CHAPTER – I

INTRODUCTION

"Movement is a medicine for creating change in a person's physical, emotional, and mental states."

Carol Welch (Siegel, 2009)

Demographic and Socioeconomic changes influence the living and working habits of populations. Economic growth, modernization, urbanization and socialization have changed the life style of Indian families. The transition from a traditional to modern lifestyle, consumption of diets rich in fat and calories combined with a high level of mental stress has compounded the problem further. With a shift in eating habits and the adoption of a sedentary life style has lead to the increasing prevalence of life style diseases like Obesity, Diabetes, Hypertension, Coronary heart disease, Metabolic syndrome and Cancer, all across India in the last few decades.

Life style changes in families are related with physical activity, food habits and tobacco consumption / smoking. These are mainly due to affluence, urbanization and mechanization **(Pancholia, www.csiindore.org).**

Urbanization in India is on the rise. In 1901, it was 11%, in 1951 it became 17.6% and by 2001, 27.8% people were living in urban area. Technological advances, while making life easy, encouraged sedentary way of living, paving way for lifestyle diseases. India's rapid economic growth could be slowed by the sharp rise in the prevalence of heart disease, diabetes and stroke and the successful information technology is likely to be the hardest hit. Long working hours, night shifts and a sedentary life style are the main cause.

There has been a growing report of depression and family breakdown also. A lot of men seem to complain about too many business trips where they have to be away from their family. It is seen as a negative if you have to travel extensively. For many, a sedentary lifestyle is not a choice but a result. Almost 47% of the workforce in Indian industries, especially in urban areas, was found to be overweight while around 27% were suffering from hypertension. Around 10% of those surveyed were also found to be diabetic **(Pancholia, www.csiindore.org).**

1.1 OBESITY

Obesity is recognized as a major health problem in many parts of the world and the incidents of the conditions is escalating at an alarming rate. Obesity is a condition with excess accumulation of body fat in relation to the lean body mass. The center for disease control and prevention defined overweight as at or above the 95^{th} percentile of BMI for age and at risk for over weight as between 85^{th} to 95^{th} percentile of BMI for age. European researchers classified over weight as at or above 85^{th} percentile and obesity as at or above 95^{th} percentile of BMI **(Flegal, Wei, & Ogden, 2002)**

1.2 PREVALENCE OF OBESITY

In a study from South India, it was 27.2% in urban area and 2 % in rural area in 1989, went up to 30% in 2000 in urban and 17% in rural population. Similarly in Delhi female population it was 34.4% in 1994 went up to 48.6 in the year 1999. Even childhood obesity is on the rise in India, according to Asia Pacific Journal of Clinical Nutrition **(Pancholia, www.csiindore.org).**

Obesity is setting in earlier than the adolescence phase for Indian children. "Indian educational system favours academics over everything else, compromising the overall development of children" **(Ramya Kannan, 2010a).**

1.3 PREVALENCE OF DIABETES AND HYPERTENSION IN INDIA

Diabetes was reported to be 5.2% in 1984, 11.6 % in 1995 and had gone up to 13.9% in 2000. Recent data suggest a significant load of diabetes cases in India, rising from 2.0 crore in 2000 to 4.6 crore by 2015. Hypertension was 4% in 1954, 11% in 1984 and went up to 25% in 1994 in Urban area and 10% in rural area **(Pancholia, www.csiindore.org).**

1.4 PREVALENCE OF CORONARY HEART DISEASE

It is also on the rise, it was 4% in 1960, 6.5% in 1968 and went up to 11% in 2001 in urban population of India. There is alarming projection from World Health Organization that sedentary lifestyle could very well be among the 10 leading causes of death and disability in the world and by the year 2020, seven million Indians will die of life style diseases **(Pancholia, www.csiindore.org).**

1.5 AWARENESS OF OBESITY IN CHENNAI

Chennaiites are less aware of obesity and children have poor knowledge on balanced and healthy diet. Children in the 8 to 16 age group had lack of knowledge of obesity and hardly had any physical activity during the day. Changing life styles and eating habits are causing obesity in children and scientifically, excess body fat in children is the cause for many clinical and biochemical abnormalities **(Ramya Kannan, 2010b).**

1.6 CHANGING LIFE STYLE OF CHILDREN

Because of computer games, gizmos and other indoor activities, children are spending lesser time playing sports. They burn fewer calories and thus tend to gain weight.

Along with sedentary lifestyle, there is also academic pressure that our children face every day. There is homework, tuitions, exams, grades etcetera to worry about and these pressures often result in less physical activity

Today, children lead sedentary lives and even parents don't have the time to play with children. Outings now are more about going to malls, not gardens / parks and watching television most of the time **(Pancholia, www.csiindore.org).**

1.7 CHANGING FOOD HABITS IN INDIA

1950s-1960s people used to ate at home 2-3 times a day and because of rapid transformation in the lifestyle of Indians, particularly those living in urban India, has resulted in dramatic increase in the demand for processed food. The main reason why processed food is luring the urban Indians is the convenience that it offers to cooking, as they don't need to spend hours in kitchen to get that appetizing food. Growth in working women's population and prevalence of nuclear families with double income are other trends causing this change in the lifestyle of Indians **(Pancholia, www.csiindore.org).**

Also, increase in overseas travel and the presence of foreign media in the country has resulted in more Indians opting for processed food. For instance, in 2005, above 5 million Indians had traveled abroad and the number is likely to rise by

15% to 20% every year. These trends have largely impacted the Indian food-processing sector, as there's been a jump in the demand for processed, ready-to-eat and ready-to-cook food. Amount of money spent by Indian on foods outside home has been assessed to have more than doubled over the last ten years to nearly $5Billion a year. Also, it's likely to double in the five years to come **(Pancholia, www.csiindore.org).**

1.8 ROLE OF MEDIA

Famous media personalities endorse aerated drinks, fried foods like chips that give nothing but ample calories. Children take these personalities as their role models and ape them.

1.9 ADVERTISING GIMMICKS

Free gifts given with chips, chocolate etcetera encourage kids as well as parents to buy foods that they don't require. Modern life style induces people to eat more than their bodies need even if they are aware of pitfalls. At the crux of the food crisis is a psychological disorder out of affluence.

