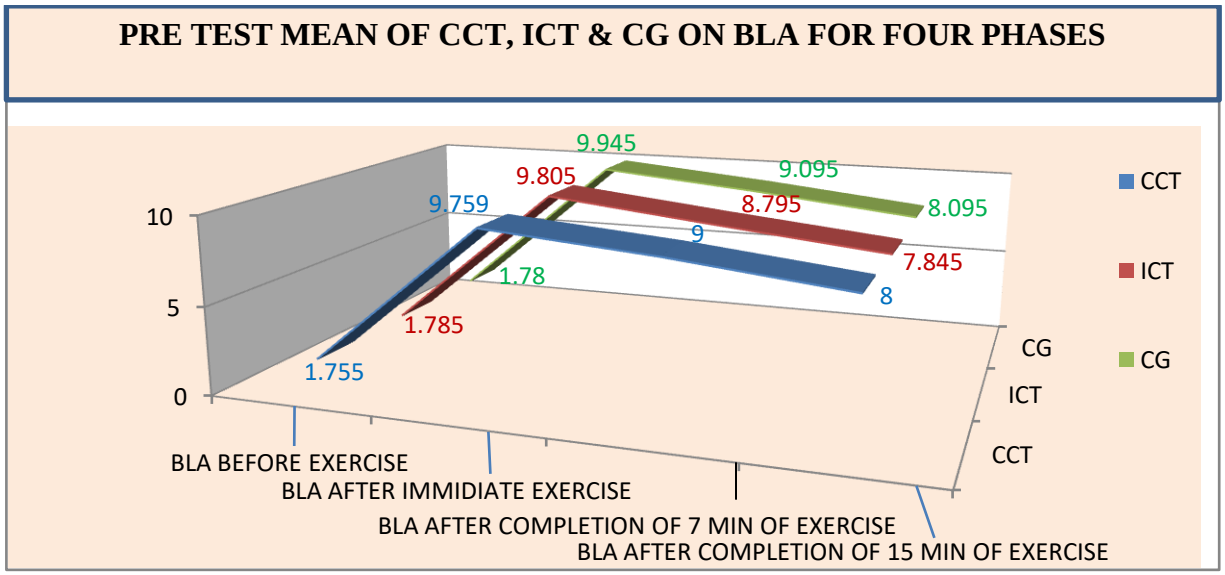
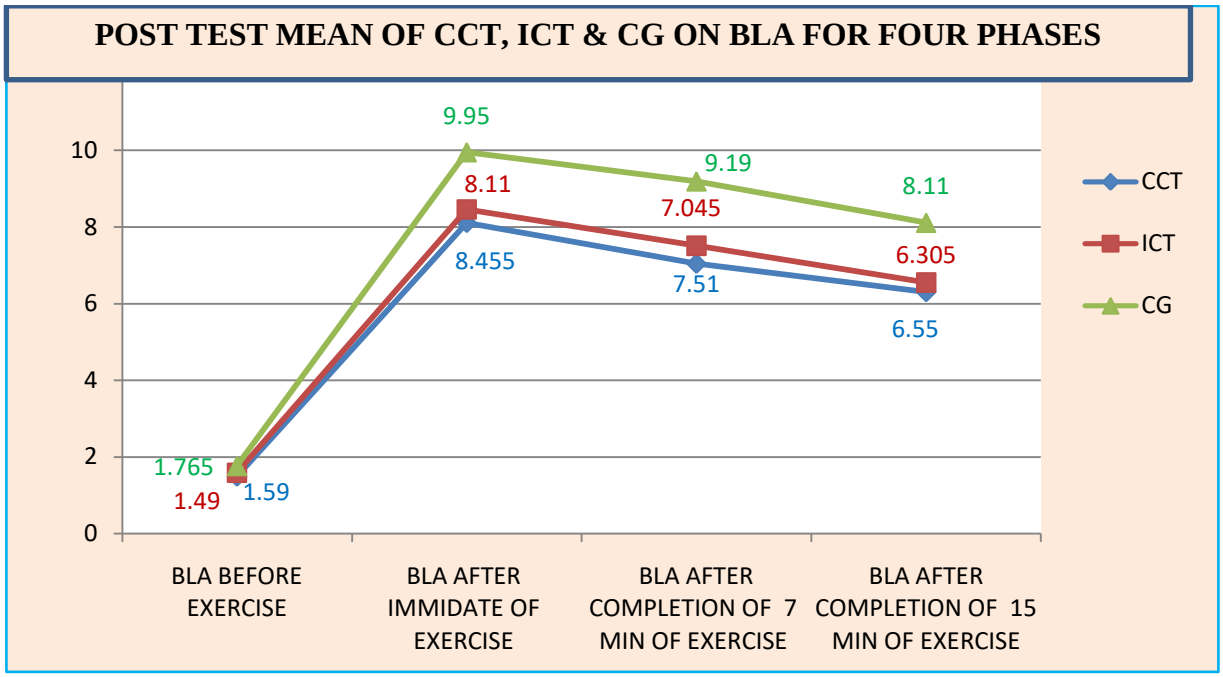


Fig.37. Post test mean of CCT, ICT & CG on heart rate for four phases.



After the observation CCT & ICT both have positive effects to reduction of lactic acid accumulation than pre test score but CG was not improved on lactic acid accumulation than before. Control group was delayed to recover towards normal condition than CCT and ICT groups. Where is in view of total four phases of post test lactic acid amount was higher than training groups. Many investigators have reported similar findings to the current study in the majority of studies (Chaloupka, 1973 Sjodin et al., 1981 İpekoğlu et al, 2018, Goodwin & Harris, 2007) denotes significant reductions about amount of lactic acid concentration and physiological efficiency in response to physical training.

So the observations of the present research investigations findings are closely related with other studies. Analysis the result of the study and the other investigators establishment of the research findings concluded that both types of circuit training programme have positive influence on lactic acid concentration in resting or during recovery period. Continuous circuit training (CCT) method is better than interval circuit training (ICT) method. Present findings are in consonance with the other researchers, stated above.

4.5. TESTING OF HYPOTHESIS

In hypothesis **1** it is expected that there would be no significant influence in any anthropometric variables- BMI, Body-weight, Percentage of body fat, Calf girth, Thigh girth due to interval circuit training.

The findings of the study stated that hypothesis 1 relating to anthropometric variables such as BMI and Body-weight is accepted whereas Percentage of body fat, Calf girth and Thigh girth is rejected.

In hypothesis **2** it is expected that there would be no significant influence in any anthropometric variables- BMI, Body-weight, Percentage of body fat, Calf girth, Thigh girth due to continuous circuit training.

The findings of the study stated that hypothesis 2 relating to anthropometric variables such as BMI and Body-weight is accepted whereas Percentage of body fat, Calf girth and Thigh girth is rejected.

In hypothesis **3** it is expected that there would be no significant difference in anthropometric variables- BMI, Body-weight, Percentage of body fat, Calf girth, Thigh girth among interval circuit training group, continuous circuit training group and control group.

According to the study's findings indicated that no significant difference on anthropometric variables- BMI, Body-weight, Percentage of body fat, Calf girth, Thigh girth among continuous circuit training group, interval circuit training group and control group after experiment. Hence the hypothesis 3 is accepted.

In hypothesis **4** it is expected that there would be no significant influence in any physical fitness variables- Speed, Agility, Flexibility, Leg explosive strength and Cardio respiratory endurance Due to interval circuit training.

According to the study's findings indicated that significant improvement on physical fitness variables- Speed, Agility, Flexibility, Leg explosive strength and Cardio respiratory endurance Due to interval circuit training. Hence the hypothesis 4 is rejected.

In hypothesis **5** it is expected that there would be no significant influence in any physical fitness variables- Speed, Agility, Flexibility, Leg explosive strength, Cardio respiratory endurance due to continuous circuit training.

According to the study's findings stated that significant improvement on physical fitness variables- Speed, Agility, Flexibility, Leg explosive strength and Cardio respiratory endurance Due to continuous circuit training. Hence the hypothesis 5 is rejected.

In hypothesis **6** it is expected that there would be no significant difference in physical fitness variables- Speed, Agility, Flexibility, Leg explosive strength, Cardio respiratory endurance among interval circuit training group, continuous circuit training group and control group.

According to the study's findings indicated that there is significant difference in physical fitness variables- Speed, Agility, Flexibility, Leg explosive strength, Cardio respiratory endurance among continuous circuit training group, interval circuit training group and control group after experiment. Hence the hypothesis 6 is rejected.

In hypothesis **7** it is expected there would be no significant influence in any physiological variables- Heart rate and blood lactic acid concentration due to interval circuit training.

According to the study's findings stated significant influence in physiological variables- Heart rate and blood lactic acid concentration due to interval circuit training. Hence the hypothesis 7 is rejected.

In hypothesis **8** it is expected that there would be no significant influence in any physiological variables- HR and BLA concentration due to continuous circuit training.

According to the study's findings indicated that significant influence in physiological variables- Heart rate and blood lactic acid concentration due to continuous circuit training. Hence the hypothesis 8 is rejected.

In hypothesis **9** it is expected that there would be no significant difference in physiological variables- HR and BLA concentration among interval circuit training group, continuous circuit training group and control group.

The findings of this investigation stated that there is significant difference in physiological variables- HR and BLA concentration among continuous circuit training group, interval circuit training group and control group after experiment. Hence the hypothesis 9 is rejected.

CHAPTER- V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

CHAPTER- V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 SUMMARY

The word ‘Training’ is used as a process of systemic instruction for the purpose of human performance in different fields. In our society there are so many field or spaces which are connected with our life activity, such as education, sports, technology, industry, health, agriculture etc. To get success in every sector there require systematic training for execute accurate skill on their specified demands. Similarly, in the realm of sports, scientific and methodical training ought to be necessary to improve athletic performance. The phrase "sports training" is specifically used in relation to athletics, games, and sports; it may also apply to the training of athletes, coaches or physical education teachers. Generally sports’ training is the well structured systematic and scientific instruction or activity according to demands of individual capability to the development of sports activities. Sports training is a designed and continuous procedure aim to reach at actual destination as a true success by execute of proper skills. Sports’ training is a planned, regulated process that modifies complex sports motor performance, acting ability, and behavior through content, method, and organizational measures in order to achieve a goal. (Klafs & Arnheim, 1981 & Singh, 1991). A complete sportsman is not complete with physical fitness, skill, tactics and technique but need to possess cognitive functions, personality traits, interest, habits, attitude, emotional stability etc. thus, training is required with systematic and scientific variation for the enhancement of above all these components.

Sports’ training is mainly focused on maximum level of performance ability of a sports person in a specified sport. In scientific view of sports training present study adopted deferent types of sports training methods to identify the effects on physical fitness, anthropometrical and physiological components.

Therefore goal of the sports training is to prepare sports personnel or team to ensure peak form and performance in a selected sport competition. A number of factors are responsible for

achieving peak performance with maximum efficiency. Scientifically execute of sports training focuses to reach towards highest efficiency for success.

