CHAPTER I

INTRODUCTION

1.1. INTRODUCTION

Human are living happily in twenty first century and also achieved in some extent of good economical status. In day to day life one should concentrate only to increase the wants and needs but one won't take care about the health. In modern society, life has become complex due to various reasons. The modern way of life has lowered people's biological fitness levels. People lead sedentary lives, as machines have made their life easy and comfortable. According to this way of life human lead short span of life with all these luxuries and sophisticated equipments. Life is meaningful only if human fulfil all the wants and needs along with good health. Without adequate physical exertion man has become a storehouse of unreleased tension. Modern man in the electronic and computer age tends to become complacent and forgets the need of physical training for his survival. Modern man, due to his luxurious, easy and comfortable life, has become an easy prey to various fatal diseases.

Today our life style has entirely changed in many ways such as food habit, inactiveness in the name of luxury and facing so many troubles with science and technology. Now human leads rapid machinery life. To keep good health human have to spare some times to do exercise. Surely it would be give happy and healthy life. Time management is a vital thing in every one's life. Hence, human being should spare atleast half an hour every morning for doing physical exercise. Exercise not only help human's lose weight but also maintain human's weight as human grow older. Cardiovascular exercises like running, cycling, swimming and aerobics are

especially good for heart, hence the name 'Cardiovascular' these types of exercises help to maintain one's blood pressure, reduce bad cholesterol and increase good cholesterol level in the blood, reduce the risk of type II diabetes.

1.2. BODY COMPOSITION AND OBESITY

The increasing standard of economic conditions during the last decades enabling the full availability of food and allowing for changes in the composition of dietary intake has been contributing not only to an accelerated growth in height and weight, but also to a disproportional development of body composition, resulting in overweight and obesity. In 2011, more than 40 million children under the age of five were overweight globally, including developing countries (**WHO, 2013**). WHO's Asia-Pacific standard of obesity, people with a BMI of <23, ≥23 but<25 and≥25 were defined as normal, overweight, and obese, respectively, and males with a waist circumference of ≥90cm were defined as obese (**WHO, 2000**). Obesity has become one of the major health concerns of modern times. It is estimated that over 700 million people across the world are currently either overweight or obese (**Scully, 2012**).

Obesity is a widespread problem with important implications on health (**Gallus, et al., 2004, Mappe, et al., 2008, Pischon, et al., 2008** and **Whitlock, et al., 2009**) contributing to several chronic disorders, it is indeed responsible of high costs for Public Health Systems which in turn are continuously struggling against this by designing effective resolution programs (**Calza, et al., 2008**). The main determinant of overweight/obesity-related health complications is indeed the adipose tissue (AT). However, not the whole body fat exerts adverse effect on health status. It is well known that AT localized in the abdominal region, particularly

visceral AT, is more directly involved in the pathophysiology of chronic degenerative disorders particularly through insulin resistance and related complications (**Malavazos, et al., 2005, 2007, Cereda, et al., 2007** and **Ritchie and Connell, 2007**) accordingly, Beside the body mass index (BMI), simple anthropometric surrogates of body fat distribution, such as waist circumference (WC) or the waist-to-height ratio (WtHR), have been introduced in clinical practice to improve risk prediction. BMI has been initially introduced to account for exceeding whole body adiposity but it shows limited accuracy, particularly at higher degrees of obesity. Thus, it is a less reliable parameter for describing intra-abdominal fat accumulation when compared to other well-tailored proxy indicators (**Huxley, et al., 2010, Wajchenberg, 2000** and **Bohler, et al., 2007**).