People are out of tune with their own bodies. The share of hotels & restaurants has increased from 14.3% of GDP in 2000-2001 to 25 % in 2007-2008. Packed food industry is growing at about 20% per annum. A growing number of people are not taking the right decisions on how much and what to eat. There are indications that dietary distortions are on the rise in India. Rising number of birth day parties, kitty parties, marriage anniversaries, outdoor meals, food corners, pizza huts and McDonalds are the effects of economic growth, modernization, urbanization and socialization.

Dietary changes that take place as Indian populations move up the socio-economic scale are increased intake of legumes, vegetables, milk, and animal fat. Substitution of coarse grain by polished grains results in the decreased fiber intake.

Increase intake of edible fat with increasing consumption of saturated hydrogenated fat in the middle class and Indian ghee in the more prosperous segments. Increase intake of calories and sweets. Increase in overall intake of energy in relation to the expenditure resulting in obesity **(Pancholia, www.csiindore.org).**

1.10 PSYCHOLOGICAL STRESS

With economic growth, modernization, urbanization, socialization and garbage of information there seems to be more depression, more family breakdown, more suicides, and homicides. Visits to psychiatrist are on the rise **(Pancholia, www.csiindore.org).**

1.11 SEXUAL HEALTH

New lifestyle affects India's sexual health also. India is reporting more sexual disorders, divorces and extra-marital affairs, according to some leading sexologists. Problems related to sex were due to changing food habits, lack of exercise, unusual work hours and more stress.

Excess weight is not only linked to increased risk of chronic disease, but has also been shown to increase risk of reproductive problem. Men with higher BMI have also exhibited altered quantity and quality of sperm **(Ruby et al. 2007).**

1.12 CRITICAL PERIODS FOR THE DEVELOPMENT OF OVERWEIGHT

The number of fat cells in the human body grows rapidly during three stages of development:

1. The last trimester of pregnancy (unborn child)
2. The first year of life and
3. The adolescent growth spurt.

Children acquire fat by an increase in the size of existing adipose cells (hypertrophy) and by new fat cell formation before adulthood (hyperplasia). New fat cells are unlikely to form after age 21 (approximately) unless someone becomes extremely obese **(Jerrold et al. 2004).** The causes of obesity as a three-legged stool: genetic causes, overeating and not enough exercise. It is important for parents to understand the cause of obesity is often a combination of these three factors. Very rarely, perhaps as often as 1 %, is obesity due to a so-called "glandular" problem – a hormonal cause.

1.13 THE CAUSES OF OBESITY - IMPLICATIONS OF THE FAT CELL

1.13.1 FAT CELL

Fat cells are the body's storage depots for fat. Persons of average weight have 25 - 35 billion fat cells. Persons with severe obesity may have as many as 100 - 150 billion cells. Fat cells expand and contract as weight is gained and lost. There appear to be two critical periods for fat cell development; the second year of life and, for females adolescence. Although these are the times when the numbers of fat cells increase most dramatically, new fat cells may be formed at any time a significant weight gain occurs **(Deanne, 1999).**

1.13.2 WEIGHT GAIN AND FAT CELLS

The causes of overweight are multiple and varied. Independent of the cause, however, the effect is an excess of triglyceride or fat. This excess fat is stored in fat cells distributed throughout the body. The initial response to weight gain is to increase the size of fat cells. They do so in a manner similar to a balloon expanding to accommodate increase in air or water. As weight gain continues, fat cells reach their limit in capacity for storing fat. At this point, new fat cells are formed.

The degree of overweight at which new fat cells are formed is not exactly known, but it is estimated to be approximately 50 - 60% above ideal weight. Studies which have examined fat cell size across a wide range of body weights indicate that individuals with mild obesity have increased fat cell size called Hypertrophic Obesity. Moderate obesity is characterized by both increased size and an increase number of cells. Severe obesity results in no further increase in size, but a marked increase in number - known as Hyperplastic Obesity **(Deanne, 1999).**

1.13.3 WEIGHT LOSS AND FAT CELLS

During weight loss, fat is mobilized from fat cells to provide energy. Since less fat is in the cell, the cell size is reduced. There are limits however on the degree to which the size of a fat cell can be reduced. Just as fat cells have an upper limit for storage before new cells are formed, they also have a lower limit. An average fat cell weighs 0.4 to 0.6 micrograms. Extreme cases, such as anorexia can result in fat cells being reduced lower than this, but in general fat cells are resistant to shrinking below their normal range **(Deanne, 1999).**

One example of this biological defence is a study by Per Bjorntorp and his colleagues in Sweden, They studied 26 patients who were losing weight and measured the fat cell size of the patients before weight loss and again when they stopped losing weight. Despite the fact that the patients varied greatly in their fat cell size before weight loss, 23 out of the 26 patients stopped losing weight when their fat cells reached between 0.4 and 0.6 micrograms. Some of these people were still overweight, however, because they had an excess number of fat cells. This study suggests that fat cell size may determine how much weight can be lost.

An equally interesting finding from this study was that when fat cells were reduced through dieting to below normal size, irrespective of the actual weight of the individual, there was a significant increase in symptoms of eating disordered behaviour, cravings, depression, and reutilization of eating behaviours.

Fat cell size is reduced by weight loss, but the question is about fat cell number. Unfortunately a fat cell is a friend for life. Although some cases of reduced fat cell number have been reported with extreme weight loss, it is believed that fat cell number does not decrease with weight loss **(Deanne, 1999).**

1.13.4 IMPLICATIONS FOR WEIGHT LOSS GOALS

Since fat cell number cannot be reduced with weight loss, the number of cells may identify how much weight a person can lose. If person A has 40 billion fat cells and B has 60 billion, and both are enlarged to the same degree, if they diet they will both lose weight but B is destined to remain at above average weight. B's cells may be normal in size but excess in number and she will carry extra weight **(Deanne, 1999)**.

1.13.5 DETERMINATION OF FAT CELL SIZE AND NUMBER

Fat cell size and number are assessed by first determining the total amount of body fat. The most reliable method is underwater weighing. The difference between the weight in water and the weight outside can be used to calculate the density of the body, and from this measure of density the percentage of fat and muscle can be determined.

Once total body fat is determined, fat cells are removed from various parts of the body including buttocks and thighs. These cells are examined microscopically and measured for cell size. Total body fat is then divided by fat cell size to determine number.

In general, anyone who is overweight has increased fat cell size. Increased fat cell number is likely in people with childhood onset obesity or who have had significant weight gain in adulthood **(Deanne, 1999)**.

