EFFECT OF CIRCUIT AND YOGIC TRAINING PROGRAMMES ON SELECTED PHYSICAL AND PHYSIOLOGICAL COMPONENTS AMONG OBESE CHILDREN

By

SHEJIN K V

Research Supervisor

Dr. T. VIVEKANANDHAN

A THESIS

SUBMITTED TO THE UNIVERSITY OF CALICUT THROUGH THE DEPARTMENT OF PHYSICAL EDUCATION FOR THE FULFILLMENT OF THE REQUIREMENT FOR THE DOCTOR OF PHILOSOPHY IN PHYSICAL EDUCATION

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DECEMBER 2020

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CERTIFICATE

This is certify that the thesis entitled **"EFFECT OF CIRCUIT AND YOGIC TRAINING PROGRAMMES ON SELECTED PHYSICAL AND PHYSIOLOGICAL COMPONENTS AMONG OBESE CHILDREN"** submitted to the University of Calicut, in fulfillment of the requirements for the award of the degree of Doctor of Philosophy in Physical Education is recorded of original research work done by **Mr. Shejin K V**, during the period of 2015 – 2020 of his study in the Department of Physical Education, University of Calicut, Thenjipalam, under my supervision and guidance and the thesis has not previously formed on the basis for the award of any Degree/Diploma/Associate ship/Fellowship or any other similar title and it represents entirely an independent work on the part of the candidate.

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DECLARATION

I hereby declare that the thesis entitled **"EFFECT OF CIRCUIT AND YOGIC TRAINING PROGRAMMES ON SELECTED PHYSICAL AND PHYSIOLOGICAL COMPONENTS AMONG OBESE CHILDREN"** submitted to the University of Calicut, in fulfillment of the requirements for the award of the degree of **Doctor of Philosophy** in Physical Education is recorded of original research work done by me under the supervision and guidance of **Dr. T. Vivekanandhan, Associate Professor, Christ College, Irinjalakuda, Thrissur** and it has not formed before on the basis for the award of any Degree/Diploma/Associate ship/Fellowship or any other similar title.

Signature of the Candidate

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Date:

Dedicated to

My Parents, Family & Friends

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5. 'Childhood Obesity – An overview', Proceedings of National Seminar "Life style diseases and Women's Health- A Dietary Perspective", ISBN: 978-81-925229-9-9, Dec 2016, pp 41-45.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The purpose of the life is to lead joyful, happy, worthy and healthy being. Health is the foundation of happy life. Good health provides freedom from disease, maximum efficiency and longevity, beauty of radiance, joyous living, modest character and attractive personality. The health is multi factorial and it is not based on only one thing. Modern industrialization and computerization have, along with its large amount of benefits, brought certain disadvantages too. One of the main disadvantages is physical inactivity. Physical activity is any bodily movement produced by skeletal muscles resulting in energy expenditure. Maintenance of good physical fitness enables one to meet the physical demands of work and leisure comfortably. People with higher levels of physical fitness are also at lower risk of developing chronic disease. Conversely, a sedentary lifestyle increases risk for overweight and obesity and many chronic diseases, including coronary artery disease, hypertension, type II diabetes, osteoporosis, and certain types of cancers. Overall, mortality rates from all causes of death are lower in physically active people than in sedentary people. Hence regular physical activity is a key factor for achieving and maintaining a healthy body among adults and children. Overweight and obesity is a global epidemic among children of all ages. Consequently, it is seen that, one-half of obese school children become obese adults. Keeping this in mind the researcher has selected the topic to find out the effect of circuit and yogic training programme on selected physical and physiological components.

The study is conducted among obese school children. To achieve the purpose of this study the scholar selected ninety (N-90) obese students from three different CBSE schools namely Chinmaya Vidyalaya, Thrissur, S N Vidyabhavan, Chenthrapinni, Thrissur, and HIRA English School, Kaipamangalam, Thrissur. The selected schools are located in the northern part of the Thrissur District, Kerala, India. Sample group's age ranged from 10 to 14 years. The selected ninety subjects (N=90) were randomly divided into three equal groups of thirty (n-30) subjects each. The groups were named as experimental group-I, experimental group-II and Control group III. All the selected subjects were tested on selected physical and physiological variables namely, Body Mass Index, Percent Body Fat, Cardio Respiratory Endurance; Muscular Strength and Endurance, Flexibility and Vital Capacity, and the readings were carefully recorded in their respective units as pre-test scores. After pre-test, Experimental group-I was treated

with Circuit training (CTG) and Experimental group-II was treated with Yogic training (YTG) for three days per week in the evening session for a total duration of sixteen weeks, whereas the Control group (CG) was not exposed to any specific training other than their regular activities. At the end of the treatment period of sixteen weeks, all the subjects were tested again on selected physical and physiological variables and their readings were carefully recorded in their respective units as post-test scores. The pre and post- test scores were analyzed with appropriate statistical tools. To find out the difference between pre and post-test of each group, paired t- test was used. Analysis of covariance (ANCOVA) was computed. The difference between Mean values of the three groups in the pre-test was taken into account during the analysis of the post-test differences between the mean values. This was achieved by the application of the analysis of covariance, where the final mean values were adjusted for differences in the initial means, and the adjusted means were tested for significance. Whenever the adjusted post-test means were found significant, the Bonferroni post-hoc test was administered to find out the paired means difference. To test the obtained results on variables, the level of significance was fixed at 0.05 levels.

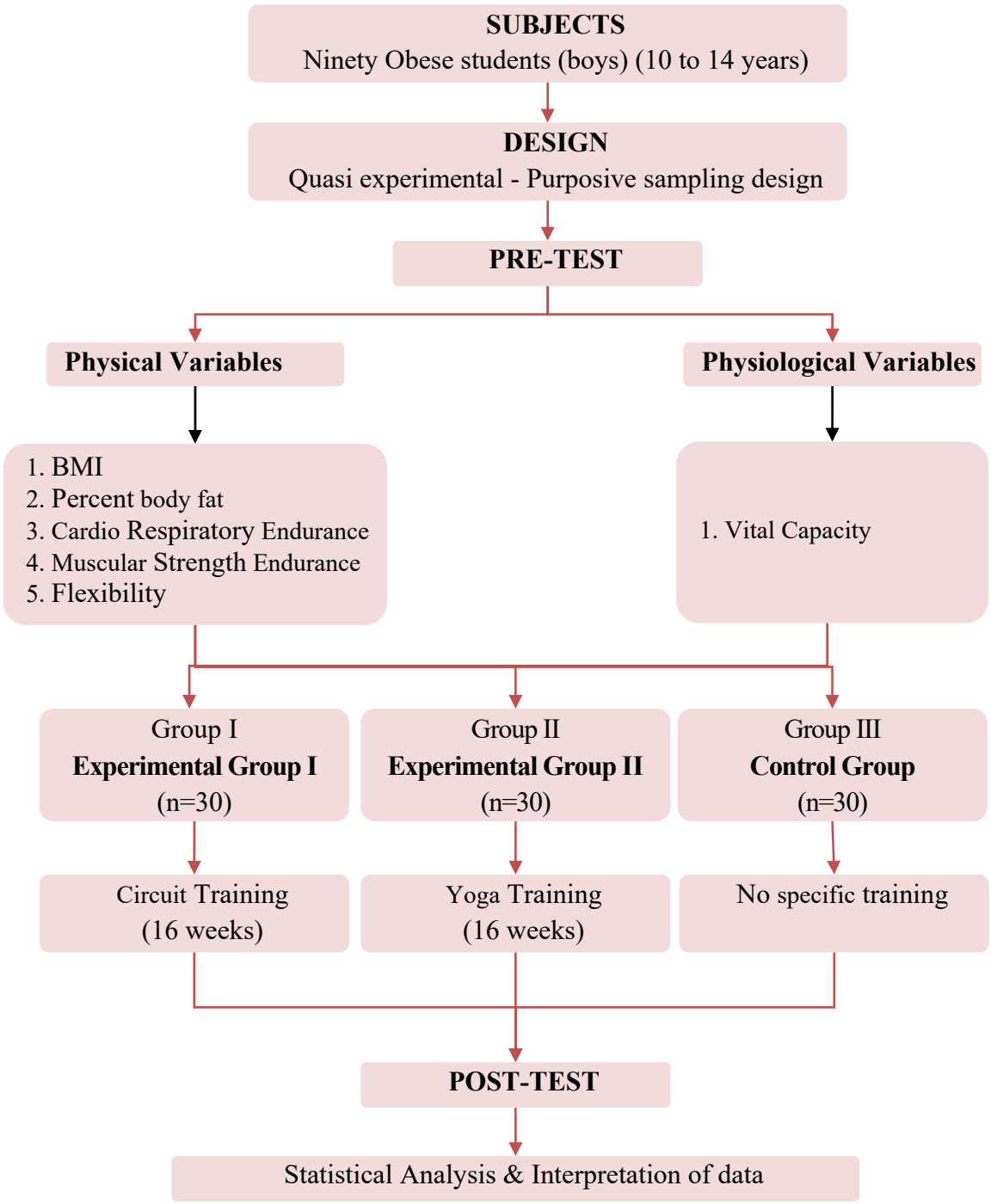
Based on the analysis of the data and results the following conclusions were drawn. The Circuit Training (CTG) and Yoga Training (YTG) had significant improvement over the period of sixteen weeks of training on body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children from base line to post test. The Control Group (CG) did not show any significant improvement when comparing the effect of Circuit training (CTG) and Yoga Training (YTG).

It was concluded that both the experimental groups (CTG &YTG) were produced significant improvement over the period of sixteen weeks of training on selected physical and physiological variables of obese children than the Control Group. When Comparing the effect of Circuit training and Yoga training (YTG), it was concluded that Circuit training (CTG) group has produced significant improvement on body mass index and muscular strength and endurance better than the Yogic training group. Yogic training group produced significant improvement on flexibility than the Circuit training and control group. Circuit and yogic training produced equal effect on percent body fat, cardio respiratory endurance and vital capacity.

As per overall analysis of the results of this study, it was concluded that Circuit Training was the suitable training to maintain perfect body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance and vital capacity of obese children. Further, from the results of this study it was concluded that Yoga Training was the suitable training to develop percent body fat and flexibility of obese children.

Key words: Circuit training, Yogic training, Body Mass Index, Percent body fat, Cardio respiratory endurance, Muscular strength endurance, Flexibility, Vital capacity.

RESEARCH FLOW CHART



CHAPTER I

INTRODUCTION

The purpose of the life is to lead joyful, happy, worthy and healthy well being. Health is the foundation of happy life. Good health provides freedom from disease, maximum efficiency and longevity, beauty of radiance, joyous living, sound character and attractive personality. The health is multi factorial and it is not based on one thing. The experts widely consider that the pillars of health are exercise, good nutrition, relaxation and sound sleep that are crucial to healthy living. The World Health Organization defines health as a state of complete physical, mental and social well-being and not merely the absence of disease and infirmity and fitness as the ability to perform muscular work satisfactorily and the Center for Disease Controls define it as set of attributes that people have or achieve that relates to the ability to perform physical activity (Kapur and Batiga, 1994). A recent consensus conference also defined fitness, in a broad sense, so as to include both physical fitness and physiological fitness, which extends to biological systems influenced by the level of habitual physical activity. (Gutin 1992)

1.1 PHYSICAL FITNESS

Modern industrialization and computerization have, alongside its large amount of benefits has brought certain disadvantages. One of the main disadvantages is physical inactivity. According to World Health Organization, ‘physical inactivity contributes annually two million deaths globally’. Regular physical activity and physical fitness make important contributions to one’s health, sense of well-being and maintenance of a healthy body weight. Physical activity is defined as any bodily movement produced by skeletal muscles resulting in energy expenditure. In contrast, physical fitness is a multi-component trait related to the ability to perform physical activity. Maintenance of good physical fitness enables one to meet the physical demands of work and leisure comfortably. People with higher levels of physical fitness are also at lower risk of developing chronic disease. Conversely, a sedentary lifestyle increases risk for overweight and obesity and many chronic diseases, including coronary artery disease, hypertension, type-2diabetes, osteoporosis, and certain types of cancer. Overall, mortality

rates from all causes of death are lower in physically active people than in sedentary people. Hence regular physical activity is a key factor for achieving and maintaining a healthy body weight of adults and children.

For many years interest in children's physical activity has focused upon beneficial health-related outcomes, such as reduced risk of cardiovascular disease, osteoporosis, and obesity. From a socio-psychological vantage, however, the focus on consequences of physical activity precludes an understanding of the determinants of physical activity behavior. That is, what motivates children and teenagers to continue and sustain physical activity levels? *Why* is there such a dramatic decline in physical activity during adolescence, and *how* can we stem the tide of declining physical activity levels? Such a motivational perspective hones in on possible intervention strategies that can be implemented by parents, teachers, coaches, and peer groups who play such an active role in the lives of youth in home, neighborhood, school, and sport contexts. Keeping kids motivated to participate in physical activities will then naturally lead to touted health outcomes. (Maureen R Weiss, 2000)

In 1950, India faced two major nutritional problems. One was the threat of famine and the resultant acute starvation and the other was chronic energy deficiency. The country adopted a multisectoral, multipronged strategy to combat these problems and improve the nutritional status of the population. This followed by green revolution and industrialization. In 1992 Govt. of India adopted open market policies, which brought in rapid industrialization throughout the country. Review of the situation in 2000/2001 prior to formulation of the Tenth Five-Year Plan (Planning Commission, 2002) showed that although under nutrition and micronutrient deficiencies continue to be major public health problems, over nutrition and obesity are also emerging as a major problem in many states. There is a paradigm shift in the quality of life in urban population resulting in substantial increase in childhood as well as adult obesity in the urban population. It is observed that 30% of obesity begins in childhood and out of that 50% to 80% become obese adults. (Biswajit M, 2007)

In the Harvard study, morbidity from cardiovascular disease, diabetes, obesity related cancers and arthritis was 50-100% higher in obese individuals who were also obese as children. With the increase in obesity prevalence there is a parallel increase in obesity associated chronic diseases and their clinical onset at ever younger ages. The

obesity has reached an epidemic proportion in urban Indian population. If we allow this epidemic to continue we will top the world in Diabetes and CHD earlier than estimated. The cost of treating diabetes mellitus and associated disorders alone will consume a major chunk of our national resources, which we can ill afford. Only community based approaches can address such large numbers of affected children. (Must A *et al*, 1992).

1.2 CHILDHOOD OVERWEIGHT AND OBESITY: AFFECTING FACTORS

Overweight and obesity is a global epidemic among children of all ages. One-half of obese school children become obese adults. However, whether or not obesity persists into adulthood, obesity in childhood appears to increase the risk of subsequent morbidity. Significance of estimating prevalence of childhood obesity thus cannot be overemphasized.

There are a few studies reporting, prevalence of childhood and adolescent obesity and overweight from different parts of India (Punjab, Maharashtra, Delhi and South India) that range from 3% to 29%, and also indicate that the prevalence is higher in urban than in rural areas. According to the World Health Organization (WHO), the prevalence of combined overweight and obesity in children rose by 47.1% between 1980 and 2013. In 2014, an estimated 41 million children under the age of five years were affected by overweight and obesity. The recent reports of WHO published, the rates of overweight and obesity continue to grow in adults and children. From 1975 to 2016, the prevalence of overweight or obese children and adolescents aged 5–19 years increased more than four-fold from 4% to 18% globally. The rise has occurred similarly among both boys and girls: in 2016 18% of girls and 19% of boys were overweight.

As per the recent global estimates by World Health Organization, in 2016, more than 1.9 billion adults aged 18 years and older were overweight. Of these over 650 million adults were obese and 39% of adults aged 18 years and over (39% of men and 40% of women) were overweight. Overall, about 13% of the world's adult populations (11% of men and 15% of women) were obese in 2016. And the worldwide prevalence of obesity nearly tripled between 1975 and 2016. In 2019, an estimated 38.2 million children under the age of 5 years were overweight or obese. Once considered a high-income country problem, overweight and obesity are now on the rise in low- and middle-

income countries, particularly in urban settings. In Africa, the number of overweight children under 5 has increased by nearly 24% percent since 2000. Almost half of the children under 5 who were overweight or obese in 2019 lived in Asia. Globally, over 340 million children and adolescents aged 5-19 were overweight or obese in 2016.

Obesity is one of the most prevalent nutritional diseases of children and adolescents in many developed and developing countries (WHO consultation on obesity: WHO 1998). The World Health Organization (WHO) has declared overweight as one of the top ten health risks in the world and one of the top five in developed nations(The World Health Report: WHO, 2002).Existing WHO standards and data from 79 developing countries including a number of industrialized countries suggest that about 22 million children of five years old are overweight worldwide (The World Health Report: WHO, 1998).Once considered a problem of affluence, obesity is fast growing in many developing countries also(WHO: IOTF, 2000). Even in countries like India, which are typically known for high prevalence of under nutrition, a significant proportion of overweight and obese children now coexist with those who are under nourished. (Popkin B M*et al,* 2001).

Pre- primary and primary school children who are over weighted and obese are more likely to continue to be obese as adolescents and adults, as well as stand at an increased risk for poor health outcomes associated with excess weight. While the central physical cause of overweightness and obesity is the imbalance of energy intake from food and energy expended through physical activity, excess weight is also caused by a number of other contributory factors including personal, social, and environmental influences. Among school-aged children, there seems to be substantial interest and resources currently being devoted to primary and secondary prevention, though intervention studies have yielded somewhat mixed results. Education, interventions, and evaluations of the effectiveness and outcomes of new initiatives aiming to reduce childhood overweight and obesity are needed to recommend future programs with the greatest likelihood of success. (Williams SE and Greene JL*et al,* 2018).

In the study, "Obesity in Indian Children" published by the pediatric cardiology team of Amrita Institute of Medical Sciences in National Medical Journal of India in 2008, conducted among 24,000 school children in Kerala, it was found that the proportion of overweight children had increased from 4.94% of the total students in 2003

to 6.57% in 2005, showing the rapidly rising graph of obesity in the state. It also highlighted the fact that Type 2 diabetes was growing among urban children.

The central physical cause of overweightness and obesity is the imbalance of energy intake from food and energy expended through physical activity. This physical problem is most often the causal factor studied in childhood obesity. However, excess weight is also caused by a number of other causative factors including personal, social, and environmental influences that pose more challenges in terms of understanding, measurement, and change. Personal characteristics and behaviors can negatively impact a child's weight, mental health, and sleep. Social and environmental factors include those influences in the home, school, community, and society. For instance, family and friends influence and support one's lifestyle and daily habits; schools are apparently providing fewer opportunities for physical activity, due to a greater emphasis on academic achievement; and environmental factors including community resources and even media in society are sending conflicting messages concerning a healthy lifestyle. Scientific research has identified a number of components that may contribute to childhood overweightness and obesity. They are; nutrition, physical activity, mental health and mood, sleep, hygiene, and media usage.

1.3 OBESITY AND ITS RISK FACTORS

The obesity has been defined as a condition of abnormal or excessive fat accumulation in adipose tissue, to the extent that health may be impaired (WHO consultation on obesity 2000). It is estimated that there are more than 300 million obese people worldwide. Urbanization and modernization, sedentary life, consumption of oily and junk food and other life style changes has contributed to overweight and obesity. The calculated global prevalence of overweight (including obesity) in children aged 5-17 years is estimated by the World Health Organization (WHO), International Obesity Task Force (IOTF) to be approximately 10%. Various studies in India have found that the incidence of childhood overweight/obesity has increased dramatically. Obesity is not an immediate lethal disease itself, but it is a significant risk factor associated with a range of serious non-communicable diseases and conditions like increased risk of coronary heart disease, hypertension, diabetes mellitus, and gallstone etc. (WHO, 2008)

1.4 SOCIO-CULTURAL ISSUES AND CHILDHOOD OBESITY IN INDIA

1. There is a general delusion among parents in India and other developing countries that an obese child is a healthy child. And that if the child is fat, 'baby fat' will go away with time. In an effort to keep child "healthy" he/she fed in excess. Many of children remain obese for life.

2. High burden of school work and academic competiveness have led to decreased participation in sports and any other form of physical activity. This is particularly true for girls who are sedentary from school years. Many of the studies from India show that female have more obesity and the metabolic syndrome as compared to males

3. The lack of appropriate play area and limited open space around home makes it difficult for children to stay physically active.

4. Parents are often overworked and find it easy to let children order "fast foods" and hardly have any time to oversee balanced nutrition for children.

5. Children spend more time in front of television and computers at the expense of sports and physical activity. (Swati Bhardwaj *et al,* 2008).

1.5 BODY MASS INDEX

The BMI is an index of weight adjusted for stature. It is one of the useful tools for diagnosing obesity or malnutrition; however, such diagnosis should take into account a person's age, gender, fitness, and ethnicity. The BMI has also been associated with mortality, with lower values generally correlating with longer life. Since ethnicity has shown to require adjustments to the levels of concern for the BMI, care must be taken when comparing different population groups.

Body mass index (BMI) or Quetelet Index is a statistical measure of the weight of a person scaled according to height. It was invented between 1830 and 1850 by the Belgian polymath Adolphe Quetelet during the course of developing "social physics". It is weight adjusted for height squared (weight in kg/ height in m^2), a useful index to assess overweight and is fairly reliable surrogate for adiposity. As a measure, BMI become popular during the early 1980s as obesity started to become a discernible issue in prosperous Western society. However, the limitation of BMI is that it cannot differentiate

muscle mass to body fat and cannot locate the site of fat e.g., people with ‘central obesity’ may have normal BMIs. (WHO consultation on obesity, 2000)

1.6 CIRCUIT TRAINING

Circuit training is a form of training where participants rotate through a number of stations, performing different exercises to time or repetitions, back to back, with minimum rest until the circuit is completed. There are various ways of constructing a circuit, but they would normally contain several movements including body weight, weighted and dynamic exercises. The great thing about circuits is the adaptability. They can be developed for cardiovascular improvement, strength, mobility, sport specific and virtually anything. They also don’t need a lot of space or time and don’t need to be overly complicated.

Circuit training is an often overlooked method for securing one's fitness and body composition goals. Circuit training is a form of body conditioning or endurance training or resistance training using high-intensity. It targets strength building or muscular endurance. An exercise "circuit" is one completion of all prescribed exercises in the program. Circuit training was first proposed by Morgan and Adamson (1959) of Leeds University as a method for developing general fitness. Their initial circuit training routine consisted of several stations arranged in circle (hence the name circuit training) so as to work muscle groups alternately form station to station. A wide variety of exercise and devices can be used in a circuit training routine, such as body weight, surgical tubing, medicine balls, dumbbells, barbells and any strength training machines. A circuit may be of short (6 to 9 exercises), medium (9 to 12 exercises) or long (12 to 15 exercises) duration and may be repeated several times depending on the number of exercise involved. In deciding the number of circuits, the number of repetitions per stations, and the load, coaches must consider the athlete’s work tolerance and fitness level.

1.6.1 Effect of Circuit Training

Circuit training may be designed to increase muscular strength and power, muscular endurance, flexibility and to a limited extent, cardio respiratory endurance. However the physiological effects depend to a large extent on the type of circuit that is set up. Circuit consisting only of weight resistance exercise produces substantial gain in strength but only minimal gains in cardio respiratory endurance. Circuit training is an effective training technique for altering muscular strength and endurance, and to a limited extent, flexibility, cardio respiratory endurance and cardiovascular fitness. The use of circuit training is particularly for off-season programs, therefore may be recommended for athletes sports require high levels of muscular endurance, power and endurance and lower level of cardio respiratory endurance.

1.7 YOGIC PRACTICES

The term Yoga comes from a Sanskrit word which means Yoke or union. Yoga is an art of life. It is science of life, and it is a kind of exercise to attain spiritual growth. It brings about a holistic development in humans. It paves the way for the self-confidence and principled living. It is the science of controlling mind which is responsible for one's action. Once a person controls his mind and his five senses he will be free of all distractions and hence make him more productive. Consistent and systematic practice of this art will make man healthier. Yoga is a systematic and methodical process to control and develop the mind and body to attain good health, balance of mind and self-realization. Thought yoga has the potential power to make us healthy added to our vigor, still most people lack the knowledge of systematic practice of yoga? They perform yogic exercises for a short period and when their health improves, they discontinue the yoga practice. For this reason, the effective results of yogic practices cannot be determined perfectly. Many scientists, doctors, psychologists etc, all over the world are extensively studying the beneficial aspects of yoga which encourages us to attain positive health through yoga. If one practices the Asanas and Pranayama regularly and systematically for long period, it is sure to find that they act as curatives of and preventives for various kinds of mental and physical ailments. The body will become light, and intellect will turn sharp and clear, memory will grow strong, willpower assumes firmness and rigidity, body fat and heart rate will be reduced, the belly will no longer project, the face will look serene, the eyes will grow bright and lustrous, the voice will turn sweet, an improve in

static motor performance, personality development, good lung capacity and brain functions and thereby physical fitness.

As we live in the age of modern science and technology, our lifestyle has become very fast. It is also becoming very hard and difficult to live natural and normal life because of the changing scenario of the world. In today's competitive environment the practice of yoga will help in the overall development of the students as they are undergoing a lot of undue stress and strain present in educational system which relies more on testing the mental capability and the memorizing ability of the students. Yoga improves posture. Increase the intake of oxygen, and enhance the functioning of the respiratory, digestive, endocrine and reproductive and excretory systems. Yoga is highly recommended for people in competitive, stressful working environments, for those who suffer from headaches, back and shoulder aches, allergies and asthma.

1.7.1 Purpose of Yoga and Asanas:

The word Asana means "steady and comfortable posture" and it is often believed that asanas are physical exercises. And of course this is true, they do have profound influence on the body, but this does not convey their full significance. Each person is made up of three aspects: body, mind and consciousness, which merge together to constitute our whole being. The asanas aim at influencing all these three aspects molding and yoking them into one harmonious whole.

Yoga has been recommended as an adjunct to psychotherapy and standard medical treatments for number of reasons. Its integration of the mental, physical and spiritual dimensions of human life is helpful to patients struggling with distorted cognitions or pain syndromes. The stretching, bending, and balancing involved in the asanas help to align the head and spinal column, stimulate the circulatory system, endocrine glands and other organs and keep the muscles and joints strong and flexible. Yoga practices have been shown to reduce the risk of heart disease by lowering blood pressure and anxiety levels. The breath control exercises, known as pranayama, emphasize slow and deep abdominal breathing. They benefits the respiratory systems helps to induce a sense of relaxation and are useful in pain management. The meditation that is an integral part of classical yoga practice has been shown to strengthen the human immune systems.

1.8 FITNESS SESSIONS IN SCHOOLS

Physical Education plays an immense role in the school curriculum. Its Quality and Quantity are vital and indispensable. Regular physical activity is associated with a healthier, longer life and with a lower risk of heart disease, high blood pressure, diabetes, obesity, and some cancers. Daily quality physical education in the nation's schools is an important part of a student's comprehensive, well-rounded education program and a means of positively affecting life-long health and well-being. The optimal physical education program will foster a lifetime commitment to physical activity as part of a healthy lifestyle. Ultimately, improved coordinated school health programs, of which physical education is a central component, will augment other prevention efforts and help to reverse the growing epidemic of childhood obesity which threatens to undo decades of progress in the fight against cardiovascular and other diseases. Effective efforts made now will help children avoid a lifetime of chronic disease and disability. (Eyre et al, 2004)

Currently high school students are becoming fatter, slower, and less motivated than students of earlier periods. Many of these young people would prefer to be sitting passively in front of the television rather than to do something physically active. Most high school students believe they do not have sufficient time, opportunity or guidance to participate in physical activities. The ideal place in which students would be able to find adequate time, opportunity and guidance are in the high schools themselves. Politicians and educators are responsible for the mandatory physical education program at the junior high school levels (grades eight to ten) should be applauded for this, but frowned upon for not enforcing it on senior high school students (grades 11 and 12). Physical Education is defined as "the process of education that develops the human body, specifically fitness and movement skills." (Baker, 1990, p.14). "Many students participate in sports and recreation activities outside of school, but most of them get hardly any exercise at all. There needs to be a place where students can get some sort of exercise and physical activity". School is the ideal place to implement such physical activities because most have the proper facilities and equipments necessary to accommodate the students and the activities involved. If Physical Education is not made a mandatory subject then many students will not gain the benefits a decent program can provide. Current recommendations are for children to engage in at least 60 minutes of physical activity

each day. Children spend over half their day in school, so it is reasonable that they should get at least 30 minutes of that time in school. (SHPPS; *Journal of School Health*, 2007). It also teaches students how to integrate exercise into their lives in order to establish a lifetime of healthy living. Unfortunately, only a few of high schools are receiving daily physical education or its equivalent for the entire school year. Since childhood obesity rates continue to rise across the country, there is public support for more physical education in schools. Recently the Government of Kerala has proposed to include Physical Education as part of school curriculum to create awareness about need for fitness. But most of the affluent schools in Kerala are not taking keen interest in the area of physical Education and they were more interested in curriculum related activities.

Since the research scholar is keenly interested in the area of health related physical fitness of CBSE students in the three Districts of Kerala, he intended to make sincere effort to investigate effect of Circuit training programmes and Yogic practices on health related physical fitness of obese children.

1.9 STATEMENT OF THE PROBLEM

The purpose of the study was to find out the effect of circuit and yogic training program on selected physical and physiological components namely cardio respiratory endurance, muscular strength and endurance, flexibility, BMI, percent body fat and vital capacity among obese children.

1.10 OBJECTIVES OF THE STUDY

The objectives of the study were as follows:

1. To find out the effect of circuit training programme on selected physical and physiological components namely muscular strength and endurance, flexibility, cardio respiratory endurance, body mass index, percent of body fat and vital capacity among obese children.

2. To find out the effect of yogic training programme on selected physical and physiological components namely muscular strength and endurance, flexibility, cardio respiratory endurance, body mass index, percent body fat and vital capacity among obese children.

3. To find out the effect of circuit and yogic training programme on selected physical and physiological components namely muscular strength and endurance, flexibility, cardio respiratory endurance, body mass index, percent body fat and vital capacity among obese children.

4. To compare and find out which training programme is superior in improving training the selected physical and physiological components namely muscular strength and endurance, flexibility, cardio respiratory endurance, body mass index, percent body fat and vital capacity among obese children.

5. To find out the best suitable training for the development of pre dominant selected physical and physiological components among obese children.