Each and every area or field it has hold a particular destination which based on own way of principles. Training means planned activity with the help of scientific support for preparation to achieve the goal. Same as in the area of sports activities, principles of the sports training methods are the strong guidance for the trainer, coaches, teachers and sportsmen to formulation, implementation and control of effective sports training programme for athletes or team. After the theoretical analysis about the science of sports training deferent principles were established by many researcher, investigator, educationist etc. (Harre; 1979, Matawejew; 1981, Singh; 1984). From many of principles some selected principles of the sports training are follows- a) Principle of Continuity, b) Principle of progression of Load, c) Principle of Individualization, d) Principle of Balance, e) Principle of Recovery, f) Principle of Specificity, g) Principle of Variation, h) Principle of Planned & Systematic Training, i) Principle of Cyclicity:

Sports performance highly depends on physical, physiological and anthropometrical components of human body. Previously discussed about the concept and how it important for an athletes and general peoples. Physical fitness can be divided into two categories: performance-related fitness and health-related fitness. Muscular strength, muscular endurance, body composition, flexibility, and cardiovascular endurance are all components of health-related physical fitness these all the components are very important for every normal life activity and However, performance related physical fitness is associated with speed, power, coordination, agility, balance, and reaction time basically all the components are very vital for sports performance. To prepare for competition simply need a well structured training programme on basis of individual demand. Many research study fund that scientific sports training methods can improve the physical fitness efficiency (Maniazhagu; 2022, Krishna; 2020, Rani; 2018, Kumar; 2016, Al-Haliq; 2015, Vinayagamoorthi And Sakthivel; 2014, Cregg; 2013, Babu & Kumar; 2013, Meethal and Najeeb; 2013, Reddy; 2012 & Sakthivel 2014).

Physiological components like as heart rate, blood pressure, blood, blood lactic acid etc. these all are the essential to promote sports performance. Internal physiological functions are associated with external body movements. Many research studies established that physical

training may effective to improve physiological potentialities. Holmgren et al. (1960) and Venkateswarlu (1975) while working on young athletes have shown the reduction of pulse rate due to different training methods. Significant positive changes found due to implication of physical training on blood lactate concentration (Hurley et al, 1984; Bandyopdhyay, 1984 & Connet et al., 1985). Yoshida et al. (1982) studied on healthy male college students and found that endurance training decreased blood lactate content during the sub-maximal exercise significantly. On the other side Richardson and Hardman (1989) found a significant relationship between blood lactate concentrations with endurance time.

Research finding of a number study proved that the sports person's anthropometric characteristics are too related with high athletic performances. BMI, Percentage of body fat, Height, Weight, Thigh girth, Calf girth etc. as Anthropometrical components all are essential factor for successful skill execution. Glick and Kaufmann (1976) observed lowering of the body weight due to physical training. Adeniran and Toriola (1988) found a result on some school going boy's significant reduction of percentage of body fat among the trained comparison with untrained students. Alex Stewart (2021) concluded Jump Squat have positive effects on calf girth. Benjamin Clay Dixon (2017) determined the positive relation between the thigh girth ratio and performance in events from 800m-5000m run. Specified training programme can enhance the thigh and calf girth of an athlete's (Saini & Bhardwaj, 2017; Vinu, 2012 & Ashwini, 2017).

The study implicates an interdisciplinary approach since the study encompasses the disciplines of sports training, exercise physiology and Kinanthropometry which is also three core branches of physical education. The study investigates different physiological, cardio pulmonary, hemodynamic and anthropometrical variables as a mark of improving sports training. Hence the relevance and scope of the study can doubtlessly be explained as an interdisciplinary and integrated sports performance pointer. A real effort was made to learn about the previous research conducted in the field, its shortcomings and gaps, the methodology used, and the steps taken in consultation with experts and the literature. A brief summary of review of literature about the related area as searched by the researcher from various sources have been discussed in chapter two. Accordingly, the present study was planned to initiate research work related to the estimation of effect of 12 weeks of proposed scientific training program formulated by expert of the field on different parameters to measure and compare the training effect of continuous and

interval circuit training methods on physical fitness, physiological and anthropometric variables. Researchers are attempting to determine the study's objectives, which include observing the training effects of both continuous and interval circuit training on physiological, anthropometric, and physical fitness variables, as well as comparing the training effects of the three groups with regard to anthropometric, physiological, and physical fitness variables.

Total sixty (N =60) boys were involved as subjects of this study. Subjects were randomly selected after medical screening from purulia cricket academy, Purulia district of West Bengal. The study's participants ranged in age from 13 to 16 years old.. They all were under skill practices on pre beginner section and joined at Purulia Cricket academy for one to three months only. Lottery method was use to conduct simple random sampling process, there all the students got an equal opportunity to select for the study. Homogeneity was tested based on their personal data and performance in the initial stage. For present study, Sixty (60) boys were chosen as subjects, and they were divided into three equal groups through simple random grouping, each group was consisted of twenty (N= 20) students. The experimental groups were intervened through scientifically structured continuous circuit training and interval circuit training program separately for twelve weeks whereas the control group was free from intervention of any kind of structured training program. Groups that were formulated for the study namely as Interval Circuit Training (ICT), Continuous Circuit Training group (CCT) and Control Group (CG). All groups were engaged in their regular academic activity and maintain their regular food habits which was not under the control of the researcher. Thus, the effect of uncontrolled variables was tried to nullify by using the expected changes of the control group.

The study was under experimental type of research and for this investigation pre-test post-test control group design was used here. Present study experimental set up consisted with total sixty subjects (N = 60) then three different groups of twenty (20) each were randomly selected from them. This study consisted of two Experimental Groups namely CCT- Continuous Circuit Training group and ICT- Interval Circuit Training group and another one was Control Group. Experimental Groups underwent circuit training of different setting of continuous and interval setting respectively for a duration of twelve weeks and the Control Group did not in specified training methods but they were involved in their regular routine schedule of the academy of cricket skill practices. Chapter III provides a detailed discussion of the names and

durations of the exercises for both Continuous Circuit Training and Interval Circuit Training, which were each composed of eight stations with eight differents physical movement types.

At first 7 minutes warming up activity with slow jogging and stretching was performed mandatorily for both of groups. Each of the two experimental groups' stations was similar to the other, but the recovery times and methods for moving from one to the next station differed. The interval circuit training group took an active two-minute break before restarting the circuit, while the continuous circuit training group did not have a recovery period. Those who are in interval circuit training method they were involved with slow jogging from one station to another station and those who are in continuous circuit training they were walked from one station to next station. Each day, both experimental groups completed a total of three circuits. Three days a week were allotted for training. Twelve weeks were spent on training in total. Group III served as the control group; they only went about their regular lives without taking part in any training. Both of experimental groups performed on circuit according to their maximum individual capacity. First four weeks followed the load 70 % of their maximum capacity. After completion of first four weeks researcher again recorded maximum capacity of the students and fifth to eight weeks followed the progression of load 75 % of their maximum capacity. Again same as before determined the maximum capacity and ninth to twelve weeks followed the progression of load 80 % of their maximum capacity.

Researcher reviewed many scientific literatures pertaining to various training program related to continuous training effect and interval training effect on a station training set up. After reviewed the literatures and discussed with professional coaches and supervisor researcher selected following variables in three heads namely anthropometric, Physical fitness and Physiological variables. BMI is an accurate assessment of someone health. BMI is considered as an important scientific variable and is a helpful tool for medical professionals as well as athletes to rapidly identify health concerns. Apart from BMI Body-weight, percentage of body fat, calf girth, thigh girth were also considered. The development of strength and power can be helped by an increase in lean body mass. Muscle size has an impact on strength and power. Accordingly, an increase in lean body mass allows an athlete to exert more force during a given training regimen; for this reason, the researchers in the current study considered fat body mass as a significant study marker. With circuit training, participants usually perform a high number of

repetitions for every exercise. This involves the recruitment of types of muscle fibers to help sustaining the exercise longer, over time, ability to perform the physical exercise for long time with no fatigued, allowing to use muscles longer and more effectively, but it depends upon the amount of lactic acid concentration in blood and its tolerance capacity on exercise. So, researcher considered lactic acid concentration and heart rate as significant variables of the study. Harvard step test was the activity which was used to evaluate the Lactic acid concentration and heart rate measured in different states. Heart rate was taken in the condition of resting period, before Harvard step test, after immediate Harvard step test, after seven (7) minutes of Harvard step test and after fifteen (15) minutes of Harvard step test. Blood lactic acid was taken carefully before Harvard step test, after immediate Harvard step test, after seven (7) minutes of Harvard step test and after fifteen (15) minutes of Harvard step test. In a circuit training set up exercises tangled were of high mandate to perform against maximum resistance with speed and change of direction is inevitable that effect on muscular system and cardio respiratory system. From this perspective researcher considered Speed, Agility, Flexibility, Leg explosive strength and Cardio respiratory fitness as physical fitness variable of the study. Taking into considerations of the criteria, feasibility, variability of instrument and relevance to the present experimental study, the above mention variable were selected.

The data were collected according to specific procedures which are shown in chapter number- III and are presented in this chapter adopting standard statistical procedures. The results are presented in tabular forms as well as in graphical structure. All the data were gathered from two ‘states’ where one was before the start of the training programme and the other was after completion of 12 weeks of training programme.

Results were discussed and analyzed under three different aspects such as Anthropometric, Physical fitness and and Physiological variables.

It was observed that **BMI** was not changed comparatively significant among three groups after the implementation of specified 12 weeks physical training programme. But signified that level of BMI was slightly decreased for CCT and ICT groups, whereas slightly increased for control group then CCT and ICT groups after the training.

Body weight was not significant among three groups after training. Following training Body weight was slightly decreased in case of interval circuit training group. Body weight was slightly gained in case of continuous circuit training and control groups after 12 weeks of training.

Percentage of Body Fat was significantly decreased for CCT and ICT groups after the complete of specified circuit training programme whereas significant enhanced body fat percentage for control group. In comparison among three groups on Percentage of Body Fat there are not significant after 12 weeks of training.

Calf Girth was significantly enhanced for CCT and ICT groups after the complete of 12 weeks training period. Among the three groups comparatively less changes observed on control group than CCT and ICT groups. After the complete of 12 weeks training period **Thigh girth** changes observed same as calf girth.

As a component of physical fitness **Speed** was significantly improved after the implication of specified circuit training programme for Interval and Continuous Circuit Training Group but significantly decreased the speed ability observed on control group.

Post test score showed that **Agility** was significantly improved after 12 weeks of training for Interval and Continuous Circuit Training Group but no significant changes observed on control group. Circuit training programme (CCT & ICT) can improve agility where interval circuit training method is better than continuous circuit training method for agility improvement.

Leg explosive strength was significantly enhanced for CCT and ICT groups after the implication of specified circuit training programme through 12 weeks but no significant changes observed on control group. In comparison among three groups after training CCT and ICT groups was not significant between them but CG was significant with ICT and CCT groups.

Both types of circuit training programme can improve **Cardio Respiratory Fitness** and continuous circuit training method is better than interval circuit training method for enhance Cardio Respiratory Fitness but no significant changes noticed on control group.

Flexibility was significantly enhanced for CCT and ICT after complete the training but no significant changes observed on control group. In comparison among three groups result was significant where both types of circuit training programme can improve flexibility but not significant difference observed between them on the other hand CCT and ICT groups are better than control group.

Heart rate was measured on five phases to observe the effects of training on heart rate of 13 to 16 years students. Heart rate was measured during resting period, before on set of exercise, immediate after exercise, after 7 min of exercise and after 15 minutes of exercise. Harvard step test was selected as an activity or exercise.

After the 12 weeks training decreased the Heart rate after the implication of specified continuous and interval circuit training programme on different (five) states but Control group students' heart rate was more or less same as before. In comparison on five different phases among three groups were significant. In respect of **resting HR** after 12 weeks of training CCT was better than ICT which is significant whereas both of training groups was better than CG which also was significant in Post-Hoc Test. In respect of **HR before exercise** after 12 weeks of training observed the changes same as resting heart rate. In respect of **HR after immediate of exercise** after 12 weeks of training CCT and ICT was better than CG which was significant whereas CCT with ICT was not significant in Post-Hoc Test. After 12 weeks of training in respect of **HR after completion of seven minutes of exercise** changes observed same as resting heart rate. After 12 weeks of training in respect of **HR after completion of fifteen minutes of exercise** CCT and ICT was better than CG which was significant whereas CCT with ICT was not significant in Post-Hoc Test.