1.3. BIA METHOD AND BODY COMPOSITION

Bioelectrical impedance analysis (BIA) is an easily performed and non-invasive way to measure body composition (**Van, 2004, Kiens, 2006** and **Goodpaster, et al., 2001**). Single frequency-BIA (SF-BIA) is commonly used to calculate total body water (TBW) and fat free mass (FFM) (**Kiens, 2006)** Multi frequency-BIA (MFBIA) (**Kiens, 2006**) and bioelectrical impedance spectroscopy (BIS) calculate intracellular water (ICW), extracellular water (ECW), TBW and FFM. Thus, BIS offers information of ICW and ECW distribution, and FFM is predicted from these. Body fat (BF) is generally calculated as the difference between body weight (BW) and FFM. There is an increasing interest to specifically estimate skeletal muscle mass (SMM), as it may better reflect the body protein reserves and nutritional status in disease and aging (**Shepherd, et al., 2013**). Aging is associated with decreased TBW, bone mass, body cell mass (BCM) and FFM (**Van, 2004).**

1.4. OBESITY AND LIFESTYLE-RELATED DISEASES

Obesity is a precursor to lifestyle-related diseases, including coronary artery disease, diabetes, hyperlipidemia, and hypertension. The mechanisms by which obesity-induced lifestyle diseases develop have not been fully identified, but abnormal distribution of body fat, particularly excessive accumulation of visceral fat in the peritoneal cavity, has recently attracted attention (**Fujioka, et al., 1987** and **Matsuzawa, et al., 1992**). The incidence and severity of endocrine disorders of metabolism are elevated in obese individuals with excess accumulation of visceral fat compared to individuals with subcutaneous fat accumulation (**Montague and O'Rahilly, 2000, Matsuzawa, et al., 1999** and **Kahn & Flier, 2000**). In addition, secretion of adipocytokines reportedly is associated with accumulation of visceral fat. As a body mass index (BMI) 30 kg/m^2, the prevalence of metabolic disorders are relatively high (**Kuzuya, 1994** and **Sakata & Labarthe, 1996**). Because obesity and intra-abdominal fat (IF) accumulations are primarily induced by physical inactivity and excess energy intake, increased physical activity and dietary modification could be an effective way to reduce metabolic disorders (**Okura et al., 2002 and Tanaka, et al., 2004**).

1.4.1. Benefits of Physical Activities

Regular exercise may be more effective at decreasing IF than dietary modification; regular exercise was found to decrease IF area without substantial weight change and preferentially reduce IF area compared with subcutaneous fat (SF) (**Ross, et al., 2000**). Although numerous investigations were conducted to determine the effects of regular aerobic exercise on IF levels (**Kay and Fiatarone,**

2006), the results of these exercise studies vary considerably depending on characteristics of the participants at baseline (**Crouse, et al., 1997**).

Physical activity is the single most effective therapeutic strategy to reduce cardio metabolic risk. According to the NHLBI National Cholesterol Education Program (NCEP), Adult Treatment Panel (ATP) III guidelines, any patient at high risk or moderately high risk for metabolic syndrome who has lifestyle-related risk factors (abdominal adiposity, physical inactivity, elevated triglycerides, or low HDL cholesterol) is a candidate for therapeutic lifestyle changes, such as physical activity, as first-line therapy (**Grundy, et al., 2004**). Physical activity is defined as any activity involving movements that prompt muscle contractions and a rise in resting metabolic rate, whereas exercise is generally a structured, planned activity (**Harvard, 2010**).

Participation in adequate exercise has been an essential part of the care of the child for optimal development, and also for education. A positive effect has been correlated not only with health and physical performance, but also on the development of personal will and discipline, adaptability, overcoming personal discomfort, achievement of set aims, fair play, teamwork, and so forth. This applies as well up to the present where great attention to physical education and sports occurs in the best schools, Scout organizations and the like. Early adaptation to optimally increased physical activity and exercise has always prevented excessive adiposity and contributed to the optimal development of vital organs, muscle and skeletal tissue, etc. (**Parızkova, 1963, 1977, 1989, 1993**).x

1.4.2. Physical Activity and Intensity Level

The research on physical activity in the presence of the metabolic syndrome has generally focused on episodes of moderate or greater intensity physical activity or structured, planned exercise throughout the week. Low intensity "lifestyle" physical activity frequently throughout the day appears to be equally as important as episodic exercise sessions. Over time, low intensity activity may impart greater benefits for cardio metabolic-risk reduction (**Kelly, 2012**). During high-intensity exercise lasting more than a few seconds, adenosine triphosphate (ATP) is resynthesized by both aerobic and anaerobic processes (**Medbo & Tabata, 1989**). The ability to resynthesize ATP may limit performance in many sports. Thus, if possible, the training of athletes for sports involving high-intensity exercise should improve the athletes' ability to release energy both aerobically and anaerobically. The success of different training regimens can and should be evaluated by the athletes' performance.