1.13.6 DISTRIBUTION OF FAT

Fat cells are distributed throughout the body. Where the excess fat is stored has implications for health. Upper body or android obesity is characterized by fat in the upper body – abdomen, chest and arms. Lower body or gynoid obesity is where fat is distributed below the waist, hips, thighs and legs. Upper body obesity is more prevalent in men and lower in women, although there are exceptions.

Waist to hip ratio gives indication of lower body obesity. Over 0.8 and 1.0 in men indicates upper body obesity, which is associated with increased risk of heart disease, stroke and diabetes **(Deanne, 1999).**

1.14 OBESITY AND MUSCULOSKELETAL PROBLEMS

In a normal weight individual, the major joints of the lower extremity are exposed to reaction forces of approximately three to six times body weight during locomotion (single leg stance phase). The obese individuals experience greater absolute loads at these joints than individuals of normal weight.

Persistent loading of the musculoskeletal system of the obese has been implicated in predisposition to pathological gait patterns, loss of mobility and subsequent progression of disability, to a range of orthopedic conditions that include knee osteoarthritis and diabetic foot pathology. Relatively few studies have considered issues related to biomechanics and joints other than the knee **(Hills et al. 2001).**

Obesity is the prime cause of premature osteoarthritis. Reducing body weight brings relief from joint pain by reducing inflammation (swelling) and putting less mechanical pressure. Strengthening the muscles around the knee will not only prevent osteoporosis but also prevent the tendency to fall by increasing the muscles' stabilizing strength. Strong muscles (quadriceps) will provide extra support to the knee **(Mittal, 2007).**

Arthritis too is a lifestyle disease. It is very common in India, occurs among 16-17 year old males and initially manifests as early morning stiffness. Bose says "weight is a certain factor in degenerative arthritis". The heavier you are, the greater the wear and tear. Avoid becoming overweight and obese, and make sure that you get adequate exercise, complimented by a healthy diet. Kannan Pugazhendhi, sports physician says that, most people ignore the fact that muscular strength provides

integrity for the joint. We can avoid arthritic manifestations by increasing muscular strength, especially for the lower body. The biggest misconception is that knee will wear out with exercise. Exercise will strengthen the muscles **(Ramya Kannan, 2010c).**

Marjolein et al. (2009) compared the frequency of musculoskeletal problems in overweight and obese children with that in normal-weight children. They concluded that overweight and obese children more frequently experience musculoskeletal problems than do normal-weight children.

1.15 OBESITY AND ADOLESCENCE

Healthy habits or poor ones established in adolescence provide the foundation for life-long habits. Adolescents are a unique population because they are neither children nor adults. Their bodies are not fully grown and they are legally minors. In fact, the very word, "adolescent" is derived from the Latin 'adolescere' which means still growing. Biologically, their bodies are growing very rapidly. When the hormones kick in during puberty, they begin to mature sexually. This is complicated because teens want so badly to be independent and to make their own choices but legally and financially they are still dependent on their parents. So, teens seem to have raging hormones and poor judgment but insist on making their own choices. Furthermore, if the parent is too controlling the teen can rebel and cause themselves even more serious problems. Dealing with an adolescent in an adult body is delicate (**Gumbiner, 2010).** Obesity is estimated by Body Mass Index (BMI) which is a ratio of body weight to height. In children and adolescents, this individual measure is adjusted for age and sex and compared to growth charts. BMI at or above the 95th percentile is considered obese.

Michelle Obama recently launched a program called, "Let's Move" with aim of solving childhood obesity within a generation. She is calling on a cooperative effort of parents, teachers, doctors, coaches, media, industry, and government to focus on this problem. The government Task Force on Childhood Obesity has developed 70 specific and measurable goals. The goals are too lengthy to go into detail here but can be found on government websites. To summarize, the main goals include:

1. Giving kids a healthy start with good prenatal care, breastfeeding, good nutrition, exercise, and limited screen time.
2. Empowering parents and caregivers with improved food labels and dietary guidelines
3. Improving food choices and meals in schools
4. Access to healthy affordable food
5. Getting youth more physically active through Physical Education, recess, walking to school, riding bikes, and improving safe playground access **(Gumbiner, 2010).**

Overweight and obesity were more prevalent, and the rate of increase more dramatic, in the adolescent population **(Magarey, Daniels, & Boulton, 2001).** Adolescent obesity is associated with a range of serious physical and psychosocial consequences. Physical complications include pulmonary, orthopaedic, neurological, gastroenterological, endocrine, and cardiovascular disorders. The psychosocial consequences of overweight and obesity include increased isolation and teasing, lower self esteem and higher body dissatisfaction. Psychiatric disorders are also increased in adolescent treatment seeking samples **(Lobstein, Baur, & Uauy, 2004).**

While there are a limited number of empirical studies on which to base adolescent obesity intervention, the following treatment components have been identified as important in the treatment of adolescent obesity:

1. Behavioural modification
2. Family support and involvement
3. A developmentally appropriate approach
4. Dietary change
5. Increased physical activity
6. Decreased sedentary behaviour
7. Motivation **(Lobstein et al., 2004)**

1.16 STATUS OF PHYSICAL EDUCATION PROGRAMME IN SCHOOLS

In many schools, poor performance on math, science and language subjects may result in dramatically poor admission to failing schools. In order to focus on key curriculum areas, "non-essential" subjects have lost importance to increase time devoted to subject areas that are tested. Schools have suffered losses in the arts, music, physical education, and school health among others to make way for time to improve math, science and language. Due to the strong connection between physical activity and positive academic outcomes **(Sturm, 2002)**, sacrificing physical education and health education, traditional areas for dealing with life decisions including tobacco use, alcohol and weight management may be too great a sacrifice. For example, in a study by **Shepard (1997)** it was found that a reduction of 240 minutes per week in academic class time to provide additional time for physical activity led to consistently higher math scores.

While there is a call for increased physical activity to help reduce overweight among children, the activity should be focused more toward the goal of developing lifelong fitness. "For too long, some fitness experts say, physical education has not lived up to its name: Traditional physical education classes provide too little activity to too few students, offer little or no guidance for maintaining a healthful lifestyle, and can make less athletic children feel inadequate, which can further turn them off to exercise" **(Delisio ER. 2001).**

Though no doubt, many adults thrived on the competition provided in their physical education classes, many found the experience anxiety producing and humiliating. The result has been the creation a generation of people who find most forms of exercise something to be avoided.