Blood lactic acid was measured on four phases to observe the effects of training on lactic acid concentration for 13 to 16 years students. BLA was measured before on set of activity, immediate after exercise, after 7 min of exercise and after 15 minutes of exercise. Harvard step test was selected as an activity or exercise. After the 12 weeks training decreased the amount of lactic acid after the implication of specified continuous and interval circuit training programme on different (four) states but Control group students' lactic acid amount was increase on post test score respectively for each phases. In comparison on four different phases among three groups

were significant. In respect of **lactic acid before exercise** after 12 weeks of training CCT was better than ICT but not significant whereas both of training groups was better than CG but significantly CCT was better than CG in Post-Hoc Test. In respect of **lactic acid after immediate of exercise** after 12 weeks of training CCT and ICT was better than CG which is significant whereas CCT with ICT was not significant in Post-Hoc Test. After 12 weeks of training in respect of **lactic acid after seven minutes of exercise** changes observed same as after immediate of activity. After 12 weeks of training in respect of **lactic acid after fifteen minutes of exercise** CCT and ICT was better than CG which is significant whereas CCT was better than ICT which was also significant in Post-Hoc Test.

5.2 CONCLUSIONS

Present research study has its own limitations and considering these perspectives following precise conclusions are drawn on the basis of the research findings.

5.2.1 On anthropometric variables

1. BMI was not changed significantly for ICT, CCT & CG after the completion of training and in comparison among three groups were not significant after training.

2. **Body weight** was not changed significantly for ICT and CCT groups but significantly changed for control group. In comparison among three groups were not significant after training.

3. Percentage of body fat (%) was significantly decreased for ICT and CCT groups but significantly increased for control group. In comparison among three groups were not significant after training.

4. Calf Girth was significantly enhanced for CCT and ICT groups and control group was not significant. Where comparatively among the three groups were not significant after training.

5. Thigh Girth was significantly enhanced for CCT and ICT groups and control group was not significant. Where comparatively among the three groups were not significant after training.

5.2.2 On Physical Fitness variables

6. Speed was significantly improved for ICT and CCT Group but significantly decreased the speed ability for control group. Where comparatively among the three groups were significant after training. In Post- Hoc test CCT with ICT was not significant But CG with ICT and CG with CCT was significant.

7. Agility was significantly improved for ICT and CCT Group but not significant changes for control group. In comparison among three groups were significant after training. In Post- Hoc test CCT with ICT and CG with CCT were not significant. But CG with ICT was significant.

8. Leg explosive strength was significantly enhanced for ICT and CCT Group but not significant changes observed on control group. In comparison among three groups were significant after training. Where CCT with ICT groups were not significant but ICT and CCT with CG was significant.

9. Cardio Respiratory Endurance was significantly improved for CCT and ICT but no significant changes observed on control group. In comparison among three groups were significant after training. Where CCT with ICT and CG with CCT groups were significant but ICT CG was not significant.

10. Flexibility was significantly enhanced for ICT and CCT Group but not significant changes observed on control group. In comparison among three groups were significant after training. Where CCT with ICT groups were not significant but ICT and CCT with CG was significant.

5.2.3 On Physiological Variables

5.2.3.1 On Heart Rate:

11. Resting heart rate was significantly decreased for CCT and ICT groups but not significant changes observed in control group. In comparison among three groups were significant after training. Where CCT was significantly better than ICT but CCT and ICT both of training groups were significantly better than CG.

12. Heart rate before exercise was significantly decreased for CCT and ICT groups but not significant changes observed in control group. In comparison among three groups were significant after training. Where CCT was significantly better than ICT but CCT and ICT both of training groups were significantly better than CG.

13. Heart rate after immediate of exercise was significantly decreased for CCT and ICT groups but significantly increased in control group. In comparison among three groups were significant after training. Where CCT and ICT groups were not significant but CCT and ICT both of training groups were significantly better than CG.

14. HR after completion of seven minutes of exercise was significantly decreased for CCT and ICT groups but not significant changes observed in control group. In comparison among three groups were significant after training. Where CCT was significantly better than ICT but CCT and ICT both of training groups were significantly better than CG.

15. HR after completion of fifteen minutes of exercise was significantly decreased for CCT and ICT groups but not significant changes observed in control group. In comparison among three groups were significant after training. Where CCT with ICT was not significant but CCT and ICT both of training groups were significantly better than CG.

5.2.3.2 Lactic Acid:

16. Blood Lactic acid before exercise was significantly decreased for CCT and ICT but not significant changes observed in CG. In comparison among three groups were significant after training. Where CCT was better than ICT but ICT and CCT groups were better than CG but not significant.

17. Blood Lactic acid after immediate of exercise was significantly decreased for CCT and ICT but not significant changes observed in CG. In comparison among three groups were significant after training. Where CCT with ICT was not significant but ICT and CCT groups were significantly better than CG.

18. BLA after completion of seven minutes of exercise was significantly decreased for CCT and ICT but significantly increased in control group. In comparison among three groups were

significant after training. Where CCT with ICT was not significant but CCT and ICT were significantly better than CG.

19. BLA after completion of fifteen minutes of exercise was significantly decreased for CCT and ICT but not significant changes observed in control group. In comparison among three groups were significant after training. Where CCT and ICT were significantly better than CG and CCT were significantly better than ICT.

CONCLUDING REMARKS:

From the findings of this study and after critical analysis of data it appears that both the groups have improved significantly in selected anthropometrical, physical fitness and physiological parameters. Whereas inter group analysis did not reflect very positive results from which it can be concluded that the ICT group is better than CCT or CCT is better than ICT. Critical analysis have clearly shown that so far anthropometric parameters are concern no significant differences between the two groups existed before and after the training. In Physical fitness only significant deference found in cardio respiratory endurance between the two groups where CCT was better than ICT. In other parameters of physical fitness differences are existed but not statistically significant.

However in physiological parameters some remarkable observations were made while both the groups were critically analyzed. Resting heart rate, immediate before activity and immediate after seven minutes of exercise (Harvard step test), HR (Heart rate) of CCT found significantly lower than that of ICT. Similarly BLA (Blood Lactic Acid) after fifteen minutes completion of exercise was found significantly lower in CCT group than ICT group. This observation is not unusual since cardio respiratory endurance was better in CCT group than ICT group.

Finally from these findings it may safely be concluded that both the training is effective in development of physical fitness and physiological potentialities. However, since continuous circuit training (CCT) has better in development of cardio respiratory endurance and thereby influenced the accumulation of BLA. Possibly it would not be fair to arrive in such an impression that continuous circuit training (CCT) was better than Interval circuit training (ICT).

5.3 RECOMMENDATIONS

From the findings of the present research study following recommendation have been drawn for the physical education teacher, sports scientist, coaches, exercise expert, physical trainer, sports person, research scholar and general peoples.

1. Present study delimited to 13-16 years of age group, same study can be conducted with female and other age groups.

2. Present study was delimited to specific anthropometrical, physical, and physiological parameter which can be extent to its feasibility in other related study.

3. Similar research may be conducted with greater number of subjects.

4. Future research may be conducted on detail molecular and cellular level analysis to unveil more potential effect of circuit training on different set up.

5. Correction study among blood lactic acid, oxygen uptake and heart rate may reveal a true picture of physiological adaptations which was not covered that I have studied may be immensely useful.

BIBLIOGRAPHY

BOOKS

Arnheim, D. D., & Prentice, W.E. (2000). Principles of athletic training. USA: McGraw-Hill Inc.

Brouha, L. (1974). Training in ; Science and medicine of exercise and sports. In W.R. Johnson, & E.R. Buskrik, Physiology of exercise for physical education and athletics (2nd ed.) (pp.276-81). New York: Harper and Row.

Chatard, J. C., Paulin, M., & Lacour J,R. (1988). Post Competition Blood Lacted Measurement and Sweeming Performance. In B.E. Ungerechts, K. Wilkie & K. Reischle, Sweeming science V (pp. 311-316). Champaign: Human Kinetics Books.

Goyal, K.(2021) Physical Education and Sports. Published by Vidya Books, ISBN: 978-93-5429-803-5

Harre, D. (1982) Principles of Sports training Berlin: Sportverlog

Johnson, B.L., & Nelson, J.K. (1982). Practical Measurement for Evaluation in Physical (Vol, 3Rd) Delhi: Surjeet Publication.

Kansal, D,K. (2008). Textbook of applied Measuremet Evaluation and Sports Selection (Vol. 2nd). New Delhi: Sports and Spiritual Science Publication.

Kent, M. (1993) The Oxford Dictionary of Sports Science and Medicine. New York: Oxford University Press.

Mathews, K.D. (1978). Measurement in Physical Education. (5th Ed. ed) Philadelphia: W.B Saunders Company.

Matveyev, L. (1981). Fundamentals of Sports training Moscow: Progress Publishers.

Sing, H. (1984). Sports Training General Theory and Method. In H. Sing, Sports Training General theory and method (pp. 230-232). Patiala: Netaji Subhas National Institute of Sports.

Singh, H (1991). Science of Sports training. New Delhi: Surjeet Publication.

Tiwari, S. (2006) Exercise Physiology. New Delhi: Sports Publication.

Uppal, A.K. (2004) Physical Fitness and Wellness. India: Friends Publication.

JOURNALS

Aboshkair, K. A., Mohammed, M., & Noori, R. A. (2023). Effect of circuit training on BMI and health physical fitness of overweight female students. *International Journal of Health Sciences, 7*(3), Article 3. https://doi.org/10.53730/ijhs.v7n3.14594

Adeniran, S. A., & Toriola, A. L. (1988). Effects of different running programmes on body fat and blood pressure in schoolboys aged 13-17 years. *The Journal of Sports Medicine and Physical Fitness*, *28*(3), 267–273.

Adling, R. B., & Bangar, D. B. (2017). Effect of eight weeks aerobic exercises on physical and physiological variables among college men. *International Journal of Physiology, 2(1),* 103–106.

Alahmadi, M. (2014). High-intensity Interval Training and Obesity. *Journal of Novel Physiotherapies*, *04*. https://doi.org/10.4172/2165-7025.1000211

Alansare, A., Alford, K., Lee, S., Church, T., & Jung, H. C. (2018). The Effects of High-Intensity Interval Training vs. Moderate-Intensity Continuous Training on Heart Rate Variability in Physically Inactive Adults. *International Journal of Environmental Research and Public Health*, *15*(7), 1508. https://doi.org/10.3390/ijerph15071508

Al-Haliq, M. (2015). Using the Circuit Training Method to Promote the Physical Fitness Components of the Hashemite University Students. *Advances in Physical Education*, *05*(03), 170–175. https://doi.org/10.4236/ape.2015.53021

Alkahtani, S. A., King, N. A., Hills, A. P., & Byrne, N. M. (2013). Effect of interval training intensity on fat oxidation, blood lactate and the rate of perceived exertion in obese men. *SpringerPlus*, *2*, 532. https://doi.org/10.1186/2193-1801-2-532

Alpert, J. S., Bass, H., Szucs, M. M., Banas, J. S., Dalen, J. E., & Dexter, L. (1974). Effects of physical training on hemodynamics and pulmonary function at rest and during exercise in patients with chronic obstructive pulmonary disease. *Chest*, *66*(6), 647–651. https://doi.org/10.1378/chest.66.6.647

Ann, Dr. U. N., & Nkiru, Dr. U. T. (2020). Effects of Circuit Training Exercise on Trunk Flexibility and Muscular Endurance of Female Secondary School Teachers in Anambra State. *International Journal of Innovative Science and Research Technology*, *5*(6), 1291–1295. https://doi.org/10.38124/IJISRT20JUN969

Anuradha, K. N., & Gandhi, R. (n.d.). Effect of circuit training on selected physical and physiological variables among school students. *Indian Streams Research Journal*, *4*(15).