1.5. INTERVAL TRAINING TECHNIQUES

Today interval training can be defined as a technique that alternates short bouts of high exertion with periods of low intensity recovery (**Sharkey & Gaskill, 2006**). The major benefit of interval training (IT) is it allows athletes to train faster and harder without burnout or overtraining while still increasing speed, power, and physiological function. Since highly competitive athlete's often share characteristics attributed to their success such as: (1) a high maximal aerobic power; (2) an ability to maintain a high percentage of their VO_2max for sustained periods; (3) a high power output or speed at lactate threshold; (4) the ability to withstand high absolute power outputs or speeds and resist the onset of muscular fatigue; (5) an

efficient/economic technique; (6) the ability to utilize fat as a fuel during sustained high work rates. A training program with high intensity and high specificity is needed to improve these characteristics (**Hawley, et al., 1997**).

1.6. INTERVAL TRAINING ADAPTATIONS PHYSIOLOGICAL ADAPTATIONS

Physiological adaptations, which occur as a result of training, can be categorized into two main areas: central and peripheral (**Laursen, Blanchard, & Jenkins, 2002**) Central adaptations improve delivery of oxygen to working muscles. Initially increased blood volume occurs, followed by larger stroke volumes, greater cardiac output (CO), and improved circulation. Training increases heart size and in particular the left ventricle to support these changes. Other supportive changes such as increased elasticity, greater contractile force, and increased vascularization of the heart muscle occur (**McArdle, Katch, & Katch, 1991**, **American College of Sports Medicine, 2006**, **Birch, 2005** and **Powers & Howley, 2004**). Another central adaptation is enhanced thermoregulatory efficiency. To prevent overheating the body increases circulatory flow and sweating rate to lower core body temperature, remove waste products, and accelerate nutrient transfer (**McArdle, Katch & Katch, 1991**, **American College of Sports Medicine, 2006**, **Birch, 2005** and **Powers & Howley, 2004**). Peripheral adaptations improve utilization and synthesis of energy in working muscle (**Laursen, Blanchard, & Jenkins 2002**). Key peripheral adaptations include increased ability to extract and use oxygen, often measured by the arterial-venous oxygen difference (a-VO_2). Improved blood flow, greater plasma volume, and increased capillarization of skeletal muscle beds, increased mitochondrial density and enzymes all potentially increase the a-VO_2 difference.

1.7. ENERGY SYSTEMS AND TRAINING INTENSITY

During high intensity efforts, the body obtains energy from the anaerobic or adenosine trisphosphate –creatine phosphate system (ATP-Pcr). Since only a small amount of ATP is stored in muscle cells at one time, after 30 seconds of "all out" maximal intensity effort, the entire ATP-Pcr system is exhausted (**McArdle, Katch & Katch, 1991**). After that time, work output must fall and additional energy systems are required to continue with exercise (**McArdle, Katch, &Katch, 1991**), (**American College of Sports Medicine, 2006**) (**Birch, 2005**), (**Powers & Howley, 2004**). High intensity and anaerobic training have been shown to target this system and increase peak power output. Anaerobic glycolysis is the next energy system affected by training. As a biproduct of high intensity metabolism, lactate accumulates quickly in muscles and body fluids causing accumulation of excess hydrogen ions which lowers pH levels and slows glycolysis. This is the common cause of burning and pain associated with fatigue. Hinging status, the amount of lactate tolerated can reach a concentration as high as 25mmols in power athletes. Seven to ten mmols of lactate is a typical lactate level during moderate intensity exercise (**Sharkey & Gaskill, 2006**, **American College of Sports Medicine, 2006**, **Powers & Howley, 2004** and **Birch, 2005**). It is also believed that low pH decreases muscles fibers' calcium binding capacity and possibly slows muscle contraction (**Burke, et al., 2006**). Exercise intensity must slow from a lower pH and prevent lactate buildup in muscles and in blood. The onset of blood lactate (OBLA) is sometimes used to measure training status. OBLA is delayed with improved peripheral and metabolic adaptations. Elite level athletes can perform at 80 to 90% of maximal capacity before OBLA (**Powers & Howley, 2004** and **Birch, 2005**). The

