The review of literature pertaining to the study on “Food Consumption and Lifestyle Pattern of Obese Adolescents and the Impact of Nutrition Intervention in Selected Districts of Tamilnadu” is reviewed under the following headings.

A. Food Consumption Pattern and Nutritional Requirements of Adolescents
B. Nutritional Disorders in Adolescents
C. Obesity and Adolescents – An Overview
D. Global Scenario of Obesity
E. Etiology and Consequences of Obesity
F. Markers of Obesity
G. Intervention Strategies to Overcome Obesity

A. FOOD CONSUMPTION PATTERN AND NUTRITIONAL REQUIREMENTS OF ADOLESCENTS

Out of all the stages of life, the most fascinating is the adolescent age. During this phase, a child is going through many changes in his/her body – changes occur in hormones, skin, height, weight, etc. The child observes these changes and makes amendments in his/her eating habits without appropriate guidance. Adolescence is the time to inculcate food and exercise habits which ensure good health forever.

Awareness about one’s body and its appearance becomes the top priority. It is important for adolescents to realise that they are going through growth spurt and poor nutrition can lead to deficiencies which may cause metabolic disorders in adulthood. Girls skip meals in their anxiety to be thin. This leads to anemia or low bone density in adulthood. Anorexia nervosa, an eating disorder, is very common among young children. Due to irregular college or school schedules, intake of caffeinated drinks increases and water intake reduces. Poor nutrition can lead to
reduced concentration in studies, hair fall, low stamina, depression or poor posture. Peer pressure is very high during adolescence. The need to be in step with the trends and belong to the peer group leads the adolescent to eating non-nutritious foods like pizzas, burgers, coffees, aerated drinks, chocolates and also other roadside junk foods (Rego, 2011).

There are 1.2 billion adolescents between the age of 10 and 19 in developing nations, making up one fifth to one quarter of their populations. While adolescents have typically been considered a low risk group for poor health, this ignores the fact that many health problems later in life can be improved or avoided by adopting healthy lifestyle habits in adolescence. Attention needs to be directed at the link between adolescent nutrition for immediate and long-term health issues, including the cost effectiveness of addressing adolescent nutrition, so that the political commitment to support an action agenda can be secured (web.worldbank.org).

Kaplan (2004) describes nutrition as a process by which all of the food a person eats are taken in and the nutrients that the body needs are absorbed. Good nutrition for adolescents can help prevent disease and promote proper health, growth, and development. Physical changes affect the body’s nutritional needs, and lifestyle may affect eating habits and food choices. Nutritional health during adolescence is important for supporting the growing body and for preventing future health problems. Elements of healthy adolescent development include adequate nutrition, as this can contribute to behavioral, cognitive, and social development in adolescence.

Over the past 20 years, adolescent obesity has more than tripled. Adolescence involves emerging autonomy and independence. In addition to excessively unhealthy foods and drinks, adolescents also do not consume enough nutritious foods. Numerous studies have found that adolescents do not eat nutritious foods. Only two per cent of children meet the dietary recommendations. With increasing numbers of friends outside the family and leisure time outside the home, parents and teachers experience decreasing control over what and when
adolescents eat. Interestingly, eating meals with one’s family may increase the nutritional intake of each meal. Adolescents who eat with their families generally consume more nutritious meals throughout the day, compared to those who eat alone or with friends. Unfortunately, family meals become less frequent in adolescence, particularly during late adolescence (Story and Neumark-Sztainer, 2005).

During adolescence, teenagers make many of their own nutritional decisions. Therefore, parents were unaware of what their teens eat and whether or not those food choices serve to help or harm development and overall health. Since some adolescents sometimes disagree with experts on what nutritional practices promote healthy development, adolescent food choices often have negative consequences.

Studies have shown that adolescents do not receive an adequate education about healthy dieting lifestyle practices, which can result in the use of unhealthful weight control methods such as skipping meals, smoking, using diet pills, and vomiting. Even if these practices decrease obesity, they result in other health problems. Fortunately, healthy alternatives exist. For example, adolescents can decrease their soda intake. Recent media attention is focused on adolescent obesity and its correlation with sweetened soft drinks offered in schools.

Lokeman (2006) found that the high caloric content of soft drinks contributes to childhood and adolescent obesity. Soft drink companies have actually agreed to remove their drinks from American middle schools and high schools due to existing research. Unfortunately, students undoubtedly choose sweetened soft drinks over milk, which contributes to inadequate calcium intake. This decrease in calcium intake may result in osteoporosis (Centers for Disease Control and Prevention, 2005).

If unhealthy eating habits are not corrected, this can continue well into adulthood (DeBate et al., 2001). Although all meals contribute to the nutrition of an adolescent, breakfast significantly affects adolescent development. An individual who skips breakfast misses very important dietary needs that are not usually
compensated for in other meals. In fact, adolescents who skip breakfast have significantly lower vitamin and mineral intake compared to those who regularly eat breakfast. Even if an adolescent eats lunch, dinner, and snacks, the adolescent usually does not compensate for the nutrients lost when skipping breakfast.

Nutritional practices influence more than just physiological development. Research has found that dietary intake impacts cognitive and social development as well. For example, teachers report that adolescents who come to school hungry due to skipping meals or inadequate nutrition are more likely to exhibit apathetic, inattentive, or disruptive behaviors (Nicklas et al., 2004). Therefore, mealtimes may help provide parents with an opportunity to show their children how to eat a healthy meal (Schoenhals, 2005).

Kaplan (2004) also revealed that adolescents who frequently eat meals with their families are less likely to participate in at-risk behaviors. In addition to the immediate impact of nutritional intake, adolescent nutrition also has an impact on later health. Research has found that female teenagers who spend more time watching television have significantly lower bone density, due in part to the lack of healthy snacks eaten during the viewing of television. Calcium intake in adolescents has noticeable effects on the bone mass of young adults (Wood, 2005). Examining the nutritional practices of teenagers is extremely important to improve the health status of our future generations.

