CHAPTER-II

REVIEW OF LITERATURE

In this brief review, an attempt is made to survey the related literatures concerning overweight, obesity, lifestyles, food habits and morbidity.

**Obesity in relation to age and sex**

The prevalence of obesity seems to vary in complex ways by sex and age across different geographical regions while an individual's risk of becoming obese varies over his or her life course. The evaluation of age patterns is not easy because in most studies varying age groups are combined together while varying criteria for measuring obesity are used. However, the existing data on obesity in Europe suggests that obesity is more prevalent among adolescents compared to children (Livingstone 2000). The same has been observed in the USA, whereas in China, Brazil and Russia the prevalence of overweight is markedly higher among children compared to adolescents (Wang et al. 2002). Children born into families where one or both parents are obese are more likely to become overweight or obese (Guillaume et al. 1995). The two large-scale respective studies in the UK have shown that childhood weight is not an accurate predictor of adult weight (Braddon et al. 1986; Wright et al. 2001). In addition, they found that overweight among teenagers is a better predictor of adult obesity as overweight teenagers are more likely to become overweight adults (Wright et al. 2001). In contrast, Ferraro et al. (2003) found that childhood overweight is significantly associated with severe obesity for both men and women but that the effect is stronger for men.

Cross-sectional studies have demonstrated that obesity increases with age and that it increases most rapidly when people are in their twenties and early thirties and continues to rise until they reach their late fifties (Rolland-Cachera et al. 1991; Flegal et al. 1998). Individuals under thirty years old, who have been consistently thin, are still at risk of developing obesity once they are in their thirties (Bulik and Allison 2001). The BMI increase with age in women tends to continue longer than in men (Seidell et al. 1995; Stam-Moraga et al. 1999). In fact, in a Swiss population, BMI in
men did not vary at all across age groups (Morabia et al. 1997). In addition to cross-sectional studies, the few longitudinal studies support the finding that people generally gain weight as they become older with 60 years of age typically marking a turning point (Rissanen et al. 1988; Williamson et al. 1990; Lewis et al. 1997; Guo et al. 1999; Heitmann and Garby 1999). In Scotland, the levels of obesity have been shown to rise steadily between the mid-twenties until the mid-fifties for men and until the mid-sixties for women and the prevalence of obesity are lowest among elderly people (Scottish Health Survey 1998). Even though obesity increases with age, almost 20 percent of children under the age of 15 and almost 30 percent of young adults (15-20 years of age) in UK are overweight or obese (Department of Health 2002). In developing countries like India, older women are more overweight and obese than younger women and there occurs an increase in the body weight with ageing, at least up to 50-60 years old in both men and women (Agrawal 2002). The relationship between obesity and age is similar in developing countries, but the maximum rates of obesity tend to be reached at an earlier age (i.e. 40 years old). Independent of gender, ageing is associated with a decrease in skeletal muscle. The absolute amount of skeletal muscle is preserved until an age of 50, after which it usually decreases rapidly, especially in the lower body (Janssen et al. 2000). The rate of loss is, however, influenced by changes in body weight (Forbes 1999). Generally, skeletal muscle relative to body mass starts to decrease during the third decade, since weight gain with age is predominantly composed of fat (Janssen et al. 2000).