aerobic glycolysis pathway is also affected by training. The body can preserve fuels such as glycogen and ATP through increased aerobic glycolysis and Beta oxidation. Preservation of stored glycogen and ATP while maintaining blood glucose is of great importance because it prevents fatigue and increases reliance on abundant fuel sources (**American College of Sports Medicine, 2006**, **Powers & Howley, 2004** and **Birch, 2005**). Neuromuscular adaptations Interval training may improve the ability of athletes to sustain high rates of carbohydrate oxidation through the recruitment of additional motor units (**Halwey, Myburgh, Noakes & Dennis, 1997**). Interval training stimulates specific neurological patterns of muscle fibers, predominately the fast twitch (FT) muscle fibers (**Saltin et al., 1976**), (**Henriksson & Reitman, 1976**, **Krustrup, Hellsten, & Bangsbo, 2004**, **Halwey, Myburgh, Noakes & Dennis, 1997**). Training improves the utilization and synthesis of all energy systems. Intensities above 100% of max are rapid at eliciting responses, with intensity and duration the most important components of training (**MacDougall, et al., 1998**).

1.8. TABATA TRAINING

Tabata training was discovered by Dr. Izumi Tabata and a team of researchers from the National Institute of Fitness and Sports in Tokyo. Dr. Tabata discovered that this kind of interval training produces much better results than aerobic training. This included building as much muscular endurance as forty-five minutes of normal cardio training. In fact in the study the subjects increased their anaerobic capacity by over a quarter as well a substantial increase in their aerobic fitness. Something to keep in mind was that the subjects were as fit as race horses before they started the trial, so the improvements were remarkable. This makes it a

very versatile program, one can use tabata for weight loss as well most improving performance in most aerobic and anaerobic sport. The full Tabata program is four minutes long, it will probably feel like the longest four minutes of one's life (**http://www.intervaltraining.net/tabata.html**).

The original Tabata protocol was done with a supramaximal effort. Each participant performed 8 rounds of 20-second HIIT intervals at 170% of Vo_{2max} with 10 seconds of downtime. Especially at this intensity, an aerobic-type modality able to measure work performed is necessary to ensure that the exercise effort put forth by each individual is 70% higher than the maximum aerobic power, which is a full-on anaerobic effort. Given this level of intensity, Tabata found that the HIIT group not only experienced significant improvements in aerobic fitness but incurred major strides in anaerobic power too. In fact, the group who did endurance training(ET) showed no change in anaerobic fitness, whereas the HIIT group exhibited a 28% improvement in anaerobic fitness. Although often used interchangeably, HIIT stands for ''highintensity interval training'' and is a model of ramped up aerobic conditioning done close to maximum exercise intensity, that is equal to or greater than 90% Vo_{2max} (**Gibala & McGee, 2008**). Competitive athletes, to enhance both aerobic and anaerobic endurance while matching the intensity and rapid bioenergetic shifts that frequently occur in sports and competition, commonly use HIIT. However, in a 2013 study, nonathletes who did one short, intense, 4-minute bout on treadmills at 90% of heart rate max, 3 times a week, significantly increased cardiorespiratory fitness by 10%. No adverse events were reported (**Tjonna, et al., 2013**). Specifically, HIIT workouts generally alternate ''effort'' or ''burst'' intervals, typically ranging between approximately 10 and 60 seconds, with