Spear (2002) says adolescence is an important time for gains in height as well as weight. While both muscle and fat increase, girls gain relatively more fat, and boys gain relatively more muscle. Thus, the requirement of energy as well as proteins increases considerably during this period. Energy and protein needs to correlate more closely with the growth pattern than with the chronological age. The peak in energy and protein requirements coincides with the peak in growth of adolescents.

Actual needs also vary with physical activity. Therefore, monitoring weight, height and Body Mass Index is essential to determine the adequacy of energy intake for individual adolescents. Generally, the requirement of protein is met even
in economically disadvantaged populations, if caloric intake is sufficient. However, if energy intake is limited, dietary protein may be used to meet energy needs and be unavailable for synthesis of new tissues or for tissue repair. This may result in reduction of growth rate and muscle mass despite an apparent adequate protein intake.

Overnutrition, a form of malnutrition where macronutrients (carbohydrates, fats, proteins) are supplied in excess of the body’s needs, can lead to obesity and is a concern in industrialized nations. In the developed world, adolescents are increasingly consuming energy-dense, nutrient poor diets comprised of fast food, processed foods, and sugar-sweetened beverages (Duffey et al., 2012).

According to Beard (2000), iron requirements peak during adolescence due to rapid growth with sharp increase in lean body mass, blood volume and red cell mass which increases iron needs for myoglobin in muscles and haemoglobin in blood. Adolescents have increased requirements for iron due to rapid growth. In particular, adolescent girls are at a heightened risk of iron deficiency due to inadequate intake of dietary iron, especially heme iron; increased demands of growth; and iron loss that occurs with menstruation. Following puberty, adolescent girls have lower iron stores compared to adolescent boys (Bergstrom, 2000).

Dietary intake recommendations for adolescents were based on a factorial modeling approach that accounts for the amount of iron needed to replace basal losses (losses in urine, feces, and sweat), iron requirements associated with growth (increases in hemoglobin and iron content of tissues), and iron losses associated with menstruation in girls. The intake recommendations also account for average bioavailability (the fraction of iron retained and used by the body) of dietary iron for this age group (Food and Nutrition board, 2001). Bruner et al., (2000) states that iron helps in improving cognition which leads to better academic performance that may be an incentive for girls to remain in school. In developing countries, the prevalence of anemia in adolescence has high rates, which range from nine to fifty per cent (Vitalle and Queiroz, 2001).

Dietary calcium has been identified as a nutrient of great potential concern for adolescents (Haddad and Johnston, 1999). Lytle (2002) stresses that bone
mineral content must be maximized during puberty to prevent osteoporosis (risk of fracture in later life). Low calcium intake in early life may account for as much as 50 per cent of the difference in hip fracture rates in postmenopausal years (Matkovic et al., 2000). Consumption of calcium rich products with every meal goes a long way towards ensuring that requirements are met for calcium and many other nutrients e.g., phosphorus, magnesium and vitamin D needed for bone health (Weaver, 2000). Adequate intake of calcium throughout childhood and adolescence is important for proper mineralization of growing bones, attainment of peak bone mass, and reduction of risk of bone fracture and osteoporosis in adulthood. Dietary intake recommendations for calcium in adolescents were established using a factorial method that summed average calcium accretion and calcium losses through urine, feces, and sweat and also adjusted for calcium absorption (Food and Nutrition Board, 2011).

In 2004, the Food and Nutrition Board set the adequate intake for adolescents by extrapolating from the adult adequate intake using relative energy intakes; however, since energy intakes of adolescents are similar to that of adults, the recommendations are identical: 1,500 mg/day of sodium (Food and Nutrition Board, 2005).

The mineral zinc is essential for growth and development, immune function, neurological function, and reproduction. Zinc plays a number of catalytic, structural, and regulatory roles in cellular metabolism. Zinc deficiency, which is estimated to affect more than 2 billion people in less developed nations (Tuerk and Fazel, 2009) can retard normal growth, impair cognitive development, and delay sexual maturation (Salgueiro, 2004). Adolescents are at increased risk of zinc deficiency due to the demands of growth (Marino, 1980). Mild zinc deficiency, which is common in both the developing and developed world, may also have negative effects on growth and development (Maggini et al., 2010) however, the lack of a sensitive indicator of mild zinc deficiency hinders the scientific study of its health implications.

The requirements for vitamins are also increased during adolescence. Because of higher energy demands, more thiamine, riboflavin and niacin are
necessary for the release of energy from carbohydrates. The increased rate of growth and sexual maturation increases the demand for folic acid and vitamin B-12 (Spear, 2002). With increasing evidence of the role of folic acid in the prevention of birth defects, all adolescent girls of childbearing age should be encouraged to consume the recommended amount of folic acid from supplements in addition to intake of food folate from varied diet (Food and Nutrition Board, 1998). Vitamins A, C, and E are needed in increased amount for new cell growth.

Adolescents’ vitamin needs are also associated with the degree of maturity rather than chronological age because of the demands of growth. Vitamin A deficiency in children and adolescents is a major public health problem worldwide, especially in less developed countries (UN Standing Committee on Nutrition, 2004).

The B vitamin, folate, is required as a coenzyme to mediate the transfer of one-carbon units. Folate coenzymes act as acceptors and donors of one-carbon units in a variety of reactions critical to the endogenous synthesis and metabolism of nucleic acids (DNA and RNA) and amino acids (Bowman et al., 2006). Thus, folate has obvious importance in growth and development. Moreover, higher intakes of folate in adolescents have been linked to better academic achievement (Nilsson et al., 2011).