Arboleda Serna, V. H., Arango Vélez, E. F., Gómez Arias, R. D., & Feito, Y. (2016). Effects of a high-intensity interval training program versus a moderate-intensity continuous training program on maximal oxygen uptake and blood pressure in healthy adults: Study protocol for a randomized controlled trial. *Trials*, *17*, 413. https://doi.org/10.1186/s13063-016-1522-y

Ashwini, K. N. (2017). A study on relationship between calf muscle girth and vertical jump ability. *International Journal of Physiology, Nutrition and Physical Education*, *3(1)*, 362–363.

Astrand, I. (1960). Aerobic work capacity in man and women with special reference to age. Acta Physiol Scand. 49: 169.

Astrand, I., Astrand, P.O., Christensen, E.H. and Hedman, R. (1960) Intermittent Muscular work. Acta Physiol Scand. 48:443

Azad, A., Gharakhanlou, R., Niknam, A., & Ghanbari, A. (2011). Effects of Aerobic Exercise on Lung Function in Overweight and Obese Students. *Tanaffos*, *10*(3), 24–31.

Babu, M. S. (2013). The Effect of Selected Circuit Training Exercises on Sprinters of High School Girls. *International Journal of Science and Research (IJSR)*, *2*(11).

Babu, M. S., & Kumar, P. (2014). [PDF] Effect of Continuous Running Fartlek and Interval Training on Speed and Coordination among Male Soccer Players | Semantic Scholar. *Journal of Physical Education and Sports Management*, *1*(1), 31–41.

Badami, S., & Baragundi, M. (2017). Comparative study of resting and post exercise pulse rates between students of medical education and physical education- a cross sectional study.

Indian Journal of Clinical Anatomy and Physiology, *4(3)*, 364–368. https://doi.org/10.18231/2394-2126.2017.0092

Baldari, C., Bonavolontà, V., Emerenziani, G. P., Gallotta, M. C., Silva, A. J., & Guidetti, L. (2009). Accuracy, reliability, linearity of Accutrend and Lactate Pro versus EBIO plus analyzer. *European Journal of Applied Physiology*, *107*(1), 105–111. https://doi.org/10.1007/s00421-009-1107-5

Bandyopadhyay, D.K. (1984). Effects of Speed and endurance activities on blood pressure, heart rate and blood lactate and their correlitaion. J Sports Med. 24 :107-11

Bandyopadhyay, D.K. (1992).Aerobic and anaerobic training effect on selected physical, physiological and biochemical variables. Unpublished Doctoral Thesis. University of Kalyani.

Banerjee, A.K. (1987). Performance evaluation of Eastern Indian athletes using physical and physiological parameters. Unpublished Doctoral Thesis, University of Kalyani.

Bansode, R. D., & Singh, S. K. (2022). Effects Of Functional Exercise On Cardiovascular Fitness And Body Mass Index Of Sedentary Students. *International Advanced Research Journal in Science, Engineering and Technology*, *9*(5), 69–73. https://doi.org/10.17148/IARJSET.2022.9513

Belcastro, A.N. & Bonen, A. (1975). Lactic acid removal rates during controlled and un controlled recovery exercise. Z Appel Physiol. 39:6, 932-36

Benda, N. M. M., Seeger, J. P. H., Stevens, G. G. C. F., Hijmans-Kersten, B. T. P., van Dijk, A. P. J., Bellersen, L., Lamfers, E. J. P., Hopman, M. T. E., & Thijssen, D. H. J. (2015). Effects of High-Intensity Interval Training versus Continuous Training on Physical Fitness, Cardiovascular Function and Quality of Life in Heart Failure Patients. *PloS One*, *10*(10), e0141256. https://doi.org/10.1371/journal.pone.0141256

Bhavsar, Dr. S. D., S. Abhange, Dr. R., & Afroz, Dr. S. (2014). Effect of Different Musical Tempo on Post-Exercise Recovery in young adults. *IOSR Journal of Dental and Medical Sciences*, *13*(5), 60–64. https://doi.org/10.9790/0853-13516064

Bianco, A., Contró, V., Proia, P., & Traina, M. (2017). Effects of different circuit training protocols on body mass, fat mass and blood parameters in overweight adults. *Journal of Biological Research*, *90*, 6279. https://doi.org/10.4081/jbr.2017.6279

Blair, S. N., Davey Smith, G., Lee, I.-M., Fox, K., Hillsdon, M., McKeown, R. E., Haskell, W. L., & Marmot, M. (2010). A Tribute to Professor Jeremiah Morris: The Man Who Invented the Field of Physical Activity Epidemiology. *Annals of Epidemiology*, *20*(9), 651–660. https://doi.org/10.1016/j.annepidem.2010.06.001

Bonifazi, M., F, S., & C, L. (2000). Preparatory versus main competitions: Differences in performances, lactate responses and pre-competition plasma cortisol concentrations in elite male swimmers. *European Journal of Applied Physiology*, *82*(5–6). https://doi.org/10.1007/s004210000230

Bonsu, B., & Terblanche, E. (2015). The training and detraining effect of high-intensity interval training on post-exercise hypotension in young overweight/obese women. *European Journal of Applied Physiology*, *116*. https://doi.org/10.1007/s00421-015-3224-7

Bramwel, . & Ellis, R. (1929). Clinical observation on Olympic athletes. Arbeits Physiol. 2:51. cited by Banerjee, 1987).

Brock, J. R., & Legg, S. J. (1997). The effects of 6 weeks training on the physical fitness of female recruits to the British army. *Ergonomics*, *40*(3), 400–411. https://doi.org/10.1080/001401397188233

Brooks, G. A. (1986). The lactate shuttle during exercise and recovery. *Medicine and Science in Sports and Exercise*, *18*(3), 360–368. https://doi.org/10.1249/00005768-198606000-00019

Brouha, L. (1943). The Step Test: A Simple Method of Measuring Physical Fitness for Muscular Work in Young Men. *Research Quarterly. American Association for Health, Physical Education and Recreation*, *14*(1), 31–37. https://doi.org/10.1080/10671188.1943.10621204

Buchheit M., Gindre C. (2006) Cardiac parasympathetic regulation: respective associations with cardiorespiratory fitness and training load. *American Journal of Physiology Heart and Circulation Physiology* 291, H451-H458 [PubMed] [Google Scholar]

Cairns, S. P. (2006). Lactic acid and exercise performance: Culprit or friend? *Sports Medicine (Auckland, N.Z.)*, *36*(4), 279–291. https://doi.org/10.2165/00007256-200636040-00001

Cal, J. L. (1973). *The effects of interval bench stepping on the metabolic energy mechanisms*. [University Microfilms]. https://ci.nii.ac.jp/ncid/BA90694501

Casado, A., Foster, C., Bakken, M., & Tjelta, L. I. (2023). Does Lactate-Guided Threshold Interval Training within a High-Volume Low-Intensity Approach Represent the "Next Step" in the Evolution of Distance Running Training? *International Journal of Environmental Research and Public Health*, *20*(5), 3782. https://doi.org/10.3390/ijerph20053782

Chaloupka, E. C., (1972) "The Physiological Effects of Two Maintenance Programs Following Eight Weeks of Interval Training", Unpublished Doctoral Dissertation, The Ohio State University, Columbus, Ohio.

Chatterjee, T., & Thukral, H. (n.d.). *Evaluation and Assessment of Leg Muscle Activity and Fatigue Accross two Popular Step Test Exercises*. Retrieved January 24, 2024, from https://www.academia.edu/ 33092273/Evaluation_and_Assessment_of_Leg_Muscle _Activity_ and_ Fatigue_ Accross_two_Popular_Step_Test_Exercises

Chittibabu, B & Akilana, N. (2013). Effect of basketball specific endurance circuit training on aerobic capacity and heart rate of high school male basketball players. *International Journal of Physical Education, Fitness and Sports*, 22–25. https://doi.org/10.26524/1345

Clarke, H. H. (1971). Basic understanding of physical fitness Washington. *DC: President's Council on Physical Fitness and Sports*. [Google Scholar]

Connet, R. J. , Gayeski, T. & Honning, . (1985). Energy Sources I fully aerobic rest work transition : a new role for glycolisis. Am J Physiol.243:922-29

Contrò, V., Bianco, A., Cooper, J., Sacco, A., Macchiarella, A., Traina, M., & Proia, P. (2017). Effects of different circuit training protocols on body mass, fat mass and blood parameters in overweight adults. *Journal of Biological Research - Bollettino Della Società Italiana Di Biologia Sperimentale*, *90*(1), Article 1. https://doi.org/10.4081/jbr.2017.6279

Cotes, J. E., Berry, G., Burkinshaw, L., Davies, C. T. M., Hall, A. M., Jones, P. R. M., & Knibbs, A. V. (1973). Cardiac Frequency During Submaximal Exercise in Young Adults; Relation to Lean Body Mass, Total Body Potassium and Amount of Leg Muscle. *Quarterly Journal of Experimental Physiology and Cognate Medical Sciences*, *58*(3), 239–250. https://doi.org/10.1113/expphysiol.1973.sp002212

Coyle, E. F., Martin, W. H., Ehsani, A. A., Hagberg, J. M., Bloomfield, S. A., Sinacore, D. R., & Holloszy, J. O. (1983). Blood lactate threshold in some well-trained ischemic heart disease patients. *Journal of Applied Physiology: Respiratory, Environmental and Exercise Physiology*, *54*(1), 18–23. https://doi.org/10.1152/jappl.1983.54.1.18

Cregg, C. J. (2013). *Effects of high intensity interval training and high volume endurance training on maximal aerobic capacity, speed and power in club level gaelic football players* [Masters, Dublin City University]. https://doras.dcu.ie/17709/

Dar, U. R. (2016). Effect of aerobic training on physical fitness components of cricket players of university of Kashmir. *International Journal of Physical Education, Sports and Health*, *3(6)*, 18–20.

Das, S.S. (1995). Effect of two specific training programmes on the performance of young soccer players. Unpublished Phd Thesis, University of Kalyani.

Daxin, L., P, C., & J, Z. (2021). The Effects of Interval Training and Continuous Training on Cardiopulmonary Fitness and Exercise Tolerance of Patients with Heart Failure-A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*, *18*(13). https://doi.org/10.3390/ijerph18136761

Dhiman, Dr. S. (2022). Effect of resistance and circuit training in relation to flexibility of kabaddi players. *Journal of Sports Science and Nutrition*, *3*(1), 125–126. https://doi.org/10.33545/27077012.2022.v3.i1b.151

Dintiman, G.B. (1964). Effects of various training program on running speed. Research Quarterly, 35:4, 456

Dixon, B. (2017). Effects of Leg Girth and Leg Strength on Division I Track Athletes Race Performance. *Morehead State Theses and Dissertations*. https://scholarworks.moreheadstate.edu/msu_theses_dissertations/125

Dodd, S. et al., (1984) Blood lactate disappearance at various intensities of recovery exercise. J Appl Physol. 57: 1462 (itet by McArdele et al., 1991).

Domenico, F. D., & D'isanto, T. (2019). Role of speed and agility in the effectiveness of motor performance. *Journal of Physical Education and Sport*, *19*(5), 1836–1842.

Drigny, J., Gremeaux, V., Dupuy, O., Gayda, M., Bherer, L., Juneau, M., & Nigam, A. (2014). Effect of interval training on cognitive functioning and cerebral oxygenation in obese patients: A pilot study. *Journal of Rehabilitation Medicine*, *46*(10), 1050–1054. https://doi.org/10.2340/16501977-1905

Driller, M. W., Fell, J. W., Gregory, J. R., Shing, C. M., & Williams, A. D. (2009). The effects of high-intensity interval training in well-trained rowers. *International Journal of Sports Physiology and Performance*, *4*(1), 110–121. https://doi.org/10.1123/ijspp.4.1.110

Dutta, S., & Ghosh, M. (2016). Health related physical fitness among physical education professional students a comparative study. *International Journal of Physical Education, Sports and Health*, *3(3)*, 601–604.