‘‘recovery’’ or ‘‘rest’’ intervals. Recovery intervals can vary but most often also span 10 to 60 seconds. In addition, the nature of the recovery intervals can range from full rest, which is during Tabata (**Burgomaster, et al., 2008, Tabata, et al., 1996** and **Tremblay, Simoneau & Bouchard, 1994**), or be composed of low to moderate- intensity movement HIIT. Because cycle ergometers and treadmills can both be set at precise intensity levels, they are ideal for research and serious conditioning where pinpoint precision is a must (i.e., **Helgerud, et al., 2007, Little, et al., 2010, Tabata, et al., 1996, Trapp, et al., 2008, Tremblay, Simoneau & Bouchard, 1994 and Zong, et al., 2013**). Consider the original Tabata format that imposed an intensity effort of 170% maximum. That intensity would be virtually impossible to reproduce without specialized equipment and also be unnecessarily intense for non-athletes (Tabata used Olympic speed skaters in his study). Likewise then, the changes in fitness found in well controlled scientific HIIT studies like the Tabata study may not always be duplicated in fitness and health club settings. This is important because Tabata is often promoted and advertised in the media to produce incredible changes in fitness based on the original study. Yet, most trainers and health clubs actually are using modified forms of Tabata that elicit an intensity far below 170% of Vo_{2max}. For instance, two Tabata-style formats developed and tested in 2013 by **Olson & Emberts et al. (2013)** were found to produce intensities of 95% and 74% of Vo_2max, respectively. Although these modified formats are sufficiently intense to promote fitness effectively in a short time, it would be erroneous to assume that the changes induced with power intensities would parallel those seen for the original Tabata protocol directly VO_{2max} However, trainers readily can use the Tabata-style format and/or many scientifically established HIIT protocols as models

to develop realistic interval programs using common gym equipment. For instance, Dr. Melanie Hood's team developed and tested a 20-minute format alternating 60 seconds of aerobic cardio exercise at an intensity of approximately 80% of heart rate reserve (80% to 95% range) with 60 seconds of recovery (**Hood, et al, 2011**) for 10 rounds. Using a heart rate monitor, this format could be used readily with a variety of aerobic-type exercises and machines such as running/jogging, elliptical trainers, electronic stair steppers, jump ropes, spin cycles, aerobic step-up benches, and so on which shows the exercise equipment/ modalities that were used by the protocols (**Emberts, et al., 2013 and Olson, 2013**).

After having gone through the above facts and various studies, investigator planned to study the effect of tabata interval methods of various durations on selected physiological and athletic performance variables of school students.

1.9. OBJECTIVES OF THE STUDY

The following are the specific objectives of this study.

1. To find out the effect of tabata interval method of 1 : 1 ratio (20 seconds active period : 20 seconds rest period) on selected physiological and athletic performance variables among school students.
2. To find out the effect of tabata interval method of 1 : 0.5 ratio (20 seconds active period : 10 seconds rest period) on selected physiological and athletic performance variables among school students.

3. To find out the significant improvement difference between tabata interval training with 1: 1 ratio and tabata interval training with 1 : 0.5 on selected criterion variables among school students.

1.10. STATEMENT OF THE PROBLEM

The present study was to find out the effect of tabata interval methods of various durations on selected physiological and athletic performance variables of school students.

1.11. HYPOTHESES

It was hypothesized that

1. There would be a significant improvement on selected physiological and athletic performance variables due to the influence of tabata interval training with 1 : 1 ratio (20 seconds active period : 20 seconds rest period).
2. There would be a significant improvement on selected physiological and athletic performance variables due to the influence of tabata interval training with 1 : 0.5 ratio (20 seconds active period : 10 seconds rest period).
3. There would be a significant improvement difference between tabata interval training with 1: 1 ratio and tabata interval training with 1 : 0.5 on selected criterion variables among school students.

1.12. SIGNIFICANCE OF THE STUDY

The results of the study may be useful to the following ways.

1. This present study will investigate the use of tabata interval methods of various durations for training the sport skills in a realistic scenario.

2. This study will provide guideline for school students to improve their physiological and athletic performance variables.
3. It would further add to the quantum of knowledge in the area of tabata interval training method.
4. The result can be used by the physical education teachers for further development in playing abilities of their trainees.
5. The study may help other physical educators to conduct further research in this area.