Adolescence is a time of growing up both physically and socially. During these years, the nutrition choices people make will affect not only their current health, but their future health as well.

B. NUTRITIONAL DISORDERS IN ADOLESCENTS

According to Sachdeva (2006), adolescents have typically been considered a low risk group for poor health, and often receive few health care resources and scant attention. However, this approach ignores the fact that many health problems later in life can be improved or avoided by adopting healthy lifestyle habits in adolescence. Nutritional disorders in adolescents are associated with several serious psychological, sociological morbidity, biological, and considerable mortality.
Nutritional disorders are multifarious sicknesses which influence the adolescents with growing frequency. The nutritional disorders in adolescence are graded with third position among the dreadful chronic diseases and this problem is rapidly growing in the past few decades. Nutritional disorders is very frequent and treatment requires to know the exclusive features of the adolescents as well as the developmental progression which are to be critically considered for choosing the correct diagnosis, treatment or outcome of eating disorders (www.goodpublichealth.org).

Adequate nutrition is essential during adolescence, since growth and development during this period play key roles in achieving normal adult size and reproductive capacity. A major potential obstacle to good nutrition for an adolescent is the development of an eating disorder such as anorexia nervosa or bulimia nervosa. Anorexia nervosa, characterized by severe underweight, fear of gaining weight, and low self-esteem and amenorrhea, is associated with many physiological and psychological complications with which the provider must be familiar.

Similarly, bulimia nervosa, which presents with eating binges followed by compensatory behaviors such as vomiting, diet pill abuse and over exercise, may be harder to detect, but can also have devastating consequences, both physically and emotionally, for a young person. Both of these disorders are best treated by a multidisciplinary team of specialists to address the medical, psychological, and nutritional components of these illnesses (Seidenfeld, 2004).

The Academy for Eating Disorders reports that among late adolescent and young adult females, at least 10 per cent have symptoms of eating disorders. In restrictive anorexia nervosa, a person severely restricts calorie intake, and often exercises excessively because of an overwhelming desire to lose weight. In bulimia nervosa, a person is afraid of gaining weight, but ingests large amounts in a brief period (binges), then tries to rid the body of the effects of these extra calories by fasting, vomiting, exercising, or using laxatives immediately afterward. Once an eating disorder occurs, holistic treatment is necessary by professionals

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addressing the medical, nutritional, and psychosocial needs of the adolescent and the family (Kreipe, 2006).

Worldwide, obesity trends are causing serious public health concern and in many countries threatening the viability of basic health care delivery. It is an independent risk factor for cardiovascular diseases and significantly increases the risk of morbidity and mortality. The last two decades have witnessed an increase in health care costs due to obesity and related issues among children and adolescents. The treatment of overweight and obesity in children and adolescents requires a multidisciplinary, multi-phase approach, which includes dietary management, physical activity enhancement, restriction of sedentary behaviour, pharmacotherapy and bariatric surgery (Raj and Humar, 2010).

Adolescence is a particularly critical time for young people with diabetes. Whether diagnosed in childhood or adolescence, it is during the adolescent years that the individual learns to take increasing responsibility for the management of their diabetes (Wysocki et al., 2000). As they start to integrate their diabetes management tasks into their emerging lifestyles, teenagers directly experience the relationship between their actions and blood glucose tests, if they do any. This will in turn influence their beliefs about diabetes, its treatment and how they will manage it (Snoek and Skinner, 2005).

Kayyali and Andrea (2012) state that the prevalence of diabetes raised by 14 per cent from the first study period (1999–2000) to the last (2007–2008), while low high-density lipoprotein cholesterol rates decreased by 6 per cent. Overall, 43 per cent of adolescents had one or more cardiovascular risk factors, and the prevalence of risk factors increased with increasing Body Mass Index. The incidence of heart disease is growing among teenagers and young adults. Heart disease among teens can occur from poor lifestyle habits. Teen heart disease can stem from one or a combination of the following conditions: obesity, high blood pressure, type 2 diabetes, smoking, illegal drug use, abusing legal drugs, and living a sedentary lifestyle. Left untreated, heart disease may lead to chronic heart failure which eventually can result in death (suite101.com).
Bone mass increases progressively during childhood, but mainly during adolescence when approximately 40 per cent of total bone mass is accumulated. Peak bone mass is reached in late adolescence, and is a well recognised risk factor for osteoporosis later in life. Thus, increasing peak bone mass can prevent osteoporosis. The increased survival of children and adolescents with chronic diseases or malignancies, as well as the use of some treatment regimens has resulted in an increase in the incidence of reduced bone mass in this age group. Experience in treating the various disorders associated with osteoporosis in childhood is limited at present. The first approach to osteoporosis management in children and adolescents should be aimed at treating the underlying disease. The use of bisphosphonates (also called diphosphonates) in children and adolescents with osteoporosis is increasing and their positive effect in improving bone mineral density is encouraging (Baroncelli et al., 2005).

According to Dunn et al., (2011), acne is a significant adolescent problem and may precipitate emotional and psychological effects. Qualitative review of the selected articles revealed that the presence of acne has a significant impact on self-esteem and quality of life. Depression and other psychological disorders are more prevalent in acne patients and acne treatment may improve symptoms of these disorders. The presence of co-morbid psychological disorders should be considered in the treatment of acne patients and future prospective trials are needed to assess the impact of treatment on psychological outcomes.

Polycystic ovary syndrome (PCOS), a heterogeneous syndrome of unknown aetiology, is the leading cause of anovulation, hirsutism and infertility in women. The clinical implications of PCOS diagnosis in adolescents remain unclear. Experts in the field still ponder whether PCOS should be managed at such a young age with a view to hindering the long-term sequelae of the syndrome (Diamanti-Kandarakis, 2010).