Edran, C., Slamet, & Juita, A. (2020). *The Effect of Leg Circuits Exercise Toward Strength of Limbs Muscles of Female Students Volley Ball Team*. https://doi.org/10.2991/assehr.k.200805.031

Filho, R. R., Rocha, L. L., Corrêa, T. D., Pessoa, C. M. S., Colombo, G., & Assuncao, M. S. C. (2016). Blood Lactate Levels Cutoff and Mortality Prediction in Sepsis-Time for a Reappraisal? A Retrospective Cohort Study. *Shock (Augusta, Ga.)*, *46*(5), 480–485. https://doi.org/10.1097/SHK.0000000000000667

Fox, E., Bartels, R., Billing, C., O'Brien, R. & Mathews, D. (1975) Frequency and duration of interval training programs and change in aerobic power. J Appl Physiol. 38:3, 481-84

Garber, C. E. (1992). Is aerobic dance and effective alternative to work – jog exercise training J sports Med Phy Fitness. 32:2 136-41.

Ghosh, A. K. (2004). Anaerobic Threshold: Its Concept and Role in Endurance Sport. *The Malaysian Journal of Medical Sciences : MJMS*, *11*(1), 24.

Gibala, M. J., & Hawley, J. A. (2017). Sprinting Toward Fitness. *Cell Metabolism*, *25*(5), 988–990. https://doi.org/10.1016/j.cmet.2017.04.030

Girinathan, M., & Lillypuspam, I. (2019). Effect of continuous training and interval training on selected speed and agility among college level men boxers. *International Journal of Yogic, Human Movement and Sports Sciences*, *4(2)*, 255–258.

Glick, Z., & Kaufmann, N. A. (1976). Weight and skinfold thickness changes during a physical training course. *Medicine and Science in Sports*, *8*(2), 109–112.

Goldsmith, C. (2018). *The Importance of Maintaining an Ideal Body Weight: Dr. G's Weightloss: Medical Weight Loss Clinics*. https://www.drgsweightloss.com/blog/the-importance-of-maintaining-an-ideal-body-weight

Goodwin, M. L., Harris, J. E., Hernández, A., & Gladden, L. B. (2007). Blood Lactate Measurements and Analysis during Exercise: A Guide for Clinicians. *Journal of Diabetes Science and Technology (Online)*, *1*(4), 558–569.

Govind K Kadam, Rajaram Shankar Kare, Joytiram Chavan, Kamlakar Kadam. (2015). Effect of interval training on health related physical fitness components of engineering college men students. *International Journal of Physical Education, Sports and Health, 2(1): 282-285*.

Guimarães, G. V., Ciolac, E. G., Carvalho, V. O., D'Avila, V. M., Bortolotto, L. A., & Bocchi, E. A. (2010). Effects of continuous vs. Interval exercise training on blood pressure and arterial stiffness in treated hypertension. *Hypertension Research: Official Journal of the Japanese Society of Hypertension*, *33*(6), 627–632. https://doi.org/10.1038/hr.2010.42

Harre, D. (1979). Trainingslehren Berlin: Sportsverlag (Cited by Singh, 1984)

Harre, D. (1982). Priciples of Sports Training. Berlin: Sportsverlag. 10:141-42, 146.

Hermansen, L. & Stensvold, I. (1972). Production and removal of lactate during exercise in man. Acta Physiol Scand. 86:191-201.

Holmes, C. J., & Racette, S. B. (2021). The Utility of Body Composition Assessment in Nutrition and Clinical Practice: An Overview of Current Methodology. *Nutrients*, *13*(8), 2493. https://doi.org/10.3390/nu13082493

Holmgren, A. (1960). Effect of raining on work capacity. Total haemoglobin, blood volume, heart volume and pulse rate in recumbent and upright position. Acta Physiol Scand. 50: 72-83

Hottenrott, K., Ludyga, S., & Schulze, S. (2012). Effects of High Intensity Training and Continuous Endurance Training on Aerobic Capacity and Body Composition in Recreationally Active Runners. *Journal of Sports Science & Medicine, 11*(3), 483–488.

Huang, H., Huang, W.-Y., & Wu, C.-E. (2023). The Effect of Plyometric Training on the Speed, Agility, and Explosive Strength Performance in Elite Athletes. *Applied Sciences*, *13*(6), Article 6. https://doi.org/10.3390/app13063605

Hurley, B. F., Hagberg, J. M., Allen, W. K., Seals, D. R., Young, J. C., Cuddihee, R. W., & Holloszy, J. O. (1984). Effect of training on blood lactate levels during submaximal exercise. *Journal of Applied Physiology*, *56*(5), 1260–1264. https://doi.org/10.1152/jappl.1984.56.5.1260

Ibikunle, P. (2016). Cardiorespiratory Responses of Professional Male Volleyball and Basketball Players to Harvard Step Test. *IOSR Journal of Sports and Physical Education*, 2347–6745. https://doi.org/10.9790/6737-03035461

Imanudin, I., Sultoni, K., Umaran, U., & Hardwis, S. (2020). *The Impact of Aerobic Circuit Training Methods on the Improvement of Anaerobic Dynamic and Aerobic Capacity*. 410–412. https://doi.org/10.2991/ahsr.k.200214.110

Indranil, M., of Physiology, D., College, M., Midnapore, Bengal, W., India, Khanna, G. L., Dhara, P. C., of Health Sciences, D., University, M. R. I., Faridabad, India, of Human Physiology, D., University, V., Midnapore, Bengal, W., & India. (2015). Effects of Training on Anthropometric, Physiological and Biochemical variables of Indian under 19 years field Hockey Players. *Biology of Exercise*, *11*(2), 15–31.

İpekoğlu, G., Baynaz, K., Mor, A., Acar, K., Arslanoğlu, C., & Arslanoğlu, E. (2018). Examining Lactate Changes during High Intensity Spinning® Training. *Universal Journal of Educational Research*, *6*(6), 1260–1263. https://doi.org/10.13189/ujer.2018.060617

Islam, H. (2017). A Comparative Study between Explosive Power Muscle Girth and Kicking Ability of Football Players. *International Journal of Science and Research (IJSR)*, *6*(6). https://www.ijsr.net/

Jadhav, D. R. R. (2020). Effect Of Circuit Training Programme On Selected Physical Fitness Variables Among Sports Person. *International Journal of Creative Research Thoughts (IJCRT)*, *8*(11).

Jakicic, J. M. (2009). The effect of physical activity on body weight. *Obesity (Silver Spring, Md.)*, *17 Suppl 3*, S34-38. https://doi.org/10.1038/oby.2009.386

Jatmiko, T., Kusnanik, N., Nurhasan, N., Muhammad, H., & Noordia, A. (2023). Enhancing Speed, Agility, and Anaerobic Capacity via a Tuja-Shuttle Run Exercise Model. *Middle East Journal of Rehabilitation and Health Studies*, *11*. https://doi.org/10.5812/mejrh-134693

Kadam, G. K., Kare, R. S., Chavan, J., & Kadam, K. (2015). Effect of interval training on health related physical fitness components of engineering college men students. *International Journal of Physical Education, Sports and Health*, *2(1)*, 282–285.

Karlsson, J. & Saltin, B. (1971). Oxygen deficit and muscle metabolites in intermittent exercise. Acta Physiol Scand. 82:115-22.

Karlsson, J., & Jacobs, I. (1982). Onset of blood lactage accumulation during muscular exercise as a threshold concept. I. Theoretical considerations. *International Journal of Sports Medicine*, *3*(4), 190–201. https://doi.org/10.1055/s-2008-1026087

Keskinen, O. P., Keskinen, K. L., & Mero, A. A. (2007). *Effect of Pool Length on Blood Lactate, Heart Rate, and Velocity in Swimming | Request PDF*. https://www.researchgate.net/publication/6687209_Effect_of_Pool_Length_on_Blood_Lactate_Heart_Rate_and_Velocity_in_Swimming

Khan, S., Nagarwala, R., Shyam, A., & Sancheti, P. (2019). Comparison of Effects of Continuous and Interval Training on Aerobic Capacity in Healthy, Non Exercising Young Individuals. *International Journal of Current Research and Review*, *11*(02), 01–06. https://doi.org/10.31782/IJCRR.2019.1121

khodanpur, B. (2010). The effect of physical training program onbody composition and body mass index. *Annals of the College of Medicine, Mosul*, *36*(1), 18–25. https://doi.org/10.33899/mmed.2010.8920

Kim, J.-W., Ko, Y.-C., Seo, T.-B., & Kim, Y.-P. (2018). Effect of circuit training on body composition, physical fitness, and metabolic syndrome risk factors in obese female college students. *Journal of Exercise Rehabilitation*, *14*(3), 460–465. https://doi.org/10.12965/jer.1836194.097

Klafs, C. E. (1981). *Modern principles of athletic training: The science of sports injury prevention and management / Carl E. Klafs, Daniel D. Arnheim* (5th ed). Mosby.

Koubaa, A. (2013). Effect Of Intermittent And Continuous Training On Body Composition Cardiorespiratory Fitness And Lipid Profile In Obese Adolescents. *IOSR Journal of Pharmacy (IOSRPHR)*, *3*(2), 31–37. https://doi.org/10.9790/3013-32103137

Kuganesan, K., & Ahilan, B. (2017). Effect of Circuit Training And Endurance Training On Selected Variables Of School Obese Boys. *Indian Journal of Physical Education, Sports and Applied Sciences*, *Vol.7, No.1*.

Kumagai, S., Nishizumi, M. & Kondo, Y. (1988). Reevaluation of contribution of physical fitness, body weight and different sports activity of resting blood pressure in young men. Int J sports Med. 9:5, 334-37.

Kumar, P. P. S. P. (2013). The Effect of Circuit Training on Cardivascular Endurance of High School Boys. *Global Journal of Human Social Scienc, 13 Issue 7 Version 1.0*.

Kumar, V. (2016). Effect of circuit training program on selected motor abilities among university male. *International Journal of Physical Education, Sports and Health, 3(4),* 255–257.

Lee, K.-L., Sung, J.-Y., Oh, T.-W., & Kim, H.-J. (2022). Functional relationship between the anatomical structures of the calf and athletic ability. *Clinical Anatomy (New York, N.Y.), 35*(5), 544–549. https://doi.org/10.1002/ca.23855

Lesinski, M., Prieske, O., & Granacher, U. (2016). Effects and dose-response relationships of resistance training on physical performance in youth athletes: A systematic review and meta-analysis. *British Journal of Sports Medicine*, *50*(13), 781–795. https://doi.org/10.1136/bjsports-2015-095497

Mahesh, C., Dileep, N., & Thakur, T. (2017). A study on relationship between Calf Girth and performance of Football players. *Asian Journal of Health Physical Education and Computer Science in Sports*, *16*.

Malhotra, M.S., Joseph, N. T., Mathur, D.N. & Sengupta, J. (1973) Assessment of physical work capacity of national Indian road sports cyclists. J Sports Med. 2:5.