1.11 HYPOTHESES

The hypotheses formulated in the present study are as following:

1. It was hypothesized that circuit training programmes may have a significant improvement over a period of sixteen weeks on selected physical and physiological variables such as muscular strength and endurance, flexibility, cardio respiratory endurance, body mass index; percent body fat and vital capacity from base line to post treatment among obese children.

2. It was hypothesized that yogic training programmes may have a significant improvement over a period of sixteen weeks on selected physical and physiological variables such as muscular strength and endurance, flexibility, cardio respiratory endurance, body mass index; percent body fat and vital capacity from base line to post treatment among obese children.

3. It was hypothesized that both circuit and yoga training programmes may have a significant improvement over a period of sixteen weeks on selected physical and physiological variables such as muscular strength and endurance, flexibility, cardio respiratory endurance, body mass index, percent body fat and vital capacity from base line to post treatment among obese children.

4. It was hypothesized that Control Group may not produce significant improvement over a period of sixteen weeks on selected physical and physiological variables such as Body Mass Index, Percent Body Fat, Cardio respiratory endurance, Muscular strength and endurance, Flexibility and Vital capacity among obese children.

5. It was hypothesized that circuit training may be the better training than Yoga training to develop the selected physical and physiological variables such as muscular strength endurance, flexibility, cardio respiratory endurance, body mass index, percent body fat and vital capacity of obese children.

1.12 SIGNIFICANCE OF THE STUDY

The present study is significant in the following aspects.

1. The salient features of the 'Circuit and Yoga training program design' used in the present study towards the development of the selected physical and physiological components such as muscular strength and endurance, flexibility, cardio respiratory endurance, body mass index, percent body fat and vital capacity are significant in sports , health and awareness.

2. This study would contribute more to the general and sports society for effective use of Circuit training and Yoga training for various populations to improve various physical and physiological components.

3. The Circuit and Yoga training used in the present study were scientifically structured one. Hence it is believed that children treated with these training modules can be benefited in time with regard to the development of selected physical and physiological components of obese children.

4. The present study would provide a scientific base and guidance to the physical educationists, coaches, sports scientists, exercise physiologists and fitness leaders to design the training programme using the training modules in the present study with the view to develop variables related to physical and physiological variables.

5. Finding of this research study would give a basic knowledge to the trainers and fitness leaders to envisage and conduct further research in various training methods, training programmes, training intensity and training load to enhance the performance of the sports persons.

6. Physical educationists and sports scientists have been constantly examining children fitness in relation to the individual skill and fitness standards. Since this study is also in the line of the same, the findings of such type of studies could be utilized in the practical aspects of coaching and training.

7. Investigators in many countries are striving hard to find out the best and easiest possible means and economical training programmes for upper primary school children. The total fitness of the children does not rely upon 1 or 2 components. There may be more elements which individually as well as collectively contribute to the fitness standards of the children.

8. The study may give a clear picture of the fitness status/body composition of the students of CBSE School of the three districts in the Malabar region of Kerala. The study will also help to know the effect of circuit and yogic training programmes on selected physical and physiological components. It further helps other investigators to take up studies in this area.

9. The findings of the study will provide guidance to physical education teachers and coaches to prepare training schedules for special population on the basis of the physical and physiological capacity of the children.

10. The findings of this study add to the quantum of knowledge in the area of training methods.

1.13 DELIMITATION

The present study was delimited in the following aspects.

1. The study would be delimited to ninety (90) obese male CBSE upper primary school children within three districts of Malabar region, Thrissur, Palakkad and Malappuram of Kerala state, India.

2. The age groups of the subjects were ranged between 10 – 14 years only.

3. The experimental part of the study would be delimited to ninety (90) obese CBSE Upper primary school children of Chinmaya Vidyalaya, Thrissur, S N Vidyabhavan, Chenthrapinni, Thrissur and HIRA English School, Kaipamangalam, Thrissur only. And these schools were located in the northern part of the Thrissur district, Kerala, India.

4. The study was delimited to selected physical and physiological components namely Cardio respiratory endurance, Muscular strength and endurance, flexibility, BMI, percentage of body fat and Vital Capacity.

5. Training program of the present study was delimited to Circuit and Yogic training only.

6. Training period for the purpose of this study has been delimited to sixteen weeks only.(weekly 3 alternative days)

1.14 LIMITATIONS

The following factors have been considered as limitations of the present study

1. The influence of certain factors like life style, food habits and health conditions of the subjects during the training as well as testing periods that might have influenced the test items were accepted as a limitation.

2. The change in climatic conditions such as temperature, atmospheric pressure, humidity, etc., during the training as well as testing period could not be controlled. So, their influence on the results of the study was recognized as one of the limitations.

3. Apart from the training programme the involvement of the subjects in daily routines was not taken into consideration.

4. Since the subjects were motivated verbally during testing and training periods no attempt was put to differentiate their level of motivation.

5. Since the selected subjects were from different locality the socio-economic status was not taken into consideration.

1.15 OPERATIONAL DEFINITIONS OF TERMS

1.15.1 Body Mass Index

It is the key index for relating a person's body weight to their height. A ratio of weight and height, called the body mass index (BMI), has been adopted for use in assessment of children, adolescents, and adults. (Medicine Net)

Body mass index a quick way to measure obesity

$BMI = Weight\ (kg) / Height\ (m^2)$

1.15.2 Percent Body Fat

Body composition is defined as the percentage of fat, muscle and bone in the body. It is expressed as the ratio of lean mass to fatty mass. Body composition is expressed as percentage fat (% fat) or percentage of lean body mass (LBM). (Jennifer R. Scott)

1.15.3 Cardio respiratory Endurance

Endurance is the ability to perform a physical work for a long time; quantitatively, the maximum duration for which an individual can sustain a specific activity, preferably also at a specific intensity. In general, it is the ability to perform a given task over a prolonged period of time before the onset of fatigue. Cardio respiratory endurance is a measurement of how well heart, lungs and muscles work together to keep the body active over an extended period of time. (Health line)

1.15.4 Muscular strength and Endurance

Strength is the maximum force that can be developed in a muscle or group of muscles during a single maximal contraction. Or muscle can exert force by contracting against a resistance. It is defined as the force that muscles or a group of muscles cam exert against a resistance on one maximum effect (Kenneth, 1993).

1.15.5 Flexibility

Flexibility is the ability to perform a joint action through a range of movement. It is the ability to move joints and use muscles through their full range of motion. (Hardayal Singh)

1.15.6 Vital Capacity

Vital capacity is the amount of air that the lungs can expel after having been filled completely. The vital capacity represents the change in volume from completely emptied lungs to completely filled lungs. i.e.; it is the maximum amount of air a person can expel from the lungs after a maximum inhalation. (https://biologydictionary.net)

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter carries an exploration of review of related literatures. The researcher finds out some of the review of literature which could be very supportive and strengthening this study. After going through the available literature, the investigator presented some of the observations and findings of the experts in this area. The essential aspect of a research is the review of the related literature. In the words of Good, "The key to the vast store house of published literature may open the doors to sources of significant problems and explanatory hypothesis, and provide helpful orientation for definition of the problem, background for selection of procedure, and comparative data for interpretation of results". In order to be truly creative and original, one must read extensively and critically as stimulus thinking.

For any research project to occupy a place in the development of a discipline, the researcher must be thoroughly familiar with both previous theory and research. The literature related to any problems helps the scholar to discover already known, which would enable the investigator to have a deep insight, clear prospective and a better understanding of a chosen problem, and various factors connected to the study. So a number of books, journals, and websites were referred. In the following pages, an attempt has been made to present a few of the important researchers and studies conducted abroad and in India briefly, as they have significant bearing on the present study.

2.1 STUDIES ON OBESE CHILDREN

Sunil Pathak et al. (2018) a cross-sectional, observational and questionnaire-based study conducted in urban and rural school going adolescents. 188 subjects (89 rural and 99 urban schools) school were enrolled. 17.6% (33), 20.2% (38), 59% (111) and 3.2% (6) children were obese, overweight, normal and underweight respectively. 65.22% of urban males & 62.26% females were either obese or overweight as compared to 15.78% of rural males and 3.92% females ($p<0.0001$) or was 17.7 (95% CI of 7.6 to 40.7) in favor of urban residence. Statistically significant ($p<0.05$) differences is found in term of annual income of family, frequency of physical training sessions conducted in

schools, frequency of restaurant & school canteen food. No statistically significant association was found between two categories (higher BMI & normal BMI) with other factors viz. breakfast before school, liking for fast food, and involvement in outdoor sports, operating gadgets during meals and having obese family members. It was concluded that the obesity and overweight is more prevalent in urban adolescent. There is no difference among male and female group and there was tendency of high frequency of obesity and overweight among those adolescents who have higher annual family income, frequency of restaurant and school canteen food and lesser frequency of physical training sessions conducted in schools.

Maria Aiello et al. (2015) to show systematic review with meta-analysis of cross-sectional studies, conducted in Brazil between 2008 and 2014. A systematic review and meta-analysis was conducted and the outcome of which was obesity (Body Mass Index ≥ 95th percentile for sex/age). A graphical presentation was done separately (Forest plot) for the results. Global and dichotomous outcomes were presented by employing, respectively the gross rates of prevalence and prevalence ratio (PR) and its confidence intervals at 95% (95% CI). The degree of heterogeneity was calculated employing the Q Cochran, while the I2 test was used to describe the variation between studies. The result of the study revealed that the overall prevalence of obesity was 14.1%. Among boys it was 16.1% and in girls it was 14.95%. There was no difference in obesity prevalence between sexes (PR 1.06; 95%CI: 0.81 to 1.40; p>0.05) and it was concluded that the prevalence of obesity among children and adolescents in Brazil is high and urgently needs measures to prevent consequences associated with the disease, as well as measures to reduce the impact, in the short term, the overweight and childhood obesity.

Alwan et al.(2013) conducted a study to assess the effect of education and economic status of parents on obesity in children. A cross-sectional survey was conducted among the school children in Riyadh, Saudi Arabia. A representative sample of 1243 (542 male and 701 female) children aged 6-16 years were contacted using multistage cluster sampling strategy. Social and demographic variables were collected using questionnaires completed by parents. Height and weight of the children were recorded by a trained team. The result of the study was the mean body mass index for all children was 19.8±5.4. The prevalence rates of overweight and obesity were 21.1% and 12.7%, respectively. Overweight and obesity were more prevalent in males than in

females. By multivariate analysis, children were more likely to be overweight if they were male (OR=0.6, p<0.01), 12 years of age (OR=3.79, p<0.01, compared to age 6 years), and if their families had higher income (OR=3.12, p<0.01, compared to families with low income). Being male (OR=0.545, p<0.01), aged 12 years (OR=3.9, p=0.005, compared to the age of 6), and having a mother who is more educated were determined to be significant risk factors for obesity in children. Mothers educated at university level were found to have a three-fold higher risk of having obese children (OR=3.4, p<0.01,) compared to mothers with lower education levels. They concluded that the overweight and obesity among Saudi children is associated with educated mothers and higher family income. This finding calls for introducing interventions in health education for both children and parents.

Alice T Cherian et al. (2012) conducted a study to examine the prevalence of obesity and overweight in urban school children in Kochi, Kerala, and South India. Three schools from the city were selected representing upper, middle and lower socioeconomic groups and the children aged 6–15 years of age were interviewed. The prevalence of obesity was 3.0% for boys and 5.3% for girls. The prevalence of obesity (7.5%) and overweight (21.9%) were highest among high income group and lowest (1.5% and 2.5%) among low income group. Prevalence of obesity and overweight was found to be higher in the high income group and among girls.

Bonnie et al. (2012) conducted a study which explored the effectiveness of dance movement therapy (DMT) in obese women with emotional eating who was trying to lose weight. The research design was based on previously published reviews. The four treatment groups were facilitated by the first two authors (two groups each), who also conducted data collection and analysis as part of their Masters dissertations. The third author was involved in research design, acted as critical friend, and substantially contributed to writing up, and the fourth author provided statistical support. The samples of 158 women were recruited from a commercial weight loss programme: 92 with BMI ≥ 28 were identified as emotional eaters and divided into: an exercise control (n = 32) and non-exercisers (n = 60). The non-exercises were partially randomized to non- exercise control (n = 30) and treatment group (n = 30). Using a pre- and post-intervention design, 24 of the DMT treatment group, 28 of the exercise control and 27 of the non-exercise control completed all measures on a battery of tests for psychological distress, body

image distress, self-esteem and emotional eating. Findings were analyzed for statistical significance. Descriptive Statistics, the T-test for paired and independent samples and the ANOVA were applied. The result of the study was the DMT group showed statistically decreased psychological distress, decreased body image distress, and increased self-esteem compared to controls. Emotional eating reduced in DMT and exercise groups. The authors cautiously conclude that DMT could form part of a treatment for obese women whose presentation includes emotional eating.

Nazeem et al. (2012) conducted a survey study aimed to assess prevalence of obesity amongst children of different socioeconomic class. The study was carried out among school children of Indore District of Madhya Pradesh, to find out the prevalence of childhood obesity and its etiologies. The study was conducted in randomly selected 2158 school children of age 7 to 14 years, of different socioeconomic classes from government and private schools. Anthropometric measurements were taken using standard protocol. Obesity was assessed using Body Mass Index (BMI) criteria, those having their BMI>95th percentile for age and sex were considered obese. To study the effect of social class subjects were classified into upper middle and lower socioeconomic class on the basis of modified Kuppuswami scale. The statistical methodology was used as Pearson correlation analysis to test statistical significance of the difference in the mean values of the different variables in obese and on obese groups. Pearson's chi-square test was used to estimate the *p* value for the difference in prevalence of obesity in different socioeconomic groups. The SPSS (version 11.0) software was used for this purpose. The result of the study was the overall prevalence of obesity was found to be 14.97% (6.817% Boys 8.16% Girls). Higher values of mean weight, height, BMI and blood pressure was found in obese children as compared to non obese. A highly significant relationship was observed for SBP and BMI ($p<.0001$) between obese and non-obese groups. Prevalence of obesity was found significantly higher in children belonging to higher class (35%) as compared to lower (13%) and middle class (15.7%) (Chi-square value 9.748; & $p< .001$). They concluded that the prevalence of obesity is on rise in Indian children, highlighting the possible role of change in the dietary pattern and physical activities.

Shabeshan (2012) conducted a study to investigate the effect of a physical fitness intervention program within a physical education class towards selected health-related fitness components among Malaysian secondary school girls. A quasi-

experimental design with a pre -test, post- test design was adopted for the study. Two Schools in a district were randomly selected. In each school, two classes were randomly assigned intact to the experimental group (n=48) and the other was the control group (n=38). The experimental and the control groups followed their regular physical education conducted for 40 minutes twice a week in addition the experimental group underwent the intervention program. The study was conducted for ten weeks and a treatment of four exercises in a form of a circuit was utilized to improve health-related fitness. Pre-test data was collected on cardiovascular endurance, Flexibility and muscular strength. The experimental and the control groups underwent regular physical education classes twice a week for ten weeks. Apart from the regular physical education classes, the experimental group underwent the treatment of four exercises in a form of a circuit immediately after the warm-up session. After ten weeks, post test data was collected. ANCOVA was utilized for the statistical analysis. The result of the study showed that main effect in cardiovascular endurance $F(1, 83) = 44.69$, $p<0.05$ and for flexibility $F(1, 83) = 46.80$, $p<0.05$. As for muscular strength, the result was not significant $F(1, 83) = 3.54$, $p>0.05$. This result indicated that a ten week physical fitness program within a physical education class was effective in enhancing cardiovascular endurance and flexibility among Malaysian secondary school girls. He concluded that an intervention program within a physical education class had a positive effect towards cardiovascular endurance and flexibility. Consequently, such intervention programs can be incorporated in the physical education curriculum to have better benefits among the girl.

Kahdilkar et al (2011) conducted research to estimate prevalence of overweight and obesity in apparently healthy children from five zones of India in the age group of 2 to 17 years and to examine trends in body mass index (BMI) during the last two decades with respect to published growth data. A multicentric study was conducted among eleven affluent urban schools from five geographical zones of India. A total of 20 243 children (1 823 – central zone, 2 092 – east zone, 5 526 – north zone, 3 357 – south zone, and 7 445 – west zone) in the age group of 2–17 years were studied. Height and weight were measured and BMI was calculated (kg/m^2). WHO Anthro plus was used to calculate Z-scores for height, weight and BMI. A comparison between study population and previously available nationally representative (1989) data was performed for each age-sex group. International Obesity Task Force (IOTF) and WHO cut-offs were used to calculate the percentage prevalence of overweight and obesity. The result of the study

revealed that the overall prevalence of overweight and obesity was 18.2% by the IOTF classification and 23.9% by the WHO standards. The prevalence of overweight and obesity was higher in boys than girls. Mean BMI values were significantly higher than those reported in the 1989 data from 5–17 years at all ages and for both sexes. The study was concluded that the rising trend of BMI in Indian children and adolescents observed in this multi centric study rings alarm bells in terms of associated adverse health consequences in adulthood.

Sumathi et al.(2011) conducted a study to assess patterns of physical activity among urban south Indian school children with respect to age, gender and socio-economic status (SES) and evaluated changes in physical activity over a one-year period. The method they used to assess Physical activity by using interviewer-administered questionnaires at baseline (n=256) and at follow up (n=203) in 2006 and 2007. Frequency and duration of each activity was recorded and metabolic equivalents or MET (multiples of basal metabolic rate reflecting intensity of activity) assigned. Sedentary activity included activities with MET < 1.5, and moderate-to- vigorous physical activity (MVPA) with >3.0. For each activity, daily duration, intensity (MET), and the product of the two (MET-minutes) were computed. Children were categorized by age group, gender and socio-economic status. Height and weight were measured. Data were summarized as number (%) for categorical variables and median (1_{st} quartile, 3_{rd} quartile) for all physical activity variables as these were not normally distributed. All physical activity variables were log transformed for all analysis. The natural log transformed values were normally distributed. Age at baseline was used to classify children into two age groups, that is, below or equivalent to 11 years and above 11 years. Mode of travel used by children was compared using Pearson's chi-square test. Baseline physical activity was compared between age group and gender using the Independent t test, and between tertiles of SES using one-way ANOVA. Changes in physical activity parameters over time were examined using the paired t test. The result indicated that the baseline, sedentary activity was higher in children aged >11 year while intensity of MVPA was higher in boys than girls. Over one year, physical activity at school significantly decreased (P<0.001). There was also a significant decrease in MVPA MET-min (P<0.001) with interaction effects of age group (P<0.001) and gender (P<0.001). They concluded that there was a significant decline in moderate-to-vigorous physical activity over a single year follow up, largely due to a decrease in physical activity at school. There appears to be a gap between State

educational policies that promote physical well-being of school-going children and actual practice.

Mahajan et al. (2011) conducted a study to assess the prevalence of obesity and overweight among school children in Puducherry, aged between 6 and 12 years and to identify any differences in prevalence based on as per age, gender, place of residence and type of school. The methodology of the study was that the children between 6 and 12 yrs were sampled using multistage random sampling with population proportionate to size from 30 clusters. Anthropometric data (BMI) was analyzed using CDC growth charts. The study was designed for secondary data analysis of a school-based cross sectional study in all the four regions of Pondicherry. A total of 12,685 children in the age group of 6-12 years, studying in class I-VII, from government and private schools of urban as well as rural areas in each of the four districts were enlisted initially, from which the study sample was selected. A predesigned and pretested interviewer administered questionnaire was used to collect information. A weighing scale and stadiometer were used to measure the weight (nearest 0.5 kg) and height (nearest 0.1 cm) of each child using standard procedure. BMI was calculated as weight (kg)/height ^{2} (m ^{2}). Sex- and age-specific percentile cut-points of a reference population (85th percentile for overweight and 95th percentile for obesity) were used. Data were analyzed using Statistical package for the Social Sciences (version 16.0). The prevalence of overweight and obesity were calculated using BMI for age/gender percentiles derived through child and teen BMI calculator developed by CDC Atlanta. The result of the study was the prevalence of overweight (85th percentile) among children was 4.41% and prevalence of obesity (>95 th percentile) was 2.12%. Mahe region had the highest prevalence of overweight (8.66%) and obesity (4.69%). Female children from private schools and urban areas were at greater risk of being overweight and obese. They concluded that Childhood obesity is a problem in Puducherry and requires timely intervention for its control.

Juan et al. (2011) conducted a study to compare the effect of a hospital clinic group- versus home-based combined exercise– diet program for the treatment of childhood obesity. The methodology of the study was, one hundred ten overweight or obese Spanish children and adolescents aged 6–16 years old were randomly selected in two intervention groups such as hospital clinic group-based [n = 45], home-based [n =

41] and a sex-age-matched control group (n = 24). They were assigned to participate in a 6-month combined exercise (aerobic and resistance training) and Mediterranean diet program. Anthropometric values (including body weight, height, body mass index, BMI-Z score, and waist circumference) were measured pre- and post -intervention for all the participants. Percentage body fat was also determined with a body fat analyzer (TANITA TBF-410 M). The subjects of hospital clinic group based were provided with five supervised exercise sessions per week for 6 months (120 sessions). The participants and their parents were strongly advised to attend a minimum of three sessions per week (minimum attendance rate). Subjects were made to understand that "three" was the minimum required number of sessions per week to improve body composition. Exercise training was conducted at the hospital by a physical education instructor. Each session lasted 60 minutes, during which time 5 minutes were allocated for warming up and cooling down (stretching), 35 minutes were allocated to moderate aerobic activity, and 20 minutes to resistance training (low-load, high-repetition exercises). The home based group participants were instructed to complete all exercises in their home environment. Their program also consisted of 5 sessions per week (6 months, 120 sessions). The duration of each session was approximately 60 minutes and involved both resistance and aerobic training exercises (circuit training). The subjects received a demonstration of how to perform the exercises and each patient was given detailed written instructions, including images of the exercises, the number of repetitions, and/or duration required. All participants were provided with a daily exercise log book for 6 months and were instructed to complete it for each exercise session, including date and duration. The data were collected and the statistical analysis was performed according to intention-to-treat. To compare the success of randomization, preliminary analyses of variance or chi-squared tests were used to determine baseline differences between groups. A Mann-Whitney U test was used to compare the attendance rates between both intervention groups. Two-way mixed ANOVA tests were used to compare the study effects on height, body weight, BMI between groups, with exercise period serving as the within-group factor and intervention type as the between-group factor. The result of the study showed a significant reduction in percentage body fat and body mass index Z-score among both intervention-group participants (4%, 0.16, hospital clinic group-based; 4.4%, 0.23, home-based; P<.0001). There was also a significant reduction in waist circumference in the home-based group (4.4 cm; P =.019). Attendance rates at intervention sessions were equivalent for both intervention groups (P =.805). They concluded that the study findings

indicate that a simple home-based combined exercise and Mediterranean diet program may be effective among overweight and obese children and adolescents, because it improves body composition, is feasible and can be adopted on a large scale without substantial expenses.

Paul et al. (2011) conducted a study to provide current national data on overweight and obesity prevalence among pre-adolescent schoolchildren (aged 10–12 years old) in Greece and, additionally, to evaluate the quality of children's diet by assessing the degree of adherence to the Mediterranean diet and its association with the obesity rates. The methodology of the study was designed that a stratified sampling in 10 regions of the country was applied to voluntarily enroll a representative sample of 4786 children. Children were weighed and measured and completed a semi-quantitative food frequency questionnaire with a supplementary section for the assessment of dietary aspects and physical activity levels. Additionally, the KIDMED index (Mediterranean Diet Quality Index for children and adolescents) was used to evaluate the degree of adherence to the Mediterranean diet. The KIDMED index was developed in an attempt to combine the Mediterranean diet (MD) guidelines for adults as well as the general dietary guidelines for children in a single index. It is based on the principles sustaining the Mediterranean dietary pattern as well as on those that undermine it. The index comprises of 16 yes or no questions. The total score ranges from 4 to 12 and is classified into 3 levels: ≥8, good adherence to the principles of the MD; 4–7, average adherence to the principles of the MD; and ≤3, very low diet quality in relation to the principles of the MD. The Student's t-test and one-way ANOVA, with Bonferroni correction to account for the inflation of type-I error due to multiple comparisons made, were applied to evaluate differences in mean values of normally distributed data. Associations between categorical variables were tested by contingency tables and chi square test. The result of the study was the overweight (OW) and obesity (OB) prevalence among boys was 29.9% and 12.9%, while in girls 29.2% and 10.6%, respectively. Only 4.3% of the children had an optimal KIDMED score. KIDMED score did not differ between boys and girls and no differences were detected between normal weight and OW and OB children. However, children from semi-urban or rural regions had higher score. Furthermore, children with higher KIDMED score reported following a healthier diet and having higher physical activity levels. They concluded that the prevalence of childhood obesity in Greece is the highest ever reported together with low adherence rates to the dietary patterns of the MD.

Current findings suggest an increased risk for even higher rates of obesity in adolescence and adulthood in the near future.

Adeel et al. (2010) carried out a study to estimate the prevalence of obesity in school-going children (6th and 7th class) and study the effects of dietary habits, physical activity, watching television on obesity. Method of study was a descriptive type with sample size of 293 children conducted over a period of four months in two private sector schools of Lahore. Information was gathered by the help of a pre designed questionnaire after getting formal consent from parents. Children included in the study were healthy with no reported chronic illness. Body weight was measured in minimal clothing using a weight scale; body height was measured in erect posture without shoes using a stadiometer. Obesity, underweight and overweight were defined by plotting BMI against age (in months and years) on WHO BMI-for-age (5–19 years [percentiles]) charts. Data was computed and analyzed using SPSS-17; and descriptive analysis was done. The result of the study was, out of 293 children 11.9% were obese (more than 97th percentile) while 21.8% were overweight (85th–97th percentile). Among obese children 74.3% were found to watch TV for 1-2 hours daily while 25.7% watch TV for 3–4 hours. 48.6% of obese children did not participate in any field sports while 34.3% have less than 3 hours participation in field sports. Among parents of obese children, 60% were found to have little or no influence on their children's food intake at school whereas 22.9% parents of obese children never advise them against eating junk food. Parents think that ban on advertisements promoting unhealthy foods (75.1%) and use of popular media characters in promoting healthy foods (83.6%) and exercise can help in preventing obesity in children. They concluded the study there was high prevalence of obesity and overweight among children in private schools has direct relationship with decreased physical activity and other factors like watching TV, role of media and lack of diet control by parents.

Premanath M et al. (2010) conducted a research to document the prevalence of obesity, overweight and underweight in the school children aged 5 to 16 years from Mysore. Five Principal Investigators and thirteen Co-Investigators were trained the teachers of 139 schools (Private-111 and Govt-28) to record the vital statistics of the children studying in their schools. A total of 43152 school children (23527 boys and 19625 girls) were surveyed. 36354 children were from private schools and 6798 children were from Government schools. Indian Academy of Pediatrics growth charts were used

as reference. The prevalence of obesity, overweight and underweight were 3.4%, 8.5% and 17.2%, respectively. The prevalence of obesity was maximum in the age group of 5–7 years and in those from private schools.

Ramesh K Goyal et al. (2010) conducted a study to investigate the prevalence of obesity and overweight and their association with socioeconomic status (SES) and the risk factors like diet, physical activity like exercise, sports, and sleeping habit in afternoon, eating habits like junk food, chocolate, eating outside at weekend, family history of diabetes and obesity. The subjects and methods of study included 5664 school children in the age group of 12–18 years; 3231 were boys and 2433 were girls. The schools were selected from different zones in the city to get an equal distribution of children by socio economic state, ethnic variability and gender. Government schools for low-income group and private schools attended by middle income and high-income groups were chosen. The questionnaire provided to seek information on socioeconomic status and parents profession. The questionnaire assessed life style, physical activity and social factors that influence physical and psychosocial health of representative samples of Children. Questionnaire items assessed were socioeconomic status, participation in sports, physical exercise, sleeping habit in afternoon, diet (having vegetarian or non vegetarian food), having junk food or not, chocolate eating habit, frequency of visiting restaurants per week. Height and weight were measured using standard procedure and BMI (kg/m2) was calculated. Socioeconomic status of parents was classified as high socioeconomic group, middle socio-economic group and lower socio-economic group based on the occupations of parents and family income which were found to be a reliable index of SES. For the statistical analysis ANOVAs or $\chi 2$ tests was used for group comparison. The result of the study was the age-adjusted prevalence of overweight was found to be 14.3% among boys and 9.2% among girls where as the prevalence of obesity was 2.9% in boys and 1.5% in girls. The prevalence of overweight among children was higher in middle SES as compared to high SES group in both boys and girls whereas the prevalence of obesity was higher in high SES group as compared to middle SES group. The prevalence of obesity as well as overweight in low SES group was the lowest as compared to other group. Eating habit like junk food, chocolate, eating outside at weekend and physical activity like exercise, sports, sleeping habit in afternoon having remarkable effect on prevalence on overweight and obesity among middle to high SES group. Family history of diabetes and obesity were also found to be positively associated.

They concluded that the prevalence of overweight and obesity varies remarkably with different socioeconomic development levels.

Pippa Griew et al. (2010) examined the effect of school clustering on children's school-time physical activity, accounting for both individual and school demographics, and investigates how the findings vary between boys and girls. Twenty-four primary schools were sampled on the basis of a high pupil transition rate to one of eight state secondary schools chosen to represent the economic, ethnic and geographic diversity across the city to maximize participation in the follow-up data collection, just one of the 24 primary schools declined to participate. Baseline data collection was carried out over 2 years (2006–2008). All 23 participating primary schools were visited during 2006-07 and 16 of these schools were re-visited in 2007–2008 for measures with a new intake of year 6 pupils. Multilevel modeling (MLM) (MLwin 2.02) was used to asses between school differences in children's physical activity, measured using accelerometry (Acti Graph GT1M), adjusting for both individual and school variables. Multilevel modeling (MLwin 2.02) was used to analyze the data of the effects of school clustering on children's school-time physical activity (counts per minute) whilst accounting for individual and school level factors. The initial stage of the modeling process was to establish the extent to which variance in school time physical activity is explained by the school attended using a variance component model. The result of the study was the significant school effect (p=0.001) was found accounting for 14.5% of the total variance in physical activity. Boys were significantly more active than girls (pb0.001), and the school attended accounted for a greater proportion of variance in boys' physical activity than girls' (23.4% vs. 12.2%). Seasonal variation and economic deprivation of the school neighborhood were both significantly associated with children's school-time activity. They concluded that the children's school-time physical activity varied according to the primary school they attend even after accounting for individual demographic and the school compositional factors and this effect varied significantly by gender.