Most physical education experts agree that programs that focus on sport and competitive types of activities have fallen short of their goal to energize students to maintain an active healthy lifestyle. The call has gone out for a new physical education that places greater emphasis on lifelong fitness activities and less on sports and in the past several years, many physical education programs have been developed that stress fitness, health awareness, and lifelong exercise habits **(Delisio ER. 2001).**

Sturm found that planned exercise is higher today than in the past but that "incidental" exercise has decreased. That is to say scheduled physical activities such as going to the fitness center have increased while walking to the store and walking to school have declined and much of that is due to the layout of residential areas, which are becoming more separated from stores and workplaces **(Sturm, 2002).**

1.17 HEALTH RELATED FITNESS

"Physical fitness is the ability to perform moderate to vigorous levels of physical activity without undue fatigue and the capability of maintaining such ability throughout life" **(Swain & & Leotholtz, 2007).**

1.17.1 COMPONENTS OF HEALTH-RELATED PHYSICAL FITNESS

Cardiorespiratory fitness is related to the ability to perform large muscle, dynamic, moderate-to-high intensity exercise for prolonged periods. It can be assessed by various techniques and has many synonyms. One such synonym is maximal aerobic capacity.

Body composition refers to the relative percentage of body weight that is fat and fat-free tissue. Percent body fat, among other techniques, may be used to assess body composition.

Flexibility is the ability to move a joint through its complete range of movement. Flexibility is dependent upon which muscle and joint is being evaluated; therefore, it is joint specific.

Muscular strength refers to the maximal force that can be generated by a specific muscle or muscle group.

Muscular endurance is the ability of a muscle group to execute repeated contractions over a period of time sufficient to cause muscular fatigue, or to maintain a specific percentage of the maximum voluntary contraction for a prolonged period of time **(Swain & Leotholtz, 2007).**

Overweight in children and adolescents are increasingly common while physical fitness in adolescents is declining. Lower fitness in adolescents may track into adulthood. Previous studies on the effects of adolescent obesity have mainly focused on psychosocial problems and typical risk factors of cardiovascular diseases while findings on health-related physical fitness are scanty. Health-related physical fitness has the advantage that it can be measured non-invasively, and adolescents would probably find it much easier to relate to being unfit than being high in cholesterol or having chronic diseases in midlife.

The effects of overweight on health-related physical fitness vary with the component of fitness being examined. Compared with normal weight, overweight adolescents tend to have poorer muscular endurance (measured by sit-up), cardiovascular fitness (measured by endurance run), but similar flexibility (measured by sit-and-reach), and even better isometric strength (measured by handgrip test) **(Mak et al. 2010).**

1.18 PHYSICAL ACTIVITY AND OBESITY

Higher levels of physical activity and cardiorespiratory fitness have a beneficial influence on several adverse health outcomes associated with overweight and obesity. For many of these adverse health outcomes, moderate to high levels of physical activity and cardiorespiratory fitness provide benefits independent of changes in weight or body composition. Overweight and obese individuals who are or who become physically active have better risk factor profiles and lower rates of disease and death than overweight and obese individuals who are inactive and unfit. Physical activity appears to work synergistically with dietary intervention and weight loss to produce more favorable risk factor profiles in overweight and obese

individuals. Although the current body of research is limited, some evidence suggests that fit overweight and obese men have lower rates of all-cause and Cardio Vascular Disease mortality when compared with normal-weight men who are unfit. More research is needed to evaluate the extent to which physical activity attenuates mortality risk in overweight and obese individuals. More public health efforts and clinical strategies for promoting physical activity are needed to decrease the incidence of obesity and its associated adverse health outcomes **(Bray & Bouchard, 2004).**

1.19 TREATMENT OF CHILDHOOD OBESITY

Obesity treatment programs for children and adolescents rarely have weight loss as a goal. Rather, the aim is to slow or halt weight gain so the child will grow into his or her body weight over a period of months to years.

Dietz (1983) estimates that for every 20 percent excess of ideal body weight, the child will need one and one-half years of weight maintenance to attain ideal body weight.

Early and appropriate intervention is particularly valuable. There is considerable evidence that childhood eating and exercise habits are more easily modified than adult habits **(Wolf, Cohen, & Rosenfeld, 1985).**

Three forms of intervention include:

1. Physical activity
2. Diet Management
3. Behaviour Modification

1.19.1 PHYSICAL ACTIVITY

Adopting a formal exercise program, or simply becoming more active, is valuable to burn fat, increase energy expenditure, and maintain lost weight. Most studies of children have not shown exercise to be a successful strategy for weight loss unless coupled with another intervention, such as nutrition education or behavior modification **(Wolf et al. 1985).** However, exercise has additional health benefits. Even when children's body weight and fatness did not change following 50 minutes of aerobic exercise three times per week, blood lipid profiles and blood pressure did improve **(Becque et al. 1988).**

1.19.2 DIET MANAGEMENT

Fasting or extreme caloric restriction is not advisable for children. Not only is this approach psychologically stressful, but it may adversely affect growth and the child's perception of "normal" eating. Balanced diets with moderate caloric restriction, especially reduced dietary fat, have been used successfully in treating obesity **(Dietz, 1983).** Nutrition education may be necessary. Diet management coupled with exercise is an effective treatment for childhood obesity **(Wolf et al., 1985).**

1.19.3 BEHAVIOUR MODIFICATION

Many behavioral strategies used with adults have been successfully applied to children and adolescents: self-monitoring and recording food intake and physical activity, slowing the rate of eating, limiting the time and place of eating, and using rewards and incentives for desirable behaviors. Particularly effective are behaviorally based treatments that include parents **(Epstein et al. 1987).**

Graves, Meyers, and Clark (1988) used problem-solving exercises in a parent-child behavioral program and found children in the problem-solving group, but not those in the behavioral treatment-only group, significantly reduced percent overweight and maintained reduced weight for six months. Problem-solving training involved identifying possible weight-control problems and, as a group, discussing solutions.

1.20 OBESITY AND PSYCHOLOGY

Childhood obesity is associated with substantial co-morbidity and late sequelae. Common health problems associated with obesity include hypertension, dyslipidaemia, and Type 2 diabetes, which is being increasingly diagnosed in children and adolescents. In addition, obesity has an adverse impact on the psychosocial and psychological well being of the children and adolescents.