Manna, I., Khanna, G., & Dhara, P. (2010). Effect of Training on Physiological and Biochemical Variables of Soccer Players of Different Age Groups. *Asian Journal of Sports Medicine*, *1*. https://doi.org/10.5812/asjsm.34875

Matwejew, L.P. (1981) Grundlagen des Sportlichen Training. Berlin: Sportverlag. (cited by Singh, 1984)

Mayorga-Vega, D., Viciana, J., & Cocca, A. (2013). Effects of a Circuit Training Program on Muscular and Cardiovascular Endurance and their Maintenance in Schoolchildren. *Journal of Human Kinetics*, *37*, 153–160. https://doi.org/10.2478/hukin-2013-0036

Mazoochi, M., Fateminezhad, S. E., & Mazoochi, T. (2013). Effects of continuous and interval training on different fitness parameters in athletes. *World Applied Sciences Journal*, *28*, 312–315. https://doi.org/10.5829/idosi.wasj.2013.28.03.81183

McArdle, W.D., Katch, F.I. & Katch, V.L. (1991). Exercise Psychology : Energy, Nutrition and Human performance. (3rd Ed.) London: Lea & Febiger.

McMaster, W. C., Stoddard, T., & Duncan, W. (1989). Enhancement of blood lactate clearance following maximal swimming. Effect of velocity of recovery swimming. *The American Journal of Sports Medicine*, *17*(4), 472–477. https://doi.org/10.1177/036354658901700404

Meckel, Y., Galily, Y., Nemet, D., & Eliakim, A. (2011). Changes in weight indexes and aerobic fitness of physical education students over three years of college. *Journal of Human Sport and Exercise*, *6*. https://doi.org/10.4100/jhse.2011.61.13

Meethal, A., & M, N. A. (2013). Effects of Circuit Training On Different Surfaces on Selected Physical and Physiological Variables of School Boys. *International Journal of Physical Education, Fitness and Sports*, 56–60. https://doi.org/10.26524/13415

Miller, M. B., Pearcey, G. E. P., Cahill, F., McCarthy, H., Stratton, S. B. D., Noftall, J. C., Buckle, S., Basset, F. A., Sun, G., & Button, D. C. (2014). The effect of a short-term high-intensity circuit training program on work capacity, body composition, and blood profiles in sedentary obese men: A pilot study. *BioMed Research International*, *2014*, 191797. https://doi.org/10.1155/2014/191797

Mishra, M. K. (2015). *An Association between Explosive Strength and Agility of Physical Education Students*. https://www.academia.edu/85020528/An_Association_between_Explosive_Strength_and_Agility_of_Physical_Education_Students

Moch.Y & Wahjuni, E. (2019). *The Effects of Continuous and Interval Training Toward VO2max Increase for Male* (Vol. 7). https://doi.org/10.2991/icssh-18.2019.31

Mohebbi, H. (2015). The effects of interval training and age on blood lactate (La) levels and lactate dehydrogenase (LDH) activity in male Wistar rats. *Pars Journal of Medical Sciences*, *Vol. 12*, *No. 4*, 37–45.

Morris, J. (1994). Exercise in the prevention of coronary heart disease: Today's best buy in public health. *Medicine and Science in Sports and Exercise*, *26*, 807–814. https://doi.org/10.1249/00005768-199407000-00001

Moses, M. O., Adedugbe, B. O., & Abass, A. O. (2015). Effects of continous and interval trainings exercises on cardiovascular characteristics of pupils in Ibadan. *Open Journal of Medicine*, *3:3*. https://doi.org/DOI: 10.3823/508

Mukhopadhyay, Dr. K. (2022). Load Dynamics, Recovery and Adaptation for Better Sporting Events. *Journal of Advances in Sports and Physical Education*, *5*(8), 180–190. https://doi.org/10.36348/jaspe.2022.v05i08.001

Nalcakan, G. R. (2014). The Effects of Sprint Interval vs. Continuous Endurance Training on Physiological And Metabolic Adaptations in Young Healthy Adults. *Journal of Human Kinetics*, *44*, 97–109. https://doi.org/10.2478/hukin-2014-0115

Nordenfelt, L. (2007). *Understanding The Concept Of Health*. https://www.fil.lu.se/hommageawlodek/site/papper/NordenfeltLennart.pdf

Nudri, W., Manan, W., & Abdullah, M. (2009). Body Mass Index and Body Fat Status of Men Involved in Sports, Exercise, and Sedentary Activites. *The Malaysian Journal of Medical Sciences : MJMS*, *16*, 21–26.

Nunney, D.N. (1960). Relation of circuit training to swimming. Research Quqrterly: 31:188-93.

Nuttall, F. Q. (2015). Body Mass Index: Obesity, BMI, and Health: A Critical Review. *Nutrition Today*, *50*(3), 117–128. https://doi.org/10.1097/NT.0000000000000092

Öner, S., Yasul, Y., & Akçinar, F. (2021). The Effects of High-Intensity Interval Training on Body Composition and Lipid Profile. *PJMHS*, *15*(2).

Ouerghi, N., Fradj, M. K. B., Bezrati, I., Khammassi, M., Feki, M., Kaabachi, N., & Bouassida, A. (2017). Effects of high-intensity interval training on body composition, aerobic and anaerobic performance and plasma lipids in overweight/obese and normal-weight young men. *Biology of Sport*, *34*(4), 385–392. https://doi.org/10.5114/biolsport.2017.69827

Pan, S.R.; (1999) Comparative Effects of Interval and Continuous Circuit Training Methods on Middle Distance Running Performance, Cardio-Respiratory Endurance, Speed and Agility on Secondary School SC/STBoys, Unpublished M. Phil Dissertation, Alagappa University,

Pandey, A., Devarshi, P., Vipra, & Chaubey, D. (2015). *Relationship between explosive strength and agility of Football male players*. *1*, 303–305.

Patil, R.B., Doddamani, B.R., Bhutkar, M. and Awanti, S.M. (2012) A Comparative Study of Physical Fitness among Rural Farmers and Urban Sedentary Group of Gulbarga District, Al Ame en J Med Sci, 5 (1). 39-44. 2012.

Permana, D., Kusnanik, N., Nurhasan, N., Setijono, H., Arifin, M., & Purwoto, S. (2022). Enhancing Strength, Leg Muscle Explosive Power, and Muscle Hypertrophy Using Hurdle-Box Jump Plyometric. *Teorìâ Ta Metodika Fìzičnogo Vihovannâ*, *22*, 113–120. https://doi.org/10.17309/tmfv.2022.1.16

Prasanna, A., Krishnan, G., Sundar, M., & Arivazhagan, R. (2020). Effect of Continuous Training and Interval Training on Selected Physiological Variables Among Delhi University College Men Students. *Aegaeum Journal*, *8*, 304–316.

Probst, M. M. (2017). *Effects Of Leg Girth And Leg Length On Division I Track Athletes Race Performance*. https://www.semanticscholar.org/paper/EFFECTS-OF-LEG-GIRTH-AND-LEG-LENGTH-ON-DIVISION-I-Probst/c0b8f2965a2d6a993907450fe863153853a5172f

Pyne, D. B., Boston, T., Martin, D. T., & Logan, A. (2000). Evaluation of the Lactate Pro blood lactate analyser. *European Journal of Applied Physiology*, *82*(1–2), 112–116. https:// doi.org/10. 1007/s004210050659

Racil, G., Coquart, J., Elmontassar, W., Haddad, M., Goebel, R., Chaouachi, A., Amri, M., & Chamari, K. (2016). Greater effects of high- compared with moderate-intensity interval training on cardio-metabolic variables, blood leptin concentration and ratings of perceived exertion in obese adolescent females. *Biology of Sport*, *33*(2), 145–152. https://doi.org/10.5604/20831862.1198633

Raghuveer, G., Hartz, J., Lubans, D., Takken, T., Wiltz, J., Mietus-Snyder, M., Perak, A., Baker-Smith, C., Pietris, N., & Edwards, N. (2020). Cardiorespiratory Fitness in Youth – An Important Marker of Health: A Scientific Statement From the American Heart Association. *Circulation*, *142*(7), e101–e118. https://doi.org/10.1161/CIR.0000000000000866

Raj, M. G., & Mohanakrishanan, R. (2019). Effect of interval training physical and physiological variables among volleyball players. *International Journal of Physiology, Nutrition and Physical Education*, *4(1)*, 1255–1258.

Rani, S. (2018). Effect of Circuit Training Programme on Endurance, Flexibility & Agility of Cricket Players. *International Journal of Research*, *5*(4), Article 4.

Rashidi, M., Salehian, O., & Vaezi, G. (2013). The effect of high intensity anaerobic training on the blood lactate levels after active recovery. *European Journal of Experimental Biology*, *3*(6), 0–0.

Reddy, J. M. (2012). COMPARISON OF CIRCUIT TRAINING METHODS ON PERFORMANCE VARIABLES OF SC/ST NON-SC/ST BOYS. *International Journal of Multidisciplinary Research*, *2*(4).

Reimers, A. K., Knapp, G., & Reimers, C.-D. (2018). Effects of Exercise on the Resting Heart Rate: A Systematic Review and Meta-Analysis of Interventional Studies. *Journal of Clinical Medicine*, *7*(12), 503. https://doi.org/10.3390/jcm7120503

Richardson, S., & Hardman, A. E. (1989). Endurance fitness and blood lactate concentration during stepping exercise in untrained subjects. *British Journal of Sports Medicine*, *23*(3), 190–193. https://doi.org/10.1136/bjsm.23.3.190

Romero-Arenas, S., Blazevich, A. J., Martínez-Pascual, M., Pérez-Gómez, J., Luque, A. J., López-Román, F. J., & Alcaraz, P. E. (2013). Effects of high-resistance circuit training in an elderly population. *Experimental Gerontology*, *48*(3), 334–340. https://doi.org/10.1016/j.exger.2013.01.007

Roy, G. S., Paul, A., & Bandopadhyyay, D. (2014). Effect of Extensive Interval Training on Lactate Threshold Level. *American Journal of Sports Science and Medicine*, *2*(5A), Article 5A. https://doi.org/10.12691/ajssm-2-5A-2

Rozenek, R., Rosenau, L., Rosenau, P., & Stone, M. H. (1993). The Effect of Intensity on Heart Rate and Blood Lactate Response to Resistance Exercise. *The Journal of Strength & Conditioning Research*, *7*(1), 51.

Saini, H. K., & Bhardwaj, D. V. (2018). Effect of plyometric and circuit training on anthropometry of Punjab state basketball players. *International Journal of Physiology, Nutrition and Physical Education*, *3*(1), 92–95.

Saiyed, M., Pais, V., Afshan, S., Shemjaz, A., & Pais, S. (2015). Relationship Of Limb Girth, Segmental Limb Length, Hamstring Flexibility With Vertical Jump In Male Sports Players. *International Journal of Current Research and Review*, *7*, 72–75.

Sakthivel, S., & Vaithiyanathan, D. K. (2022). Impact Of Circuit Training On Muscular Strength And Leg Explosive Power Among Volleyball Players. *Journal of Positive School Psychology*, *6*(10), Article 10.

Sambodo, P. T., Suharjana, M., & Santiko, G. Y. (2018). *The Effect of Circuit Training on Aerobic Fitness and Body Fat Percentage*. 472–475. https://doi.org/10.2991/yishpess-cois-18.2018.119

Sarkar, S. (2013). *Effect of Circuit Training Program on Explosive Strength and Strength Endurance of School Going Students*.

Sawka, M. N., Knowlton, R. G., Miles, D. S., & Critz, J. B. (1979). Post-competition blood lactate concentrations in collegiate swimmers. *European Journal of Applied Physiology and Occupational Physiology*, *41*(2), 93–99. https://doi.org/10.1007/BF00421656

Seo, Y.-G., Lim, H., Kim, Y., Ju, Y.-S., Choi, Y.-J., Lee, H.-J., Jang, H. B., Park, S. I., & Park, K. H. (2021). Effects of circuit training or a nutritional intervention on body mass index and other cardiometabolic outcomes in children and adolescents with overweight or obesity. *PloS One*, *16*(1), e0245875. https://doi.org/10.1371/journal.pone.0245875

Shaw, I., Triplett, T., Shaw, B. S., Shaw, I., Triplett, T., & Shaw, B. S. (2022). Resistance Training and Weight Management: Rationale and Efficacy. In *Weight Management—Challenges and Opportunities*. IntechOpen. https://doi.org/10.5772/intechopen.101840

Shekhawat, B. P. S., & Chauhan, G. S. (2021). Effect of circuit training on speed and agility of adolescent male basketball players. *International Journal of Physiology, Nutrition and Physical Education*, *6*(1), 01–05.