Thyroid hormone plays a crucial role in the growth and function of the central nervous system. The purpose of the study was to examine the relationships between the status of subclinical thyroid conditions and cognition among adolescents in the United States. Subclinical hypothyroidism was
associated with better performance in some areas of cognitive functions while subclinical hyperthyroidism could be a potential risk factor (Wu et al., 2006).

Stress is the "wear and tear". Our bodies go through as we adjust to our constantly changing environment. Adolescence can be a stressful time for children, parents and adults who work with teens (www.allhealth.com.au). A study was done by Aggarwal et al., (2007) to adapt and test the validity of a scale measuring stress caused due to life events in an Indian adolescent; to assess clinical value of the instrument in exploring causal relationships between stressful events and behavioral problems; and to compare the degree of overlap in stress-causing events between adolescents and their parents during the same timeframe. Thus, a life event scale for adolescents was especially adapted to the Indian conditions.

Nutritional disorders are very frequent and treatment requires to know the exclusive features of the adolescents as well as the developmental progression which are to be critically considered for choosing the correct diagnosis, treatment or outcome of eating disorders. Consequently, adolescents need to be considered separately and differentiated from adult patients with eating disorders.

C. OBESITY AND ADOLESCENTS – AN OVERVIEW

Obesity compounds a common adolescent problem of low self-esteem and can disrupt psychosocial development, interfering with the normal process of adolescence, a timeless journey that prepares the child for adulthood (Greydanus and Bhave, 2004). The National Health and Nutrition Evaluation Survey (NHANES) data are some of the better data available in terms of what is going on nationally. The latest NHANES cycle, which analyzes 1999-2000 data, shows that about 30 percent of adolescents have a Body Mass Index (BMI) that falls at or above the 85th percentile and about 15 per cent of adolescents have a BMI that falls above the 95th percentile (National Center for Health Statistics, 2002; Odgen et al., 2002).

The degree of obesity is increasing. Guo et al., (2000) estimated that more than 75 per cent of overweight adolescents will remain overweight into adulthood.
Persistence of overweight among youth increases with age, degree of obesity, and parental obesity. There is also a clustering of cardiovascular risk factors.

Data from the Bogalusa Heart Study showed that of the participants, the children and adolescents, about a quarter in the general study population had at least one cardiovascular risk factor. But when they separated out those who were above the 95th percentile it increased from about 27 per cent to about 61 per cent with at least one cardiovascular risk factor. When looking at how many people had two cardiovascular risk factors, it increased from about seven per cent in the general population up to about 27 per cent. When separating the children and adolescents who had three risk factors; it was about 11 per cent of the population. Again, the more obese they are, the more likely they are to have this clustering of cardiovascular risk factors (Freedman et al., 1999).

When considering the 1988 to 1994 National Health and Nutrition Examination Survey III data, it is clear that about 30,000 adolescents were diagnosed just within that study group as having Type 2 diabetes. Depending upon the source of the clinical data or studies considered, adolescent Type two diabetics accounts for anywhere from 8 to 46 per cent of all the new cases of diabetes among adolescents in pediatric clinics (Sinha et al., 2002). Clinicians need to consider that adolescent obesity is likely to persist.

Disordered eating is a concern of many professionals who address obesity prevention or treatment. Neumark-Sztainer et al., (1999) demonstrated that overweight females were twice as likely to engage in what we might call high-risk dieting behaviors that border on or are actually considered disordered eating. This includes using laxatives and diuretics or vomiting to lose weight. Obesity increases the risk for these types of behaviors.

Investigations of school-aged children and adolescents in Great Britain found that they were at about eight times the risk of developing an eating disorder if they were dieting. Although not all of these children were overweight, many adolescents who are not overweight diet, but certainly the overweight individuals
were very well represented in the study. Hypertension, diabetes mellitus, sleep apnea, orthopedic abnormalities, pseudotumor cerebri, and severe psychosocial stress are conditions for which we may recommend very quick or rapid weight loss because they can have such severe consequences (Fleming and Towey, 2003).

An obese young person may have difficulty dealing with peers and this communication problem can seriously disrupt normal adolescent development. Psychological complications have been associated with obesity in adolescents, including depression, poor self-image, and difficulties in both the home and social environment (including school). Potential medical complications of obesity noted in adolescence and especially in adulthood, include hypertension, coronary artery disease, diabetes mellitus, dys-lipidemia, cholecystitis, premature joint destruction, arthritis, stroke, some cancers, premature death and many others (Sorof et al., 2004).

Wang and Dietz (2002) looked at the National Hospital Discharge Survey data. They considered cases in which obesity was listed either as a primary or a secondary diagnosis for treatment. These data represent a twenty-year span, 1979 to 1999, and included significant increases in primary and secondary diagnoses of obesity. When looking at length of hospital stays, they found that the hospital stays were longer if obesity was a primary diagnosis; cost for treating child and adolescent or pediatric obesity increased four-fold during the study. This finding probably under represents what is actually happening because records had to have obesity listed as a primary or secondary diagnosis which is not always the diagnosis.

Reviews of child and adolescent obesity treatment programmes describe essential components for successful interventions, focusing both on treatment components of programs as well as organizational factors. Adolescent obesity interventions in clinical settings generally offer assessment and counseling related to diet and physical activity as well as behavior strategies such as problem solving, stimulus control, or behavior modification (Epstein et al., 2001).
Obesity is a complex health issue. Health professionals, parents, and community leaders should all consider areas of young people’s lives where they can make a difference in nutrition and physical activity. Professionals need to reinforce the role of parental modeling in adolescent overweight and obesity reduction.