1.13. DELIMITATIONS

1. To achieve the purpose of the study, forty five school students those who represented Divisional and State level competitions irrespective of sports and games were selected randomly as subjects from the Navbharath Matriculation Higher Secondary School, Ponnaiyah Ramajayam Public Higher Secondary School and St. Antony's Higher Secondary School, Thanjavur, Tamil Nadu, India. The age of the subjects ranged between 15-17 years.
2. The selected subjects were divided into two experimental groups: Group I (TTG1 - Tabata Interval Training group with 1 : 1 ratio (20 seconds active period : 20 seconds rest period)), Group II (TTG2 - Tabata Interval Training group with 1: 0.5 ratio (20 seconds active period : 10 seconds rest period)) and a control group (CG) with fifteen subjects (n=15) each.
3. The following dependent variables were selected for this study: Physiological variables namely body fat, VO_2max and resting heart rate. Athletic performance variables such as speed, speed endurance, agility, abdominal muscular endurance and arm strength.

4. The duration of the training period was restricted to six weeks and the number of sessions per week was confined to three.
5. The level of significance was fixed at 0.05 level, which was considered to be appropriate.
6. The data were collected prior to and also immediately after the six weeks of training period.

1.14. LIMITATIONS

1. Subjects' previous training was not considered.
2. Subjects included in the study could not be controlled with regard to their life style, diet and habits which might have influenced their performance.
3. Subject's body type and the socio-economic status of subjects were not taken into consideration.

1.15. MEANING AND DEFINITION OF THE OPERATIONAL TERMS

1.15.1. Training

Training may be defined as the systematic process of repetitive progressive exercise of work, involving the learning process and acclimatization (**Arnhein, 1985**).

1.15.2. Sports Training

Sports training are long, continuous and systematic process or physical and mental hard work, to attain high level performance in competitions or various levels by making the best use of the principles derived from other sports sciences (**Singh, 1991**).

1.15.3. Interval Training

Interval training, as the name implies, is a series of repeated bouts of exercise alternated with periods of relief. Light or mild exercise alternated with periods of relief. (**Fox and Mathew, 1974**).

1.15.4. Tabata Interval Training

Tabata interval training is the single most effective type of high intensity interval training, it is also the most intense by far, and surprisingly its the shortest in duration, it only last for four minutes **(http://www.intervaltraining. net/tabata.html).**

1.15.5. Tabata Interval Training with 1 : 1 Ratio

In the current study, during supervised sessions tabata interval training with 1 :1 ratio refers that the subjects undergo their tabata interval training exercises with 20 seconds work : 20 seconds rest ratio.

1.15.6. Tabata Interval Training with 1 : 0.5 Ratio

In the current study, during supervised sessions tabata interval training with 1 :1 ratio refers that the subjects undergo their tabata interval training with 20 seconds work : 10 seconds rest ratio.

1.15.7. Body Fat

Body fat is the most variable tissues in the body and it is distributed throughout in the abdominal cavity (**Earle, 1982**).

1.15.8. VO_2max

It is defined as a greatest oxygen uptake obtained by an individual while breathing air at sea level during the performance of physical work (**Shaver, 1982**).

1.15.9. Resting Heart Rate

Pulse rate is actually the frequency of pressure waves (waves per minute) propagated along the peripheral arteries such as carotid or radial arteries **(Pearce, 1985)**.

1.15.10. Speed

The ability to perform a movement within a short period of time (**Birch, MacLaren and George, 2005**).

1.15.11. Speed Endurance

Speed endurance is the ability to tolerate a high level of waste products like lactic acid. It is measured by timing a maximum effort sprint from a standing or crouch start over 150 metres. The average velocity is calculated by dividing distance by time (**Seagrave, 1996**).

1.15.12. Agility

Agility is the ability to decelerate, accelerate and change direction quickly while maintaining good body control without decreasing speed (**Brown, et al., 2000**).

1.15.13. Muscular Endurance

The ability of a muscle or group of muscles to overcome resistance or to act against resistance for longer duration under conditions of fatigue or tiredness (**Singh, 1991**).

1.15.14. Muscular Strength

Muscular strength refers to the amount of force a muscle can produce with a single maximal effort. Muscle strength is measured during muscular contraction. The size of your muscle fibers and the ability of nerves to activate

muscle fibers are related to muscle strength (**https://www.verywell.com/how-to-increase-muscular-strength-3496121**).