Shoenfeld, Y. & Keren, G. (1981). Age, weight and heart rate at rest as predictors of aerobic fitness. J Sports Med. 21:377.

Sjödin, B., & Jacobs, I. (1981). Onset of Blood Lactate Accumulation and Marathon Running Performance. *International Journal of Sports Medicine*, *02*(01), 23–26. https://doi.org/10.1055/s-2008-1034579

Smith, P. (2018, June 22). What Is Cardiorespiratory Endurance and How Can You Improve It? *BODi*. https://www.beachbodyondemand.com/blog/cardiorespiratory-endurance-definition

Sornalingam, D. (2012). Effects of Ladder Training on Selected Motor Fitness Variables Among Handball Players. *International Journal of Scientific Research*, *3*, 406–407. https://doi.org/10.15373/22778179/APR2014/144

Sperlich, B., Wallmann-Sperlich, B., Zinner, C., Stauffenberg, V. V., Losert, H., & Holmberg, H.-C. (2017). Functional High-Intensity Circuit Training Improves Body Composition, Peak Oxygen Uptake, Strength, and Alters Certain Dimensions of Quality of Life in Overweight Women. *Frontiers in Physiology*, *8*. https://doi.org/10.3389/fphys.2017.00172

Sridhar, D. K. S., & Maniazhagu, D. D. (2018). Effects of Explosive Strength And Strength Endurance Based Circuit Training On Explosive Power. *Journal of Emerging Technologies and Innovative Research (JETIR)*, *5*(11).

Stephen B. Thacker CDC Library collection. (2011). *Body mass index: Considerations for practitioners*. https://stacks.cdc.gov/view/cdc/25368

Stewart, A. (2010, December 30). *5 Best Calf Exercises: How to Increase Calf Mass*. Muscle & Strength. https://www.muscleandstrength.com/articles/top-5-exercises-increasing-calf-mass.html

Sutha, K., & Dharuman, M. (2020). *Effects of circuit training activities on flexibility of school Girls*. *33*, 39–41.

Swift, D. L., Johannsen, N. M., Lavie, C. J., Earnest, C. P., & Church, T. S. (2014). The Role of Exercise and Physical Activity in Weight Loss and Maintenance. *Progress in Cardiovascular Diseases*, *56*(4), 441–447. https://doi.org/10.1016/j.pcad.2013.09.012

Tanner, R. K., Fuller, K. L., & Ross, M. L. R. (2010). Evaluation of three portable blood lactate analysers: Lactate Pro, Lactate Scout and Lactate Plus. *European Journal of Applied Physiology*, *109*(3), 551–559. https://doi.org/10.1007/s00421-010-1379-9

Themistocleous, I.-C., Petros, A., & Stefanakis, M. (2021). Effects of Moderate-Intensity Intermittent Circuit Training in Obese and Overweight Individuals. *International Journal of Sports and Exercise Medicine*, *7*. https://doi.org/10.23937/2469-5718/1510194

Tolfrey, K., & Armstrong, N. (1995). Child-adult differences in whole blood lactate responses to incremental treadmill exercise. *British Journal of Sports Medicine*, *29*(3), 196–199.

Ucan, Y. (2014, August 19). Effects of Circuit Resistance Training on Body Composition and Bone Status in Young Males. *The Sport Journal*. https://thesportjournal.org/article/effects-of-circuit-resistance-training-on-body-composition-and-bone-status-in-young-males/

Ujuagu, N., & Uzor, T. (2020). Effects of Circuit Training Exercise on Trunk Flexibility and Muscular Endurance of Female Secondary School Teachers in Anambra State.

International Journal of Innovative Science and Research Technology, *5*, 1291–1295. https://doi.org/10.38124/IJISRT20JUN969

Vadivel, Dr. G. R., & Maniazhagu, Dr. D. (2022). Effects of Circuit Training and Circuit Weight Training on Muscular Strength Endurance. *Journal of Advances in Sports and Physical Education*, *5*(3), 38–42. https://doi.org/10.36348/jaspe.2022.v05i03.001

Vale, W., Costa, A., Machado, S., Neto, G., Penna, T., & Oliveira, A. (2020). Effect of high intensity interval training on body fat indicators in adults with overweight or obesity: Systematic review and meta-analysis of randomized studies. *Revista Andaluza de Medicina Del Deporte*, *13*. https://doi.org/10.33155/j.ramd.2020.04.008

Van Etten, L. M., Verstappen, F. T., & Westerterp, K. R. (1994). Effect of body build on weight-training-induced adaptations in body composition and muscular strength. *Medicine and Science in Sports and Exercise*, *26*(4), 515–521. https://doi.org/10.1249/00005768-199404000-00018

Venkateswarlu, K. (1975) Research on Man in Motivation. Madras: Ramons's.

Verkhoshansky Y.V. (1996). Speedand Velocity in Sports Movement, New Studies in Athletics, 11(2-3), pp. 29-37

Vescovi, J. D., Falenchuk, O., & Wells, G. D. (2011). Blood lactate concentration and clearance in elite swimmers during competition. *International Journal of Sports Physiology and Performance*, *6*(1), 106–117. https://doi.org/10.1123/ijspp.6.1.106

Vinayagamoorthi, A., & Sakthival, A. (2014). Effect of Cardiac Circuit Training on selected Physical and Physiological variables of high school boys. *Journal of Academic Sports Scholar*, *3*(8). https://scholar.google.com/scholar?cluster=8698917905149615575&hl=en&oi=scholarr

Vinu, D. W. (2012). The effect of circuit training and circuit weight training with and with out protein supplementary on thigh girth. *The Pharma Innovation*, *1*, 73–78.

Vrachimis, A., Hadjicharalambous, M., & Tyler, C. (2016). The Effect of Circuit Training on Resting Heart Rate Variability, Cardiovascular Disease Risk Factors and Physical Fitness

in Healthy Untrained Adults. *Health*, *8*(2), Article 2. https://doi.org/10.4236/health.2016.82017

Walke, B. (2008, July 23). *What is Interval Training? | Examples of Interval Training*. https://stretchcoach.com/articles/interval-training/

Wang, P.-C., Yeh, W.-C., Tsai, Y.-W., & Chen, J.-Y. (2022). Calf circumference has a positive correlation with physical performance among community-dwelling middle-aged, older women. *Frontiers in Public Health*, *10*, 1038491. https://doi.org/10.3389/fpubh.2022.1038491

Wang, X., Liu, Z., Zhang, H., & Ji, C. (2023). Effects of High-Intensity Interval Training on Executive Functions in College Students: Evidence from Different Doses. *Brain Sciences*, *13*(4), 571. https://doi.org/10.3390/brainsci13040571

Wesley, C., & Kivi, D. (2017). The Effects of Kettlebell Mass and Swing Cadence on Heart Rate, Blood Lactate, and Rating of Perceived Exertion during an Interval Training Protocol. *International Journal of Sports Science*, *7*(3), 122–127.

Wewege, M., Berg, R., Ward, R., & Keech, A. (2017). The effects of high-intensity interval training vs. moderate-intensity continuous training on body composition in overweight and obese adults: A systematic review and meta-analysis: Exercise for improving body composition. *Obesity Reviews*, *18*. https://doi.org/10.1111/obr.12532

Yoshida, T., Suda, Y., & Takeuchi, N. (1982). Endurance training regimen based upon arterial blood lactate: Effects on anaerobic threshold. *European Journal of Applied Physiology and Occupational Physiology*, *49*(2), 223–230. https://doi.org/10.1007/BF02334071

Yue, T., Wang, Y., Liu, H., Kong, Z., & Qi, F. (2022). Effects of High-Intensity Interval vs. Moderate-Intensity Continuous Training on Cardiac Rehabilitation in Patients With Cardiovascular Disease: A Systematic Review and Meta-Analysis. *Frontiers in Cardiovascular Medicine*, *9*. https://doi.org/10.3389/fcvm.2022.845225

Zarwan, Sefri, H., & Ade, Z. (2020). *Effect of Interval Training Method On Improving Physical Conditions*. 972–975. https://doi.org/10.2991/assehr.k.200824.216

Zhao, T., Le, S., Freitag, N., Schumann, M., Wang, X., & Cheng, S. (2021). Effect of Chronic Exercise Training on Blood Lactate Metabolism Among Patients With Type 2 Diabetes Mellitus: A Systematic Review and Meta-Analysis. *Frontiers in Physiology*, *12*, 652023. https://doi.org/10.3389/fphys.2021.652023

RECORD CARD FOR STUDENTS PERFORMANCES

STUDENTS NAME: AGE:

SCHOOL NAME:

TYPE OF TRAINING: CCT / ICT

STATION NUMBER	NAME OF THE EXERCISE	NUMBER OF REPETITION	TIME OF REPETITION FOR ONE STATION	TIME FOR ONE CIRCUIT	RESTING TIME IN BETWEEN CIRCUIT	TOTAL TIME FOR THREE CIRCUIT
1	**SPOT JUMP**		30 SEC	1 ST		
2	**PUSH UPS**		30 SEC			
3	**HIGH KNEE**		20 SEC			
4	**SIT UPS**		1 MIN	2 ND		
5	**BOX JUMP**		30 SEC			
6	**SQUAT THRUST**		1 MIN			
7	**SHUTTLE RUN**	4 X 10 MT		3 RD		
8	**STEPS UP**		1 MIN			

RECORD CARD FOR TRAINING PROTOCOL

STUDENTS NAME: AGE:

SCHOOL NAME:

TYPE OF TRAINING: CCT / ICT

MONTH OF EXERCISE: 1st / 2nd / 3rd

INTENSITY OF EXERCISE: 70% / 75% / 80%

STATION NUMBER	NAME OF THE EXERCISE	NUMBER OF REPETITION			TIME OF REPETITION FOR ONE STATION	TIME FOR ONE CIRCUIT	RESTING TIME IN BETWEEN CIRCUIT	TOTAL TIME FOR THREE CIRCUIT
1	**SPOT JUMP**				30 SEC	1 ST		
2	**PUSH UPS**				30 SEC			
3	**HIGH KNEE**				20 SEC			
4	**SIT UPS**				1 MIN	2 ND		
5	**BOX JUMP**				30 SEC			
6	**SQUAT THRUST**				1 MIN			
7	**SHUTTLE RUN**	4 X 10 MT				3 RD		
8	**STEPS UP**				1 MIN			

PURULIA CRICKET ACADEMY

DI OFFICE MORE, PURULIA, WEST BENGAL-723102

Reg No: S0009824 ESTD: 2017

From:

The Secretary

To whom it may concern

This is to certified that Mr. Sk Saha Alam, son of Sk Noor Alam , Research Scholar from Jadavpur University, has completed his twelve (12) weeks training programme and gathered research data from this academy's students.

We observed him to be extremely engaged, genuine, and dedicated throughout this research program period. I wish him the best of luck in the future.