D. GLOBAL SCENARIO OF OBESITY

Obesity, a disorder of energy balance is characterized by excess body fat. It is chronic in nature and is often associated with wide range of psychosocial problems, metabolic abnormalities and degenerative diseases that reduces quality of life, some of which could be life threatening. In recent years, the occurrence of obesity has increased in developing countries also, and now even replacing more traditional public health concerns, including undernutrition and infectious diseases. Though, it is not a recent phenomenon. However, the prevalence of obesity has never before reached up to such epidemic proportion as today (Krishnaswamy, 2000).

Obesity is considered the most common adolescent health condition. Adolescent obesity and poor nutritional habits certainly should cause alarm since they appear to be significantly associated with an increased risk of diabetes, high blood pressure, high cholesterol, asthma, arthritis, and poor health status (Centers for Disease Control and Prevention, 2005).

Global Health Observatory (2012) reports that worldwide, at least 2.8 million people die each year as a result of being overweight or obese, and an estimated 35.8 million (2.3 per cent) of global DALYs (Disability Adjusted Life Years) are caused by overweight or obesity. In 2008, 35 per cent of adults aged 20+ were overweight (BMI ≥ 25 kg/m²) (34 per cent of men and 35 per cent of women). The worldwide prevalence of obesity has more than doubled between 1980 and 2008. In 2008, 10 per cent of men and 14 per cent of women in the world were obese (BMI ≥30 kg/m²), compared with 5 per cent for men and 8 per cent for women in 1980. An estimated 205 million men and 297 million women over the age of 20 were obese - a total of more than half a billion adults worldwide.
The prevalence of overweight and obesity were highest in the World Health
Organisation (WHO) Regions of the Americas (62 per cent for overweight in both
sexes, and 26 per cent for obesity) and lowest in the WHO Region for South East
Asia (14 per cent for overweight in both sexes and 3 per cent for obesity). In the
WHO Region for Europe and the WHO Region for the Eastern Mediterranean and
the WHO Region for the America over 50 per cent of women were overweight. For
all three of these regions, roughly half of overweight women are obese (23 per
cent in Europe, 24 per cent in the Eastern Mediterranean, 29 per cent in the
Americas). In all WHO regions women were more likely to be obese than men. In
the WHO regions for Africa, Eastern Mediterranean and South East Asia, women
had roughly doubled the obesity prevalence of men (www.who.int).

The prevalence rates for overweight and obese people are different in each
region, with the Middle East, Central and Eastern Europe, and North America
having higher prevalence rates. In most countries, women show a greater Body
Mass Index distribution with higher obesity rates than do men. Obesity is now
usually associated with poverty, even in developing countries. Relatively new data
suggest that abdominal obesity in adults, with its associated enhanced morbidity,
occur particularly in those who had lower birth weights and early childhood
stunting. Waist measurements in nationally representative studies are scarce but
will now be needed to estimate the full impact of the worldwide obesity epidemic
(James et al., 2001).

India is gaining weight. Traditionally known for malnutrition, Indians now
report more and more frequently with overweight, obesity, and their
consequences. Indians exhibit unique features of obesity (Kalra and Unnikrishnan,
2012). India is the second most populous country in the world that comprises 17
per cent of the world’s population and contributes to 16 per cent of the world’s
deaths. Nutritional status of the Indian population varies significantly across the
regions. Certain regions are associated with extremely high rates of childhood
undernutrition (ranging from 20 per cent to 80 per cent), whereas others have a
high prevalence of adult undernutrition (> 50 per cent), and some have both.
Earlier, developing countries, including India, had focused scarce public health resources primarily on the high prevalence of undernutrition. However, these nations are currently facing the double burden of undernutrition as well as overnutrition. Data regarding the nutritional status of adults, as determined by Body Mass Index (BMI), indicate that 50 per cent of Indian adults suffer from different types of chronic energy deficiency, in that they have a BMI <18.5 kg/m². In the same survey, it was observed that the BMI values were similar in men and women; however, there were more overweight/obese (BMI≥25 kg/m²) women (6.6 per cent) than men (3.5 per cent). In certain regions, obesity and consequent diseases are posing an enormous public health problem (Pednekar, 2008).

The prevalence of obesity is higher among adolescents than among preschool-aged children. The prevalence of obesity was higher among boys (18.6 per cent) than girls (15.0 per cent) (Ogden et al., 2012). The nutritional status and health of children and adolescents has declined in recent years. The problem of overweight and obesity is not confined only to developed countries but is also widely prevalent in developing countries (Laxmaiah et al., 2007). The prevalence is higher in urban than in rural areas (Kaur et al., 2005). Thus, teens are at significant risk of becoming obese adults.

According to the National Family Health Survey (NFHS), the percentage of ever married women aged 15 to 49 years who are overweight or obese increased from 11 per cent in NFHS-2 to 15 per cent in NFHS-3. The prevalence of overweight and obesity is three times higher among women with 12 or more years of schooling than those with no education. The percentage of women who are overweight or obese is highest in Punjab (30 per cent), followed by Kerala (28 per cent) and Delhi (26 per cent), all of which are relatively richer states (www.nfhsindia.org).

A cross-sectional survey was conducted by Singh and Pella (2007) in 6-12 urban streets in each of five cities in five different regions of India [Moradabad (n=2002), Trivandrum (n=1602), Calcutta (n=900), Nagpur (n=894), and Bombay (n=1542)] using a common study protocol and criteria of diagnosis to
find out the prevalence of overweight and obesity in the urban populations of India. The overall prevalence of obesity was 6.8 per cent and overweight 33.5 per cent among women and men, respectively. The highest prevalence of obesity (7.8 per cent) and overweight (36.9 per cent) was found among subjects aged 35-44 years in both sexes. The prevalence of obesity was significantly (P < 0.05) greater in Trivandrum (8.5 per cent), Calcutta (7.1 per cent), and Bombay (8.3 per cent) compared with Moradabad (6.2 per cent) among women and in Trivandrum (7.4 per cent) and Bombay (7.2 per cent), compared with Nagpur (5 per cent) among men.