Fernando et al. (2010) conducted a study to assess the 2-year impact of the MOVI program on obesity, blood lipid levels, and blood pressure among 9 to10-year-old schoolchildren in Cuenca. The MOVI recreational physical activity program conducted in 1044 fourth- and fifth-grade primary schoolchildren from the Province of Cuenca, Spain. The methodology of study was designed in which Cluster-randomized controlled

trial with 10 intervention and 10 control schools. The MOVI program was a noncompetitive and recreational physical activity program, adapted to the children's age and held after classes in the school's sports facilities. MOVI consisted of 3 weekly 90-minute sessions of physical activity per week, during approximately 28 weeks every year. The sports instructors underwent a 2-day training program, and a written plan of activities for each session was developed to ensure program standardization in all 10 intervention schools. Both in the control and intervention groups, the endpoints were measured 3 times: at the beginning of the program (September 2004), at the end of the first year (June 2005), and at the end of the second year (June 2006). Changes in end points between baseline (September 2004) and the end of follow-up (June 2006) were compared between the control and intervention group by using mixed regression models, with adjustment for the baseline endpoint value, age, and the school. The data were analyzed with mixed regression models, in which the dependent variable was each endpoint at the end of the second year of intervention. The effect of the intervention was included in the model as a fixed effect, by using an independent dummy term with a value of 1 for intervention schools and 0 for control schools. The result of the study when compared with control subjects, intervention girls reduced the frequency of overweight (odds ratio, 0.55; 95% CI, 0.39-0.78; P < .001). However, intervention was associated with an increase in the percentage of body fat in boys (0.97%; 95% CI, 0.14-1.81; P = .02). Girls in the intervention group had lower total cholesterol level (–6.86 mg/ dL; 95% CI, –9.70-–4.01; P < .001) and lipoprotein B level (–3.61 mg/dL; 95% CI, –6.27 -–0.95; P = .008) than control subjects. Results were similar in boys. They concluded that in two years, In 2 years, the physical activity program lowered the frequency of overweight in girls and reduced total cholesterol and apolipoprotein B in both girls and boys.

Patrick et al. (2009) conducted a study to explore whether characteristics of the U.S. secondary school physical activity environment are associated with student body mass index (BMI) and physical activity. The methodology they used that the data for this study was collected from two studies, those are Monitoring the Future (MTF; an annual nationally representative survey of 8th-, 10th-, and 12th-grade public and private school students) and Youth, Education, and Society (a survey of administrators in schools that have completed their 2-year participation in the MTF study). School policies and programs related to various health issues, including physical education and sports activities were examined for relationships with student self-reported height, weight,

being active in sports, exercising vigorously, and participating in school athletics. The design of the study was, each of three grade levels (8th, 10th, 12th),a stratified random sampling procedure is used that involves three stages: (1) geographic regions are selected; (2) schools are selected within regions with probability proportional to the estimated number of students in the target grade; and (3) students are selected within schools, usually by means of randomly selecting whole classrooms. A total of about 45,000 students are surveyed each year. Sample weights are assigned to each student to take into account variations in selection probabilities that occurred at all stages. Students self-reported their height (in feet and inches) and weight (in pounds), using pre-coded close-ended response alternatives. BMI was calculated by dividing weight (in kilograms) by height (in meters) squared. Age- and gender-specific growth curves produced by the Centers for Disease Control and Prevention were used to determine whether each student's BMI was categorized as overweight (85th to less than the 95th percentile) or obese (equal to or greater than the 95th percentile). Measures of student Physical activity were obtained from responses to three questions: (1) How often do you actively participate in sports, athletics or exercising? (2) How often do you exercise vigorously (jogging, swimming, calisthenics, or any other active sports)? (3) To what extent did you participate in school athletic teams this school year? The result of the study was percentage of students who attended schools that required PE in their grade differed sharply by grade level: 88% of 8th graders, 48% of 10th graders, and 20% of 12^{th} graders. There were few statistically significant associations between school PE requirements and student BMI. The average percentage of students who participated in interscholastic or varsity sports was associated at the bivariate level with a lower percentage of students being overweight in all three grades. Other measures of PE and sports activity showed varying associations with BMI and physical activity measures. They concluded that the relationship between the school physical activity environment and student BMI and physical activity were not uniformly strong and the currently practicing of the existing variations in physical activity policies in the schools, may not be sufficient to produce discernible school wide differences; thus, there is a need for more vigorous physical activity programmes in Physical Education than is typically provided.

Haider et al. (2009) conducted a study to determine prevalence of obesity and malnutrition among school-going children, from grades 6th to 8th of different schools of

Karachi and assess associations that affect the weight of the children. The method of the study was a cross sectional study design with children studying in grades 6th to 8th grade in four schools of Karachi. They visited 10 schools of which 4 consented; two subsidized government schools and two private schools. A questionnaire was developed in consultation with a qualified nutritionist. Height and weight were measured on calibrated scales. A modified BMI criterion for Asian populations was used. Data was collected from 284 students. Chi-square test was used to determine the significance of association between the variables. The result of the study was 52% were found to be underweight whereas 34% of all the children were normal. Of the population, 6% was obese and 8% overweight. Of all obese children, 70% belonged to the higher socio-economic status (SES) group, while of the underweight children, 63.3% were in the lower SES. Amongst obese children in our study, 65% ate meat every day, compared to 33% of normal kids. They concluded that obesity and under nutrition co-exist in Pakistani school-children and the study shows that socio-economic factors are important since obesity and overweight increase with SES. Higher SES groups should be targeted for overweight while underweight is a problem of lower SES. Meat intake and lack of physical activity are some of the other factors that have been highlighted in the study.

Supreet et al. (2008) conducted a study to assess the prevalence of overweight and obesity amongst children in the age group of 5-18 years belonging to low, middle and high income group in National Capital Territory NCT of Delhi. A total of 16,595 children (LIG 5087, MIG 5134 and HIG 6368) were covered in the study. Overweight and obesity were assessed using Body Mass Index and Triceps Skin Fold Thickness (TSFT) utilizing the age and sex specific cut off points. A pre-tested, semi structured questionnaire was administered to each subject to elicit information on socio demographic profile, physical activity pattern, dietary intake and anthropometric measurements. Each child's assessment of height, weight, and triceps skin fold thickness measurements were conducted. Anthropometric measurements of weight and height were recorded utilizing the standard equipments and methodology. International Obesity Task Force (IOTF) classification was utilized for the estimation of overweight and obese subjects. Overweight was defined as children with BMI value between 85th to 95th percentile and obesity was defined as children with a BMI value above 95th percentile for a specific age and sex. The children are asked to perform common physical activities, as they performed during their leisure time activities like jogging, running, playing

outdoor games (involve running), yoga, physical exercise and others like swimming, dancing etc. The results were that the prevalence of obesity and overweight in Low Income Group (LIG) school children was 0.1 and 2.7 percent respectively, amongst Middle Income Group (MIG) school children it was 0.6 and 6.5 percent and in High Income Group (HIG) school children was 6.8 and 15.3 percent respectively (p<0001). With regard to the TSFT criteria, the prevalence of obesity and overweight in LIG school children was 1.2 and 2.4 percent, amongst MIG school children it was 2.5 and 4.9 percent and in children belonging to HIG schools was 9.3 and 13.1 percent respectively (p<0.001). It was concluded that the prevalence of overweight and obesity was higher in the HIG children as compared to the MIG and the LIG for all age groups, highlighting the possible role of change in the dietary pattern and physical activities with increase in income levels.

Agarwal et al.(2008) conducted a school based cross sectional study to know the prevalence of obesity among adolescents in public schools of Ludhiana, catering to the affluent segment of population, with annual school fees of more than Rs. 20,000/- per annum. The schools were selected by random selecting technique using purposive sampling. They selected 1000 students from these schools by random, purposive sampling. Their anthropometry was taken. Students also filled-up a pre-validated questionnaire regarding socio-economic status, dietary habits and lifestyle. The Body Mass Index of each student was calculated. The international cutoff points for the body mass index were used; BMI ≥95th percentile for age and sex was considered as obese and BMI ≥85th percentile was considered as overweight. *T-test*, *Z*-test and Chi square ($\chi 2$) test was used. *P*-value <0.05 was taken as significant. The result was incidence of obesity was 3.4% and overweight was 12.7%. A significantly greater number of boys (15%) were overweight as compared to girls (10%).

Bharati et al. (2008) conducted a study to assess the magnitude of overweight/obesity and its correlates among school going children of Wardha city in central India and suggest interventions. The methodology they used, a cross-sectional study was carried out in all the 31 middle-schools (5th to 7th standard) and high-schools (8th to 10th standard) of Wardha city. Probability proportionate to size of population technique (PPS) was used to decide the number of children to be studied from each school, each class and then each section. Systematic random sampling technique was

used to select the children from each section. Pre-designed and pre-tested questionnaire was used to elicit the information on family characteristics and individual characteristics. Height and weight was measured and BMI was calculated. Overweight and obesity was assessed by BMI for age. Student who had BMI for age >85th and < 95th percentile of reference population were classified as overweight and BMI for age >95th percentile of reference population were classified as obese. Statistical techniques used to analyze the data were epi_info 2002 v 3.3 and SPSS 12.0.1 (SPSS for windows, version12.0.1.2001.Chicago: SPSS Inc.). The result of the study was the Overweight and obesity was found to be 3.1 per cent (95% CI: 2.5-3.8%) and 1.2 per cent (95% CI: 0.8-1.8%) respectively; together constitute 4.3 per cent (95% CI: 3.6-5.2%) for overweight/ obesity. Final model of the multivariate logistic regression showed that the important correlates of overweight/obesity were urban residence, father and/or mother involved in service/business, English medium school and child playing outdoor games for less than 30 min. And they concluded that, the magnitude of overweight/obesity among school going children of Wardha city was found to be 4.3 per cent. Family characteristics play important role in predisposing the children to overweight/obesity and hence the interventions need to be directed towards the families.

Mohammed (2008) conducted a study to describe the prevalence of childhood overweight and obesity in rural high- and low-altitude populations of south western Saudi Arabia and to identify specific at-risk groups within these populations. A cross-sectional study was conducted on 912 school children and adolescents aged 6–15 years born and living permanently at high altitudes (2800–3150 m) and 972 children and adolescents of comparable ages born and living permanently at low altitudes (_500 m). Height and weight were measured. For children _10 years, the weight-to-height index according to World Health Organization (WHO) standards was used for assessing overweight and obesity. For adolescents 10–15 years, overweight and obesity were assessed by age and gender-specific percentiles for body mass index based on the WHO/National Centre for Health Statistics reference population. A questionnaire was used for measuring parents' socioeconomic status. The data were analysed through SPSS and *t* test and chi-square test were used to compare between means and percentages, respectively. The result of the study was the overall prevalence of overweight and obesity at high and a low altitude was 10%. The study showed that some school children and adolescents were at a significantly higher risk of developing overweight and obesity.

Significant risk factors included moderate-to-high parental income, age _10 years, high-altitude birth and residence, and female sex (crude odds ratio 3.2 [95% CI, 1.8– 5.5], 2.3 [95% CI, 1.6–3.2], 2.1 [95% CI, 1.5–2.9], and 1.9 [95% CI, 1.4–2.6], respectively). A multivariate analysis using the direct binary logistic regression model revealed that moderate-to-high parental income, age _10 years, female sex, and high-altitude birth and residence were significant independent predictors of childhood overweight and obesity. (adjusted OR 3.2 [95% CI, 1.6–2.6], 2.6 [95% CI, 1.8–3.8], 2.0 [95% CI, 1.6–2.9], and 1.8 [95% CI, 1.3–2.6]), respectively. They concluded that the study identified the risk factors for childhood overweight and obesity in Saudi Arabia, among these; high altitude was a significant and independent factor.

Procter et al. (2008) conducted a study to explore the impact that schools have on their pupils' obesity and so identify those where targeted input is most needed. A modelling process was developed using data that had been collected over 2 years on a socio-economically and ethnically representative sample of 2367 school pupils aged 5 and 9 years old attending 35 Leeds primary schools. The three steps in the model involved calculating the ''Observed'' level of obesity for each school using mean body mass index standard deviation (BMI SDS); adjusting this using ethnicity and census-derived deprivation data to calculate the ''Expected'' level; and calculating the ''Value Added'' by each school from differences in obesity at school entry and transfer. They found there was significant variance between the schools in terms of mean BMI SDS (range _0.07 to +0.78). Residential deprivation score and ethnicity accounted for only a small proportion of the variation. Expected levels of obesity therefore differed little from the Observed, but the Value Added step produced very different rankings. As such, there is variation between schools in terms of their levels of obesity. Their modelling process allowed identifying schools whose levels differed from that expected given the socio-demographic makeup of the pupils attending. The Value Added step suggests that there may be a significant school effect. If this is validated in extended studies, the methodology could allow for exploration of mechanisms contributing to the school effect, and identify schools with the highest unexpected prevalence.

Tarek et al. (2008) conducted a study to assess the magnitude of obesity and overweight among primary school boys aged from 10- 14 years, and to find a possible association between obesity/overweight and dietary habits and the socio demographic

differentials among the children in Al-Hassa, Kingdom of Saudi Arabia. The methodology and design of study was a cross-sectional descriptive study, including 1139 Saudi male children enrolled in the 5th and 6th grades in public primary schools in Al Hassa, Kingdom of Saudi Arabia (KSA), was conducted. The test included a multistage random sampling technique, based on interview using Youth and Adolescent Food Frequency Questionnaire, gathering data regarding dietary intake, dietary habits, followed by anthropometric measurements with the calculation of body mass index (BMI), the interpretation of which was based on Coles tables for the standard definition of overweight and obesity. Socio demographic data were collected through a parental questionnaire from. Statistical techniques used to analyze the data by using the SPSS 12 and the descriptive and inferential data analyses were applied using the appropriate statistical tests of significance (chi-square, *t*-test). The result of the study was the prevalence of overweight among the subjects was 14.2%, while that of obesity was 9.7%; the prevalence was more in the urban, older age students. The mothers of obese and overweight children were less educated and more working. Missing and or infrequent intake of breakfast at home, frequent consumption of fast foods, low servings per day of fruits, vegetables, milk and dairy products, with frequent consumption of sweets/candy and carbonated drinks were all predictors of obesity and overweight among the schoolchildren studied. They concluded that less healthy dietary habits and poor selection of food may be responsible for the high prevalence of obesity.

Aydin et al. (2008) conducted a study to investigate the relative effects of outdoor school environments on physical activity among third and fourth year students of Turkish primary school. This study is unique in that it explores primary schoolchildren's attitudes toward the outdoor school environments in Ankara. They studied the schoolyards for two main reasons. First, they have a practical interest in improving the landscape characteristics of the schoolyards in Turkey to promote more and better quality physical activity. Since children in dense urban environments have limited access to and opportunities for exercise in areas other than schoolyards, these outdoor environments are intended to provide the primary setting for their exercise. Second, research has shown that schoolyards with predominantly natural features (e.g. trees and water features) reduce stress and promote more physical activities among school children. It is also assumed that students with more active lifestyles in school have a lower rate of obesity. In order to assess this correlation, body mass index (BMI) measurements and activity

patterns reported by each student were analyzed. This study included a semi- structured interview with students to understand the relationship between the activities students engage in, the places they like in the schoolyard, their satisfaction with the outdoor school environment, the relationship between satisfaction with the those environments and student physical activities, problems of the schoolyards in terms of physical qualities, and type of schoolyard that they define as beautiful. The methodology and design of the study was that, they were randomly selected five public schools from the various districts of Ankara, which is aimed to represent a cross-section of the population. The schools are located in different districts of the city with different physical and social characteristics, which indicate variation in the economic and social status among students. The data were collected through a questionnaire which administered via face-to-face interviews, addressed students' perceptions of outdoor school environments (schoolyards), dietary habits (what they eat and drink), the status of BMI of each student, their activity patterns during recess, their satisfaction with the schoolyards and their suggestions to improve the standards of the schoolyards. A total of 290 questionnaires were administered in five schools. Of 290 children analysed in this study, 155 (53.4%) were girls and 135 (46.6%) were boys. The data were also collected from teachers and school administrators through the same techniques and procedure. ANOVA was used to analyse the data as statistical procedure. The t tests were used to assess the differences between the overall mean scores of BMI values of male and female, and third and fourth grade students. Analysis of variance was used to determine relationships between dependent and independent variables and differences between the independent variables. The result of the study revealed that, there were similarities in the landscape features and physical qualities of schoolyards, particularly in the types of play and activities in which students engage. Results indicated that active students who walk to and from schools have lower body mass index (BMI) values than passive students, and students in schools with larger yards have lower BMI values. Most of the students prefer spacious and vegetated yards. A major concern is the crowdedness of the yards during recess that limit children's activity. Schoolyards with advanced landscape features are preferred more, and this in turn affects students' positive satisfaction. They concluded that the outdoor school environments have a correlation to health outcomes and should be designed to promote more activity. Improving the physical and landscape qualities of the public schoolyards should be the primary concern of the designers in order to increase awareness of natural environment and more important, increase the health of children.

Lloyd et al. (2007) conducted a study to determine the current levels of physical education (PE) and sports participation among American secondary school students, and to establish the extent to which they vary by grade level, racial/ethnic background, and socioeconomic status (SES) of the students. The methodology and design of the study was that, nationally representative data were used from over 500 schools and 54,000 students surveyed in 2003, 2004, and 2005 as part of the Youth, Education, and Society (YES) study and the Monitoring the Future (MTF) study. As part of YES, school administrators completed questionnaires on physical activity (including rates of sports and PE participation) of students in their schools. Students in the same schools completed self-administered questionnaires in the same year as part of MTF, providing individual background data, including their gender, racial/ethnic identification, and parents' education level. Data were analysed in 2006. The Chi-square and t-test statistics were used to analyse the data. The result of the study was that the Physical education requirements, and actual student participation rates, decline substantially between 8th and 12th grades. About 87% of 8th graders were in schools that required them to take PE, compared to only 20% of 12th graders. Principals estimate that over 90% of 8th graders actually take PE, compared to 34% of 12th graders. Subgroup differences in PE participation rates were small. Only a fraction of all students participate in varsity sports during the school year, with girls participating only slightly less than boys (33% vs. 37%). Participation correlates negatively with SES and was lower among black and Hispanic students than white students, even after controlling for other variables. Participation rates in intramural sports were even lower, declined in higher grades, and were lower among low-SES and Hispanic students (after controlling for other variables). They concluded that Physical education is noticeably lacking in American high schools for all groups. Racial/ ethnic minorities and low-SES youth, who are at higher than average risk of being overweight in adolescence, are getting less exercise due to their lower participation in school sports.

Manu et al. (2007) conducted a study to determine the time trends of childhood obesity and overweight in a large population of schoolchildren from Ernakulam, Kerala, India, over a period of 2 years. The relationship of obesity with childhood hypertension was also explored. They used a stratified random cluster sampling method to select the children. Anthropometric data were collected from 24,842 students, 5–16 years of age, during 2003–04. Blood pressure and anthropometric data were collected from 20,263

students during 2005–06. Overweight and obesity were defined by body mass index for gender and age. Gender, age and height were considered for determining hypertension. Data were analyzed by using SPSS (version 11.0). Statistical significance of the difference in the mean value of different variables between the 2 groups was tested by applying t test. The result of the study revealed that the proportion of overweight children increased from 4.94% of the total students in 2003 to 6.57% in 2005(OR: 1.36; 95% CI: 1.25–1.47; p<0.0001). The increase was significant in both boys and girls. The proportion of overweight children was significantly higher in urban regions and in private schools, and the rising trend was limited to private schools. Systolic or diastolic incident hypertension was found in 17.34% ofoverweightchildrenversus10.1% of the remaining students (OR: 1.87; 95% CI: 1.60–2.17; p<0.0001). They concluded that the Childhood obesity showed an increasing trend in a short period of 2 years. Hypertension was common in Overweight children.

Kumar et al. (2007) conducted a study to know the prevalence of obesity in two affluent school children of Davangere city studying between 5th and 10th standard and to identify the factors influencing childhood obesity. The methodology, they used as a cross sectional study followed by a case control study was conducted in two affluent schools of Davangere city – Sri.Siddaganga and Sri.Taralabalu residential school. A total of 1496, school children studying between 5th and 10th standard aged between 10 and 15 years were enrolled and data on family history of obesity, diet, snacking habits and physical activity was collected. The height and weight of students were measured by adopting standard procedures and BMI was calculated using K.N. Agarwal percentiles, children with 95th Percentile of BMI were taken as cut-off point. Children with BMI more than this cut-off point with respect to age and sex were considered as obese. The Children having chronic illness, severe malnutrition, Endocrinal problems, Physical & Mental defects and Children aged below 10 years and above 15 years were excluded. Statistical Analysis was done by Chi-square test & Odds ratio. The result of the study was the Prevalence of obesity was 5.74%. Prevalence of obesity was more in girls (8.82%) than boys (4.10%).

Connelly et al. (2007) conducted a study to present practice-relevant guidance on interventions to reduce at least one measure of adiposity in child populations that do or do not contain overweight or obese children. They conducted the study on the basis of

report that preventing childhood overweight and obesity has become a major public health issue in developed and developing countries Systematic reviews of this topic have not provided practice-relevant guidance because of the generally low quality of research and the heterogeneity of reported effectiveness. The study was designed in a systematic review of eligible randomized, controlled trials or controlled trials using a novel approach to synthesizing the trial results through application of descriptive epidemiological and realistic evaluation concepts. Eligible trials involved at least 30 participants, lasted at least 12 weeks and involved non-clinical child populations. The two researchers of this study (JC, MD) were classified the physical activity intervention as 'compulsory' or 'voluntary' blind to outcome. The data were extracted from trails and recorded systematically by constructing a Performa involved the reference number; first author; year of publication; country of the trial, design; unit of analysis; age group; ethnicity; numbers in each group; description of intervention; results; researcher's comments; appraisal comments; quality score; intensity score; and effectiveness. The result of the study was Twenty-eight eligible trials were identified. Eleven trials were effective and 17 were ineffective in reducing adiposity. Blind to outcome, the main factor distinguishing effective from ineffective trials was the provision of moderate to vigorous aerobic physical activity in the former on a relatively 'compulsory' rather than 'voluntary' basis. They concluded the study that, by using a novel approach to synthesizing trials, a decisive role for the 'compulsory' provision of aerobic physical activity has been demonstrated. Further research is required to identify how such activity can be sustained and transformed into a personally chosen behaviour by children and over the life course.

2.2 STUDIES ON CIRCUIT TRAINING

A.Sakthivel (2020) conducted a study to investigate the influence of the combined effects of aerobic training resistance training and yogic practices on selected health related physical fitness variables of adolescent boys. To achieve the purpose of the study (N=45) forty five. A total of forty five ranging were selected from Chinmaya Vidyalaya Matric Higher Secondary School, M.S.S.D Higher Secondary School, Coimbatore for the study. Their age ranged between 12 and 14 years, were randomly selected from as subjects. They were divided into three equal groups, each group consisted of fifteen subjects, in which experimental group – I underwent resistance

aerobic training, experimental group - II underwent resistance training with Yoga Practice and group - III acted as control that did not participate in any special activities apart from their regular curricular activities. A pilot study was conducted to assess the initial capacity to the subject in order to fix the load. The following variables were chosen namely percent body fat (Skin fold Caliper), resting heart rate (omrom heart rate monitor) and explosive power (Vertical jump test). The data were collected before (pretest) and after the experimental period of six weeks (post test) in identical manner. The pre-test and post test scores were subjected to statistical analysis by using the Analysis of Covariance (ANCOVA). Wherever the F'ratio for adjusted post test was found to be significant Scheffe's post hoc test was used to determine the paired mean difference among the groups. All the data were analyzed using computer with SPSS statistical package, The level of significance was fixed at 0.05 level of confidence from the findings of the study it evident that the adolescent boys in almost all the physical fitness variables.

Dilip Biswas, Dr. Ashim Kumar Bose, **et.al. (2019)** conducted the study to evaluate the best method for handling Overweight. Out of 96 selected participants from Fluvio Coastal zone of West Bengal, India on the basis of BMI, 80 overweight girl (Age ranged: 20±2 years) were considered for the study. The subjects were divided into four groups (20 for each group) randomly namely Weight Training Group (WTG) Aerobics Training Group (A T G) Graded Circuit Training Group (GCTG) and Control Group (CG). Separately designed 12 weeks training programme for WTG, ATG and GCTG was applied on the subjects at morning between 8.00 am to 9.15am for three alternate days a week. After every four weeks, total load was increased. Pre and post-test on all the groups were conducted to measure the training effect on Body Mass index(BMI) and Waist to Hip Ratio(WHR).They were statistically analysed by using the analysis of Co-variance ($p< 0.05$) to determine the differences and LSD test was applied as a post hoc test to find out the paired mean differences.

Gaganpreet Kaur, Dr. Jogiswar Goswami et.al. (2019) conducted a study to test the effects of circuit training programme on the aerobic capacity, speed and explosive strength performance of the school children of Delhi. For the same, the researcher has selected 40 children for both the groups i.e. experimental and control. The children were having age ranged between 16 ± 2 years. A circuit training program has

been implemented on the experimental group whereas the control group did not get any treatment. The pre data from both the groups has been collected in advance prior to the training. After a training period of 12 weeks training (4 days a week), the post data has been collected. For the data analysis, the researcher has employed all the tests which test the assumptions of analysis of covariance. The result of ANCOVA has showed that the training has put significant impact on the dependent variables and it was found effective.

Prakash Meti (2018) conducted the study to find out the effect of circuit training for developing vital capacity and peak flow rate among school going students. 30 students between the age group of 15 to 17 years were selected for the study. The six weeks circuit training program for shuttler group was conducted in order to study the effect of circuit training on vital capacity and pea flow rate of subjects. The Pre Test and Post Test were proficient through dry spirometer and pea flow meter to estimation the effects of circuit training on vital capacity and peak flow rate respectively of school students. A specialized circuit training program was applied to the subjects during the PE classes which was on alternate days under the supervision of a researcher. Training program includes 5 stations i.e. (Burpees Jump, on the spot jog, suryanamaskar, sit ups and squat thrusts). Participants needs to perform two 60 seconds on each station and 4 set on each station with a break of 2 minutes in between set and 15 sec break in between change of station. Results shows no significant difference between pre test post test vital capacity value of subjects as the sig (2- tailed) value is (0.62) which is greater than 0.05 level of significance, results also depicts t-value as (0.01) for variable Peak flow rate which is less than 0.05 level of significance.

Suman Rani (2018) compared the strength of B.P.Ed students. A total 20 players were selected as sample for the study. All the students were belongs to department of physical education, MDU, Rohtak. The age of sample were ranged from 18 to 25. To assess the Strength Medicine Ball Throw test was used. To compare the obtained results‘t’ test was used as a statistical tool and the level of significance was set at 0.05. The result revealed the positive effect of Circuit training on strength of the B.P.ED students. After analysis of the obtained results, it was observed that mean score of post test is higher than the pre test mean score. It means there was a statistically significant difference in strength of the B.P.ED students.

Ab Raoof et al. (2017) investigated the influence of circuit training on agility among college students. Thirty male college students (n=30) were randomly selected as subjects and their age ranged between 18 and 22 years. The selected subjects were randomly assigned into two equal groups such as circuit training group (CTG), and control group (CG) with fifteen subjects each (n=15). The experimental group underwent their respective experimental treatment for eight weeks three days per week and a session on each day. Control group was not undergone any specific training apart from their regular activities. Agility was taken as dependent variable for this study and it was measured by shuttle run. The collected data was analyzed by using analysis of covariance (ANCOVA). The result revealed that the circuit training group produced significant improvement ($p \leq 0.05$) on agility as compare to control group.

Billy Sperlich et. al. (2017) analysed the effects of circuit-like functional high-intensity training (Circuit-HIIT) alone or in combination with high-volume low-intensity exercise (Circuit-combined) on selected cardio-respiratory and metabolic parameters, body composition, functional strength and the quality of life of overweight women were compared. In this single-center, two-armed randomized, controlled study, overweight women performed 9-weeks (3 sessions·wk^{-1}) of either Circuit-HIIT (n = 11), or Circuit-combined (n = 8). Peak oxygen uptake and perception of physical pain were increased to a greater extent (p <0.05) by Circuit-HIIT, whereas Circuit-combined improved perception of general health more (p <0.05). Both interventions lowered body mass, body-mass-index, waist-to-hip ratio, fat mass, and enhanced fat-free mass; decreased ratings of perceived exertion during sub maximal treadmill running; improved the numbers of push-ups, burpees, one-legged squats, and 30-s skipping performed, as well as the height of counter-movement jumps; and improved physical and social functioning, role of physical limitations, vitality, role of emotional limitations, and mental health to a similar extent (all $p <$ 0.05). Either forms of these multi-stimulating, circuit-like, multiple-joint training can be employed to improve body composition, selected variables of functional strength, and certain dimensions of quality of life in overweight women. However, Circuit-HIIT improves peak oxygen uptake to a greater extent, but with more perception of pain, whereas Circuit-combined results in better perception of general health.

Kunal (2017) His study consisted of 40 of 14-16 years tribal boys selected randomly from Napara High School(H.S.), Purulia District, W.B; and the subjects were divided into two equated viz. experimental and control groups for circuit training of three alternate days per week for ten weeks. Their pre and post test data of Systolic Blood Pressure and Diastolic Blood Pressure was measured. The data was analyzed by applying paired, t‟ test. On the basis of analysis within the limitation imposed on the experimental conditions the investigators find out the outcomes and they concluded that circuit training improves Systolic and Diastolic Blood Pressure.

Mahesh (2017) examined the effects of circuit training and fartlek training on selected physical fitness variables (speed, flexibility, muscular strength and muscular endurance) of the male schoolchildren's. For the present study, sixty school boys' students studying from Mahatma Gandhi intercollegiate, Gorakhpur (U.P) were selected randomly as subjects. Their age ranged from 13 to 17. Twenty subjects were distributed into three equally groups. Control group (N=20), Group – I circuit training (N=20), group–II plyometric training (N=20). The experimental groups with varied load and velocity (intensity) under went their respective training programme for three days in a week for eight weeks. Analysis of co-variance (ANCOVA) and Scheffe's post hoc tests were used to examine the significance between the variables for testing groups. Statistical significance was set to a priority at $p < 0.05$. All physical fitness variables have significant improvement in circuit training, plyometric training and control group. The speed and flexibility have no significant improvement in between experimental groups but the muscular strength and muscular endurance have significantly improved.