There is a growing body of research that addresses the psychological impact of obesity, especially among public school children. Research has indicated the process of stigmatization could explain an association between obesity and psychological disorders. A stigmatized person possesses "some attribute or characteristic, that conveys a social identity that is devalued in some particular context" **(Puhl & Brownell, 2003).**

Obesity is one of the most stigmatizing and least socially acceptable conditions in childhood **(Schwimmer et al. 2003).** Young children are often stigmatized because of obesity and such behaviors can start at ages as young as 3-5 years **(Morgan et al. 2002a; Zametkin et al. 2004).** Obese children are often teased and are targets of bullying. Stigmatization could have a marked impact on childhood

psychological development **(Morgan, 2002b; Puhl & Brownell, 2003),** and could explain some of the psychological disorders obese children experience. **Zametkin et al., (2004)** reported that obesity is associated with depression, suicidal thoughts and suicide attempts among children. Other studies indicate severely obese children score lower on health-related quality of life indicators **(Friedlander et al. 2003; Schwimmer et al. 2003)**

Additionally, overweight children are also more prone to display unhealthy behaviors such as extreme dieting, skipping meals, and prolonged television watching. Often, overweight children rated their school performance poorly **(Mellin et al. 2002; Puhl & Brownell, 2003; Zametkin et al. 2004).** Furthermore, the studies also indicate that obese children experience social isolation, namely rejection by their peers **(Strauss & Pollack, 2003).** The teasing, harassment and rejection associated with stigmatization has long-term consequences because obese adults tend to face disparate treatment in educational settings and the workplace, and have higher poverty rates and lower marriage rates **(Puhl & Brownell, 2003, Zametkin et al. 2004). Mellin et al. (2002)** found that family connectedness mediated the adverse effects of obesity. Children who talked to their parents about their eating habits were less to be involved in unhealthy behaviors and displayed less psychosocial distress. Participation in collective activities, such as sports and club activities is also associated with improved social ties.

Obese children are at risk for significant health problems, but also face many psychological and social consequences, including low self-esteem. Children who are obese face an increased risk of emotional problems lasting well into adulthood. Factors such as peer rejection, weight-related teasing, and internalized social

standards play a major role in diminishing an obese child's self-esteem. Self-esteem affects numerous aspects of health and behavior including social adjustment, activity engagement, goal direction, and the presence of anxiety. Furthermore, low self-esteem has been associated with depression and suicidal ideas

The social and psychological issues of childhood obesity are perhaps even more intrusive on the child's life than the physical. Childhood is a critical time for the development of self-esteem, thus the psychological issues faced by an overweight child places even more urgency on the prevention of the problem.

Obesity is "one of the most stigmatizing and least socially acceptable conditions in childhood." An historic study showed that normal weight children rank obese children as the least desirable friends. Obese individuals were described as lazy, dirty, dumb and deceitful. These descriptions were made by children as young as six years old **(Aviva, 2003).** Depression and Oppositional Defiant Disorder (ODD) have also been linked to childhood obesity **(Sarah, 2003).**

Negative psychosocial complications have been previously reported for obese children and adolescents. Obese children tend to suffer from low self-esteem, poor body image, depression, school performance difficulties, and learning problems more than their nonobese peers. It is not known whether these psychosocial problems develop as a consequence of the child's obesity or are factors that increase the child's vulnerability to becoming obese.

Given the fact that obese children and adolescents are frequently the target of early discrimination and stigmatization, it seems likely that psychosocial problems play a role in the exacerbation of obesity, even if not involved in the initial etiology

of the excess weight gain. For example, peer rejection accompanied by social isolation is associated with childhood obesity. Even young children have already developed preferences for "thinness" among their friends and playmates, ranking overweight children lowest as preferred playmates and forming negative impressions of the obese child. As the obese child ages, the effects of discrimination and stigmatization become more salient and may spread to several aspects of their life including social, economic, and educational areas. In addition, the weight gain associated with the use of some psychotropic medications may further exacerbate the obesity of the obese child with significant psychiatric pathology **(Tershakovec, 2004).**

A recent study of overweight to very obese 5-10 year old African American children (117 participants) showed that overweight was associated with low self-esteem in children who were eight years old and older, not in the younger children. **(Kirshenbaum, http://www.myoverweightchild.com/self-esteem.html)**

1.21 GAIT

Gait is the term used to describe the way people walk. When children first start walking, it takes some time before they learn to walk in the same way as older children and adults. For example they first walk with their legs wide apart for balance.

Parents often worry about the way their children walk, especially young children and wonder whether it is "normal" **(David, 2007).**

1.22 OBESITY AND GAIT

Walking uses a repetitious sequence of limb motion to move the body forward while simultaneously maintaining stance stability. Because each sequence involves a

series of interactions between two multi-segmented lower limbs and the total body mass, identification of the numerous events that occur necessitates viewing gait from several different aspects. There are three basic approaches. Of these, the simplest system subdivides the cycle according to the variations in reciprocal floor contact by the two feet. A second method uses the time and distance qualities of the stride. The third approach identifies the functional significance of the events within the gait cycle and designates these intervals as the functional phases of gait **(Professional Staff Association of Rancho Los Amigos Medical Center, 1989 as cited in Perry, 1992).**

1.23 RECIPROCAL FLOOR CONTACT PATTERNS

As the body moves forward, one limb serves as a mobile source of support while the other limb advances itself to a new support site. Then the limbs reverse their roles. For the transfer of body weight from one limb to the other, both feet are in contact with the ground. This series of events is repeated by each limb with reciprocal timing until the person's destination is reached.

A single sequence of these functions by one limb is called a gait cycle. With one action flowing smoothly into the next, there is no specific starting or ending point. Hence, any event could be selected as the onset of the gait cycle. Because the moment of floor contact is the most readily defined event, this action generally has been selected as the start of the gait cycle. Normal persons initiate floor contact with their heel. As not all patients have this capability, the generic term initial contact will be used to designate the onset of the gait cycle **(Professional Staff Association of Rancho Los Amigos Medical Center, 1989 as cited in Perry, 1992).**

1.24 GAIT CYCLE DIVISIONS

Each gait cycle is divided into two periods, stance and swing. These often are called gait phases. Stance is the term used to designate the entire period during which the foot is on the ground. Stance begins with initial contact. The word swing applies to the time the foot is in the air for limb advancement. Swing begins as the foot is lifted from the floor (toe-off). Stance is subdivided into three intervals according to the sequence of floor contact by the two feet. Both the start and end of stance involve a period of bilateral foot contact with the floor (double stance), while the middle portion of stance has one foot contact. Initial double stance begins the gait cycle. It is the time both feet are on the floor after initial contact. An alternate term is double limb support. This designation is to be avoided, however, as it implies an equal sharing of body weight by the two feet, which is not true during most of the double stance interval.