Clear gender differences are seen in most of the countries with more women being obese than men (Filizof et al. 2001; Mokhtar et al. 2001; Ismail et al. 2002; IASO 2008). Women are more likely to become obese at a number of stages in the life course: during pregnancy, after childbirth, during the menopause and at retirement (Glenny et al. 1997; Rossner 1998; Ferraro et al. 2003). In the UK, 23 percent of men and 25 percent of women are obese (Rennie and Jebb 2005). Study in Mexico shows that the estimated prevalence of obesity is 24.2 percent in men and 34.5 percent in women (Olaiz et al. 2006). In Brazil, 8.8 percent of men and 13.0 percent of women are obese in 2003. Among Brazilian children and adolescents, the prevalence of overweight and obesity in boys increase from 2.9 percent in 1974-1975 to 13.1 percent in 1996-1997 and among girls the prevalence increased from 5.3 percent to
14.8 percent (Wang et al. 2002). The prevalence of overweight among Canadian boys is increased from 15 percent in 1981 to 28.8 percent in 1996 and among Canadian girls from 15 percent to 23.6 percent (Tremblay and Willms 2000). In Asian countries, the gender differences in the prevalence of obesity are also reported in many studies. For example, in Japan, based on the National Nutrition Survey (2000), the prevalence of overweight is 24.5 percent in men and 17.8 percent in women, whereas that for obesity is 2.3 percent in men and 3.4 percent in women (Yoshiike et al. 2002). High prevalence is also reported among Iranian adults with 11.1 percent of men and 25.2 percent of women are obese (Janghorbani et al. 2007). Saudi Arabia reported that overweight is prevalent at 30.7 percent among men and 28.4 percent among women, while obesity is prevalent at 14.2 percent among men and 23.6 percent among women (Al-Othaimeen et al. 2007). Studies also show that over 40 percent of the women populations in Kuwait and Qatar are obese (Bener and Tewfik 2006; Al Rashdan and Nesef 2009). In China, the prevalence of overweight and obesity is 24.1 percent and 2.8 percent in men and 26.1 percent and 5.0 percent in women respectively (Reynolds et al. 2007). Among Chinese children, the combine prevalence of overweight and obesity in 7-12 year old is exceeded 25 percent in boys and 14 percent in girls in 2000 (Ji et al. 2004).

Research on obesity in India has found prevalence to be higher among women than men (Gopinath et al. 1994; Mishra et al. 2001), and among economically better off persons (Dhurandhar and Kulkurani 1992; Singh et al. 2000; Griffiths and Bentley 2001). A study of urban population in Mumbai (Shukla et al. 2002) indicates that the prevalence of overweight is higher in women (30%) than in men (19%). Three out of four urban Indian women have waistlines measuring well over 80cm or 32 inches (the danger score in obesity) while one out of four are either overweight or obese, reports the latest National Family Health Survey (IIPS 2007). In 2006, 75 percent urban women are found to be apple-shaped compared to 58 percent men, by the 60-Country International Day of Evaluation of Abdominal Obesity (IDEA) study. In 2004, the All Indian Institute of Medical Sciences (AIIMS) reported over 50 percent women between age 35 and 59 in urban India, compared to 40 percent men, to be overweight (Datta 2008).
NFHS-2 shows that the prevalence of overweight and obesity among women in urban India is 17.7 percent and 5.8 percent respectively. A higher prevalence of overweight is observed nationally in women of reproductive ages in urban areas (24%) compare to rural areas (6%) of India (IIPS 2000). The percentage of ever-married women aged 15-49 years who are overweight or obese increased from 11 percent in NFHS-2 to 15 percent in NFHS-3 (IIPS 2000, 2007). According to National Family Health Survey-3, the prevalence of overweight and obesity among Indian women as estimated from 15-49 years of age is 12.6 percent and 2.8 percent respectively (IIPS 2007). In the Indian Women’s Health Study, the overall prevalence of central obesity among women between 25-64 year ages is 55 percent (Singh et al. 1998). Study among Punjabi urban women shows that the prevalence of overweight and obesity is 20 percent and 25.3 percent respectively (Sidhu and Kaur 2002). Urban women of Delhi show the prevalence of obesity to be 33.4 percent (Gopinath et al. 1994). Women belonging to high socioeconomic conditions of Hyderabad have a prevalence of obesity of 36.3 percent (Rao et al. 1995). In Manipur, among Tangkhul Naga women, the prevalence of overweight and obesity is found to be 9.2 percent and 0.6 percent respectively (Mungreiphy and Kapoor 2008). Vadera et al. (2010) shows that the prevalence of overweight/obese among men and women is found to be 16.1 percent and 29.7 percent respectively in Jamnagar city of Gujarat.