Maniazhagu et al. (2017) examined the effects of explosive strength and strength endurance based circuit training on speed performance. To achieve the purpose of the study, thirty boys' student in the age group 13 to 14 were selected as subjects at random. The selected subjects were from RCM High School, Natarajapuram, Sivagangai(DT), Tamilnadu. The study was formulated as pre and post-test random group design, in which thirty students were divided into three equal groups. The experimental group-1 (n=10, ESbCT) underwent explosive strength based circuit training, the experimental group-2 (n=10, SEbCT) underwent strength endurance based circuit training and group 3 served as control group (n=10, CG) did not undergo any specific training. In this study, two training programme were adopted as independent

variables, i.e., explosive strength based circuit training and strength endurance based circuit training. The speed was selected as dependent variables. The speed was tested by 50 meters run recoded in seconds. The selected two treatment group namely explosive strength based circuit training and strength endurance based circuit training were performed five days in week for the period of six weeks, as per the stipulated training programme. The speed performance was collected before and after the training period. The collected pre and post test data was critically analyzed with statistical tool of one way analysis of co variance, for observed the significant adjusted post-test mean difference of three groups. The Scheffe's post hoc test was used to find out pair-wise comparisons between groups. To test the hypothesis 0.05 level of significant was fixed in this study. The nature of speed highly improved in explosive strength based circuit training than the strength endurance based circuit training.

Neha Kumari, Dr. Sandeep Tiwari, et.al. (2017) conducted the study to assess the effect of Circuit Training Programme on Physiological parameters on Pre-Obese Adolescents. The objective of the study was to found out the effect of 30 minutes Circuit Training Programme on BMI, Body-Fat, of sedentary pre-obese adolescent for a total duration of 21 days. For the purpose of the study, thirty (n=30) subjects were selected. The age group of the subjects ranged from 12 years to 18 years. The subject selected were the students from Kendriya Vidyalaya, Shalimar Bagh New Delhi. The Statistical Technique employed for analyzing the data were Mean, Standard Deviation and't' test. The level of significance was set at 0.05 for interpreting the results. The result of the study indicates a significant difference in BMI, Body-Fat, between Experimental and Control group. Further, Experimental group had significantly lower average performance mean score as a result of 21 days of Circuit Training than the control group subjects who were not engaged in any training programme.

Sunita Rani et al. (2017) conducted a study to discover the effects of Circuit Training on selected physical fitness variables of sportspersons. State level healthy male players of Athletics, Football, Cricket and Hockey were selected for experimentation. Total subjects were 28, ranging 15-19 years of age. All the subjects were divided into two equal groups i.e. Experimental group (n=14) and Control group (n=14). Experimental group was given Circuit training program while Control group was not given any specific training programme. 6 weeks training programme was designed and

the subjects were required to attend five days training programme in a week. AAHPER youth fitness test was used to collect pre and post test data on selected physical fitness variables. Paired t-test was used to check if any significant difference exists or not between pre and post-test scores of Circuit training group and pre and post test scores of Control group. Independent t-test was employed to check significant difference between pre scores of Circuit training and Control group and post-test scores of Circuit training and Control group and mean, S.D and t-ratio were tested. The study was concluded on the basis of findings that Circuit training has significant effect on all selected physical fitness variables.

Febin J, Robertet al. (2016) examined the effect of aerobic exercise and circuit training on obesity among school student. To achieve this purpose, forty five school student aged between 14 to17 years, studying in the ONGC public school children were selected. The subjects were divided into three equal groups of fifteen subjects each, namely aerobic exercise group, circuit training group and control group. The aerobic exercise group was given cycling, calisthenics, rhythmic exercises, continuous slow running. Circuit training group was given bench press, half squats, standing jumps daily for twelve weeks. Weight was tested before (pre) and after (post) the training programme for both experimental and control group by using Waist circumference. ANCOVA was used to find out the significant difference if any between the groups. The results of the study indicated that the Aerobic exercise group has significantly improved from circuit training and control group the selected dependent variable namely waist circumference. However control group did not show any improvement on the obesity as it was not involved in any of the specific training programme.

Shiv kumar Diswaret. al. (2016) undertaken a study to find out the comparative effect of SAQ and circuit training program on selected physical fitness variables of school level basketball players. Thirty (30) school level basketball players aged between 14-17 years will randomly be selected from Simpkins School Agra U.P. The subjects were randomly divided in three groups as group A (SAQ training group), group B (circuit training group) and group C (control group) respectively. After the pre-test with Physical fitness test Experiment Group-A underwent a training SAQ programme of selected exercise. Group-B received a Circuit training program of selected exercises, whereas the Control group did not performed any training program. Group A

and B has under gone SAQ training program and circuit training for 60 minutes three times a week except Sunday for duration of 12 weeks. Post data was collected after 12 weeks of experimental period. Analysis of Variance (ANOVA) was applied at 0.05 level of significance and Post hoc mean comparison was done by using LSD test. It may be concluded that SAQ training program was significantly better than circuit training program for speed and agility whereas circuit training program was better than SAQ training program for abdominal, arms & shoulder endurance being studied by the researcher. In case of explosive strength no significant difference was found between both the training programs.

Sofien Regaieg et. al. (2016) conducted a study to determine whether a 16-week training program; in addition to the school physical education and without dietary intervention; could have beneficial effects on body composition and aerobic capacity of obese children. Twenty-eight obese children (16 boys, 12 girls; aged 12-14 years) were enrolled and were divided into either the exercise group (EG, $n = 14$) or the control group (CG, $n = 14$). EG participated in a 16-week aerobic exercises (four 60-min sessions per week at 70-85% of HRmax (maximum heart rate)), in addition to the school physical education. Fat-Free Mass (FFM) and Fat Mass (FM) were assessed with bioelectrical impedance equipment. To assess aerobic capacity, maximal metabolic equivalent of task (MET max) and maximal workload (W max) were estimated with an electronically braked bicycle ergometer. The results of the study revealed that there were no differences between the two groups. After the training program, only the EG showed significant reduction in BMI (body mass index) and waist circumference compared with the baseline values ($P < 0.001$). Exercise training significantly decreased FM only in the EG. A significant increase in FFM was seen in both groups; more marked in the EG. There was a significant increase in METmax ($P < 0.05$) and Wmax ($P = 0.02$) in the EG, and no significant changes in these parameters were seen in the CG. HRmax significantly decreased only in the EG ($P < 0.05$). They concluded the study that the training program has beneficial effects on body composition and aerobic capacity parameters in obese children. Our intervention has the advantage of providing a sustainable and reproducible school and community approach for the management of children obesity.

Vikesh (2016) examined the effect of circuit training on selected motor abilities among university male students. For the purpose of the study total 60 boys were selected

as subjects from the Department of Physical Education (T), Guru Nanak Dev University, Amritsar, Punjab (India) and their age ranged from 18 to 25 years. The subjects were divided into two groups: Group-A: Experimental (N1=30) and Group-B: Control (N2=30). All the subjects were informed about the aim and methodology of the study. The subjects from Group-A were subjected to 8-week of Circuit Training Program. Group-B acted as control who did not participate any special training apart from the regular curricular activities. The training program starts with warm up exercises for 10 minutes., The following stations were set up as; Sit ups (lower abdominals), pushups, Squat jumps, Compass jumps, Astride jumps, Shuttle runs for the main training schedule. Experimental group performed 20 to 30seconds work on each exercise with a 20 to 30 seconds recovery. They performed 2 to 4 sets with a 2 to 3 minutes recovery between each set. T-test was used to find out the statistical significances of each age groups pre and post mean differences.

Vrachimis et. al. (2016) examined the effect of circuit training (CT) on resting heart rate variability (HRV) and other cardiovascular disease (CVD) risk factors such as blood lipids and blood glucose and on fitness components. Twenty-four healthy untrained adults (age 26.5 ± 5.1 years; height 1.67 ± 8.4 m; weight 66.8 ± 15.1 kg; 26.3% ± 5.2%; maximum oxygen uptake (VO2max) 48.5 ± 10.0 ml·kg−1·min−1) were assigned to either CT (n = 12) involving bodyweight exercises, or control (CON, n = 12) groups. Prior to the start and following the end of the six-week training period, time-, frequency-domain and nonlinear measures of resting HRV, arterial blood pressure, body composition, fasting blood lipids, lipoproteins and glucose, VO2max, upper body muscular endurance (UBME) and abdominal and hip flexor (AHFME), back strength (BS) and handgrip were assessed. None of the resting HRV measures ($P > 0.05$) were affected by the CT intervention. However, diastolic blood pressure decreased ($P = 0.03$), lean body weight ($P = 0.03$) increased, VO_2max ($P = 0.03$), UBME ($P < 0.001$), AHFME ($P = 0.04$), and BS ($P = 0.03$) were significantly higher following CT, whereas the other variables were not influenced by the CT. Six-week of CT involving bodyweight exercises has no significant impact on resting HRV. However, this type of training might decrease the risk for development of CVD by reducing arterial blood pressure and by improving body composition, aerobic capacity, muscular endurance and strength.

Frietas, et. al. (2015) investigated the acute effects of two different resistance circuit training protocols on basketball players' physical and technical performance and rate of perceived exertion (RPE). In a repeated-measures, crossover experimental design, 9 semi-professional basketball players performed a Power Circuit Training (PCT; 45% 1RM) and a High Resistance Circuit Training (HRC; 6RM), on consecutive weeks. Vertical and horizontal jumps performance, 3-points shooting accuracy, repeated sprint ability (RSA), agility and upper body power output were measured pre- and post-training. RPE was assessed 20 min post-resistance training. One-way repeated measures ANOVA showed performance decrements in vertical jump height and peak power, horizontal jump distance, 3-points percentage, bench press power output, RSA total and ideal time and agility T-Test total time following HRC but not PCT (P<=0.05). RPE was higher in HRC compared with PCT. The results of this study indicated that HRC was perceived as being harder and produced higher fatigue levels, which in turn lowered acute performance. However, low-to-moderate intensity loads did not negatively affect performance. Thus, completing a PCT session may be the most appropriate option prior to a practice/game as it avoids acute resistance training-induced performance decrements. However, if the objective of the basketball session is to develop/perfect technical skills during fatiguing conditions, HRC may be the more suitable option.

Malathy and Robert (2015) examined the influence of physical exercise, circuit training and yogic practice on endurance among college girls in Tamilnadu state. One hundred and twenty (n=120) girls in college level have been randomly selected from Tamil Nadu state, India during the academic year 2014 - 2015. The age of subjects ranged from 17 to 20 years. Using matching procedure, the subjects were divided into four equal groups of thirty subjects each. Group-I (n=30) underwent physical exercise training, Group-II (n=30) underwent circuit training, Group-III (n=30) underwent yogic practices training and Group-IV (n=30) acted as control group. The experimental group participated in the physical exercise training, circuit training and yogic practice respectively for 12 weeks, 6 days in a week, one session per day and each session lasted 90 minutes .The data collected from the three groups prior to and post experimentation on the selected dependent variables were statistically analyzed to find out the significant difference if any by applying the analysis of covariance (ANCOVA) And the Scheff's test also applied as post hoc test to determine the paired mean differences. In all the cases the level of confidence was fixed at 0.05 for significance. The result of the study reveals,

there was a significant improvement on endurance due to the influence of physical exercise training, circuit training and yogic practice among college girls and also helped to improve the physical fitness variables along with the performance level of the subjects. The study was concluded that Iyengar yoga practices training group was significantly better than the sundara yoga training group.

Rani Sangeeta et. al. (2015) conducted a study to check the effects of selected training programme on health related physical fitness components of obese children. The subjects were taken from Mussoorie International School aged between 10 to 14 years in the year 2004-2005. The data was collected by administering the fit youth today test to the obese children before and after giving the training programme to them in term of pre-test and post-test. Eighty (80) obese students were selected as the subjects in this study. In each group for each programme twenty (20) students were taken as the subjects. In order to find out the significance difference between the various training programmes, analysis of covariance was used and the level of significance was chosen at 0.05 levels. Analysis of covariance was computed by the ANCOVA test. To find out the (LSD) least significance difference among the groups LSD was used. The results of the study reveals that there were highly significance differences between the three groups that is Brisk Walking, Jogging and Circuit training programme. Circuit training seems to be more effective than other groups. There was no improvement in control group participants as they did not take part in any of the training program. So for good health obesity should be prevented and this study shows that the Circuit training is more effective training program as comparison of other program to reduce the fats from the body.

Chittibabu and Akilan (2013) evaluated the study the effectiveness of a basketball specific endurance circuit training on aerobic capacity and heart rate of high school male basketball players. To achieve the purpose of the study twenty four (24) male high school basketball players were selected from Neyveli Lignite Corporation Sports School, Neyveli and St. Joseph Higher Secondary School, Manjakuppam, Cuddalore. These subjects were randomly distributed into two groups namely basketball specific endurance circuit training group (N=12) and control group (N=12). The mean age of the selected players was 16.85 ± 0.67. Aerobic capacity, resting heart rate and peak heart rate were selected as criterion variables. Aerobic capacity was measured by multistage fitness test and resting and peak heart rate was measured using polar heart rate

monitor. The basketball specific endurance circuit training was administered 3 days per week for six week. They performed 2 minutes of work at 90 to 95% of targeted heart rate using Karvonen method. They performed 8 repetitions during first and second week, followed by 10 repetitions during third and fourth week and 12 repetitions during fifth and sixth week of training and followed by 2 minutes of active resting at 60 to 70% of targeted heart rate. In this study 1:1 work rest ratio was followed. Both groups were tested before and after training, the collected data was analysed using ANCOVA. The result of the study showed that aerobic capacity, resting heart rate and peak heart rate between the groups was significant, it indicates that after adjusting pre-test scores, there was a significant difference between the two groups on post-test scores. The findings of the study showed that significant increase in aerobic capacity and decrease in resting and peak heart rate. It was concluded that basketball specific endurance circuit training is effective in improving aerobic capacity and increases the cardiovascular fitness of male high school boys during competitive phase.

Mayorga-Vega D, Viciana J, Cocca A. et.al. (2013) conducted a study to evaluate the effects of circuit training program along with a maintenance program on muscular and cardiovascular endurance in children in a physical education setting. Seventy two children 10 – 12 years old from four different classes were randomly grouped into either an experimental group (n = 35) or a control group (n = 37) (two classes for each group). After an eight–week development program carried out twice a week and four-week detraining period, the experimental group performed a four-week maintenance program once a week. The program included one circuit of eight stations of 15/45 to 35/25 seconds of work/rest performed twice. Abdominal muscular endurance (sit ups in 30 seconds test), upper limbs muscular endurance (bent arm hang test) and cardio vascular endurance (20-m endurance shuttle run test) were measured at the beginning and at the end of the development program, and at the end of the maintenance program. After the development program, muscular and cardiovascular endurance increased significantly in the experimental group ($p < 0.05$). The gains obtained remained after the maintenance program. The respective values did not change in the control group ($p > 0.05$). The results showed that the circuit training program was effective to increase and maintain both muscular and cardiovascular endurance among school children. This could help physical education teachers design programs that permit students to maintain fit muscular and cardiovascular endurance levels.

Shabeshan Rengasamy (2012) carried out a study to investigate the effect of a physical fitness intervention program within a physical education class towards selected health-related fitness components among Malaysian secondary school girls. A quasi-experimental design with a pre- test-post- test design was adopted for the study. Two Schools in a district were randomly selected. In each school, two classes were randomly assigned intact to the experimental group (n=48) and the other was the control group (n=38). The experimental and the control groups followed their regular physical education conducted for 40 minutes twice a week in addition the experimental group underwent the intervention program. The study was conducted for ten weeks and a treatment of four exercises in a form of a circuit was utilized to improve health-related fitness. Pre- test data was collected on cardiovascular endurance, Flexibility and muscular strength. The experimental and the control groups underwent regular physical education classes twice a week for ten weeks. Apart from the regular physical education classes, the experimental group underwent the treatment of four exercises in a form of a circuit immediately after the warm-up session. After ten weeks, post test data was collected. ANCOVA was utilized for the statistical analysis. The result of the study showed that main effect in cardiovascular endurance $F(1, 83) = 44.69$, $p<0.05$ and for flexibility $F(1, 83) = 46.80$, $p<0.05$. As for muscular strength, the result was not significant $F(1, 83) = 3.54$, $p>0.05$. This result indicated that a ten week physical fitness program within a physical education class was effective in enhancing cardiovascular endurance and flexibility among Malaysian secondary school girls. He concluded that an intervention program within a physical education class had a positive effect towards cardiovascular endurance and flexibility. Consequently, such intervention programs can be incorporated in the physical education curriculum to have better benefits among the girl.

Xavier Maria Raj et. al. (2012) compared the effects of plyometric, circuit training and circuit breaker programmes on selected motor components of school level basketball players. For the purpose of the study; four groups: three experimental groups viz: plyometric training group (A), circuit training group (B), and circuit breaker programme group (C) and the fourth group served as the control group. Random group design was employed. Reliability coefficients for the test- re- test scores on selected motor components: Cardiorespiratory endurance (1.5 mile Run) 0.87, Hip and back flexibility (Sit and Reach Test) 0.97, Spine flexibility (Bridge Up Test) 0.94, Shoulder

flexibility (Shoulder Rotation Test) 0.97,Static balance (Stork Stand Test) 0.97, Dynamic balance (Modified Bass Test) 0.97 were selected to collect the data. To find out the comparative effects of plyometric training, circuit training and circuit breaker programme on selected motor components of school level Basketball players, analysis of covariance was employed, the proposed hypothesis was tested at .05 level of confidence. The result revealed significant improvement in most of the selected motor components. All the three experimental groups were effective in improving the Cardio respiratory endurance (1.5 mile Run), Hip, back and spine flexibility and also balance (staticand dynamic). The result showed that plyometric groups were comparatively better than the circuit training group and circuit breaker programme in improving the Cardio respiratory endurance of the subjects. In the case of shoulder flexibility all the three experimental groups did not show any significant improvement.

Duncan MJ, Al Nakeeb Y, et.al. (2009) conducted a study on Research examining the impact of physical activity on children's body image has been limited and equivocal. The current researchers examined the effect of 6- weeks' circuit based training on body esteem and body mass index (BMI) in 68 British children (34 boys and 34 girls, aged 10-11 years, 16% overweight, 7% obese). The body Esteem Scale for children (BES-C) was administered to both the intervention group and control group, pre, post and 6 weeks post the intervention. BMI was directly assessed from height and body mass pre and post intervention. The result of this study revealed that, as compared to the control group, participation in 6 weeks circuit training significantly improved body esteem scores post-intervention. However, these scores were not sustained 6 weeks post-intervention. The improvement in body esteem scores from pre – to Post-intervention was greater for girls as compared to boys. Additionally, BMI decreased significantly in the intervention group compared to the control group.

Patrica CH Wong, Michael YH Chia et.al. (2008) conducted a study to analyze the effects of a 12-week twice weekly additional exercise training, which comprised a combination of circuit-based resistance training and aerobic exercises, in additional to typical physical education sessions, on aerobic fitness, body composition and serum C reactive protein (CRP) and lipids were analyzed in 13-to 14-year-old obese boys contrasted with a control group. Both the exercise group(EG, n = 12) and control group (CG, n = 12) participated in the typical2 sessions of 40-minutes physical education

(PE) per week in schools, but only EG participated in additional 2 sessions per week of 45 to 60 minutes per session of exercise training, which comprised a combination of circuit-based resistance training and aerobic exercises maintained at 65% to 85% maximum heart rate (HRmax = 220-age). Body composition was measured using dual energy X-ray absorptiometry (DEXA). Fasting serum CRP and blood lipids was analyzed pre- and post-exercise programme. Aerobic fitness was measured by an objective laboratory sub maximal exercise test, PWC 170 (Predicted Work Capacity at HR 170 bpm). Exercise training significantly improved lean muscle mass, body mass index, fitness, resting HR, systolic blood pressure and triglycerides in EG. Serum CRP concentrations were elevated at baseline in both groups, but training did not result in a change in CRP levels. In the CG, body weight increased significantly at the end of the 12-week period.

Mosher (1994) conducted a study determined the effects of a combined aerobic and circuit weight training programme on maximal oxygen consumption, body composition, and muscular strength of college-age women. Of the 33 who volunteered to participate, 17 were randomly assigned to the exercise programme while the remaining 16 served as control group. The training involved a 45 minutes circuit of 30 activities including five 3 minute aerobic exercises and 25-30 sec weight training or callisthenic exercises. The subjects exercised 40- 50% of their 1- RM for each weight station. Work load for the aerobic stations were assigned based on the work load needed to elicit 75 - 85% of the maximal heart rate reached during the Vo2 max test. Data were analyzed using repeated measures ANOVA with significance established at $p < 0.05$. The exercise group had significant increases in Vo2 max, upper body strength, and lower body strength, and significant decreases in skinfold sum and percent body fat. This indicates that an aerobic circuit weight training programme is an effective way to improve cardiovascular fitness, body composition, and muscular strength in college-age women.

Beard Leslie self (1988) performed an investigation of the effects of a 10 weeks physical training (aerobics) and nutrition/education counseling programme on body fat of 443 children attending Tarrant elementary school. The students participated in regular physical education classes or aerobic classes. In the beginning of the programme those subjects who found obese, were given nutrition education/ counseling by either handout or lecturer by their parents. Skin fold measurements were taken prior to and following

treatment period of 10 weeks. ANOVA was used to determine 17 differences in body fat between treatment and regular groups and 27 differences in body fat between obese children receiving handout or lectures and non obese children receiving no nutrition education/counseling. Results were that statistically significant differences were found between body fat of aerobic and regular Physical education groups (P >0.05). The aerobic group demonstrated significantly greater decreased in skin fold fat than the regular physical education groups. No statistically significant differences in body fat were found between the three nutrition education/counseling groups. It was concluded that the aerobic programme was more effective than the regular physical education programme for the fat reduction. Neither nutrition education/counseling strategies were shown to be effective in reducing body fatness.

Larry D. Hensley and Whitefield B. East; et. al. (1982) undertook a study on body fatness and motor performance during pre-adolescence. The purpose of this study was to investigate the relationship between selected physical fitness performance tests and body fat in pre-adolescent boys and girls. Measures of age, height, weight, skin fold thickness at two sites, and performance scored on the vertical jump and standing broad jump, modified pull ups, 40 yards dash and 400 yards run were obtained on 563 elementary school children. The results of one way ANOVA indicated that there was a significant difference between boys and girls on all of the physical performance tests. Although the boys were slightly taller and heavier and scored better than girls on the performance test, there was no significance difference between the sexes in the sum of skin folds. Separate regression equation for the sum of two skin folds by performance in each test indicated that with the exception of modified pull up test, body fatness was only marginally related to performance. These findings indicated that although inversely related to the ability to remove the total body weight, body fatness was of minimal importance of performance differences between young boys and girls.

2.3 STUDIES ON YOGA PRACTICES

Sathiskumar P (2020) led a study to find out the effect of yogic practices on selected physiological variables among school boys. To facilitate the study, 30 subjects were selected from P.K.N. Boys Higher Secondary School, Madurai, Tamil Nadu. Their age was between 15 and 17 years. They were assigned in to two groups, one group served as yogic practices group and second group as control group. The study was

formulated by true random group design, consisted of pre test and post test. Pre test was conducted for all the subjects on selected physiological variables. The experimental group was participated in yogic practices for a period of six weeks. The initial and final scores in selected physiological variables were put in to statistical treatment using Analysis of Covariance (ANCOVA) to find out the significant mean differences. It was concluded that there was insignificant differences on blood pressure due to yogic practices when comparing to control group.

Alaguraja, K., Yoga, P. et.al. (2019) conducted the study to investigate the effect of yogic package on body mass index among high school girls. To achieve the purpose of the study thirty obese were selected from Karaikudi, Tamilnadu, India during the year 2019. The subject's age ranges from 18 to 25 years. The selected students were divided into two equal groups consists of 15 students each namely experimental group and control group. The experimental group underwent a yogic package programme for six weeks. The control group was not taking part in any training during the course of the study. Body mass index was taken as criterion variable in this study. The selected subjects were tested on Body mass index was measured through body mass index analyzer method. Pre-test was taken before the training period and post-test was measured immediately after the six week training period. Statistical technique't' ratio was used to analyze the means of the pre-test and post test data of experimental group and control group. The results revealed that there was a significant difference found on the criterion variable. The difference is found due to yogic package given to the experimental group on Body mass index when compared to control group.

Alaguraja, K., Yoga, P. et.al. (2019) conducted a study to explore the effect of yogic package on body mass index among rural school boys. To achieve the purpose of the study thirty rural school boys were selected from Karaikudi, Tamilnadu, India during the year 2018. The subject's age ranges from 15 to 17 years. The selected students were divided into two equal groups consists of 15 students each namely experimental group and control group. The experimental group underwent a yogic package programme for six weeks. The control group was not taking part in any training during the course of the study. Body mass index was taken as criterion variable in this study. The selected subjects were tested on Body mass index was measured through body mass index analyzer method. Pre-test was taken before the training period and post-test was

measured immediately after the six week training period. Statistical technique‘t’ ratio was used to analyze the means of the pre-test and post test data of experimental group and control group. The results revealed that there was a significant difference found on the criterion variable. The difference is found due to yogic package given to the experimental group on Body mass index when compared to control group.

Bobby, G. (2018) conducted a study to find out the effect of yogic practices on selected physiological variables among obese school boys at Thiruvallur district, Chennai, ThamilNadu. To felicitate the study, the investigator with prior permission from the school authorities measured height and weight of 120 school boys in the age group of 12 to 17 years. Further 30 subjects were selected on the basis of BMI measurements. It was decided to keep 30 kg/m^2 as base line for the selection of subjects. They were divided into two equal groups, each group consists of 15 subjects, in which group 1 underwent yoga training group (YTG), group 2 Control group (CG) and they did not take part any special training apart from their daily activity. Body mass Index was selected as criterion variables of this study and it was measured by using formula (BMI=Mass (kg)/Height (m^2)) weighing machine was used to measure weight and Stadiometer was used to measure height and subject was selected by random assignment. Initial data were collected on selected dependent variables and final data were collected after 6 weeks training. The differences between the final scores in selected variables were subjected to statistical treatment using test were used to find out the difference among the groups.

Satish, V, Rao, et.al. (2018) conducted a study to evaluate the effects of yoga versus physical exercise training on cardio-respiratory fitness in adolescent school children. Eight hundred and two school students were randomly selected from 10 schools across four districts for this study. Two arm RCT around 802 students were randomized to receive daily one hour yoga training ($n = 411$) or physical exercise ($n = 391$) over a period of two months. VO_2 max was estimated using 20 m shuttle run test. However, yoga ($n = 377$) and physical exercise ($n = 371$) students contributed data to the analyses. Data was analysed using students t test. The result showed that there was a significant improvement in VO_2 max using 20 m Shuttle run test in both yoga ($p < 0.001$) and exercise ($p < 0.001$) group following intervention. There was no significant change in VO_2 max between yoga and physical exercise group following intervention. However, in

the subgroup with an above median cut-off of VO_2 max; there was a significant improvement in yoga group compared to control group following intervention ($p = 0.03$). It was concluded that yoga can improve cardio-respiratory fitness and aerobic capacity as physical exercise intervention in adolescent school children.

Manju and Dolly (2017) examined the effect of yogic asanas on physical and mental ability of sports girls. For achieving this aim twenty (20) sports girls were taken as subjects and given training programme of ten yogic asanas. Abdominal and shoulder strength, speed, endurance, agility and power were taken as components and AAPHERD physical fitness test battery was used for measuring physical ability. To measure mental ability, a group test of general mental ability by S. Jalota was used. The yoga training programme was scheduled for 12 weeks and t-test was applied to find out the difference between pre-test and post-test mean scores of sports girls on physical and mental ability. The results of study revealed that sports girls significantly improved their abdominal and shoulder strength, endurance, agility, power and mental ability after the training of yogic asanas, whereas no significant improvement was found in speed.

Kubendran (2017) examined the effect of sand training and yogic practices on breath holding time among college men football players. To achieve this purpose, forty five men football players from various colleges of University of Madras were randomly selected and they were assigned into three groups namely sand training group, yogic practice group and control group. The training program was scheduled for five days in a week and each training session consists of 45 minutes. Analysis of covariance (ANCOVA) statistical technique was used to test the adjusted post-test mean differences among sand training group, yogic practice group and control group and the adjusted post-test result was significant, the Scheffe's post-hoc test was used to determine the significance of the paired mean differences. Yogic practice group made significant improvement on breath holding time among college men football players after the six weeks of yogic practices. The study was concluded that yogic practices significantly improved breath holding time than sand training.

Amalesh Adhikari, Deba Prasad et.al. (2016) conducted a study to investigate the effect of Yogic Exercises on Physiological Variables among the Adolescents. Fifty male students of U.G. college level were practiced different types of yogic exercises like Surya Namaskar, Asanas, Pranayama and Meditation for eight weeks by maintaining a

schedule. The physiological variables are resting heart rate and blood pressure. The resting heart rate was measured by Pulse Oximeter and blood pressure was measured by Omron Blood Pressure Monitor. The result of the study reveals that there was significant difference between pre-test and post-test. So, it was evident that yogic exercises impact significantly on physiological variables among the adolescents.

Anil A Deshmukh (2016) conducted a study to find out the effect of yogic practices on selected motor fitness components of college girls. Forty girls students were randomly selected from Indirabai Meghe Mahila Mahavidyalaya, Amravati (Maharashtra) India as subjects, for this study. Age of the subjects ranged from 18 to 20 years. Twenty girls were assigned as experimental group and another 20 girls were assigned as control group during the academic year 2014-2015. Six weeks of yoga asanas training were given to the experimental group. The control group was not allowed to participate in any of the training programs, except their routine physical education classes. Measurements for the variables were taken at the beginning (pre - test) and at the end of the experimental period, after six weeks (post - test) the data were collected for all the variables from both control and experimental groups, for five days. During this period the subject were not allowed to participate in any training. The criterion measures adopted for the study measuring the motor fitness components are given below: Shoulder flexibility was measured by administering shoulder and wrist elevation test and Muscular endurance was by administering bent-knee sit-ups. The data collected on 40 subjects beginning (pre- test) and at the end of the experimental period, after six weeks (post- test) the data were collected for all the variables from both control and experimental groups on shoulder flexibility and muscular endurance variables were analyzed by using the 't' test. Result: There was significant difference in shoulder flexibility and muscular flexibility between pre and post-test experimental group. There was insignificant difference in shoulder flexibility and muscular flexibility between pre and post-test control group. There was insignificant difference in shoulder flexibility and muscular flexibility between experimental and control group pre -test. There was significant difference in shoulder flexibility and muscular flexibility between experimental and control group post-test. Shoulder flexibility and muscular endurance was significantly improved by the yogic practices group when compared with control group.