Prakash Singh 04.03.2020

Secretary

Purulia Cricket Academy

Secretary
Purulia Cricket Academy

PICTURES OF DATA COLLECTION

PIC 1: PERCENTAGE OF BODY FAT (%)

PIC 2: CALF GIRTH

PIC 3: THIGH GIRTH

PIC 4: SPEED (50 YARDS DASH)

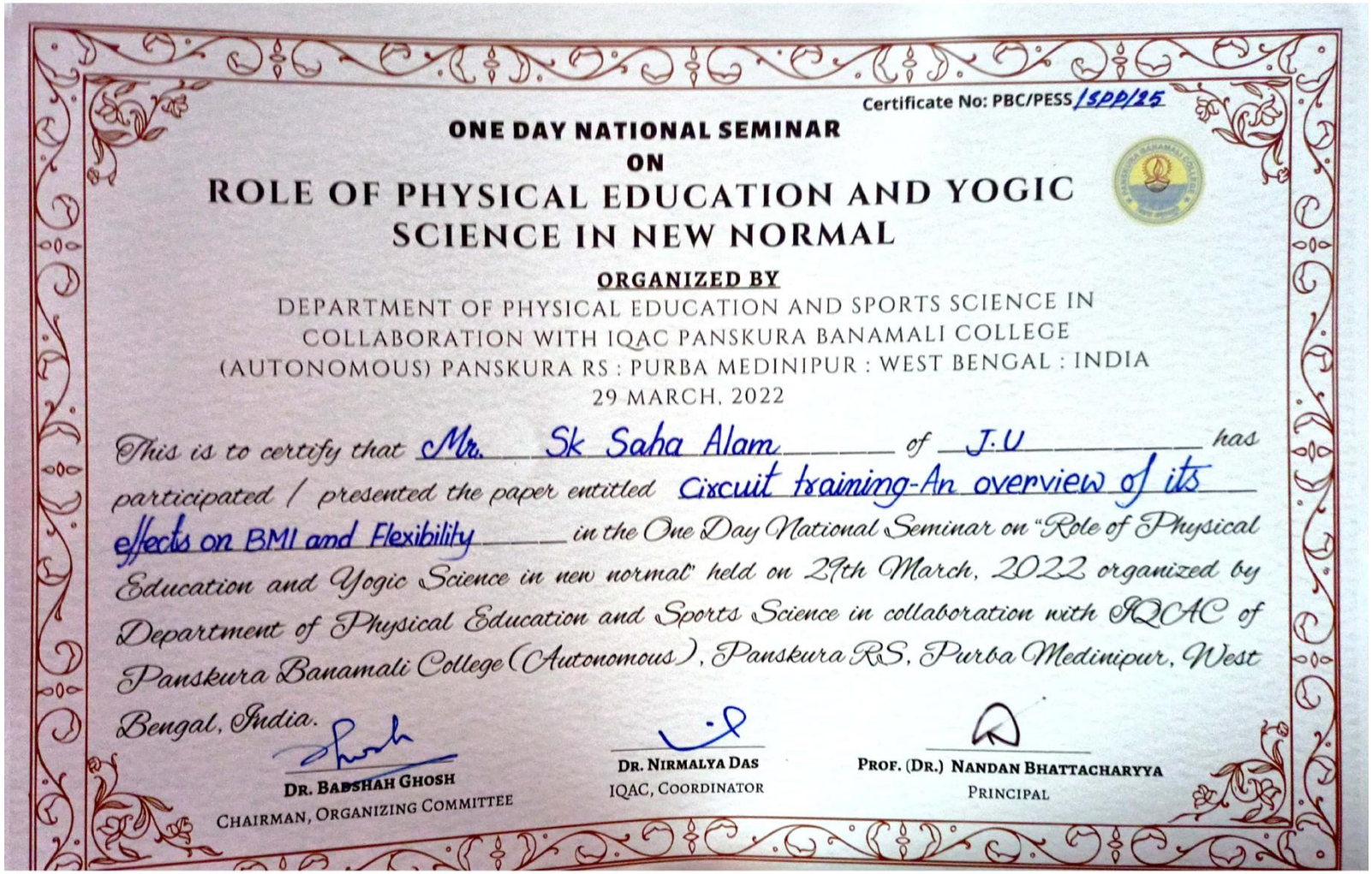
PIC 5: AGILITY (SHUTTLE RUN)

PIC 5: LEG EXPLOSIVE STRENGTH (STANDING BROAD JUMP)

PIC 6: CARDIO RESPIRATORY ENDURANCE

PIC 7: FLEXIBILITY (MODIFIED SIT-AND-REACH TEST)

PIC 8: BLOOD COLLECTION



Certificate No: PBC/PESS/SPD/25

ONE DAY NATIONAL SEMINAR

ON

ROLE OF PHYSICAL EDUCATION AND YOGIC SCIENCE IN NEW NORMAL

ORGANIZED BY

DEPARTMENT OF PHYSICAL EDUCATION AND SPORTS SCIENCE IN COLLABORATION WITH IQAC PANSKURA BANAMALI COLLEGE (AUTONOMOUS) PANSKURA RS : PURBA MEDINIPUR : WEST BENGAL : INDIA

29 MARCH, 2022

This is to certify that Mr. Sk Saha Alam of J.U has participated / presented the paper entitled Circuit training-An overview of its effects on BMI and Flexibility in the One Day National Seminar on "Role of Physical Education and Yogic Science in new normal" held on 29th March, 2022 organized by Department of Physical Education and Sports Science in collaboration with IQAC of Panskura Banamali College (Autonomous), Panskura RS, Purba Medinipur, West Bengal, India.

Dr. Badshah Ghosh
Chairman, Organizing Committee

Dr. Nirmalya Das
IQAC, Coordinator

Prof. (Dr.) Nandan Bhattacharyya
Principal

International Journal of Advance Research, Ideas and Innovations in Technology

INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078
(Volume 7, Issue 4 - V7I4-1812)
Available online at: https://www.ijariit.com

Effects of different circuit training methods on agility and speed ability: A comparative study

Sk Saha Alam
sahaalamfootball@gmail.com
Jadavpur University, Kolkata, West Bengal

Dr. Sudip Sundar Das
dassudip2006@rediffmail.com
Jadavpur University, Kolkata, West Bengal

ABSTRACT

The intention of present study was to investigate the effects of continuous and interval circuit training on agility and speed ability of secondary level school students. Total 60 boys' students, age level 13 to 16 years were randomly selected as sample from Purulia district of West Bengal, India. Samples were equally divided into three groups: continuous circuit training group (CCT), interval circuit training group (ICT) and Control group (CG). CCT and ICT groups participated in specific training programme for three days per week; the training was composed for 12 weeks. On the other hand, CG was on normal life activity. The data was collected before and after the application of training protocol on agility and speed. 't' test and ANOVA was used to find out the statistical significance. The level of significant for the study was selected as 0.05. The investigation concluded that interval and continuous circuit training does have significant positive effect to enhance Physical fitness components speed and agility even after 12 weeks of training on secondary level school students.

Keywords: *Sports Training, circuit training, Interval Training, Continuous Training, Speed, Agility.*

1. INTRODUCTION

Current Sports training is an extremely popular impression in whole world because sports performance is the most discussible phenomenon. Sports' training is a particular process of preparation of sports personnel based on systematic and scientific principles designed at improving and maintaining advanced performance ability in different sports activities. There are different methods of sports training, such as circuit training, continuous training, interval training, plyometric training, weight training, fartlek training etc. Among all these Circuit training processes was founded by R. E. Morgan and G. T. Adamson. Aim of Circuit training can be designed to develop strength, muscular endurance, speed, agility, neuromuscular-coordination, flexibility, cardiovascular endurance etc. Several research investigations have even established that circuit training is the most competent way to enhance muscle endurance, speed, agility etc. In sports area motor abilities, as capability specify limits that impact the person's prospective for performance success in skills. The circuit training design utilizes a set of 8 to 10 exercises which will be performed exercise one after another. Every exercise is performed for a particular number of repetitions or for a particular time period prior to move on to the next exercise. It provides an attractive preparation environment for the athlete and there are composed times and intensity to encourage the athlete to prolong mobility and staying power.

Circuit training is an excellent way to improve overall fitness level for an athlete and also for general people. Peoples are gradually being inactive because society gets active supports by machine. Actually, machine can give production approximate ten times more than manual production, so generally we are depending very much on machine for socio economical demand. Inactivity, type of lifestyle, mental depression these types of several phenomenon generate various types of hypo kinetic diseases and health risks factors in whole world. Need to keep in our mind Inactive lifestyle can make a rigid wall for health progress. It may be physical health, mental health or social heath. To make peace in life for the purpose of profession, daily house work, recreation, social work, family work, require to engage with various types of physical or mental activities. Some training or special support of learning can help to human for bring a value life. It may be in the field of general education, sports, mechanical, agriculture etc. Activity and physical movement help to maintain our normal physical fitness, Control the weight, minimize the risk of heart disease, minimize the risk for diabetes, Strengthen the bones and muscles, Improve the mental health and improve the ability to do daily activities. Traditionally, it has been viewed as a combination of factors that are basic to all movements involving such elements of physical fitness as strength, speed, agility, flexibility and so on. Sports training and series of exercises are very important for sports performers as well as for general people. For application of any sports training or exercises schedule maintain some principles and special demand such as Who is the trainee, what is the capacity of performer, volume of the training,

Portrait of the Society

First Published: 15th August, 2022

ISBN 978-93-91771-07-2

Published by:

CRESCENT PUBLISHING CORPORATION

4806/24, Mathur Lane,
Ansari Road, Darya Ganj,
New Delhi - 110 002
Ph.: 011 - 23244131
Mob.: + 91 - 9711991838, 9999021668
E-mail: crescentbook@gmail.com
Website: www.crescentpublishingcorp.weebly.com

Cover page Painted and Designed by:
Anasuya Adhikari

Printed at:
Roshan Offset Printers
Delhi

PRINTED IN INDIA

15

Physical Training and Fitness for Human Body to the Benefit of Society : An Experimental Study

S.K. Saha Alam & Dr. Sudip Sundar Das

Abstract

The investigator tried to explore the effect of physical training on physical fitness for the benefit to the people of society. For this experimental study, total forty boy's students age ranges of 13 to 16 years were randomly selected as sample from Purulia district of west Bengal, India. All the Samples were equally divided into two groups, Such as circuit training group (CT) and Control group (CG). Circuit training group participated in specific training methods for three days per week; the training was composed for 12 weeks. And the other side, CG was follow normal life activity. Data of this study was collected before and after the application of training protocol on two physical fitness components such as Flexibility and leg Explosive strength. 't' test was used to find out the statistical significance. The level of significant for the study was selected as 0.05. The researcher concluded that circuit training methods does have significant positive outcome to improve Physical fitness components as flexibility and leg explosive strength after 12 weeks of physical training on school going students.

Keywords: Physical Fitness, circuit training, flexibility, health, social benefit.

Introduction

A fit personality is one who gets pleasure from quality of life. To make a successful nation need healthy people because

COMPARISON OF TRAINING EFFECTS OF CONTINUOUS AND INTERVAL CIRCUIT TRAINING METHODS

ORIGINALITY REPORT

9%
SIMILARITY INDEX

PRIMARY SOURCES

1	www.ijariit.com Internet	1452 words — 4%
2	ijless.kypublications.com Internet	449 words — 1%
3	ijems.net Internet	327 words — 1%
4	ijhpecss.org Internet	252 words — 1%
5	www.journalofsports.com Internet	189 words — < 1%
6	Katerina Spanoudaki, Panayiotis Dimitriadis, Emmanouil A. Varouchakis, Gerald A. Corzo Perez. "Estimation of Hydropower Potential Using Bayesian and Stochastic Approaches for Streamflow Simulation and Accounting for the Intermediate Storage Retention", Energies, 2022 Crossref	144 words — < 1%
7	tnsroindia.org.in Internet	144 words — < 1%
8	s3-ap-southeast-1.amazonaws.com	