Among the school going children in India, the prevalence of overweight is 14.3 percent among boys and 9.2 percent among girls whereas the occurrence of obesity is reported at 2.9 percent in boys and 1.5 percent in girls in 12-18 year (Goyal et al. 2010). The prevalence of overweight (8.5%) and obesity (2.8%) among Delhi boys are found more or less the same with frequency of overweight (9.0%) and obesity (2.9%) among Delhi girls (Kaur et al. 2008). The occurrence of overweight (15.7%) and obesity (12.4%) is reported among the Punjabi boys, and overweight (12.9%) and obesity (9.9%) is found among Punjabi girls (Chhatwal et al. 2004). A study in Guntur city, Andhra Pradesh shows the prevalence of overweight (8.4%) among girls and overweight (6.9%) among boys in 13-17 years old school children (Kumari and Krishna 2011). In Karnataka, the overall prevalence of overweight is 9.3 percent among adolescent boys and 10.5 percent among adolescent girls whereas, 5.2 percent of boys and 4.3 percent girls are obese (Kotian et al. 2010). The prevalence of
obesity and overweight among the affluent adolescent girls of Surat is 6.6 percent and 13.5 percent respectively (Kumar et al. 2012). In Manipur, the prevalence of overweight among adolescent girls (3.8%) and boys (3.1%) was observed (Dkhar and Singh 2012).

**Prevalence of overweight and obesity**

World Health Organization believes that the current level of obesity has substantially increased and has now reached epidemic proportions. In 1995, there were an estimated 200 million obese adults worldwide and by 2000, the number of obese adults has increased to over 300 million. Furthermore, 22 million children under the age of five are overweight worldwide (Finer 2003). In 2010, the prevalence of adults overweight is more than 1.4 billion and more than 400 million adults are obese (WHO 2011). Another 40 million children under the age of five are also reported overweight in the same year (WHO 2011). If the current trends continue, over two-third of the population will be overweight/obese worldwide within two decades (Kelly et al. 2008). The levels of obesity in industrialized societies continue to rise and are increased considerably over the last 20 years. In 1985, the prevalence of obesity in Canada has more than doubled from 5.6 percent to 14.8 percent in 1998, and it is estimated that 3.3 million people are obese (Katzmarzyk 2002; Belanger-Ducharme and Tremblay 2005). In 2004, the Canadian Community Health Survey reported that among adolescents, overweight has more than doubled and obesity rate has tripled over the past 25 years (Shields 2006). The pattern in Australia is similar, where the prevalence of obesity is 2.5 times higher than in 1981 and it is estimated that 20.8 percent of the population are obese (Cameron et al. 2003). Likewise, in the United States, figures from the National Health and Nutrition Examination Survey (NHANES) shows that the prevalence of obesity among adults aged 20-74 years old are increased from 13.3 percent to 30.9 percent between 1960 and 2000, and most of this rise has occurred in the past 20 years showing continuous increases in prevalence (Flegal et al. 2002). In fact, in 2006, a study reported that 66.3 percent and 32.2 percent of American adults are overweight and obese respectively (Ogden et al. 2006). The prevalence of overweight and obesity among adolescents in Bolivia is 14.0 percent and 5.0 percent respectively (Perez-Cueto et al. 2009). In majority of the
European countries, the prevalence of obesity has increased by about 10-40 percent in the past 10 years. A study shows that the prevalence of overweight and obesity among adults in the European Union is 35.9 percent and 17.2 percent respectively (IASO 2008). Again, 26 million children in European Union countries are overweight and 6.4 million obese (Kosti and Panagiotakos 2006). Prevalence among children in Portugal, Greece and England are also among the highest (IASO 2009). Molarius et al. (2000) found that the prevalence of obesity has increased in general in all of the WHO populations between the initial and final survey, with the exception of Moscow, where prevalence is decreased for both men and women. In England, the level of obesity has tripled since 1980 and around 21 percent of men and 24 percent of women are obese (National Audit Office 2001, Chief Medical Officer for England 2002). Furthermore, obesity in children and adolescents of all ethnicities has increased nearly two-fold over the past 10 years (Matijasevich et al. 2009).