According to Chopra et al., (2002), increasing rates of overweight and obesity has reached epidemic proportions in developed countries and is rapidly increasing in many middle-income and less-developed countries. The proportion of adolescents and children in the general population who are overweight and obese has doubled over the past two decades in developed and developing countries including India (Bundred et al., 2000) and have a rising prevalence of diabetes. Goyal et al., (2010) estimated the prevalence of obesity was 2.9 per cent in boys and 1.5 per cent in girls in Ahmedabad.

Globally, an estimated 10 per cent of school-aged children, between 5 and 17 years of age, are overweight or obese. In India, many studies have shown that the prevalence of overweight among adolescents varies between 10 per cent and 30 per cent (Kotian, 2010). The results of studies among adolescents from parts of Punjab, Maharashtra, Delhi, and South India revealed that the prevalence of overweight and obesity was high (11 per cent - 29 per cent). In Ludhiana, Punjab, urban children in the age group of 11-17 years of age were more overweight (11.6 per cent) than their rural counterparts (4.7 per cent). In Pune, Maharashtra, studies among 1228 boys in the age group of 10-15 years indicated that ~20 per cent were overweight, whereas 5.7 per cent were obese.

A study carried out in Ludhiana, Punjab, on school children in the age group of 9-15 years revealed that the overall prevalence of overweight and obesity were 11 per cent and 14 per cent, respectively. Another study carried out in Delhi, India;
among 5000 private school children in the age group of 4-18 years in 2002 by the Nutrition Foundation of India revealed that the prevalence of overweight was 29 per cent. A similar study conducted by Laxmaiah et al., (2007) in Chennai, South India, showed that the prevalence of overweight was 17 per cent and of obesity was 3 per cent.

However, few studies have examined the worldwide situation regarding adolescent obesity, particularly due to the fact that no standard or reference is agreed upon internationally. Different definitions have been used in studies to define obesity and overweight (Guillaume, 1999). There has been a lack of consensus over the definitions, the current lack of consistency and agreement between different studies over the classification of obesity and overweight in children and adolescents makes it difficult to give an overview of the global prevalence of obesity and overweight. Thus, the world based standardized obesity and overweight classification system is urgently needed but now internationally based cutoff points have been published (Cole et al., 2000).

E. ETIOLOGY AND CONSEQUENCES OF OBESITY

Obesity is a genetically complex disorder that produces a myriad of health problems. Most of the recognized complications of obesity are not only strongly influenced by lifestyle factors, but also present with independent genetic predispositions that are notoriously difficult to disentangle in humans (Naukkarinen et al., 2012).

Sturm and Wells (2001) state that obesity is also linked to higher rates of certain types of cancer. Obesity is an independent risk factor for heart disease, hypoxia, sleep apnea, hernia, and arthritis. Morbidity from obesity may be as great as from poverty, smoking, or drinking problem. Obesity is the seventh leading cause of death in the US. Approximately 300 000 deaths are attributed to obesity each year, comparable to the 400 000 deaths attributed to the usage of tobacco products.

Environment strongly influences obesity. This includes lifestyle behaviors such as what and how much a person eats, as well as his or her level of physical

Sedentary Lifestyle Syndrome or ‘SeDS’ is the term developed by more than 200 of the nation's leading physiologists to diagnose the growing epidemic of physical inactivity and its relationship to chronic, preventable diseases. Sedentary is defined as engaging in less than 30 minutes of moderate physical activity, equivalent to brisk walking, each day (www.nvo.com). Another environmental factor affecting the American obesity trend is portion size. The National Restaurant Association’s Dinner Decision Making study found that most consumers rank portion size as one of the 10 ‘hallmarks of a great place’ (www.restaurant.org).

Obesity increases the likelihood of various diseases, particularly heart disease, type 2 diabetes, obstructive sleep apnea, certain types of cancer, osteoarthritis (Haslam and James, 2005) and asthma (Poulain et al., 2006). Obesity is most commonly caused by a combination of excessive food energy intake, lack of physical activity, and genetic susceptibility, although a few cases are caused primarily by genes, endocrine disorders, medications or psychiatric illness. Evidence to support the view that some obese people eat little yet gain weight due to a slow metabolism is limited; on average obese people have a greater energy expenditure than their thin counterparts due to the energy required to maintain an increased body mass (Kushner and Robert, 2007).

Dieting and physical exercise are the mainstays of treatment for obesity. Diet quality can be improved by reducing the consumption of energy-dense foods such as those high in fat and sugars, and by increasing the intake of dietary fiber. Anti-obesity drugs may be taken to reduce appetite or inhibit fat absorption together with a suitable diet. If diet, exercise and medication are not effective, a gastric balloon may assist with weight loss, or surgery may be performed to
reduce stomach volume and/or bowel length, leading to earlier satiation and reduced ability to absorb nutrients from food (Imaz et al., 2008).

Obesity is one of the most serious public health problems of the 21st century (Barness et al., 2007). Woodhouse (2008) states that obesity is stigmatized in much of the modern world (particularly in the Western world), though it was widely perceived as a symbol of wealth and fertility at other times in history, and still is in some parts of the world. Overweight and obesity are the result of a variety of social, behavioral, cultural, environmental, and physiological factors (Blackburn, 2002). Addressing nutrition and physical activity jointly is essential in prevention and treatment of overweight and obesity. Because of its complex etiology, no single approach to weight management is adequate. Considering that obesity is difficult to reverse and that weight reduction and maintenance of weight loss are complex tasks, emphasis should be on lifelong prevention through good nutrition and physical activity.