Single limb support begins when the opposite foot is lifted for swing. In keeping with the terminology for the double contact periods, this should be (and often is) called single stance. To emphasize the functional significance of floor contact by just one foot, the term support is preferred. During the single limb support interval the body's entire weight is resting on that one extremity. The duration of single stance is the best index of the limb's support capability. Terminal double stance is the third subdivision. It begins with floor contact by the other foot (contralateral initial contact) and continues until the original stance limb is lifted for swing (ipsilateral toe-off). The term terminal double limb support has been avoided, as weight bearing is very asymmetrical **(Professional Staff Association of Rancho Los Amigos Medical Center, 1989 as cited in Perry, 1992).**

1.25 TIMING

The gross normal distribution of the floor contact periods is 60% for stance and 40% for swing". Timing for the phases of stance is 10% for each double stance interval and 40% for single limb support. The single limb support of one limb equals swing of the other, as they are occurring at the same time.

The precise duration of these gait cycle intervals varies with the person's walking velocity." At the customary 80 m/min rate of walking, the stance and swing periods represent 62% and 38% of the gait cycle respectively. The duration of both gait periods shows an inverse relationship to walking speed. That is, both total stance and swing times are shortened as gait velocity increases. The change in stance and swing times becomes progressively greater as speed slows. Among the subdivisions of stance a different relationship exits.

Walking faster proportionally lengthens single stance and shortens the two double stance intervals. The reverse is true as the person's walking speed slows. This pattern of change also is curvilinear. Having an interval when both feet are in contact with the ground for the limbs to exchange their support roles is a basic characteristic of walking. When double stance is omitted, the person has entered the running mode of locomotion **(Professional Staff Association of Rancho Los Amigos Medical Center, 1989 as cited in Perry, 1992).**

1.26 STRIDE AND STEP

The gait cycle also has been identified by the descriptive term stride. Occasionally the word step is used, but this is inappropriate. Stride is the equivalent of a gait cycle. It is based on the actions of one limb. The duration of a stride is the

interval between two sequential initial floor contacts by the same limb (example: right Initial Contact and the next right Initial Contact). Step refers to the timing between the two limbs. There are two steps in each stride (or gait cycle). At the midpoint of one stride the other foot contacts the ground to begin its next stance period. The interval between initial contacts by each foot is a step (example: left and then right). The same offset in timing will be repeated in reciprocal fashion throughout the walk **(Professional Staff Association of Rancho Los Amigos Medical Center, 1989 as cited in Perry, 1992).**

1.27 PHASES OF GAIT

In order to provide the basic functions required for walking, each stride involves an ever-changing alignment between the body and the supporting foot during stance and selective advancement of the limb segments in swing. These reactions result in a series of motion patterns performed by the hip, knee and ankle. Early in the development of gait analysis the investigators recognized that each pattern of motion related to a different functional demand and designated them as the phases of gait. Further experience in correlating the data has progressively expanded the number of gait phases identified.

It now is evident that each stride contains eight functional patterns. Technically these are sub phases, as the basic divisions of the gait cycle are stance and swing, but common practice also calls the functional intervals phases.

In the past it has been the custom to use normal events as the critical actions separating the phases. While this practice proved appropriate for the amputee, it often failed to accommodate the gait deviations of patients impaired by paralysis or

arthritis. For example, the onset of stance customarily has been called heel strike; yet the heel of a paralytic patient may never contact the ground or do so much later in the gait cycle. Similarly initial floor contact may be by the whole foot (foot flat), rather than having forefoot contact occur later, after a period of heel-only support. To avoid these difficulties and other areas of confusion, the Rancho Los Amigos gait analysis committee developed a generic terminology for the functional phases of gait **(Professional Staff Association of Rancho Los Amigos Medical Center, 1989 as cited in Perry, 1992).**

Analysis of a person's walking pattern by phases more directly identifies the functional significance of the different motions occurring at the individual joints. The phases of gait also provide a means for correlating the simultaneous actions of the individual joints into patterns of total limb function. This is a particularly important approach for interpreting the functional effects of disability. The relative significance of one joint's motion compared to the others varies among the gait phases. Also, a posture that is appropriate in one gait phase would signify dysfunction at another point in the stride, because the functional need has changed. As a result, both timing and joint angle are very significant. This latter fact adds to the complexities of gait analysis.

Each of the eight gait phases has a functional objective and a critical pattern of selective synergistic motion to accomplish this goal. The sequential combination of the phases also enables the limb to accomplish three basic tasks. These are weight acceptance, single limb support and limb advancement. Weight acceptance begins the stance period and uses the first two gait phases (initial contact and loading response). Single limb support continues stance with the next two phases of gait

(mid stance and terminal stance). Limb advancement begins in the final phase of stance (pre-swing) and then continues through the three phases of swing (initial swing, midswing and terminal swing) **(Professional Staff Association of Rancho Los Amigos Medical Center, 1989 as cited in Perry, 1992).**

1.27.1 WEIGHT ACCEPTANCE

This is the most demanding task in the gait cycle. Three functional patterns are needed: shock absorption, initial limb stability and the preservation of progression. The challenge is the abrupt transfer of body weight onto a limb that has just finished swinging forward and has an unstable alignment. Two gait Phases are involved, initial contact and loading response.

1.27.1.1 INITIAL CONTACT

Interval: 0-2% Gait Cycle

This phase includes the moment when the foot just touches the floor. The joint postures present at this time determine the limb's loading response pattern. **Objective:** The limb is positioned to start stance with a heel rocker.

1.27.1.2 LOADING RESPONSE

Interval: 0-10% Gait Cycle

This is the initial double stance period. The phase begins with initial floor contact and continues until the other foot is lifted for swing. **Objectives:** Shock absorption, Weight-bearing stability and Preservation of progression.