Maya K (2016) emphasized in this study that, the Yoga can help to check any imbalance in muscular development and will enable both mind and body to function more efficiently. Practicing of yoga asanas strengthen the muscles, release physical tension and improve concentration and poise. Yoga makes limbs balanced strong and relaxed. The standing poses improve balance and muscle flexibility. Yogic practice can help players to relax and replenish their energy after strenuous games. It also promotes calm, clear thinking even in situations that call for fast reactions. Yoga stretches and strengthens all muscles of body and brings peace and calm to the mind and spirit and the article has summarized the importance of yoga.

Patel, S., Kumar, K. et.al. (2016) conducted a study was to observe the impact of yoga practices for 6 weeks on body mass index (BMI) cholesterol of subjects with the age group 15- 25 years. For this 25 male subjects were selected randomly from New Delhi India. In this Pre- post study data were collected before and after intervention of yoga practices for 6 weeks 45 days. Body mass index (BMI) was measured according to world health organization (WHO) body mass index (BMI) chart; and the serum cholesterol was measured through lipid profile test. Paired t - test was applied for statistical analysis and p-value <0.01was consider the level of significance. The study was concluded that significant decreased was seen in body mass index and level of cholesterol. This study showed that yoga has reducing Body Mass Index (BMI) and the cholesterol level of the obese youth.

Shivakumar, Suthakar, et.al. (2016) conducted a study to examine the effect of selected yogic exercises on cardiovascular endurance of secondary school children. To achieve this purpose, 60 secondary school students were selected from Government High School, Thondoti, Madhugiri Taluk, Tumkur District, Karnataka as subjects. Their age ranged from 13-16 years. They were divided into two groups of 30 subjects each and assigned to experimental group and control group. The experimental group was underwent selected yogic exercises for a week and control group was not given any specific training. All the subjects underwent Cardiovascular Endurance Test. They were assessed before and after the training period of six weeks. The‘t’ test was used to analyze the data. The study revealed that cardiovascular endurance has significantly improved due to the influence of six weeks of yogic exercises on cardiovascular endurance of secondary school students.

Karthikeyan (2015) undertook a research to see the influences of asana with meditation on selected hematological variables among residential school boys. To achieve the purpose of the present study, forty boys from Velammal Matriculation Higher Secondary School, Viraganoor, Madurai, Tamilnadu were selected as subjects at random and their ages ranged from 15 to 17 years. The selected subjects are divided in to two groups. The experimental group underwent asana with meditation for six weeks. The control group was not undergone any training other than their daily routine. The criterion measures HDL and LDL were tested using enzymatic calorimeter method. The two groups were statistically analysed by using analysis of covariance (ANCOVA) at 0.05 levels. The result of the study reveals that there was a significant improvement in the experimental group on selected variables when compared to the control group after the completion of six weeks of asana with meditation practice. The asana with meditation practice group has showed better performance on HDL, LDL and explosive power than the control group.

Kalidas Karak, Mrityunjoy Jana, et.al. (2015) they conducted a study to analyze the effect of Yoga on Anthropometrical and Physiological variables of the college going male students within the age group of 18-22 years. A total of 30 subjects were taken for the study from S.B.S.S Mahavidyalaya, Goaltore, Paschim Medinipur, West Bengal. The Anthropometrical and Physiological parameters were Weight, BMI and Fat (%) & Pulse rate, S.B.P and D.B.P which were measured by the reputed physician. The Pre-test and Post-test were taken of all the parameters (Anthropometrical and Physiological) before and after of six (6) months of yoga training. The Weight and Height were measured by weighing Machine and Stadiometer respectively. They were measured for the calculation of Body Mass Index (BMI = Weight in kg/Height in meter 2) and for measuring the percentage of Body Fat, Skin Fold Caliper was used. Similarly, the physiological parameters were assessed by recording the blood pressure (S.B.P and D.B.P) and pulse rate before and after six (6) months of regular yogic exercise or training. The subjects were randomly selected for the study as subjects. To measure the blood pressure mercury sphygmomanometer was used and pulse Rate was recorded after a rest for 30 minutes in right radial artery by Palpatory method. For statistical analysis and Interpretation of data't' test was conducted at 0.05 level of significance. The result of the study reveals that there were significant difference found in reduction in the pulse rate, Systolic Blood Pressure and diastolic Blood Pressure after Six (6) months of yoga

practice. The mean pulse rate (beats/min) before yoga was 78.60 which reduced significantly to 72.50 after six months of yoga practice. The mean systolic blood pressure before yoga practice was (mm of Hg) 127.50 and after six months it was lowered to a highly significant level of 120.50.The mean diastolic blood pressure before yoga was 88.60 and it was reduced significantly to 80.50. Similarly, the result of Weight, BMI and Fat (%) were also significant at 0.05 level after the Six (6) months of yoga practice. On the basis of the obtained result, it has been observed and concluded that yoga practice can be used as an intervention in ageing persons to reduce the morbidity and mortality from cardiovascular diseases. It reduces the high blood pressure, pulse rate and Body Weight, BMI and Fat (%) and plays an important role in healthy impact on the life style of a man.

Mukesh Kumar Mishra, Ajay Kumar Pandey, et.al. (2015) conducted a study to inspect the effect of yogic training on selected physiological variables. For the purpose of study twenty five male students of 9^{th} and 10^{th}standard from Children Senior Secondary School, Azamgarh, Uttar Pradesh were selected randomly as the subjects for the study. The age of the subjects were ranging from 13 - 16 years. The variables selected for the present study were yogic training (independent variable), resting heart rate and vital capacity (dependent variables). The data was collected through the pre and post test. For the study single group design was used in which the pre test was taken prior to the yogic training and post test was taken after eight weeks of yogic training. For comparing pre and post test means of resting heart rate and vital capacity, descriptive analysis and paired t-test were applied at 0.05 level of significant. The result of the study showed that there was significant difference between pre and post-test of resting heart rate and vital capacity. On the basis of the findings it was concluded that the yogic training may be responsible for the improvement of selected physiological variables like resting heart rate and vital capacity.

Ramesh Kumar and Chandrasekaran (2015) explored the effect of varied combinations of yogic practices on physiological variables of school boys of Kuwait aged 13-15. To achieve the purpose of this study a survey was conducted and 1000 students from Indian central school, Kuwait to find out the health related fitness status. Among the group 183 students were reported low fitness. In that forty male students who are low in fitness were selected for the experimental study. As per the records, their age ranged from 13 to 15 years. True randomized experimental group design has been

employed with two groups, namely varied combinations of yogic practices group and control group with 20 students each. Resting heart rate, systolic blood pressure and diastolic blood pressure were the criterion variables for the present study. Group I underwent varied combinations of yogic practices viz, asanas, imaginary meditation followed by pranayama for a period of twelve weeks and no training was given to the control group. The two groups were statistically analysed by using analysis of covariance (ANCOVA). The result of the study reveals that there was a significant improvement in the experimental group on selected variables when compared to the control group after the completion of twelve weeks of varied combinations of yogic practices.

Senthilkumar (2015) explored the effects of selected yogic exercises on vital capacity and body fat. To facilitate the study, thirty subjects from selvam higher secondary school, Namakkal were selected as subjects at random and their ages between 14 to 17 years. The subjects were divided into two equal groups. Yogic exercise was given to experimental group for the period of 6 weeks. The pre-tests were taken from the subjects before administrating the training. The subjects were involved with their respective training for a period of 6 weeks. At the end of the sixth weeks of the training post-test were taken. The significant differences between the means of experimental group and control group for the pre-test and post-test scores were determined by paired t ratio. The level of significance was fixed at 0.05 level of confidence. Vital capacity and body fat of experimental group showed significant difference when compared to control group. There was no significant difference in vital capacity and body fat of control group.

Manikandan (2014) conducted a study to investigate the effect of yoga on Cardio Respiratory system and Body Composition of sixty students; age ranging from 14 to 16 years of RANI Seethi Achi Hr.Sec.School, Annamalai Nagar, Tamilnadu, India were selected as the subject of the study. The subject was randomly distributed in two groups. One group is designated as experimental group and other one as control group. The study was restricted to the following variables: Vital Capacity, Resting Pulse Rate, Breath Holding Time, Blood Pressure and Body Composition. Experimental group performed twelve weeks of yogic practices such as Sarvangasana, Halasana, Naukasana, Bhujangasana, Dhanurasana, Ustrasana, Gomukasana, Paschimatasana, Ardha-Matsyendrasana,Savasana and Pranayama was used for Yogic training. Analysis of covariance was applied to study the Effect of Yoga on Cardio Respiratory System and

Body Composition and are significant at P<0.05. A long term effect of yoga proved useful and significant differences was observed in Vital Capacity, Resting Pulse Rate, Breath Holding Time, Blood Pressure and Body Composition.

Saroja (2012) designed a study to find out the effects of complex training and the combined effects of complex training and yogic practices on selected physical and physiological variables among college boys. To achieve the purpose 45 college boys were randomly from Alagappa University College of Physical Education, Karaikudui, Tamilnadu in the age group of 18 to 25 years were selected as subjects. They were divided into three equal groups' namely complex training group, combination of complex training and yogic practices group and control group. The variables such as speed, strength, explosive power were the physical fitness variables and resting pulse rate, blood pressure were physiological variables. All the subjects were tested on before and after the training period of six weeks. The analysis of covariance was used to analyze the data and the outcome showed that there was a significant improvement in the selected physical physiological variables after the treatment. Hence the study was concluded that combined effects of complex training and yogic practices significantly improved the selected physical and physiological variables greater in magnitude than the complex training alone among the college male students.

Thakur and Bandopadhyay (2012) piloted a study to find out the effect gymnastic activities on flexibility measures on school boys. For this study, one hundred (N-100) school boys of Howrah District, West Bengal were randomly selected and their age limit was 10 t0 12 years. All the subjects were divided into two equal groups viz. Group. Y and Group .C. Group Y was experimental group that practiced yogic asanas GroupC was control group. Flexibility, body composition, school attitude inventory scale and self-concept inventory scale were employed to all the subjects of both the groups and thereafter specific yogic treatment was given to Group Y for three days a week, continued one year and finally the subjects were retested on criterion measures. The data were analysed by t-ratio to find out the effects of the treatment. The result showed that all the flexibility measures, Body mass index, % of body fat, school attitude and self-concept were improved significantly among yogasanas group but lean body mass not improved significantly after one year yogic treatment.

T.P.Yokesh (2012) conducted a study to investigate the impact of yogic practice and aerobic exercise on selected Physical and physiological variables among overweight school boys. To achieve this purpose the subjects of forty five overweight school boys from various schools in Tiruchirappalli district were selected at random. Their age ranged between 14 and 17. The selected subjects were randomly divided into three equal groups of 15 each, namely yogic practice group (group A), Aerobic exercise (group B) and control group (group C). The experimental group had undergone yogic practices and aerobic exercise for 12 weeks, five days a week and daily one session only in the morning, duration of session one hour, whereas the control group (group C) maintained their daily routine activities and no special training was given. Physical variable namely flexibility and physiological variable breath holding time were chosen as variables for this study. The subjects of the three groups were tested using standardized tests and procedures on selected physical and physiological variables before and after the training period. The following test items namely sit and reach and breath holding time were used to collect relevant data. The collected data were analyzed statistically through analysis of Covariance (ANCOVA) to find out the pre and post training performances. To compare the significant difference, between the adjusted final means and better group. The yogic practice and aerobics exercise showed significant improvement due to 12 weeks of training on flexibility and breathe holding time compared to control group.

Ankad et al. (2011) conducted to ascertain if a short-term practice of pranayama and meditation had improvements in cardiovascular functions in healthy individuals with respect to age, gender, and body mass index (BMI). This interventional study was conducted in the Department of physiology of S.N. Medical College, Bagalkot. Fifty healthy subjects (24 males and 26 females) of 20-60 years age group, fulfilling the inclusion and exclusion criteria underwent two hours daily yoga programme for 15 days taught by a certified yoga teacher. Pre and post yoga cardiovascular functions were assessed by recording pulse rate, systolic blood pressure, diastolic blood pressure, and mean blood pressure. The parameters were statistically analyzed through the Student's t test. The result of the study revealed that there was significant reduction in resting pulse rate, systolic blood pressure, diastolic blood pressure, and mean arterial blood pressure after the practice of pranayama and meditation for 15 days. The response was similar in both the genders, both the age groups, <40 yrs and >40 yrs and both the groups with BMI, <25 kg/m(2) and >25 kg/m(2). The study was concluded that the

regular pranayama and meditation practice was beneficial for cardiovascular functions irrespective of age, gender, and BMI in normal healthy individuals.

Sugumar C (2011) study was framed to find out the effect of yogic practices on body composition among the college men students. Thirty healthy, untrained male subjects were selected from various Departments of Gandhigram Rural Institute, Deemed University, Gandhigram, Dindigual and their age ranged from 18 to 25 years. The subjects were equally divided into two groups namely the control and the experimental group. The experimental group underwent selected asanas and pranayama for five days per week for six weeks. Control group did not undergo any training programme rather than their routine work. Body composition was measured by using BIA method in the three sites. Prior to and after end of practice period all subjects were tested. The results of pre-test and post-test were compared with using Analysis of Co-variance. An outcome of body composition shows that there was significant improvement due to the six weeks yogic practice when compared to the control group.

Yokesh, T. P., Chandrasekaran, K. et.al. (2011) conducted the study to investigate the impact of yogic practice among overweight school boys. To achieve this purpose, thirty overweight school boys from various schools in Tiruchirappalli district were selected at random. Their age ranged between 14 and 17. The selected subjects were divided into two equal groups of 15 each, namely yogic practice group (group A) and control group (group B). The experimental group had undergone yogic practices for 12 weeks, five days a week. Whereas the control group (group B) maintained their daily routine activities and no special training was given. The subjects of the two groups were tested using standardized tests and procedures on selected physical variables before and after the training period to find out the training efforts in the following test items: BMI (body mass index) by measuring their height and weight of the subjects and flexibility by sit and reach box. The collected data were analyzed statistically through analysis of Covariance (ANCOVA) to find out the pre and post training performances. To compare the significant difference between the adjusted in the final means for better group. The yogic practice group showed significant improvement due to 12 weeks of training on BMI and flexibility compared to control group.

Rajakumar (2010) analyzed the impact of yogic practices and physical exercises on selected physiological variables among the intercollegiate soccer players. To

achieve the purpose of the study, sixty (60) male intercollegiate soccer players from the various colleges in Chennai were selected at randomly. Their age ranged between 17 to 22 years. The selected subjects were divided into three equal groups of 20 each, namely yogic practice group (Group A), physical exercises group (Group B) and control group (Group C). The experimental groups have underwent 12 weeks of training namely; yogic practices and physical exercises respectively, whereas the control group (Group C) maintained their daily routine activities and no special training was given. The subjects of the three groups were tested using standardized tests and procedures on selected physiological variables before and after the training period to find out the training efforts in the following test items: Resting pulse rate through stethoscope, Breath holding time through digital stop watch, Peak flow rate through Wright's peak flow meter. The collected data were analyzed statistically through Analysis of Co-variance (ANCOVA) and Schiff's post hoc test to find out the pre and post training performances, compare the significant difference between the adjusted final means and the better group. The yogic practice group showed significant improvement due to 12 weeks training on resting pulse rate, breath holding time and peak flow rate compared to the physical exercise and control group. In the overall training effects in terms of improved number of physiological variables and their magnitude of improvement through training, yogic practice group is found to be the better group when compared to the other two groups.

2.4 SUMMARY OF RELATED LITERATURE

The review of literature helped the investigator to spot out relevant topics and variables. Further the literature helped the investigator to frame the suitable hypothesis leading to the problems. The latest literature also helped the investigator to support his finding with regard to the problem. Further the literature collected in the study also helped the research scholar to summarize his study. The researcher has presented the reviews in the related subjects by depending upon the highly authentic sources. Each review has been written in detail with related to the subject. Finally the researcher puts an end to this chapter after giving all relevant details to each review.

Based on the experience gained through review of the studies, the investigator formulated suitable methodology to be followed in this research, which is presented in Chapter III of this thesis.

CHAPTER- III

METHODOLOGY

This chapter explores selection of subjects, selection of variables, experimental design, pilot study, criterion measures, reliability of data, reliability of instruments, subject reliability, orientation of the subjects, administration of test items, administration of training programme, collection of data, statistical techniques and also the justifications adopted for the analysis of data.

3.1 SELECTION OF SUBJECTS

The study was designed to find out the effects of Circuit and Yogic training programmes on selected physical and physiological components among obese children at the age of ten to fourteen (10 – 14) years. To achieve the purpose of the study, the scholar randomly selected ninety (N-90) obese male students from the three different CBSE schools namely Chinmaya Vidyalaya, Thrissur, S N Vidyabhavan, Chenthrapinni, HIRA English School, Kaipamangalam, and these schools were located in the northern part of the Thrissur district, Kerala, India.

A pilot questionnaire was used to collect information regarding the anthropometric measurements and health behaviour to access the obesity of the school students. The anthropometric measurements of the schoolchildren were taken by using standard protocol to access the obesity by using the BMI criteria, BMI= weight in kg/ height in metres^2. A weighing scale and stadiometer were used to measure the weight (nearest 0.5 kg) and height (nearest 0.1 cm) of each child using standard procedure.

A BMI of more than 25 was considered overweight and more than 30 was considered obese. After calculation of BMI of the children (subjects), it was converted and expressed as a percentile which can be obtained from a percentile calculator. The height and weight will be varied during growth and development, in relation to their body fat. Moreover a child's BMI must be interpreted in relative to other children of the same age and sex. On the basis of the BMI, 90 obese (equal to or greater than the 95th percentile) students were randomly selected. Appropriate methods were used while

selecting the subjects. The two site skin fold test was applied on them to access their body composition (fat percentage) to confirm their BMI status category. On the basis of BMI and body composition, (fat percentage more than 30%) the 90 obese children were randomly selected and divided into three equal groups (N=30). The subjects were explained the purpose and nature of the study and requested to be volunteers for the study.

3.2 SELECTION OF VARIABLES

The research scholar reviewed the available scientific literature pertaining to the problem from books, journals, magazines, e-resources, and research papers which revealed the importance of Circuit training and Yogic training. Taking into consideration of feasibility, and availability of the instruments the following variables were selected for this study.

3.2.1 Dependent Variables

Physical Variables

- Cardio Respiratory Endurance
- Muscular strength and endurance
- Flexibility
- BMI
- Percent Body fat

Physiological Variable

- Vital Capacity

3.2.2 Independent Variables

- Circuit Training
- Yogic Training

3. 3 CRITERION MEASURES

The present study was undertaken primarily to find out the effect of Circuit and Yogic training on selected physical and physiological variables among obese children. The following tests were administered to measure the selected physical and physiological variables. The tests were administered to the subjects before and after the training programme.

TABLE 3.1 SELECTION OF VARIABLES & TEST ITEMS- PHYSICAL FITNESS AND PHYSIOLOGICAL VARIABLES

Sl. No	***Variables***	***Tests***	***Units***
1	Body Composition	BMI	Kg/M2
2	Percent Body Fat	Skin fold	Percentage
3	Cardio Respiratory Endurance	600 Yard run/walk test	Seconds
4	Muscular strength and endurance	Sit Ups	Number/ Minutes
5	Flexibility	Sit & Reach	Centimeters
6	Vital capacity	Spiro meter	Liters

The chosen tests are highly standardized, appropriate and ideal to assess, the criterion variables.

3.3.1 Body Mass Index:

It is the key index for relating a person's body weight to their height. A ratio of weight and height, called the body mass index (BMI), has been adopted for the assessment of children, adolescents, and adults. Body Mass Index is a quick way to measure obesity.

BMI = Weight (kg) / Height (m^2).

3.3.2 Percent Body Fat:

Body composition is defined as the percentage of fat, muscles and bone in the body. It is expressed as the ratio of lean mass to fatty mass. Body composition is expressed as percent fat (% of fat) or percentage of lean body mass (LBM).

3.3.3 Cardio respiratory endurance:

Cardio respiratory endurance is a measurement of how well heart, lungs and muscles work together to keep the body active over an extended period of time.

3.3.4 Muscular Strength and Endurance:

Muscular strength and endurance are two important parts of body's ability to move, lift things and do day-to-day activities. Muscular strength is the amount of force you can put out or the amount of weight you can lift. Muscular endurance is how many times can move that weight without getting exhausted.

3.3.5 Flexibility:

"Flexibility is the functional capacity of the joints to move through a full range of motion" (American College of Sports Medicine –ACSM). The flexibility was measured by using Sit and Reach test and measured in centimeters.

3.3.6 Vital Capacity:

Vital capacity refers to the maximum amount of air the person is capable of expelling from their lungs after maximum inhalation. Spiro meter test was conducted to find out vital capacity.

3.4 EXPERIMENTAL DESIGN

The experimental design used in the study was quasi experimental design with purposive sampling. To achieve the purpose of the study, ninety subjects (N=90) from three schools of thirty subjects (n-30) each were selected and assigned to experimental and control groups. The groups were named as experimental group-I, experimental group-II and Control group. Experimental group-I was treated with Circuit training

(CTG), Experimental group-II was treated with Yogic training (YTG) and Control group with no treatment (CG).Pre-test was conducted for all the three groups on selected physical and physiological components namely Body Mass Index, Percent Body fat, Cardio Respiratory Endurance, Muscular strength and endurance, Flexibility and Vital Capacity and their readings were recorded in their respective units as pre-test scores. After pre-test both the experimental groups were treated with their respective training programme three days per week, for a period of sixteen weeks whereas the Control group was not exposed to any specific training other than their regular activities. Post test was conducted for all the three groups at the end of sixteen weeks of training on selected physical and physiological components namely Body Mass Index, Percent Body fat, Cardio Respiratory Endurance, Muscular strength and endurance, Flexibility and Vital Capacity and their readings were recorded in their respective units as post-test scores. The pre and post test scores were analysed with appropriate statistical tools. Before beginning the study, subjects were informed about training programmes orally and they submitted their written informed consent to school authorities and researcher. And this research was conducted ethically according to guidelines.

3.5 PILOT STUDY

The researcher collected 2686 anthropometrical measurements data to assess the BMI of the children from the CBSE schools of three districts namely Thrissur, Palakkad and Malappuram those belong to Malabar region of Kerala state. The researcher found that out of 2686 anthropometrical data collected, 606 (22.6%) were under weight, 1239 (46.19%) were healthy weight, 482 (17.94%) were overweight, 191 (7.11%) were prone to obese, and 358 (13.33%) were obese.

A pilot study was conducted to assess the initial capacity of the obese students in order to fix the training load. For this purpose, ten students were selected randomly and underwent both training programmes under watchful eyes of the experts and the researcher. Based on the response of the students in the pilot study the training schedule were constructed, however, the individual differences were considered while constructing the training programme. The basic principles of training (intensity, repetition, set, rest in-between sets, load progression, and specificity) were also followed.

3.5.1 RESEARCH FLOW CHART

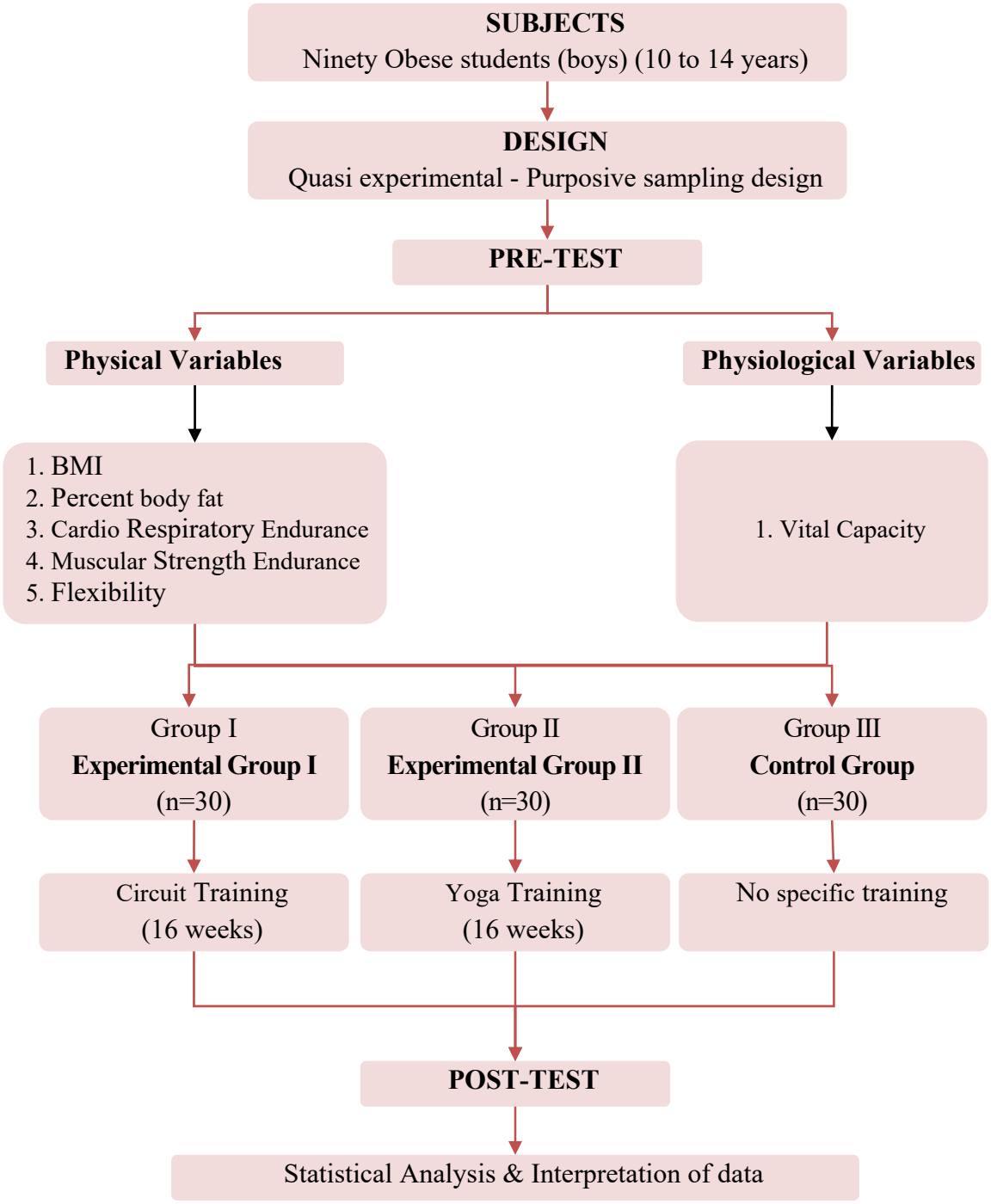


Figure 3.1 Research Flow Chart

3.6 RELIABILITY OF DATA

The reliability of data was established by using test-retest method. To achieve this purpose, ten students were randomly selected and the test was administered twice after a day's gap. Care was taken to keep all testing conditions uniformly during testing and retesting. The scores recorded for the ten students during the test and retests were correlated using intra class correlation for the different variables. The co-efficient of correlation is presented in Table – 3.2.

TABLE 3.2 RELIABILITY CO-EFFICIENT OF CORRELATION OFTEST-RETEST SCORES

Sl. No	***Variables***	***Co-efficient of correlation 'r'(N=10)***
1	Body Mass Index	0.91*
2	Percent Body Fat	0.90*
3	Cardio Respiratory Endurance	0.88*
4	Muscular strength endurance	0.89*
5	Flexibility	0.96*
6	Vital capacity	0.92*

* Significant at 0.05 level

3.7 RELIABILITY OF INSTRUMENTS

Instruments such as Measuring tape, stop watches, skin fold calliper, wet spirometer stadiometer, electronic weighing machine, and sit and reach box used for this study, were from standard companies. All instruments were maintained in good condition. The calibration of the equipments were tested and found to be accurate enough to carry out the test procedures successively.

3.8 TESTER'S RELIABILITY

To ensure the tester's reliability of the tests, the investigator had a number of practice sessions in the testing procedure and well versed in the technique of conducting the test. Tester reliability of test was established by test-retest process. For this purpose, ten students were selected at random on the chosen variables, which were recorded twice under identical conditions on different occasions by the different investigator.

3.9 SUBJECTS RELIABILITY

In order to get uniform results from the same students, they were used under similar conditions for the same test by the same tester. The test-retest method was used to find out the students reliability.

3.10 ORIENTATION TO THE SUBJECTS

The investigator held a meeting with the students prior to the administration of tests. The purpose, the significance of this study and the requirements of the testing procedure were explained to them in detail, so that there was no ambiguity in their minds, regarding the efforts required of them. All the students voluntarily came forward to co-operate in the testing procedures and the training to put their best efforts in the interest of the scientific investigation and in order to enhance their own physical and physiological fitness. The students were very enthusiastic and co-operative throughout the project.

3.11 ADMINISTRATION OF TEST ITEMS

3.11.1 Physical Variables

3.11.1.1 Body Mass Index

Purpose: To calculate or to measure obesity. A measure of body fat, which is the ratio of the weight of the body in kilograms to the square of its height in meters.

$$BMI = Weight\ (kg) / Height\ (m^2)$$

Calibration: The use of standard test weights and measuring rods to check the accuracy of equipment.

Height: A standing measurement in meters.

Stadiometer: Instrument for measuring height.

Weighing Machine (Scale): Instrument for measuring weight.

Weight: A measurement in kilograms.

Zeroed: Assuring the scale balances at ‘zero or 00’ before the student steps on the platform.

Score: The calculated score which indicates the weight status of the subjects. (The correlation between the BMI number and body fatness is fairly strong; however the correlation varies by sex, race, and age.)

TABLE 3.3 BMI- Body Mass Index

BMI	***Weight Status***
Below 18.5	Underweight
18.5 – 24.9	Normal
25.0 – 29.9	Overweight
30.0 and Above	Obese

3.11.1.2 Body composition:

Two-Site Skinfold Test:

Purpose: To analyze or to determine body fat percentage. One of the widely used anthropometric methods for measuring body fat.

Equipment: Skinfold Caliper

Scoring: The median of three measurements at each site was recorded as a subjects score.