F. MARKERS OF OBESITY

Evaluating overweight and obesity in children and adolescents has been a matter of debate due to the lack of a simple, inexpensive, and accurate means to measure body fat. Direct measurement of fat and estimation of body fat is difficult due to individual variations in body fat distribution, genetics, and level of physical fitness (Speiser et al., 2005). Measurements of skin fold thickness and waist circumference are not currently recommended to assess childhood obesity. High BMI levels are predictive for obesity later in life as well as increased morbidity and mortality. In some situations, Body Mass Index calculations inaccurately predict health risk because there is no accounting for those with high muscle mass or for the difference between visceral or subcutaneous fat (Barlow, 2007).

A simple and inexpensive way to estimate body fat in children over two years is by using weight and height measurements to calculate body mass index, commonly referred to as BMI. Body mass index is a measure of weight adjusted for height which is noninvasive and clinically convenient to calculate. It correlates
with the amount of body fat in children and with the level of health risks, particularly cardiovascular risk factors (Mei et al., 2002).

A subject who has excess fat may be classified as healthy, or one with a muscular build may be classified as obese. Calculation of body mass index is done by dividing weight (in kilograms) by height (in meters) squared or by dividing weight (in pounds) by height (in inches) squared times. Weight and height are simple and direct measures of body size that are easy to obtain in a variety of settings using relatively inexpensive instruments. Weight is highly correlated with body fat, but it also correlates with height, which is poorly associated with body fat. Thus weight adjusted for height is more useful than weight alone as an indicator of overweight (Power et al., 1997).

Accurate height and weight measures are critical in assessing overweight and obesity. All children should be weighed and measured at least yearly by physicians or allied health professionals and have their Body Mass Index calculated and plotted on a standard growth chart. Weights should be measured on a calibrated beam balance scale or on a digital scale with a "strain gauge" mechanism that is accurate to within 0.1 kg or 1/4 lb. Spring-type bathroom scales should not be used since they will not maintain a high degree of accuracy with repeated use. Scales should be calibrated at least two or three times per year using standard weights or by an inspector of weights and measures. Beam scales should be checked frequently by moving the sliding weights to the zero position then moving the zeroing weight until the beam balances at zero. Measuring height requires a stadiometer, yardstick or measuring tape (Murphy, 2001).

Measurements should be plotted on age and gender specific growth charts of Centers for Disease Control growth charts. Since children's weight and height distributions change with age, percentiles are specific to age and gender, compared to adults, in which BMI absolute values are interpreted. There are two cutoff points which capture varying risk levels. The increase in obesity prevalence is therefore measured against a stable cutoff point, the 95th percentile BMI for gender and age. For older and younger children, there are exceptions to the cutoff
points. For older adolescents, a BMI of 30 kg/m² (the adult obesity cut point) may not be ≥95th percentile. The Expert Committee recommends that the lower of a BMI of 30 kg/m² or a BMI ≥95th percentile be used to define obesity (Barlow, 2007).

Calculating and plotting BMI percentiles provides an opportunity to discuss a child’s growth with parents during office visits. If a child’s growth trajectory is too fast, this can be identified early and lifestyle changes can be discussed to prevent continued development of excess weight (Stephens and Summar, 2008).

Several organizations have developed tools to assess eating and activity patterns, to provide anticipatory guidance for normal weight children, and to begin intervention for overweight and obese children. The Institute for Community Health Promotion at Brown University has developed the WAVE (Weight, Activity, Variety, Excess) Assessment and WAVE Recommendations. The assessment includes assessing a patient’s body mass index, asking about physical activity during the past week, evaluating a patient’s food intake for variety of food groups, and determining excess consumption of certain foods or nutrients. Additionally, the assessment asks the patient what he thinks of his eating pattern, pros and cons, as well as willingness to make changes. The WAVE recommendations provide help for addressing obesity by stating concerns, offering specific advice, helping set goals and providing education materials and resources. Simple advice for increasing physical activity, eating a variety of healthy foods, and avoiding excess calories are given. The Rate Your Plate tool is completed by patients to assess food choices, meal skipping, and eating out frequency. Patients can calculate a Rate Your Plate score, see information on what the score means and be encouraged to set goals for change in eating patterns. The Rapid Eating Assessment for Patients (REAP) also asks about food choices as well as physical activity, screen time, shopping and cooking habits, and includes a physician key for diet assessment and counseling (Gans, 2003).

Children's Mercy Hospitals and Clinics in Kansas City, Missouri have developed a Health Habits Assessment to measure individual and parental eating
and activity habits. Patients and parents were asked about breakfast consumption, intake of fruits and vegetables, consumption of sugar-sweetened drinks and juice, number of family meals in a week, daily screen time and daily physical activity. Parents and children were asked to assess their readiness to make behavioral changes and to identify potential barriers to change. Families were encouraged to choose one area of focus to set goals for changes. Educational materials as well as tracking logs were provided to promote change (Children's Mercy Hospitals and Clinics Department of Nutrition Services, Healthy Lifestyle Team, 2006; www.lcph.org). Online weight loss readiness quizzes are also available to help families decide if they are ready to make health changes (http://outside.utsouthwestern.edu).

G. INTERVENTION STRATEGIES TO OVERCOME OBESITY

Nutrition intervention is a specific set of activities and materials used to address the nutrition problem (www.eatright.org). The prevalence of obesity among adolescents and children is increasing. In addition, obesity in adolescents is known to be an independent risk factor for adult obesity. Therefore, there is a need to develop interventions to reduce the prevalence of obesity in children. Because there is good evidence that obesity is related to the energy content of the diet and an increasingly sedentary lifestyle, these interventions should focus on changing these behaviours.