1.27.2 SINGLE LIMB SUPPORT

Lifting the other foot for swing begins the single limb support interval for the stance limb. This continues until the opposite foot again contacts the floor. During the resulting interval, one limb has the total responsibility for supporting body weight in both the sagittal and coronal planes while progression must be continued. Two phases are involved in single limb support: mid stance and terminal stance. They are differentiated primarily by their mechanisms of progression.

1.27.2.1 MID STANCE

Interval: 10-30% Gait Cycle

This is the first half of the single limb support interval. It begins as the other foot is lifted and continues until body weight is aligned over the forefoot. **Objectives:** Progression over the stationary foot and Limb and trunk stability **(Professional Staff Association of Rancho Los Amigos Medical Center, 1989 as cited in Perry, 1992).**

1.27.2.2 TERMINAL STANCE

Interval: 30-50% Gait Cycle

This phase completes single limb support. It begins with heel rise and continues until the other foot strikes the ground. Throughout this phase body weight moves ahead of the forefoot. **Objective:** Progression of the body beyond the supporting foot.

1.27.3 LIMB ADVANCEMENT

To meet the high demands of advancing the limb, preparatory posturing begins in stance. Then the limb swings through three postures as it lifts itself, advances and prepares for the next stance interval. Four gait phases are involved: pre-swing (end of stance), initial swing, mid swing and terminal swing.

1.27.3.1 PRE-SWING

Interval: 50-60% Gait Cycle

This final phase of stance is the second (terminal) double stance interval in the gait cycle. It begins with initial contact of the opposite limb and ends with ipsilateral toe-off. Weight release and weight transfer are other titles some investigators give to this phase. While the abrupt transfer of body weight promptly unloads the limb, this extremity makes no active contribution to the event. Instead, the unloaded limb uses its freedom to prepare for the rapid demands of swing. All the motions and muscle actions occurring at this time relate to this latter task. Hence, the term pre-swing is more representative of its functional commitment. **Objective:** Position the limb for swing **(Professional Staff Association of Rancho Los Amigos Medical Center, 1989 as cited in Perry, 1992).**

1.27.3.2 INITIAL SWING

Interval: 60-73% Gait Cycle

This first phase is approximately one-third of the swing period. It begins with lift of the foot from the floor and ends when the swinging foot is opposite the stance foot. **Objectives:** Foot clearance of the floor and Advancement of the limb from its trailing position.

1.27.3.3 MID SWING

Interval: 73-87% Gait Cycle

This second phase of the swing period begins as the swinging limb is opposite the stance limb. The phase ends when the swinging limb is forward and the tibia is vertical (example: hip and knee flexion postures are equal). **Objectives:** Limb advancement and Foot clearance from the floor.

1.27.3.4 TERMINAL SWING

Interval: 87-100% Gait Cycle

This final phase of swing begins with a vertical tibia and ends when the foot strikes the floor. Limb advancement is completed as the leg (shank) moves ahead of the thigh. Objectives: Complete limb advancement and prepare the limb for stance **(Professional Staff Association of Rancho Los Amigos Medical Center, 1989 as cited in Perry, 1992).**

1.28 BIOMECHANICS

Biomechanics is a scientific discipline which studies biological systems, such as the human body, by the methods of mechanical engineering. Since gait is a mechanical process which is performed by a biological system, it is appropriate to study it in this way. Mechanical engineering is a vast subject but the descriptions which follow are limited to those aspects which are most relevant to gait analysis, especially time, mass, force, center of gravity, moments of force, and motion, both linear and angular **(Whittle, 2007).**

1.29 BIOMECHANICS OF GAIT IN OBESE

Obesity is also known to be associated with orthopedic problems due to the overload on musculoskeletal structures. Obesity in children could lead to modifications of the gait pattern. For an obese individual, the difficulties associated with increasing age, along with the lack of regular physical activity, are capable of making the gait dysfunctions even more severe **(De Souza et al. 2005).**

Excess weight reduces the mechanical effectiveness of gait because of the shorter amplitude of movements, discomfort, early fatigue and the ability to absorb shock leading to joint degeneration. A gait analysis of obese middle aged adults conducted by **Spyropoulos, Pisciotta, and Pavlou, (1991)** reported similar temporal and kinematic differences between obese and normal weight individuals to those found for children.

The obese children walk with increased double support duration and decreased single support duration. Gait analysis in obese children showed differences in spatiotemporal parameters similar to those in obese adults, with longer gait cycle and stance phase duration and a reduced cadence **(Hills & Parker, 1991).**

There is still little detailed information regarding the basic characteristics of obese gait, particularly in children.

1.30 OBJECTIVES OF THE STUDY

The objectives of the study were:

1. To measure Body Mass Index among the subjects for status analysis.

2. To measure selected health related fitness variables such as cardiorespiratory endurance, body composition, flexibility, muscular strength and muscular endurance among obese school boys.
3. To measure the selected psychological variables such as self esteem and assertiveness.
4. To measure the selected biomechanical gait variables such as gait velocity, cadence, step length, stride length, gait cycle time, single support time, double support time, stance time and swing time among obese school boys.
5. To implement fitness programme for 13 weeks among obese school boys.

1.31 STATEMENT OF THE PROBLEM

The purpose of the study was to analyze the Body Mass Index status and to find out the effect of intervention of fitness programme on selected health related fitness, psychological and biomechanical gait variables among obese school boys.

1.32 HYPOTHESES

1. It was hypothesized that school boys could be successfully selected at random and their body mass index status could be analyzed.
2. It was hypothesized that the intervention of fitness programme would have a significant improvement on the selected health related fitness variables such as cardiorespiratory endurance, body composition, flexibility, muscular strength and muscular endurance among obese subjects.
3. It was hypothesized that the intervention of fitness programme would have a significant improvement on the selected psychological variables such as self esteem and assertiveness among obese school boys.

4. It was hypothesized that the intervention of fitness programme would have a significant improvement on the selected biomechanical gait variables such as gait velocity, cadence, step length, stride length, gait cycle time, single support time, double support time, stance time and swing time among obese school boys.