(The two-site skinfold test, using the triceps and sub scapula sites, has been the most commonly used body composition test for young people age 6 through college. Two site skin fold measurement (triceps and sub scapula) was taken to measure the percentage of the body fat.) the reading of the two sites, (triceps and sub scapula) as recorded by using the equations to estimate percent body fat of children from the sum of triceps and sub scapula are as follows, for male,% body fat = (0.735 x sum of skin fold) +1.0. (Source: Lohman TG.)

TABLE 3.4 FAT PERCENTAGE OF MALE RATING SCALE

Sl. No.	*Male Rating Age-(6 – 17Yrs)*	*% of Fat*	*Skinfolds in mm*
1	Very Low	2 – 6%	0 - 5 mm
2	Low	7 – 10%	5 – 10 mm
3	Optimal Range	11 – 20%	15 – 20 mm
4	Moderately High	21 – 25%	21 - 29 mm
5	High	26 – 30%	30 – 39 mm
6	Very High	31 – 40% above	40 mm above

3.11.1.3 Cardio respiratory endurance

600- Yard Run/Walk Test

Objective: To measure cardio-respiratory endurance.

Equipment: 400m Track marked for 600-Yard, stop watch and whistle

Procedure: The subjects were asked to use the standing start. At the signal "Ready go" the subjects start running the 600- yard distance. The running may interspersed with walking. It is possible to have a dozen pupils run at one time by having the pupils pair off before the start of the event. Each pupil listens for and remembers his partner's time as the pupil cross the finish.

Rule: Walking is permitted but the subject is to cover the distance in the shortest possible time.

Scoring: Record in minutes and seconds. (AAHPER Youth Fitness Test Manual, (Washington: D.C. 1958).

3.11.1.4 Muscular strength and endurance (Sit-ups)

Objective: To measure the abdominal muscular endurance.

Equipment: Mats, stop watch, score sheet and pen.

Procedure: Students are asked to lie on his back with knees flexed, feet on floor, with heels between 12 to 18 inches from buttocks. The angle at the knees should be less than 90 degrees. The subjects put their hands on the back of their neck with fingers clasped and places the elbows squarely on the mat or floor. The feet are held by their partner to keep them in touch with the surface. The subject tightens his abdominal muscles and brings his head and elbows forward as he curls up, finally touching elbows to knees. This action constitutes one sit-up. The pupil returns to the starting position with his elbows on the surface before he sits up again. The timer gives the signal "ready-go," and the sit-up performance is started on the word "go." Performance is stopped on the word "stop."

Scoring: The score is the maximum number of sit-ups completed in 60 seconds.

3.11.1.5 Flexibility (Sit and reach)

Purpose: To measure the flexibility of the students.

Equipment: Sit and reach apparatus (Specially constructed box 30cm by 30cm by 53 cm with measuring scale), score sheet.

Procedure: The sit and reach apparatus should have the 25 cm mark equivalent to the point where the feet touch the box. The student had sat barefoot with the legs fully extended with the soles of the feet have placed flat against the horizontal cross board of the apparatus, with the inner edge of the sole have placed 2 cm from the scale, keeping the knees have fully extended, arms evenly stretched and palms down. The student had bent and reached forward (without jerking) pushing the sliding marker along the scale with the fingertips as far forward as possible. The position of maximum flexion must be held for approximately two seconds. The test has repeated twice.

Scoring: Record the maximum distance reached to the nearest 0.5 cm.

3.12 PHYSIOLOGICAL VARIABLES

3.12.1 Vital Capacity

Purpose: To measure the vital capacity of the students.

Equipment: Helios 401 is a spirometer which is used in conjunction with a Windows based computer. It is used to determine the dynamic lung function by measuring the Vital Capacity (VC). It has a hand piece which houses a turbine transducer. This hand piece is connected to a computer through a USB interface cable. The software given along with the system is used to record Spirometry manoeuvres and to suggest a diagnosis. The computer monitor is used to display the Spirometry parameters, the device parameters, information messages and user guide messages. A printer attached to the computer can be used to obtain a hard-copy record of the manoeuvres and the related parameter values.

Procedure: Below is a brief description of how to install the RMS Helios spirometer.

1. Unpack the spirometer and the accessories.

2. Fix the transducer in its housing in the hand piece.

3. Fix the mouthpiece over the transducer and the hand piece.

4. Connect the USB-Serial connector of the USB-Serial cable to the spirometer.

5. Connect the USB connector of the USB-Serial cable to the computer.

6. Switch the computer on.

7. Insert the spirometer software installation CD into the computer.

The Helios spirometer was placed at a height that allows the subject to stand erect at the beginning of the test. The subject forcefully inhaled and exhaled twice before the test. The subject was cautioned not to allow air to escape through a nose or around the mouth piece. The subject at completion should bend slightly forward to blow as much air as possible in to the spirometer.

Scoring: The reading is shown in the Helios spirometer graph and the result was recorded in liters

3.13 TRAINING PROGRAMME

TABLE 3.5 TRAINING PROGRAMME

Group	***Treatment***
Experimental Group I	Circuit Training (CTG)
Experimental Group II	Yoga Training (YTG)
Control Group	Not engaged in any specific training program
Training Duration One Hour (60 minutes)	Warm up, Instruction, , Treatment (training) Cool Down, Correction and Clarification (60 minutes)
Training session Per week	Three days per weeks session in the evening
Total Length of Training	Sixteen weeks
Training Load Progression	Every Four weeks

The well-structured training schedules for two different groups were presented in the tables, Group-I named as Circuit Training (CTG), Group-II Yoga Training (YTG) and Group-III Control Group (CG). Group-I was treated with Circuit Training for three days (Monday, Wednesday and Friday) Group-II was treated with Yoga Training for three days per week (Tuesday, Thursday and Saturday). All the experimental groups underwent the respective training schedule one hour per day in the evening including warming up and cool down for three days a week for a period of sixteen weeks. Load progression techniques were adapted for every four weeks. The detailed training scheduled for each group was given in the form of tables by indicating the intensity, repetitions, set, rest and duration.

3.13.1 CIRCUIT TRAINING PROGRAMME (CTG)

TABLE 3.6 CIRCUIT TRAINING SCHEDULE FOR FIRST – FOUR WEEKS

Sl. No	Exercise Circuit station	Exercise in each station	Rest in between exercise and change over to another station	No. of sets	Recovery in between sets
1	skipping	30 sec	60 sec	2	5 minutes
2	Step-ups	30 sec	60 sec	2	
3	On the spot Running	30 sec	60 sec	2	
4	Push-ups	30 sec	60 sec	2	
5	Double knee tuck jumps	30 sec	60 sec	2	
6	Sit-ups	30 sec	60 sec	2	
7	Two count Jumping Jack	30 sec	60 sec	2	
8	Jump and turn	30 sec	60 sec	2	

TABLE 3.7 CIRCUIT TRAINING SCHEDULE FOR FIVE - EIGHT WEEKS

Sl. No	Exercise Circuit station	Exercise in each station	Rest in between exercise and change over to another station	No. of sets	Recovery in between sets
1	skipping	40 sec	60 sec	2	5minutes
2	Step-ups	40 sec	60 sec	2	
3	Squat thrust	40 sec	60 sec	2	
4	Push-ups	40 sec	60 sec	2	
5	Double knee tuck jumps	40 sec	60 sec	2	
6	Sit-ups	40 sec	60 sec	2	
7	Shuttle run	40 sec	60 sec	2	
8	Jump and turn	40 sec	60 sec	2	

TABLE 3.8 CIRCUIT TRAINING SCHEDULE FOR NINE– TWELVE WEEKS

Sl. No	Exercise Circuit station	Exercise in each station	Rest in between exercise and change over to another station	No. of sets	Recovery in between sets
1	skipping	50 sec	60 sec	3	5minutes
2	Step-ups	50 sec	60 sec	3	
3	Squat thrust	50 sec	60 sec	3	
4	Push-ups	50 sec	60 sec	3	
5	Double knee tuck jumps	50 sec	60 sec	3	
6	Sit-ups	50 sec	60 sec	3	
7	Shuttle run	50 sec	60 sec	3	
8	Jump and turn	50 sec	60 sec	3	

TABLE 3.9 CIRCUIT TRAINING SCHEDULE FOR THIRTEEN – SIXTEEN WEEKS

Sl. No	Exercise Circuit station	Exercise in each station	Rest in between exercise and change our another station	No. of sets	Recovery in between sets
1	skipping	60 sec	60 sec	3	5 minutes
2	Step-ups	60 sec	60 sec	3	
3	Burpees	60 sec	60 sec	3	
4	Push-ups	60 sec	60 sec	3	
5	Double knee tuck jumps	60 sec	60 sec	3	
6	Sit-ups	60 sec	60 sec	3	
7	Shuttle run	60 sec	60 sec	3	
8	Jump and turn	60 sec	60 sec	3	

Group I underwent sixteen weeks of circuit training. In the circuit training eight stations were marked. For first four weeks the subjects underwent all the eight stations with simple exercises. In each station the subjects performed thirty seconds exercise and another sixty seconds was given to change from one station to another and rest in between exercise. The subjects have to perform all the exercises in eight stations and thus are calculated as one circuit. A rest period of five minutes was given in between circuits. Totally two circuits for first eight weeks and three circuits for another eight weeks were performed. Initially ten minutes was given for warming up and ten minutes for cool down, Instructions, Corrections and guidance were given then and there. Altogether maximum of one hour training for three days in a week in the evening session was designed for this training program.

Next five - eight weeks, the intensity was raised by difficulty and repetition of exercise and duration of exercise in station was increased from thirty to forty seconds. Sixty seconds time duration was given to change from one station to another and rest in between exercise, two circuits and rest between circuits were maintained as in the previous weeks of training.

Nine - twelve weeks, the intensity was raised by increasing the difficulty and the repetition of exercise and duration of exercise in station was increased from forty seconds to fifty seconds, the rest in between were same as in the previous weeks, the volume was increased by three circuits (sets).

Twelve - Sixteen weeks, the intensity was raised by increasing the difficulty and the repetition of exercise and duration of exercise in station was increased from fifty seconds to sixty seconds, the rest in between circuit were same as in the previous weeks.

The circuit training was given only in the evening session for three days a week, for a period of sixteen weeks.

3.13.2 YOGA TRAINING (YTG)

TABLE 3.10 YOGIC TRAINING SCHEDULE FOR 1-4 WEEKS

Days	Activities	Duration	Sets	Recovery
Tuesday	Orientation	10 min		2 minutes
Thursday	Meditation	05 min		
Saturday	Warming up exercises	15 min		
	Suryanamaskar	06 min		
1	Trikonasana	15 sec	2	2 minutes
2	Eka padasana (One foot pose)	15 sec	2	
3	Natarajasana	15 sec	2	
4	Ushtrasana	15 sec	2	2 minutes
5	Sasankasana	15 sec	2	
6	Vakrasana	15 sec	2	
7	Pavanamuktasana	15 sec	2	2 minutes
8	Uttana Padasana	15 sec	2	
9	Bhujangasana	15 sec	2	
	Savasana	5 minutes		
	Pranayama	5 minutes		
	Sectional Breathing			
	Chandra Anuloma			
	Surya Anuloma			

(Over all Training Duration 60 minutes, including warming, instruction)

Table 3.10 revels that, the first four weeks the above mentioned asana and Pranayama were practiced three days per week in the evening session for a total duration of sixty minutes including warming up, orientation and meditation. The load progression techniques were adapted for every four weeks by increasing the difficulty of asana, duration and number of sets.

TABLE 3.11 YOGIC TRAINING SCHEDULE FOR 5-8 WEEKS

Days	Activities	Duration	Sets	Recovery
Tuesday	Orientation	10 min		2 minutes
Thursday	Meditation	05 min		
Saturday	warming up exercises	10 min		
	Suryanamaskar	06 min		
1	ParivarthaTrikonasana	15 sec	3	2 minutes
2	Vrukshasana	15 sec	3	
3	ArdhaChakrasana	15 sec	3	
4	Garudasana	15 sec	3	2 minutes
5	Ardhamatsyendrasana	15 sec	3	
6	Paschimotanasana	15 sec	3	
7	Pavanamuktasana	15 sec	3	2 minutes
8	Salabhasana	15 sec	3	
9	Sarvangasana	15 sec	3	
	Savasana	5 minutes		
	Pranayama	6 minutes		
	Kapalapathi			
	Nadisodhana			
	Brahmari			

(Over all Training Duration 60 minutes, including warming, instruction)

Table 3.11 revels that the 5-8 weeks the above mention asana and Pranayama were practiced weekly three days in the evening session for a total duration of sixty minutes including warming up, orientation and meditation.

TABLE 3.12 YOGIC TRAINING SCHEDULE FOR 9-12 WEEKS

Days	Activities	Duration	Sets	Recovery
Tuesday	Orientation	5min		2 minutes
Thursday	Meditation	5 min		
Saturday	Warming up exercises	10 min		
	Suryanamaskar	5 min		
1	ParivarthaTrikonasana	20 sec	4	2 minutes
2	Padahastasana	20 sec	4	
3	Chandrasana	20 sec	4	
4	Veerabhadrasana (warrior pose)	20 sec	4	2 minutes
5	Ushtrasana	20 sec	4	
6	Vakrasana	20 sec	4	
7	Hasta uttanasana	20 sec	4	2 minutes
8	Pavanamuktasana	20 sec	4	
9	Sarvangasana	20 sec	4	
	Savasana	4 minutes		
	Pranayama	5minutes		
	Sectional Breathing			
	Chandra Analoma			
	Surya Analoma			

(Over all Training Duration 60 minutes, including warming, instruction)

Table 3.12 revels that the 9-12 weeks the above mention asana and pranayama were practiced weekly three days in the evening session for a total duration of sixty minutes including warming up, orientation and meditation.

TABLE 3.13 YOGIC TRAINING SCHEDULE FOR 13-16 WEEKS

Days	Activities	Duration	Sets	Recovery
Tuesday	Orientation	5min		2 minutes
Thursday	Meditation	5 min		
Saturday	Warming up exercises	10 min		
	Suryanamaskar	5 min		
1	Talasana (Palm tree posture)	20 sec	4	2 minutes
2	Utkatasana (Chair pose)	20 sec	4	
3	Trikonasana	20 sec	4	
4	Natarajasana	20 sec	4	2 minutes
5	Ardha Matsyendrasana	20 sec	4	
6	Pavanamuktasana	20 sec	4	
7	Setubandhasana	20 sec	4	2 minutes
8	Halasana	20 sec	4	
9	Sarvangasana	20 sec	4	
	Savasana	5 minutes		
	Pranayama	5 minutes		
	Sectional Breathing			
	Chandra Anuloma			
	Surya Anuloma			

(Over all Training Duration 60 minutes, including warming, instruction)

Table 3.13 revels those 13-16 weeks the above mention asana and Pranayama were practiced weekly three days in the evening session for a total duration of sixty minutes including warming up, orientation and meditation

3.14 COLLECTION OF DATA

The selected ninety subjects (N=90) were randomly divided to three equal groups of thirty (n-30) subjects each. The groups were named as experimental group-I, experimental group-II and Control group. Proper orientation was given to all the subjects about the testing procedure of various physical and physiological components. All the

selected subjects were tested on selected physical and physiological variables such as Body Mass Index, Percent Body Fat, Cardio respiratory endurance; Muscular strength and endurance, Flexibility and Vital Capacity and their readings were carefully recorded in their respective units as pre-test scores. After pre-test Experimental group-I was treated with Circuit training (CTG) and Experimental group-II was treated with Yogic training (YTG) for three days per week in the evening session for a total duration of sixteen weeks, whereas the Control group (CG) was not exposed to any specific training other than their regular activities. At the end of the treatment period of sixteen weeks, the subjects of experimental groups namely Circuit Training Group (CTG) and Yoga Training Group (YTG) - II, and Control Group (CG) were tested again on selected physical and physiological variables namely Body Mass Index, Percent Body Fat, Cardio Respiratory Endurance, Muscular strength and endurance, Flexibility and Vital Capacity and their readings were carefully recorded in their respective units as post-test scores. The pre and post test scores were analysed with appropriate statistical tools, and their results were presented in the form of tables and figures in the IV chapter.

3.15 STATISTICAL TECHNIQUES AND ITS JUSTIFICATION

The following statistical techniques were adopted to treat the collected data in connection with formulated hypotheses and objectives of this study. To find out the difference between pre and post-test of each group, paired t- test was used. Analysis of covariance (ANCOVA) was computed because the students were selected at random, but the groups were not equated in relation to the factors to be examined. Hence, the difference between means of the three groups in the pre-test had to be taken into account during the analysis of the post-test differences between the means. This was achieved by the application of the analysis of covariance, where the final means were adjusted for differences in the initial means, and the adjusted means were tested for significance. Whenever the adjusted post-test means were found significant, the Bonferroni post-hoc test was administered to find out the paired means difference. To test the obtained results on variables, the level of significance 0.05 was chosen and considered as sufficient for the study.

CHAPTER – IV

ANALYSIS AND INTERPRETATION OF DATA

4.0 INTRODUCTION

The chapter deals with the statistical analysis of data collected pertaining to experimental study on the effect of circuit and yogic training programmes on selected physical fitness and physiological variables among the obese male students of CBSE schools from Kerala. The selected subjects were initially tested on criterion variables used in this study and the same was considered as Pre-test. After assessing the pre test, the subjects in the experimental groups were treated with their respective treatments for three alternative days a week for the period of sixteen weeks. The subjects for this study were selected at random but the groups were equated in relation to the factors have been examined. Hence the difference among the means of three groups in the pre test had to be taken into account during the analysis of the post test difference among the means. To achieve, the statistical application of Analysis of co variance (ANCOVA) was used to determine whether the two training programmes produced significantly different improvements in selected variables after sixteen weeks of training. If the mean difference was significant, the final means were adjusted for differences in the initial means, and the adjusted means were tested for significance. Whenever the adjusted post-test means were found significant, the Bonferroni post-hoc test was administered to find out the paired means difference. To test the obtained results on variables, the level of significance 0.05 was chosen and considered as sufficient for the study.

4.1 LEVEL OF SIGNIFICANCE

The procedure of testing hypothesis is in accordance with the result obtained in relation to the level of confidence, which was fixed at 0.05 levels, which was considered necessary for this study. The probability level below which we rejected the hypothesis is termed as the level of significance. The F ratio obtained by analysis of variance and analysis of covariance needed to be significant at 0.05 levels.

4.2 RESULTS OF TREATMENT EFFECT

The statistical analysis on significance of the mean gains or losses made between pre and post-tests of various controlled groups as Circuit Training Group (CTG, Group-I), Yoga Training Group (YTG, Group-II), and Control Group (CG, Group-III) on selected physical fitness and physiological variables of body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children result were presented in the tables 4.1 to 4.4.

TABLE 4.1 SIGNIFICANCE OF MEAN GAINS /LOSSES BETWEEN PRE AND POST TEST OF CIRCUIT TRAINING GROUP ON PHYSICAL FITNESS AND PHYSIOLOGICAL VARIABLES OF OBESE CHILDREN

Variables	Pre test mean ±SD	Post test mean ± SD	M.D	SEM	't' ratio	df	Sig
Body Mass Index(Kg/m^2)	23.43±1.67	21.06±1.57	2.37	0.14	16.02	29	0.00
Percent Body Fat (Percentage)	29.81±4.20	27.84±4.46	1.97	0.32	6.09	29	0.00
Cardio respiratory endurance(Seconds)	2.72±0.60	2.35±0.52	0.37	0.04	8.09	29	0.00
Muscular strength and endurance(Numbers)	21.86±5.82	25.6±5.63	3.74	0.17	21.65	29	0.00
Flexibility (Centimeters)	31.06±1.87	33.20±2.32	2.14	0.37	5.70	29	0.00
Vital Capacity(Liters)	1.93±0.50	2.40±0.40	0.47	0.07	5.90	29	0.00

*Significant at 0.05 level (2.04)

Table – 4.1 shows that the obtained t ratio on selected physical fitness and physiological variables of obese children. The obtained t- ratios were, 16.02 (Body mass Index), 6.09 (Percent Body Fat), 8.09 (Cardio Respiratory Endurance), 21.65 (Muscular Strength and Endurance), 5.70 (Flexibility), and 5.90 (Vital Capacity). The obtained t-ratio on selected physical fitness and physiological variables were greater than the critical value of 2.04 for degrees of freedom 29. It was observed that the mean gains and losses made from pre-test and post-test were statistically significant resulting that sixteen weeks of circuit training produced significant improvement in body mass index($2.37 p<0.05$), percent body fat($1.97 p<0.05$), cardio respiratory endurance($0.37 p<0.05$), muscular

strength and endurance(3.74p<0.05), flexibility(2.14p<0.05) and vital capacity(0.47 p<0.05) from the performance of baseline to post treatment.

TABLE4.2 SIGNIFICANCE OF MEAN GAINS / LOSSES BETWEEN PRE AND POST TEST OF YOGA TRAINING GROUP ON PHYSICAL FITNESS AND PHYSIOLOGICAL VARIABLES OF OBESE CHILDREN

Variables	Pre test mean ±SD	Post test mean ± SD	M.D	SEM	't'-ratio	df	Sig
Body Mass Index(Kg/m^2)	23.60±3.32	22.43±2.95	1.17	0.15	7.30	29	0.00
Percent Body Fat (Percentage)	28.58±1.79	26.11±2.08	2.47	0.24	9.91	29	0.00
Cardio respiratory endurance(Seconds)	2.88±0.62	2.54±0.57	0.34	0.07	4.61	29	0.00
Muscular strength and endurance(Numbers)	21.80±4.36	23.70±4.72	1.90	0.23	8.20	29	0.00
Flexibility (Centimetres)	30.46±3.28	34.73±2.98	4.27	0.17	24.74	29	0.00
Vital Capacity(Litres)	1.92±0.49	2.36±0.42	0.44	0.06	7.09	29	0.00

*Significant at 0.05 level (2.04)

Table – 4.2 indicate that the obtained t ratios on selected physical fitness and physiological variables of obese children. The obtained t- ratios were 7.30 (Body mass Index), 9.91 (Percent Body Fat), 4.61 (Cardio Respiratory Endurance), 8.20 (Muscular Strength and Endurance), 24.74 (Flexibility) and 7.09 (Vital Capacity). The obtained t-ratio on selected physical fitness and physiological variables were greater than the critical value of 2.04 for degrees of freedom 29. It was observed that the mean gains and losses made from pre-test and post-test were statistically significant resulting that sixteen weeks of yoga training produced significant improvement in body mass index(1.17 p<0.05), percent body fat(2.47p<0.05), cardio respiratory endurance(0.34 p<0.05), muscular strength and endurance(1.90 p<0.05), flexibility(4.27p<0.05) and vital capacity(0.44 p<0.05) from the performance of baseline to post treatment.

TABLE4.3 SIGNIFICANCE OF MEAN GAINS /LOSSES BETWEEN PRE AND POST TEST OF CONTROL GROUP ON PHYSICAL FITNESS AND PHYSIOLOGICAL VARIABLES OF OBESE CHILDREN

Variables	Pre test mean ±SD	Post test mean ± SD	M.D	SEM	't'-ratio	df	Sig
Body Mass Index(Kg/m^2)	23.00 ± 1.46	22.90 ± 1.74	0.10	0.12	0.76	29	0.44
Percent Body Fat (Percentage)	28.07 ± 3.53	27.97 ± 3.56	0.10	0.10	1.06	29	0.29
Cardio respiratory endurance(Seconds)	2.80 ± 0.55	2.80 ± 0.56	0.00	0.00	1.52	29	0.13
Muscular strength and endurance(Numbers)	21.76 ± 4.78	21.96 ± 4.76	0.02	0.19	1.03	29	0.31
Flexibility (Centimetres)	31.63 ± 4.94	32.0 ± 5.09	0.37	0.13	2.62*	29	0.01*
Vital Capacity(Litres)	2.05 ± 0.53	2.02 ± 0.51	0.03	0.03	0.87	29	0.38

*Significant at 0.05 level (2.04)

Table- 4.3 describes the obtained t- ratio on selected physical fitness and physiological variables of obese children. The obtained t-ratios were 0.76 (Body mass Index), 1.06 (Percent Body Fat), 1.52 (Cardio Respiratory Endurance), 1.03 (Muscular Strength and Endurance), 2.62 (Flexibility), and 0.87 (Vital Capacity). The obtained t-ratio on selected physical fitness and physiological variables were lesser than the critical value of 2.04 for degrees of freedom 29, except flexibility. It was observed that the mean gains and losses made from pre-test and post-test were statistically not significant except in the case of flexibility, because the control group was not treated with any training programme for sixteen weeks that's why it shows insignificant result in body mass index(0.10 $p>0.05$), percent body fat (0.10 $p>0.05$), cardio respiratory endurance(0.00 $p>0.05$), muscular strength and endurance (0.02 $p>0.05$), and vital capacity(0.03$p>0.05$) from the performance of baseline to post treatment, but there is significant difference in flexibility (0.37 $p<0.05$).