Schools have been a popular setting for implementation of interventions, as they offer continuous, intensive contact with children. School infrastructure and physical environment, policies, curricula and staff have potential to positively influence child health. However, despite the apparent advantages of addressing childhood obesity in a school setting, a relative lack of effectiveness of a number of major interventions to reduce childhood obesity has brought into question the wisdom of allocating scarce resources to school-based interventions.

Haerens et al., (2006) intervention combined environmental changes with personal computer-tailored feedback on BMI, with and without parental support, compared with control in nearly 3000 13-year-olds in 15 middle schools in
Belgium. The intervention included 4.7 h extra physical education per week. In girls, BMI and BMI z-score increased significantly less in the intervention with parental support group compared with the control group (p < 0.05) or the intervention-alone group (p = 0.05). In boys, no significant positive intervention effects were found after two school years.

Interventions that changed at least one aspect of the school environment, such as the food provided, opportunities for physical activity, or the curriculum, are included (Kalakanis and Moulton, 2006). Limited research evidence suggests that increasing the amount of physical education taught in schools may be associated with a reduced risk of being overweight (Veugelers and Fitzgerald 2005). No studies evaluating the relationship between obesity and school vending machines were available. However, the presence of other food sources is negatively associated with consumption of fruits and vegetables and positively associated with a higher percentage of daily calories obtained from fat (Kubik, 2003).

Modifying school playground facilities to stimulate physical activity and providing supervision during play periods may increase activity levels of elementary school children (Sallis, 2001). Other school-related characteristics that may be promising avenues of intervention include recess, intramural programs, access to facilities outside of school hours, and support for healthy eating and physical activity (Wechsler, 2000). A number of schools have successfully integrated third-party activity programs into their physical education curriculums or after-school activities (Marathon Kids program evaluation, 2005-2006).

PubMed and OVID Medline databases were searched for school-based obesity interventions with anthropometric measures in children and adolescents between the ages of 7 and 19 years from June 1986 to June 2006. Studies were reviewed by duration, type of intervention, and defined qualitative and quantitative measures, resulting in a yield of 51 intervention studies. No persistence of positive results in reducing obesity in school-age children has been observed. Studies employing long-term follow-up of quantitative and qualitative measurements of short-term interventions in particular are warranted (Shaya et al., 2008).
According to Gerberding and Marks (2004), unhealthy eating habits and physical inactivity are early to become established and contribute in a major way toward development of obesity. Commonly suggested modifiable public health strategies to combat obesity are promotion of breast-feeding, limiting television viewing, encouraging physical activity, increasing fruit and vegetable intake, controlling portion sizes, and limiting sweetened drink. Dietary modification is a very important part of all strategies aimed at combating childhood overweight and obesity. For addressing adolescent and childhood obesity, school based interventions are a major channel. Adolescents and children spend most of the hours in school and schools serve as important channels through which important behaviour changes to reduce childhood obesity can be addressed.

Schools are ideal settings for population-based interventions to address obesity (Ford et al., 2008; Story, 1999). Foster et al., (2008) examined the effects of a multicomponent, School Nutrition Policy Initiative on the prevention of overweight (85th to 94.9th percentile) and obesity (>95th percentile) among children in grades 4 through 6 over a 2-year period. A multicomponent school-based intervention can be effective in preventing the development of overweight among children in grades 4 through 6 in urban public schools with a high proportion of children eligible for free and low priced school meals.

Children spend approximately half of their waking hours in school. Schools provide 1 to 2 meals daily and are a natural setting for education about healthy food choices. Despite their intuitive appeal, the results for school-based interventions have been mixed. Although some school-based programs have had favourable effects on Body Mass Index, (James et al., 2004) and some have not (Caballero et al., 2003). The reason for this is unknown but may include an insufficient dose, barriers to effective implementation, the inability to effectively target children at highest risk, and that the behaviors targeted by interventions may not relate directly to body weight.

The 12-week physical activity intervention by Robbins et al., (2006) reported that the school nurses experienced difficulty counseling some girls who
lacked places, resources and social support for engaging in physical activity. Some girls expressed that their parents discouraged physical activity at home because of the noise and the low importance placed on being physically active as compared with doing homework or chores.

Nearly all of the interventions tested have been developed and/or implemented by university-based teams. Few studies have examined the effects of school-based programs that have originated in the community. Also, as Doak et al., (2006) note, few studies have examined the possible adverse effects of obesity prevention programs, such as worsening body image or decreases in BMI z scores among those who are normal weight or underweight.

The development of health behaviour theory of multiple behaviour change has the potential to create better understanding of why some ‘simple’ interventions appear more effective than more complex interventions and vice versa (Noar et al., 2008). This will enable more effective behaviour change interventions to prevent obesity in adolescents and children. There is a need for research to view behaviour change within the context of an obesogenic environment (Swinburn et al., 2000) and the co-dependency of the success of prevention interventions upon a ‘paradigm shift in thinking’ (Government Office for Science, 2007; www.foresight.gov.uk).

Kropski et al., (2008) examined the effectiveness of school-based programs for reducing childhood overweight or obesity. They found that the efficacy of school-based obesity prevention programs is limited by the small number of published studies and by methodological concerns. Qualitative analysis suggests programs grounded in social learning may be more appropriate for girls, while structural and environmental interventions enabling physical activity may be more effective for boys. High-quality evaluation protocols should be considered essential component of future programs.

Multi-faceted school-based interventions can reduce obesity and overweight in schoolchildren, particularly girls. Interventions include nutrition
education, promotion of physical activity, reduction of sedentary behaviour, behavioural therapy, teacher training, curriculum materials, and modification of school meals and tuck shop stock. Family-based behaviour-modification programmes (family therapy in addition to diet education, regular visits to a pediatrician and encouragement to exercise) may impede weight gain in obese children (Mulvihill et al., 2000).