1.33 SIGNIFICANCE OF THE PROBLEM

1. The results of the study would be helpful to the physical education teachers to design a specific fitness programme to improve the health related fitness status of the students.
2. The results of the study would add knowledge and new information in the field of fitness and biomechanics.
3. The results of the study would help the parents and school administrators to pay special attention on the health related fitness and psychological variables among obese school boys.
4. The results of the study would be helpful to the parents and physical education teachers to avoid musculoskeletal disorders by taking corrective measures through fitness intervention among their children.
5. The results of the study would be helpful to the parents to understand the effect of fitness intervention on selected health related fitness, psychological and biomechanical gait variables among obese school boys.
6. The results of the study would help the school administrators to understand the importance of fitness programme intervention in reducing the obesity among school students.

7. The results of the study would help the physical education teachers to understand the abnormal gait among the obese students and to take corrective measures.
8. The results of the study would make awareness among the parents regarding the role of parents in treating and alleviating the menace obesity among their children.
9. The results of the study would help to increase the self esteem among the obese school students.
10. The results of the study would help to create a healthy society and healthy India in future.

1.34 DELIMITATIONS

1. Two thousand male subjects were selected at random from schools at Chennai for body mass index status analysis.
2. Only sixty obese subjects were selected at random for the purpose of the study.
3. The age of the subjects was between 13 and 17 years.
4. The health related fitness variables such as cardiorespiratory endurance, body composition, flexibility, muscular strength and muscular endurance were selected for the purpose of the study.
5. The psychological variables such as self esteem and assertiveness were selected for the purpose of the study.
6. The biomechanical gait variables such as gait velocity, cadence, step length, stride length, gait cycle time, single support time, double support time, stance time and swing time were selected for the purpose of the study.

7. The fitness intervention programme was given for a period of 13 weeks.
8. The psychological variables were measured through standardized questionnaires such as Rosenberg self esteem scale-1965 and Rathus Assertiveness schedule-1973.
9. The gait of the obese subjects was captured in a video camera (SONY-HDV1080i-Handycam) and assessed through Silicon Coach Software pro 7.
10. Only two-dimensional gait analysis was conducted in this study.
11. No subject had current or past neurological or cardiovascular illness, orthopedic abnormality, or pain which might affect their gait.

1.35 LIMITATIONS

1. The diet of the subjects was not restricted with strict observation.
2. The socio-economic background of the subjects was not considered for the purpose of the study.
3. The heredity and previous fitness experience of the subjects were not considered in this study.
4. No special class was conducted to intervene the psychological status of the subjects.
5. The other extraneous factors which would have influenced the results of the study were not controlled.

1.36 MEANING AND DEFINITION OF THE TERMS

1.36.1 OBESITY

Obesity is an excessive amount of body fat relative to body weight **(Vivian & Dale, 2004).**

1.36.2 ADOLESCENCE

The developmental period of transition from childhood to early adulthood that involves biological, cognitive and socio-emotional changes **(Santrock, 2006).**

1.36.3 HEALTH RELATED FITNESS

Health related fitness relates to those components of fitness which make up our health status: strength, muscular endurance, aerobic endurance, flexibility and body composition **(Ray Barker, 2003).**

Health related fitness is defined as a state characterized by (a) an ability to perform and sustain daily activities and (b) demonstration of traits or capacities that are associated with low risk of premature development of diseases and conditions related to movement **(Joseph & Francis, 1998).**

1.36.4 CARDIORESPIRATORY FITNESS

Cardiorespiratory fitness is the ability of the heart, lungs, and blood vessels to deliver sufficient nutrients, oxygen, and blood to working skeletal muscles, during moderate to high intensity activities over prolonged periods of time **(Cheryl, 2002).**

Cardiorespiratory endurance is the ability to perform dynamic exercise involving large muscle groups at moderate- to- high intensity for prolonged periods **(Vivian, 2010).**

The ability of the lungs, heart and blood vessels to deliver adequate amounts of oxygen to the cells to meet the demands of prolonged physical activity **(Wener & Sharon, 2009).**

1.36.5 BODY COMPOSITION

Body composition is the relative percentage of body tissues that are lean and adipose **(Cheryl, 2002).**

1.36.6 FLEXIBILITY

Flexibility is the ability of a limb to move freely around a joint through a full range of motion **(Patricia, Anita & Pierre, 2007).**

1.36.7 MUSCULAR STRENGTH

Muscular strength is defined as the ability of a muscle group to develop maximum contractile force against a resistance in a single contraction **(Vivian, 2010).**

1.36.8 MUSCULAR ENDURANCE

Muscular endurance is the ability of a muscle group to exert submaximal force for extended periods **(Vivian, 2010).**

1.36.9 SELF ESTEEM

Self esteem is the disposition to experience oneself as competent to cope with the basic challenges of life and as worthy of happiness **(Robert, 2003).**

1.36.10 ASSERTIVENESS

Assertiveness is being fair to ourselves and fair to others **(Sarah, 2005).**

1.36.11 GAIT

Gait is defined as a repetitive sequence of limb movements to safely advance the body forwards with minimum energy expenditure **(David, 2007).**

Gait is defined as the style of walking **(Narayanan, 2005).**

1.36.12 GAIT VELOCITY

The velocity of walking is the distance covered by the body in a given time in a particular direction **(Linda Merriman & Warren, 2002).**

1.36.13 CADENCE

Cadence is the number of steps in a given time **(Narayanan, 2005).**

1.36.14 GAIT CYCLE

Gait cycle is defined as the period from heel contact of one foot to the next heel contact of the same foot **(Iwan, 2006).**

1.36.15 STEP LENGTH

Step length is defined as the distance between two consecutive heel strikes **(Stuart, 2008).**

The distance covered from one heel strike to the next ipsilateral heel strike **(Kathryn et al. 2003).**

1.36.16 STRIDE LENGTH

Stride length is defined as the distance between two consecutive heel strikes by the same leg **(Stuart, 2008).**

The distance covered from one heel strike to the next ipsilateral heel strike **(Kathryn et al. 2003).**

1.36.17 SINGLE SUPPORT

Single support is defined as the time over which the body is supported by only one leg **(Stuart, 2008).**

1.36.18 DOUBLE SUPPORT

Double support is defined as the time over which the body is supported by both the legs **(Stuart, 2008).**

1.36.19 STANCE TIME

Stance time is defined as the duration as one foot is on the ground during one gait cycle **(Narayanan, 2005).**

1.36.20 SWING TIME

Swing time is defined as the duration when one foot is in the air during one gait cycle **(Narayanan, 2005).**