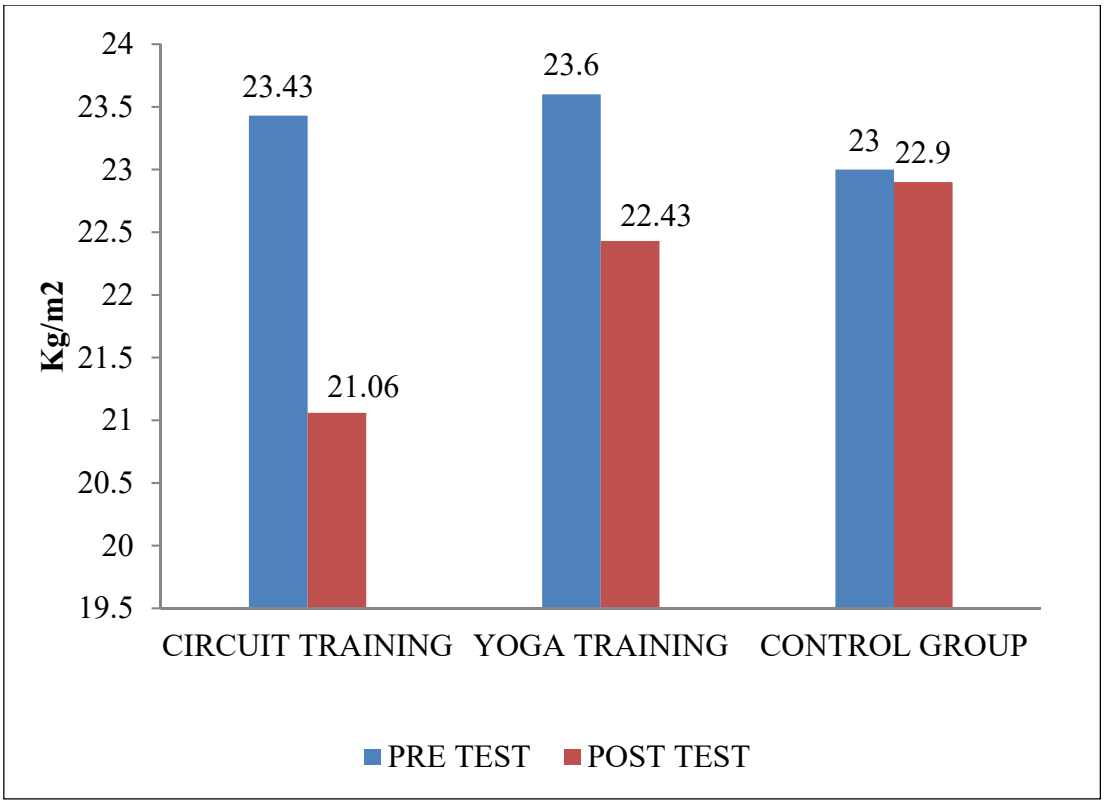


Figure 4.1 : Bar diagram - Body Mass Index

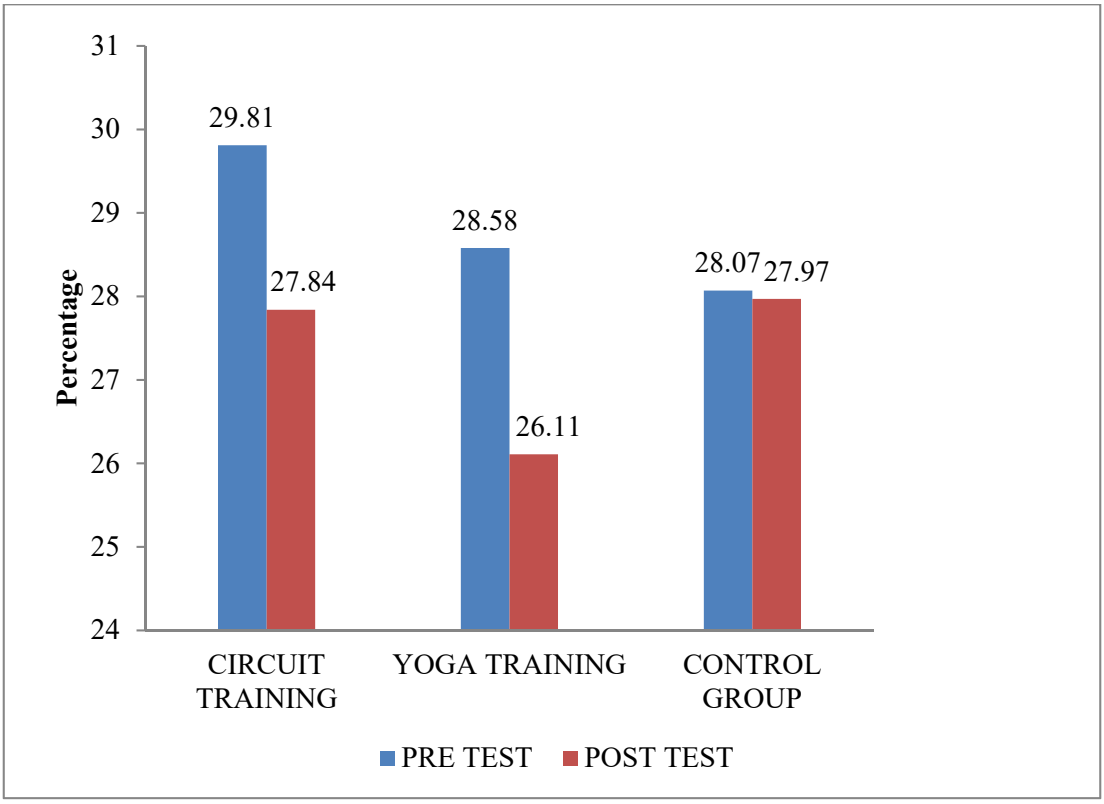


Figure 4.2 - Bar diagram - Percent Body Fat

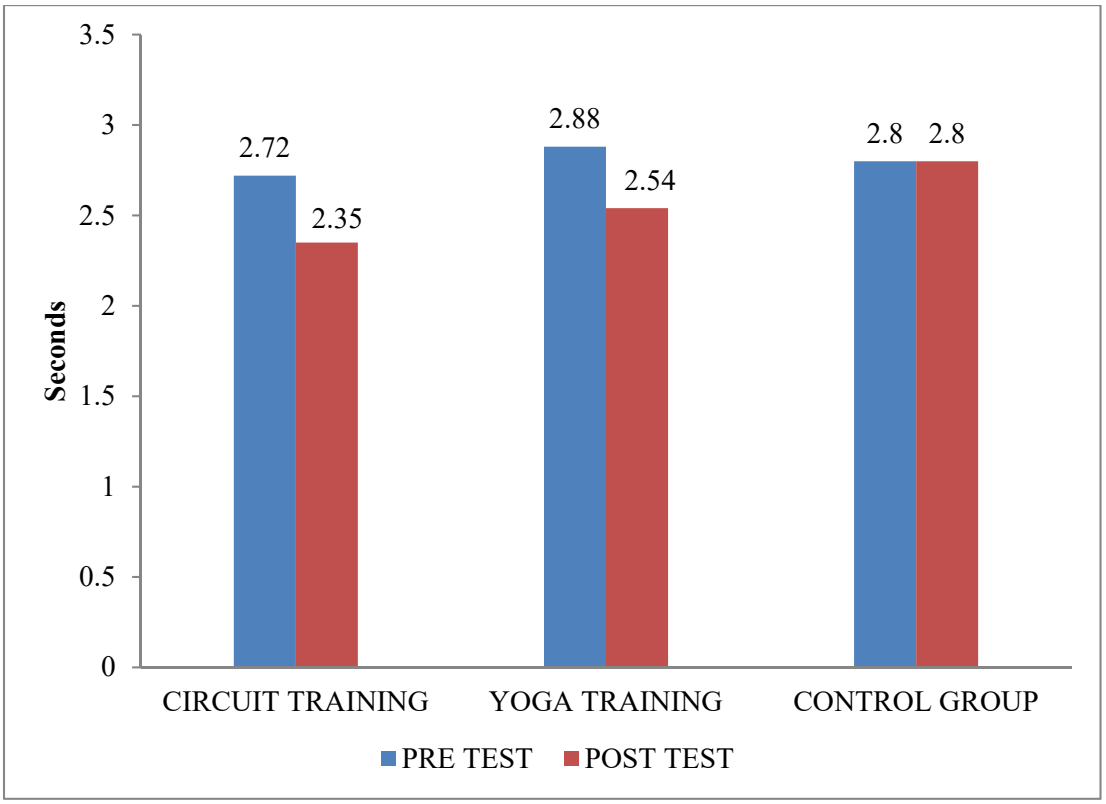


Figure 4.3 Bar diagram - Cardio Respiratory Endurance

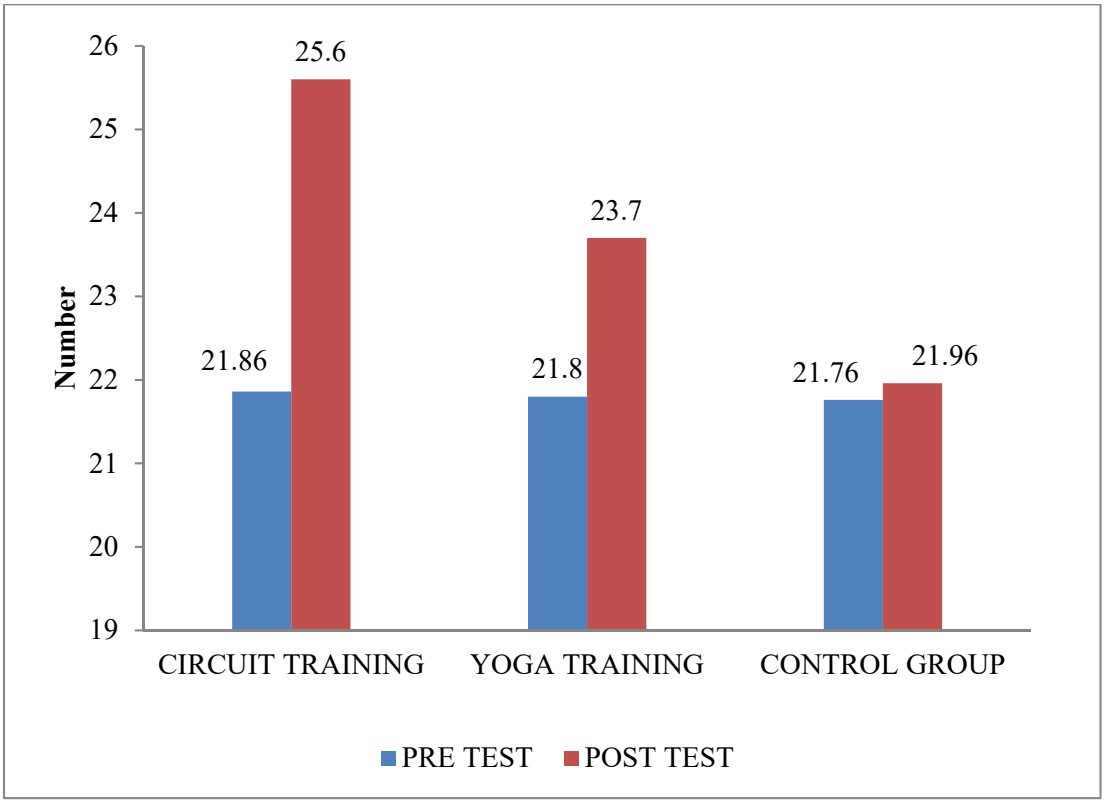


Figure 4.4 Bar diagram - Muscular Strength Endurance

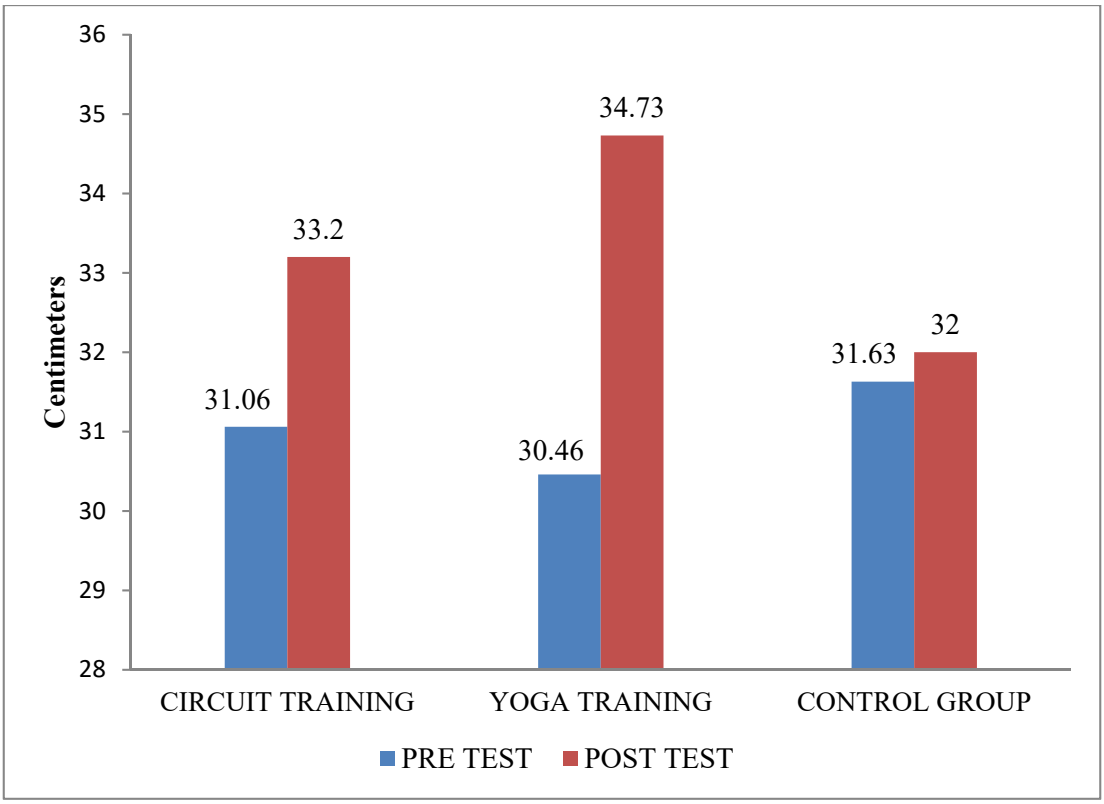


Figure 4.5 Bar diagram - Flexibility

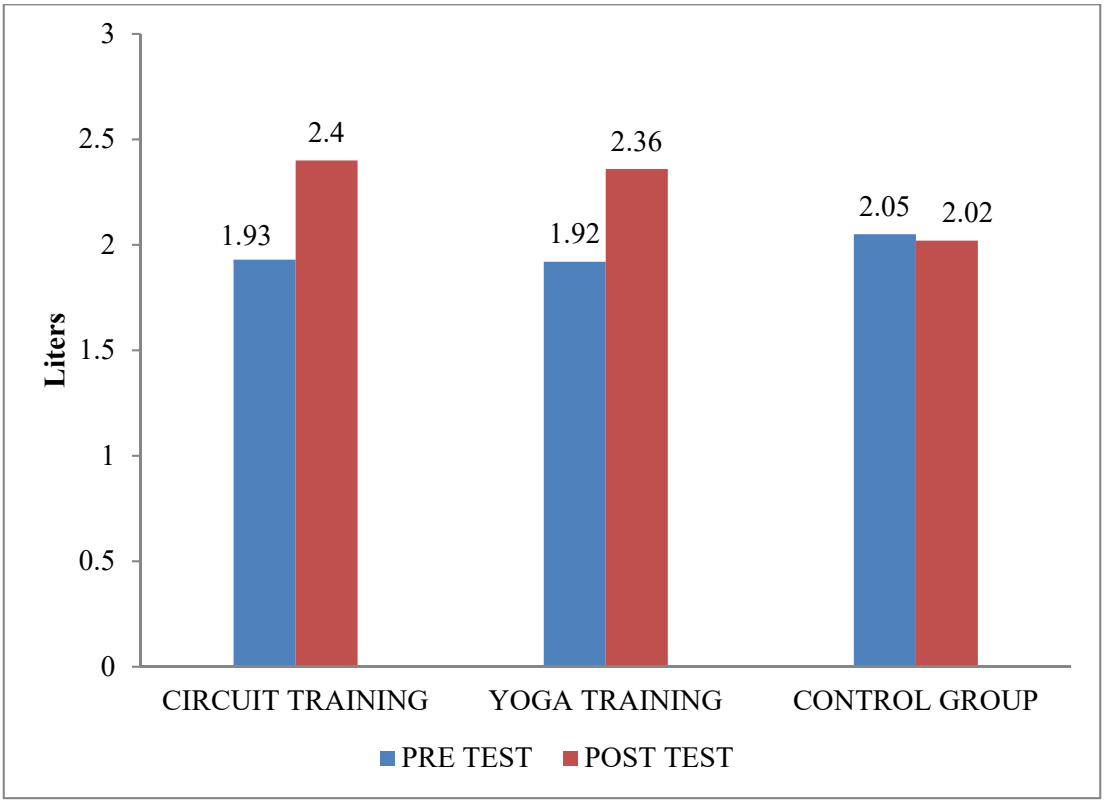


Figure 4.6 Bar diagram - Vital Capacity

4.3 RESULTS

4.3.1 Analysis the Significance of Mean Difference on Criterion Variables

In the analysis of covariance, analyzing the data on pre test means and post test means among the group namely, Circuit Training Group (CTG), Yoga Training Group (YTG), and Control Group (CG) on selected criterion variables is the preliminary process. As the final step of analysis of covariance, the post- test means are codified for differences in the pre- test means, and the adjusted means are tested for significance. Thus, the data were analyzed and the results on pre- test, post- test and adjusted test are given below.

4.3.2 Results of analysis of variance on Pre-Test means

In the initial data analysis of variance ('F' test) was used to find out the significance of mean difference in the pre-test among the three groups namely Circuit Training Group (CTG, Group-I), Yoga Training Group (YTG, Group-II), and Control Group (CG, Group-III) on selected physical fitness and physiological variables of body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children. The analysis is presented in table 4.4

Table – 4.4 reveals that the obtained 'F' values on pre-test means among the three groups. The obtained 'F' ratios were: 0.53 (Body mass index), 2.16 (Percent body fat), 0.50 (Cardio respiratory endurance), 0.00 (Muscular strength and endurance) 0.79 (Flexibility) and 0.60 (Vital capacity). The 'F' values on these variables are not significant since it fails to reach the critical value of 3.10 for degree of freedom 2 and 87 at 0.05 levels. On the basis of the results, it is assumed that the mean differences among the three groups of Circuit Training Group (CTG), Yoga Training Group (YTG), and Control Group (CG) on selected physical fitness and physiological variables of obese children (Fig 4.1 to 4.10) used in this study before the commencement of the respective treatments are found to be insignificant. Thus this analysis emphasized the random assignments of subjects into three groups are successful.

TABLE4.4 ANALYSIS OF VARIANCE ON PRE-TEST MEANS AMONG THE CTG, YTG AND CG ON PHYSICAL FITNESS AND PHYSIOLOGICAL VARIABLES OF OBESE CHILDREN

Variables	Source of Variance	Sum of Squares	Df	Mean Square	F	Sig.
Body Mass Index(Kg/m^2)	Between Groups	5.75	2	2.87	0.53	0.58
	Within Groups	464.56	87	5.34		
Percent Body Fat (Percentage)	Between Groups	48.03	2	24.01	2.16	0.12
	Within Groups	967.28	87	11.11		
Cardio respiratory endurance (Seconds)	Between Groups	0.35	2	0.17	0.50	0.60
	Within Groups	30.77	87	0.35		
Muscular Strength and Endurance (Numbers)	Between Groups	0.15	2	0.07	0.00	0.99
	Within Groups	2199.63	87	25.28		
Flexibility (Centimeters)	Between Groups	20.42	2	10.21	0.79	0.45
	Within Groups	1120.30	87	12.87		
Vital Capacity (Liters)	Between Groups	0.31	2	0.15	0.60	0.55
	Within Groups	22.97	87	0.26		

*Significant at 0.05 level (3.10)

4.3.3 Results of analysis of variance on post-test means

In the analysis of variance on post-test means, 'F' test was used to find out the significance of mean differences in the post-test among the three groups namely, Circuit Training Group (CTG, Group-I), Yoga Training Group (YTG, Group-II) and Control Group (CG, Group-III) on selected physical fitness and physiological variables of body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children. The analysis is presented in the table 4.5.

Table – 4.5 reveals that the obtained 'F' values on post-test means among the three groups. The obtained 'F' ratios were: 5.72 (Body mass index), 2.60 (Percent body fat), 5.15 (Cardio respiratory endurance), 3.86 (Muscular strength and endurance) 4.19 (Flexibility) and 6.39 (Vital capacity). Since the observed F- values on post-test means among the groups namely Circuit Training Group (CTG, Group-I), Yoga Training Group (YTG, Group-II), and Control Group (CG, Group-III) selected physical fitness and physiological variables of obese children are highly significant except percent body fat as the values are higher than the required critical value of 3.10. Thus the results obtained

proved that the interventions namely Circuit Training Group (CTG, Group-I), Yoga Training Group (YTG, Group-II), and Control Group (CG, Group-III) produced significantly different improvements among themselves.

TABLE4.5 ANALYSIS OF VARIANCE ON POST-TEST MEANS AMONG THE CTG, YTG AND CG ON PHYSICAL FITNESS AND PHYSIOLOGICAL VARIABLES OF OBESE CHILDREN

Variables	Source of Variance	Sum of Squares	Df	Mean Square	F	Sig.
Body Mass Index(Kg/m^2)	Between Groups	54.46	2	27.23	5.72	0.00
	Within Groups	413.93	87	4.75		
Percent Body Fat(Percentage)	Between Groups	64.32	2	32.16	2.60	0.07
	Within Groups	1072.78	87	12.33		
Cardio respiratory endurance (Seconds)	Between Groups	3.13	2	1.56	5.15	0.00
	Within Groups	26.48	87	0.30		
Muscular Strength and Endurance (Numbers)	Between Groups	198.15	2	99.07	3.86	0.02
	Within Groups	2228.46	87	25.61		
Flexibility (Centimeters)	Between Groups	112.62	2	56.31	4.19	0.01
	Within Groups	1168.66	87	13.43		
Vital Capacity (Liters)	Between Groups	2.62	2	1.31	6.39	0.00
	Within Groups	17.87	87	0.20		

*Significant at 0.05 level (3.10)

4.3.4 Results of analysis of co-variance on adjusted post-test means

In the analysis of co-variance on adjusted post-test means, F' test was used to find out the significance of mean differences in the adjusted post-test among the three groups namely, Circuit Training Group (CTG, Group-I), Yoga Training Group (YTG, Group-II), and Control Group (CG, Group-III) on selected physical fitness and physiological variables of body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children. The analysis is presented in table 4.6

TABLE4.6 ANALYSIS OF CO-VARIANCE ON ADJUSTED POST-TEST MEANS AMONG THE CTG, YTG AND CG ON PHYSICAL FITNESS AND PHYSIOLOGICAL VARIABLES OF OBESE CHILDREN

Variables	Source of Variance	Sum of Squares	Df	Mean Square	F	Sig.
Body Mass Index(Kg/m^2)	Between Groups	73.58	2	36.79	63.61	0.00
	Within Groups	49.73	86	0.57		
Percent Body Fat(Percentage)	Between Groups	89.62	2	44.81	25.09	0.00
	Within Groups	153.57	86	1.78		
Cardio respiratory endurance (Seconds)	Between Groups	2.70	2	1.35	20.61	0.00
	Within Groups	5.65	86	0.06		
Muscular Strength and Endurance (Numbers)	Between Groups	187.52	2	93.76	77.01	0.00
	Within Groups	104.70	86	1.21		
Flexibility (Centimeters)	Between Groups	217.84	2	108.92	58.07	0.00
	Within Groups	161.30	86	1.87		
Vital Capacity (Liters)	Between Groups	3.93	2	1.96	22.98	0.00
	Within Groups	7.35	86	0.08		

*Significant at 0.05 level (3.10)

The table 4.6 shows the result of analysis of co-variance on adjusted post-test means among the three groups on selected physical fitness and physiological variables.The obtained 'F' values were: 63.61 (Body mass index), 25.09 (Percent body fat), 20.61 (Cardio respiratory endurance), 77.01 (Muscular strength and endurance) 58.07 (Flexibility) and 22.98 (vital capacity). The F-values which observed on adjusted post-test means among the groups of Circuit Training Group (CTG, Group-I), Yoga Training Group (YTG, Group-II), and Control Group (CG, Group-III) on selected physical fitness and physiological variables of obese children are found to be greater than the required critical value of 3.10 at 0.05 level of confidence for degree of freedom 2 and 86. It is concluded that there is a significant mean differences among the three treatment groups in developing the selected physical fitness and physiological variables of body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children. In order to find out the significant difference among the intervention programme used in the present study, the source for the significance of adjusted means was tested by Bonferroni Post-hoc test.

TABLE 4.7 BONFERRONI POST HOCTEST MEAN DIFFERENCES ON BODY MASS INDEX AMONG THREE GROUPS

CTG	YTG	CG	Mean Differences	Sig
20.98	22.20	-	1.22	0.00
20.98	-	23.20	2.22	0.00
-	22.20	23.20	1.00	0.00

*Significant at 0.05 level, Score in Kg/M^2

Table 4.7 shows that the post hoc analysis of obtained order of adjusted post test means. It was observed that the mean difference values of circuit training group on body mass index was significantly higher than the method yoga training group, and control group. That means circuit training group reducing body mass index significantly higher than the yogic training group and control group. The yogic traininggroup also decreased the body mass index better than the control group.

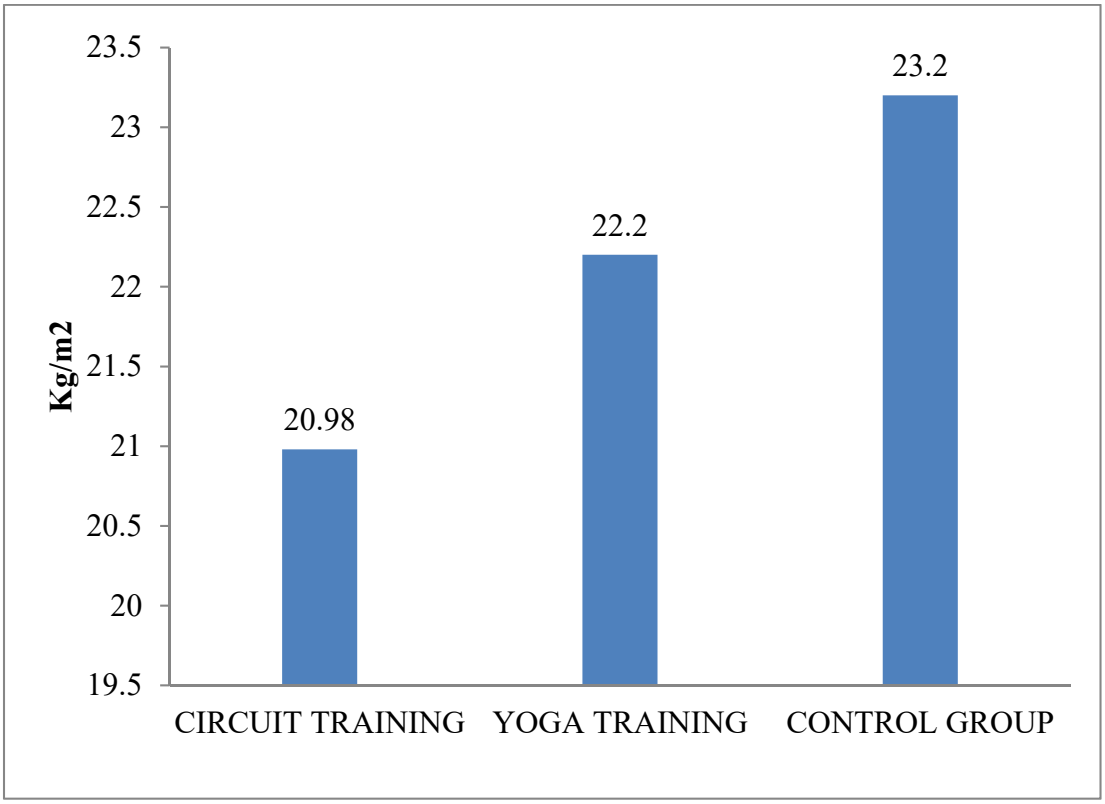


Figure 4.7 ADJUSTED MEAN VALUES OF EXPERIMENTAL GROUPS AND CONTROL GROUP ON BODY MASS INDEX

TABLE 4.8 BONFERRONI POST HOCTEST MEAN DIFFERENCES ON PERCENT BODY FATAMONG THREE GROUPS

CTG	YTG	CG	Mean Differences	Sig
26.88	26.35	-	0.52	0.40
26.88	-	28.70	1.81	0.00
-	26.35	28.70	2.34	0.00

*Significant at 0.05 level, (Scores in Percentage)

Table 4.8 shows that the post hoc analysis of obtained order of adjusted post test means. It was observed that the mean difference values between circuit training and yoga training on percent body fat was not statistically significant. Even though there is no significant difference between the two experimental groups, both the experimental groups has produced significant improvement on percent body fat when compared to control group. However the result revealed that both training groups decreased percent body fat after the training intervention.

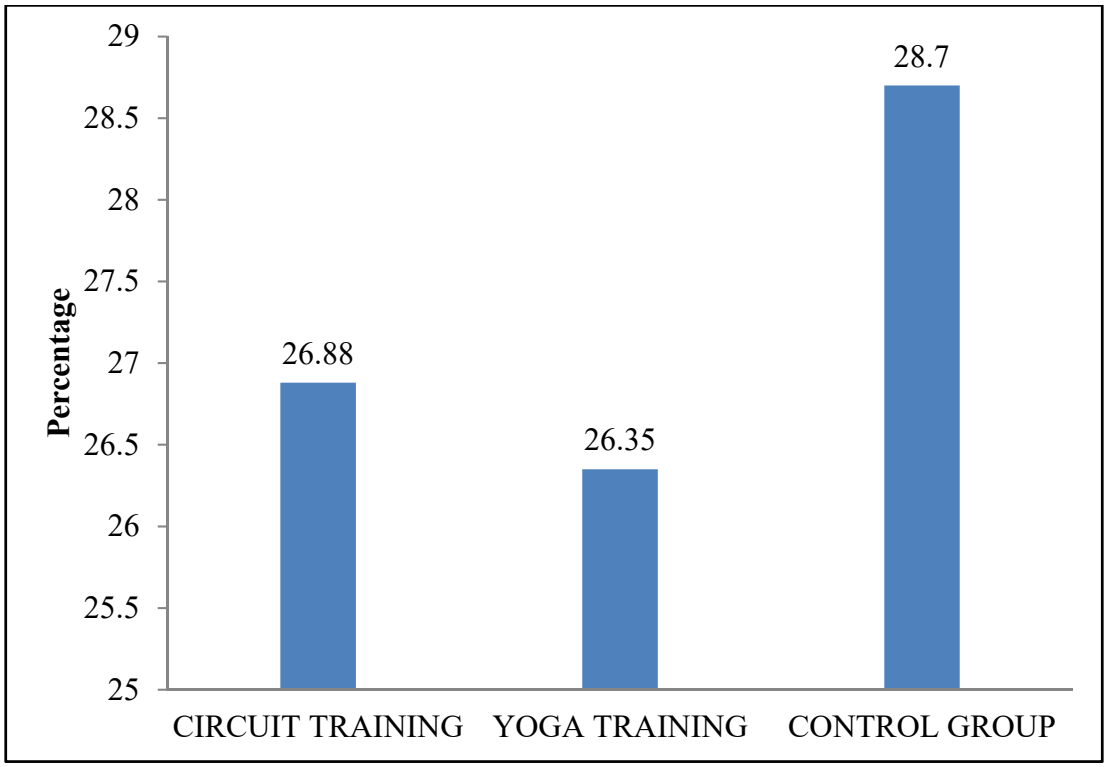


Figure 4.8 - ADJUSTED MEAN VALUES OF EXPERIMENTAL GROUPS AND CONTROL GROUP ON PERCENT BODY FAT

TABLE 4.9 BONFERRONI POST HOC TEST MEAN DIFFERENCES ON CARDIO RESPIRATORY ENDURANCE AMONG THREE GROUPS

CTG	YTG	CG	Mean Differences	Sig
2.41	2.47	-	0.06	1.00
2.41	-	2.81	0.39	0.00
-	2.47	2.81	0.33	0.00

*Significant at 0.05 level - (Scores in seconds)

Table 4.9 showsthat the post hoc analysis of obtained order of adjusted post test means. It was observed that the mean difference values between circuit training and yoga training on cardio respiratory endurance was not statistically significant. Even if there is no significant difference between the two experimental groups, both training groups has produced significant improvement on cardio respiratory endurance when compared to control group. Both training groups developed cardio respiratory endurance after the treatment.

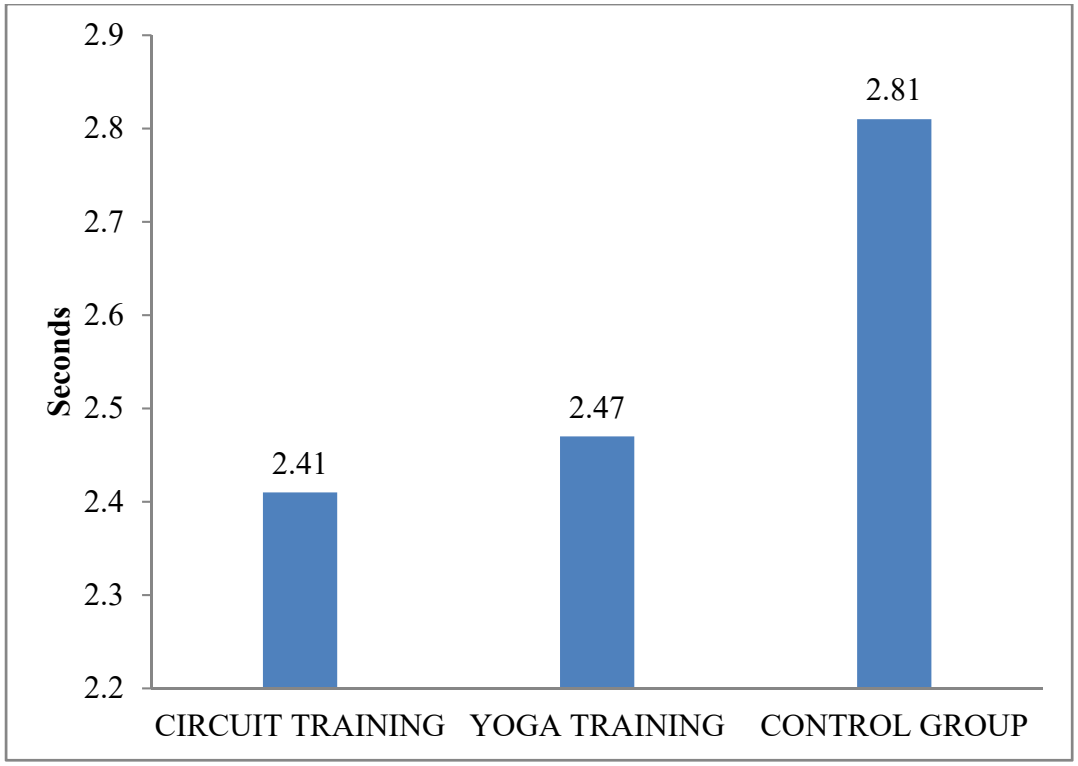


Figure 4.9 ADJUSTED MEAN VALUES OF EXPERIMENTAL GROUPS AND CONTROL GROUP ON CARDIO RESPIRATORY ENDURANCE

TABLE 4.10 BONFERRONI POST HOC TEST MEAN DIFFERENCES ON MUSCULAR STRENGTH ENDURANCEAMONG THREE GROUPS

CTG	YTG	CG	Mean Differences	Sig
25.54	23.71	-	1.83	0.00
25.54	-	22.00	3.53	0.00
-	23.71	22.00	1.70	0.00

*Significant at 0.05 level(Scores in Number/ Minutes)

Table 4.10 shows that the post hoc analysis of obtained order of adjusted post test means. It was observed that the mean difference values of circuit training group developing the muscular strength and endurance was significantly higher than the yoga training group and control group. The yoga training group also developed significant difference on muscular strength and endurance than the control group.

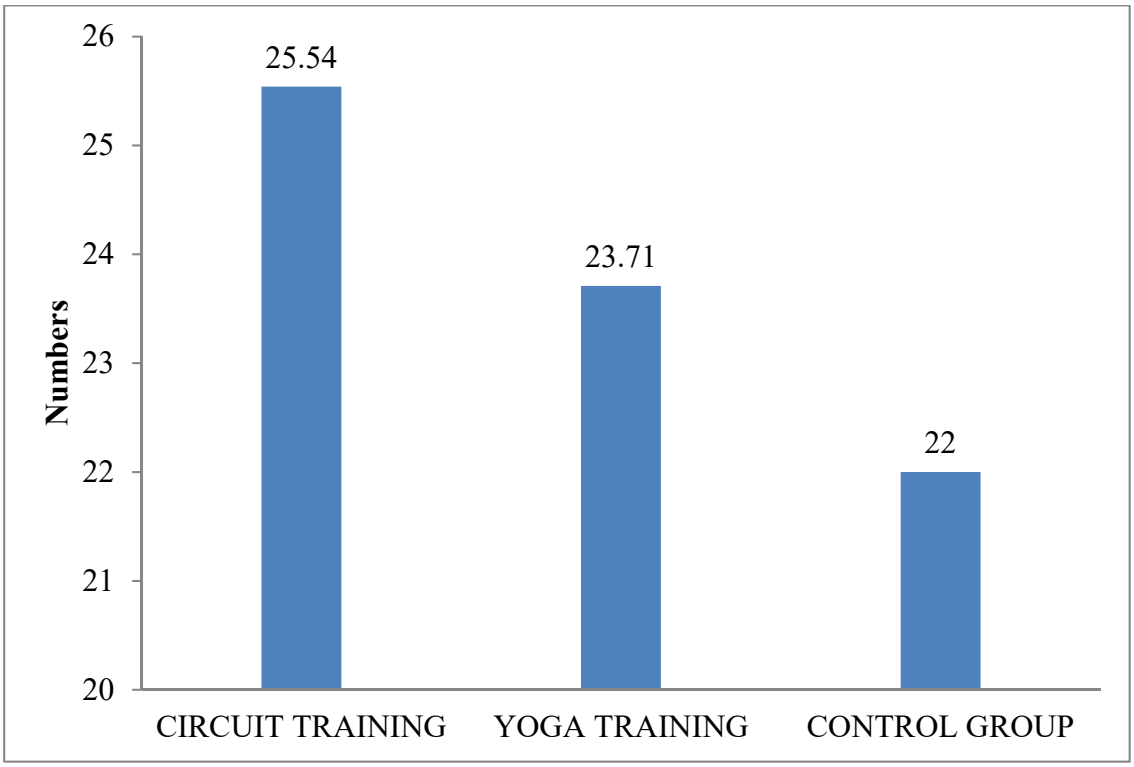


Figure 4.10 ADJUSTED MEAN VALUES OF EXPERIMENTAL GROUPS AND CONTROL GROUP ON MUSCULAR STRENGTH AND ENDURANCE

TABLE4.11 BONFERRONI POST HOCTEST MEAN DIFFERENCES ON FLEXIBLITY AMONG THREE GROUPS

CTG	YTG	CG	Mean Differences	Sig
33.18	35.29	-	2.10	0.00
33.18	-	31.45	1.73	0.00
-	35.29	31.45	3.84	0.00

*Significant at 0.05 level, (Scores in Centimeter)

Table 4.11 shows that the post hoc analysis of obtained order adjusted post test means. It was observed that the mean difference values of yoga training group developing the flexibility was significantly higher than the circuit training group and control group. The circuit training group also produced increased flexibility after the training than the control group.

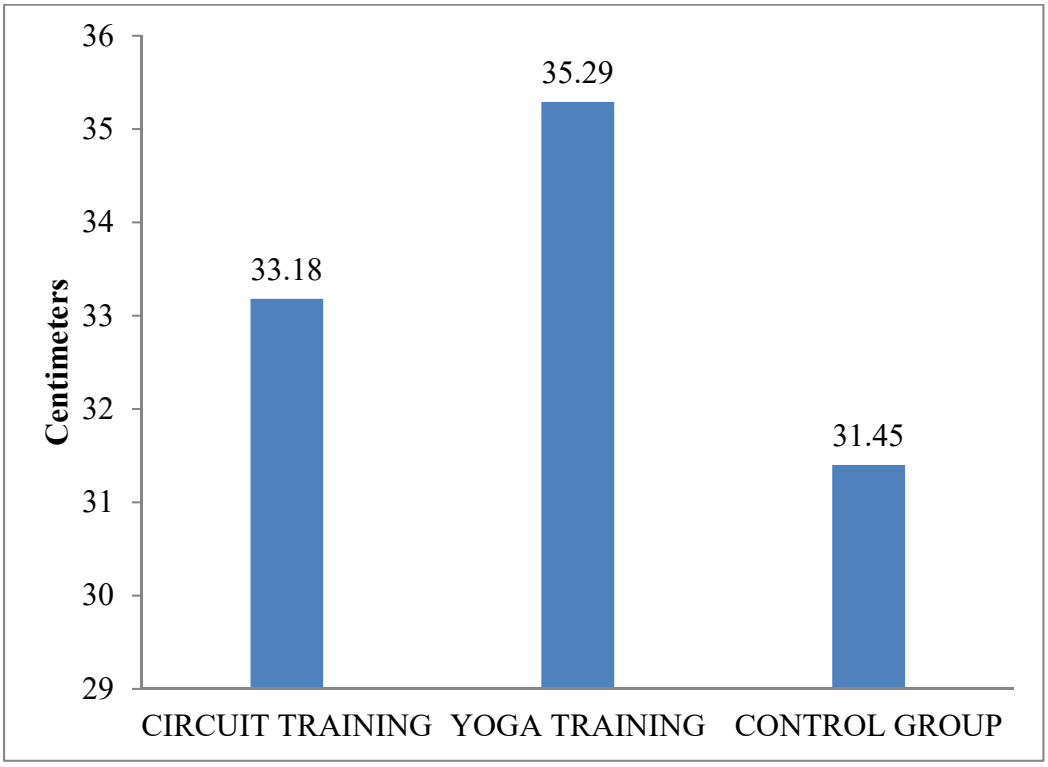


Figure 4.11 ADJUSTED MEAN VALUES OF EXPERIMENTAL GROUPS AND CONTROL GROUP ON FLEXIBILITY

TABLE 4.12 BONFERRONI POST HOC TEST MEAN DIFFERENCES ON VITAL CAPACITY AMONG THREE GROUPS

CTG	YTG	CG	Mean Differences	Sig
2.42	2.40	-	0.02	1.00
2.42	-	1.96	0.45	0.00
-	2.40	1.96	0.43	0.00

*Significant at 0.05 level, (Scores in Liters)

Table 4.12 shows that the post hoc analysis of obtained order adjusted post test means. It was observed that the mean difference values between circuit training and yoga training on vital capacity was not statistically significant, so there is no significant difference between the two experimental groups, whereas both the experimental groups produced significant improvement on vital capacity when compared to control group.

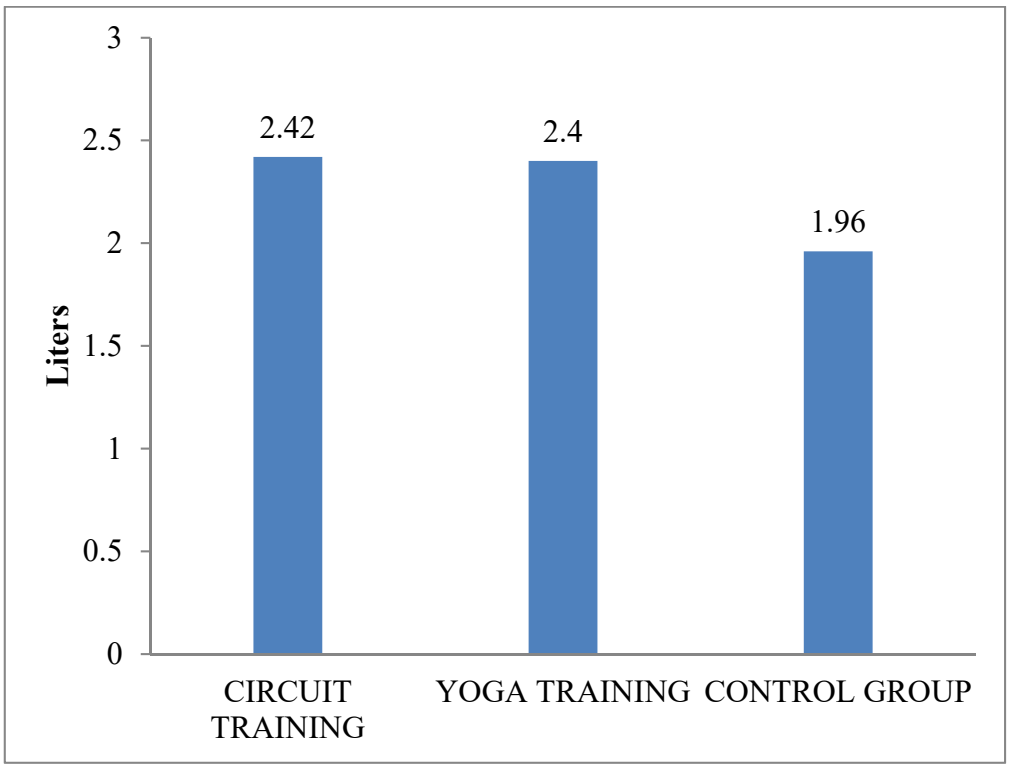


Figure 4.12 ADJUSTED MEAN VALUES OF EXPERIMENTAL GROUPS AND CONTROL GROUP ON VITAL CAPACITY

4.4 FINDINGS

The findings observed on individualized effects of circuit training, yoga training and control group on selected physical fitness and physiological variables of obese children are enlisted below. After testing the comparative effect of circuit training, yoga training and control group on physical fitness and physiological variables of obese children, significant mean difference was observed.

1. In testing the individualized effect of Circuit Training (CTG) the mean difference between pre and post- test on body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity from base line to post treatment were statistically significant.

2. In testing the individualized effect of Yoga Training (YTG) the mean difference between pre and post- test on body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity from base line to post treatment were statistically significant.

3. In testing the individualized effect of Control Group (CG), the mean difference between pre and post- test on body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, vital capacity from base line to post treatment were statistically not significant; but in the case of flexibility there is significant difference between pre and post tests.

4. In analyzing result of pre-test of Circuit Training (CTG), Yoga Training (YTG) and control group (CG) the mean difference observed on body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity were statistically not significant.

5. In analyzing result of post-test of Circuit Training (CTG), Yoga Training (YTG) and control group (CG) the mean differences observed on body mass index, cardio respiratory endurance, muscular strength and endurance, flexibility, vital capacity were statistically significant (except percent body fat - yoga group) for Circuit Training (CTG) and Yoga Training (YTG). There is no significant difference in control group.

6. In analyzing result of adjusted post-test of Circuit Training (CTG), Yoga Training (YTG) and control group (CG) the mean difference observed on body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity were statistically significant.

7. In analyzing the comparative effect of Circuit Training (CTG), Yoga Training (YTG) and control group (CG) on body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity, the Circuit training (CTG) and Yoga training groups (YTG) showed the significant improvement on all selected physical fitness and physiological variables of obese children than the control group.

8. In analyzing the comparative effect of Circuit Training (CTG) and Yoga Training groups (YTG) on body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility, vital capacity, the Circuit training group (CTG) showed significant improvement on body mass index and muscular strength and endurance than the Yogic training group (YTG). The Yogic training group (YTG) showed significant improvement on flexibility than the Circuit training group (CTG). Whereas in the remaining variables such as percent body fat, cardio respiratory endurance and vital capacity both experimental groups were statistically not significant, so both the groups are equal in producing the similar results.

9. In analyzing the overall results of this study it was found that the Circuit Training (CTG) was the superior training module to develop the physical fitness variables such as body mass index and muscular strength and endurance. Yoga Training (YTG) was the superior training module to develop flexibility.

4.5 DISCUSSION ON FINDINGS

The purpose of the present research was to determine the effect of Circuit Training and Yoga Training on selected physical fitness and physiological variables of obese children.

While testing the individual effect of Circuit Training (CTG) and Yoga Training (YTG), each one has significantly and positively developed the fitness and physiological

variables of obese children. The source of such significant changes occurred from baseline to post treatment of each training module on selected fitness and physiological variables of obese children of body mass index, percent body fat, cardio respiratory endurance; muscular strength and endurance, flexibility and vital capacity used in the present study would be accommodated to its scientific nature. As far as the performance of control group is concerned, the observed mean difference from base line to post- test was not significant.

Likewise, the result obtained in testing the comparative effect of the performance of Circuit Training (CTG) and Yoga Training (YTG), Circuit Training (CTG) is the superior module to develop body mass index and muscular strength and endurance than the Yogic training (YTG),and whereas Yogic training (YTG) is the superior module to develop flexibility than the Circuit training (CTG).The results obtained on testing the individualized effects and comparative effects are discussedwith theoretical and empirical constructs as follows.

4.5.1 Body Mass Index (BMI)

The output of the present study shows that there was a significant difference among experimental group of circuit training, yogic training and the control group on the variable of Body Mass Index (BMI) owing to the sixteen weeks of experimental interventions of obese children and the significant improvement were noticed on Body Mass Index variable between the circuit and yogic training group. The result of the study clearly indicated that there was significant improvement from pre test to post test among two groups on Body Mass Index. The Body Mass Index in the circuit training group from pre test (23.43 ± 1.67) to post test (21.06 ± 1.57) and in the yogic training group from pre test (23.60 ± 3.32) to post test (22.43 ± 2.95), the Body Mass Index has significantly improved from pre test to post test in the two experimental groups but there was no change in control group. The study further indicated that the BMI after the yogic training treatment is significantly reduced and it is different from that of circuit training and Control group. However the Body Mass Index was significantly reduced after circuit treatment in comparison with other methods, which means circuit training dominated in the body mass index than the yoga training.

The results of the present study are similar to the previous studies or very well be supported and findings made by following studies conducted by ***Patel, S., Kumar, K. et.al; (2016)*****,** study was concluded that significant reduction of body mass index and low level of cholesterol was seen after the training programme. ***KalidasKarak, Mrityunjoy Jana, et.al; (2015)*** stated that yoga practice can be used as an intervention in ageing persons to reduce the morbidity and mortality from cardiovascular diseases. It reduces the high blood pressure, pulse rate and Body Weight, BMI and Fat (%).Similarly, ***Yokesh, T. P., Chandrasekaran, K. et.al; (2011)***, concluded that yogic practice group showed significant improvement due to 12 weeks of training on BMI and flexibility compared to control group.

4.5.2 Percent body fat (body composition)

The circuit training group and yogic training group showed significant improvement on percent body fat (body composition) from pre training to post training. The percent body fat in the circuit training group pre test (29.81 ± 4.20) to post test (27.84 ± 4.46) and in the yogic training pre test (28.58 ± 1.79) to post test (26.11 ± 2.08). The percent body fat has significant reduction in two training groups after the training intervention, which means that both training programmes bought significant impact on percent body fat whereas control group did not show any significant improvement on selected physical fitness variable. Further, the study indicated that the result of circuit training and yogic training groups are equal on the variable of percent body fat.

The result of the present study is conformity with the study of ***KalidasKarak, Mrityunjoy Jana, et.al; (2015) and Thakur and Bandopadhyay (2012)***who stated that yogic practice has bought significant impact on percent body fat and it has decreased after the training intervention. The decrease in percent body fat has seen in the present study in agreement with the earlier studies. The previous studies and research conducted by ***Rani Sangeeta, et.al; (2015), Beard Leslie self (1988) and Larry D. Hensley and Whitefeild B. East; et.al. (1982)*** indicated that circuit training also be helpful for to reduce the body fat percentage. The present study also indicated that both training interventions have made significant impact on the variable of percent body fat.

4.5.3 Cardio respiratory endurance

The findings of the present study reveal that there was a significant difference among circuit training group, yogic training group and control group on health related physical fitness variable of cardio respiratory endurance owing to the sixteen week training interventions of obese male students, and the significant improvement has been noticed on fitness variable of cardio respiratory endurance between experimental groups. The result of the study clearly indicated that there was a significant improvement from pre test to post test among two groups on cardio respiratory endurance, through circuit training group (pre test 2.72 ± 0.60) post test 2.35 ± 0.52) and Yogic training group (pre test 2.88 ± 0.62 post test 2.54 ± 0.57). But there was no change in control group. Both the interventions have significant impact on cardio respiratory endurance. Further the result indicated that the circuit training and yoga training group are equal on the variable of cardio respiratory endurance.

The results of the present study are in line with previous study of ***(Malathy and Robert, 2015)***which stated that there was a significant development on Cardio respiratory endurance due to the influence of circuit training and yogic practice among the obese Children and also helped to improve the physical fitness variables along with the performance level of the subjects. The result of this study also in line with the findings of ***Mayorga-Vega D, Viciana J, Cocca A. et.al; (2013),Satish, V, Rao, et.al; (2018),and ShabeshanRengasamy, (2012)*** who were also reported that there was a significant improvement in cardio respiratory endurance after the circuit and yogic treatments.

4.5.4 Muscular strength and endurance

The results of the present study explained that there was significant difference among the experimental groups and control group on health related physical fitness variable of muscular strength and endurance due to the sixteen weeks of training programmes of obese male students and the significant improvement has been noticed on fitness variable of muscular strength and endurance between experimental groups. The result of the study clearly explained that there was significant improvement from pre test to post test among experimental groups on muscular strength and endurance through circuit training (pre test 21.86 ± 5.82 post test 25.6 ± 5.63) and yogic training (pre test 21.80 ± 4.36 post test 23.70 ± 4.72). The muscular strength and endurance has

significantly enhanced from pre to post test in the two experimental groups after the training interventions but the control group has not produced any significant change in the particular variable. Even though,both interventions have significant impact on muscular strength and endurance, the result indicated that the Circuit training group dominated on the variable of muscular strength and endurance better than the Yoga training group. The present study is in line with the previous study's findings that the circuit and yogic training programmes resulted in an improvement in muscular strength and endurance. The following studies lead support to the result of the present study.

Mayorga-Vega D, Viciana J, Cocca A. et.al; (2013).Their study was to evaluate the effects of circuit training program along with a maintenance program on muscular and cardiovascular endurance in children in a physical education setting. Seventy two children of 10 – 12 years old from four different classes were randomly grouped into experimental group and control group. After an eight–week development program carried out twice a week and four-week detraining period, the experimental group performed a four-week maintenance program once a week. After the development program, muscular and cardiovascular endurance increased significantly in the experimental group. The results showed that the circuit training program was effective to increase and maintain both muscular and cardiovascular endurance among school children.

Manju and Dolly (2017) examined the effect of yogic asanas on physical and mental ability of sports girls. For achieving this aim twenty (20) sports girls were taken as subjects and given training programme of ten yogic asanas. Abdominal and shoulder strength, speed, endurance, agility and power were taken as components and AAPHERD physical fitness test battery was used for measuring physical ability. The yoga training programme was scheduled for 12 weeks. The results of study revealed that sports girls significantly improved their abdominal and shoulder strength, endurance, agility, power and mental ability after the training of yogic asanas.

4.5.5 Flexibility

The result of the present study reveals that there was a significant difference among experimental group of circuit training; yogic training and the control group onphysical fitness variable of flexibility owing to the sixteen weeks of experimental interventions of obese children, and the significant improvement were noticed on

flexibility variable between the circuit and yogic training group. The result of the study clearly indicated that there was significant improvement from pre test to post test among two groups on flexibility. The flexibility in the circuit training group from pre test (31.06 ± 1.87) to post test (33.20 ± 2.32) and in the yogic training group from pre test (30.46 ± 3.28) to post test (34.73 ± 2.98), the flexibility has significantly enhanced from pre- test to post test in the two experimental groups after the specified training period, where as no change in control group. The study further indicated that the result of circuit training was significantly different from yogic treatment. On the other hand, the flexibility after the Yoga treatment is significantly different from that of Circuit training and Control group. The result of the study also revealed that the flexibility was significantly increased after yoga training in compare with other training method.

The above findings are very well supported by observations made by the following studies conducted by ***ShabeshanRengasamy, (2012)*** and ***Anil ADeshmukh (2016).***

4.5.6 Vital capacity

The findings of the present study on the physiological variable of vital capacity revealed that there was a significant improvement which was noticed after the intervention of circuit and yogic training. The result of the study clearly revealed that there was a significant improvement from pre test to post test in the circuit and yogic training group on vital capacity. The vital capacity in the circuit training group, (pre test 1.93 ± 0.50, post test 2.40 ± 0.40) and in the yogic training, (pre test 1.92 ± 0.49, post test 2.36 ± 0.42). It can be inferred that the circuit training and yoga training treatment has significant impact on Vital capacity. Further, the study indicated that the result of circuit training and yoga training groups are equal on the variable of vital capacity.

The result of the present study is in conformity with the study of ***Prakash Meti; (2018)Mukesh Kumar Mishra, Ajay Kumar Pandey, et.al; (2015),Senthilkumar (2015) and Manikandan, (2014)*** whostated that circuit and yogic training has bought significant impact on vital capacity and it has improved after the training intervention. The improvement in the vital capacity has seen in the present study in agreement with the earlier studies. Hence the above mentioned studies lend support to the result of the present study.

4.6 DISCUSSION ON HYPOTHESIS

1. The hypothesis No.1 stated that in studying the individualized effect, Circuit training would have significant improvement over the period of sixteen weeks training on physical fitness and physiological variables of body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children. The analysis of data indicated that sixteen weeks of Circuit Training had significantly influenced on body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children from base line to post treatment. Hence, the formulated hypothesis No.1 was accepted.

2. The hypothesis No.2 stated that in studying the individualized effect, Yoga training would have significant improvement over the period of sixteen weeks training on selected physical fitness and physiological variables of body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children. The analysis of data indicated that sixteen weeks of yogic Training had significantly influenced on selected physical fitness and physiological variables of body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children from base line to post treatment. Hence, the formulated hypothesis No.2 was accepted.

3. The hypothesis No.3 stated that in studying the individualized effect, control group may not have any significant improvement over the period of sixteen weeks on selected physical fitness and physiological variables of body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children. The analysis of data indicated that after sixteen weeks the control group would have not significantly influenced on selected physical fitness and physiological variables of body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance and vital capacity of obese children from base line to post treatment. Hence, the formulated hypothesis No.3 was accepted for the above variables and rejected in case of flexibility.

4. The hypothesis No.4 stated that that in studying the comparative effect, Circuit training and Yoga training would have significant improvement over the period of sixteen weeks training on selected physical fitness and physiological variables of body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children than the control group. The analysis of data indicated that sixteen weeks of Circuit training and Yoga training had significantly influenced on selected physical fitness and physiological variables of body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children than control group from base line to post treatment. Hence, the formulated hypothesis No. 4 was accepted.

5. The hypothesis No.5 stated that in studying the comparative effects of Circuit training and Yoga training, the Circuit training would have better training effect for significant improvement over the period of sixteen weeks training on selected physical fitness and physiological variables of body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children than the Yoga training group. The analysis of data indicated that sixteen weeks of Circuit Training had significantly influenced on body mass index and muscular strength and endurance of obese children than Yoga training group from base line to post treatment. Whereas Yoga training showed significant improvement on flexibility than the Circuit Training group from base line to post treatment. Whereas in the remaining variables such as percent body fat, cardio respiratory endurance and physiological variable of vital capacity both the experimental groups are equal in producing results. The formulated hypothesis No.5 was accepted on the selected physical fitness variables of body mass index and muscular strength and endurance. Whereas the other variables such as percent body fat, cardio respiratory endurance and vital capacity show equal results and negative result on flexibility. Hence, the formulated hypothesis No.5 was partially accepted.

CHAPTER – V

SUMMARY, CONCLUSIONS AND RECOMMANDATIONS

5.1 SUMMARY

It is estimated that there are more than 300 million obese people worldwide. Urbanization and modernization, sedentary life, consumption of oily and junk food and other life style changes have contributed to overweight and obesity. The calculated global prevalence of overweight (including obesity) in children aged 5 - 17 years is estimated by the World Health Organization (WHO), International Obesity Task Force (IOTF) to be approximately 10%. Various studies in India have found that the incidence of childhood overweight/obesity has increased noticeably. Physical fitness is nowadays considered as one of the most important health markers in childhood (Ortega et al., 2008). Accordingly in the last decades several countries have been promoting physical fitness improvement among young people in different ways (Department of Health and Human Services, 1990). In many circumstances, schools have been considered the best setting in which children with low fitness levels can be identified and a healthy lifestyle can be promoted (Ortega et al., 2008). Schools are mainly attempting to increase the pupils' health level by using measures such as the improvement of their physical fitness through physical education (PE) (Ministerio de Education y Ciencia, 2006).

Circuit training was first proposed by Morgan and Adamson of Leeds University as method for developing general fitness. Their initial circuit routine consisted of several stations arranged in a circle (hence it is named as circuit training) so as to work muscle group alternately from station to station. A wide variety of exercises and devices can be used in a circuit training routine, such as body weight, medicine balls, dumbbells, barbells and any strength training machines. A circuit may be of short (6 to 9 exercises), medium (9 to 12 exercises) and long (12 to 15 exercised) duration and may be repeated several times depending on the number of exercises involved. In deciding the number of circuits, the number of repatriations per station, and the load, coaches consider the athletes' work tolerance and fitness level.

Yoga has been recommended as an alternative training for children to keep their body and mind fit for day to day life. Its integration of the mental, physical and spiritual dimensions of human life is helpful to children for maintaining good health. The basic asana practices can control the obesity in the childhood. The stretching, bending, and balancing involved in the asana help to align the head and spinal column, stimulate the circulatory system, endocrine glands and other organs and keep the muscles and joints strong and flexible. Systematically planned yoga training is the right activity for the age group of ten to fourteen years to control the obesity in the early years. The scholar was keeping this in mind had planned and implemented the yoga raining in this study.

To carry out this study the scholar randomly selected ninety (N-90) obese students from the three different CBSE schools namely Chinmaya Vidyalaya, Thrissur, S N Vidyabhavan, Chenthrapinni, HIRA English School, Kaipamangalam, and these schools were located in the northern part of the Thrissur District, Kerala, India. Their age ranged from 10 to 14 years. The selected ninety subjects (N=90) were randomly divided into three equal groups of thirty (n=30) subjects each. The groups were named as experimental group-I, experimental group-II and Control group III. All the selected subjects were tested on selected physical and physiological variables such as Body Mass Index, Percent Body Fatand Cardio Respiratory Endurance, Muscular strength and endurance, Flexibility and Vital Capacity and their readings were carefully recorded in their respective units as pre-test scores. After pre-test Experimental group-I was treated with Circuit training (CTG) and Experimental group-II was treated with Yogic training (YTG) for three days per week in the evening and morning session respectively for a total duration of sixteen weeks, whereas the Control group (CG) was not undergone any type of specific training other than their daily activities. At the end of the treatment period of sixteen weeks, all the subjectswere tested again on selected physical and physiological variables and their readings were carefully recorded in their respective units as post-test scores. The pre and post- test scores were analyzed with appropriate statistical tools. To find out the difference between pre and post-test of each group, paired t- test was used. Analysis of covariance (ANCOVA) was computed. The difference between means of the three groups in the pre-test had to be taken into account during the analysis of the post-test differences between the means. This was achieved by the application of the analysis of covariance, where the final means were adjusted for differences in the initial means, and the adjusted means were tested for significance.

Whenever the adjusted post-test means were found significant, theBonferroni post-hoc test was administered to find out the paired means difference. To test the obtained results on variables, the level of significance was fixed at 0.05 levels. Based on the analysis of the data and results the following conclusions were drawn.

5.2 CONCLUSIONS

On the basis of the findings and within the limitations of the study the following conclusions were drawn.

1. The Circuit Training (CTG) had significant improvement over the period of sixteen weeks of training on body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children.

2. The Yoga Training (YTG) had significant improvement over the period of sixteen weeks of training on body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children.

3. The Control Group (CG) did not show any significant improvement over the period of sixteen of weeks training on body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance and vital capacity of obese children.

4. Comparing the effect of Circuit training (CTG), Yoga Training (YTG) and Control Group, it was concluded that both the experimental groups of circuit training (CTG), and yogic training (YTG) groups have produced significant improvement over the period of sixteen weeks of training on body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children than the Control Group.

5. Comparing the effect of Circuit training and Yoga Training (YTG), it was concluded that Circuit training (CTG) group have produced significant improvement over the period of sixteen weeks of training on body mass

index and muscular strength and endurance better than the Yoga training group. Yoga training produced significant improvement on flexibility than the Circuit training and control group. Circuit and yoga training produced equal effect on percent body fat, cardio respiratory endurance and vital capacity.

6. In overall analysis of the results of this study, it was concluded that Circuit training was the suitable training to decrease body mass index and to develop muscular strength and endurance of obese children.

7. Further, from the results of this study it was concluded that Yoga Training was the suitable training to develop flexibility of obese children.

5.3 RECOMMENDATIONS

The following recommendations have been made on the basis of the results achieved through this study.

1. Based on the results the effect of Circuit Training and Yoga training on body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children, the physical education teachers, trainers and coaches can prefer this type of training, so as to achieve their aim in time.

2. Similar study can be conducted by combining Circuit Training and Yoga Training in same session on body mass index, percent body fat, cardio respiratory endurance, muscular strength and endurance, flexibility and vital capacity of obese children.

3. Similar study can be conducted by using Circuit Training and Cardio Yoga Training in concurrent and periodization nature for combined and specific sports in different categories.

4. It is recommended that the Circuit Training and Yoga Training may be used for other set of populations by modifying the load, repetition and volume.

5. It is recommended that the combined Circuit Training and Yoga Training may be given to the high level performance athletes during the competition periods also.

6. It is recommended that this type of training can be undertaken based on the nature of sports and level of playing on motor fitness components.

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