Contrary to popular belief, obesity is not confined to industrialized societies and is spreading rapidly among developing countries (Friedrich 2002). For example, in Africa, where the focus has been on under nutrition, the levels of obesity among affluent populations are rising and in Ghana, there are only slightly more underweight than overweight people (IOTF 2003). The prevalence of overweight and obesity in Asia demands significant concern since the risk of developing medical complications starts to increase at BMI values lower than 25kg/m² (Wen et al. 2009). Although the prevalence of obesity in China is only a few percent, it is gradually rising and with such a large population (Bjorntorp 1997). Data from the Thailand National Health Examination Survey (2003–2004) shows a significant increase in the prevalence of overweight and obesity, from 25 percent in 1991 to 48 percent in 2004 in a sample of Thai adults aged 35-59 years (Thailand Health Profile 2008). In 1996, the overweight/obesity prevalence is 10.6 percent in India, 1.6 percent in Nepal and 2.7 percent in Bangladesh. In 2006, these rates are increased to 14.8 percent, 10.1 percent and 8.9 percent respectively (Balarajan and Villamor 2009). In Malaysia, a study using the National Health Survey data reveals that among adults, 20.7 percent are overweight and 5.8 percent are obese (Ismail et al. 2002).
One of the earliest studies on obesity in India has reported 27 percent prevalence of overweight/obesity in the urban areas and 10 percent in rural areas (Gopinath et al. 1994). ICMR task force carried out a study involving more than 5000 individuals has demonstrated 43 percent prevalence of overweight in urban Delhi and 12 percent in rural Haryana (ICMR 1994). Two other studies from north India has found a prevalence of 17 percent in Ludhiana (Wander et al. 1994) and 15 percent in Kashmir (Zargar et al. 2000). Similar trends are also observed in other parts of the country. Study in the urban areas of Tamil Nadu increase from 17 percent to 30 percent (Ramachandran et al. 2001) and in rural areas increase sharply from 2 percent (Ramachandran et al. 1992) to 17 percent (Ramachandran et al. 2004). The urban cities in the country are facing high prevalence of obesity. In a multi centric study involving seven urban cities (Chennai, Bangalore, Hyderabad, Mumbai, Calcutta and New Delhi) in India among the age group of 20-40 and >40 age group has been observed a prevalence of 31 percent and 38 percent respectively (Snehalatha et al. 2003). Another study again shows that the prevalence of overweight and obesity at Punjab, Maharashtra, Delhi and Chennai is 11 percent and 29 percent respectively (Kaur et al. 2005). The prevalence of adult overweight and obesity is found to be 22.1 percent and 5.2 percent respectively in Jamnagar city Gujarat (Vadera et al. 2010).

Prevalence of overweight and obesity in school children in Punjab is found to be 14.2 percent and 11.1 percent respectively (Chhatwal et al. 2004). Another study shows the prevalence of overweight and obesity among the affluent adolescents of Ludhiana, Punjab is 12.7 percent and 3.4 percent respectively (Agrawal et al. 2008). Data on south Indian school children shows that the frequency of overweight has increased from 4.3 percent in 2003 to 6.5 percent in 2005 (Raj et al. 2007). Mysore obesity study has observed the prevalence of overweight and obesity in school children aged 5 to 16 years to be 8.5 percent and 3.4 percent respectively (Premanath et al. 2010). A study conducted in Pune documented the prevalence of obesity at 5.7 percent and overweight at 19.9 percent (Khadilkar and Khadilkar 2004). The overall frequencies of overweight and obesity are 5.7 percent and 0.8 percent respectively among the Bengalee speaking adolescent of Midnapore town, West Bengal (Bisai et al. 2010). Study among urban school children of Vishakhapatnam shows the frequency of overweight and obesity at 13.1 percent and 5.1 percent respectively.
(Sirisha et al. 2011). Singh et al. (2007) found the overall prevalence of adult overweight (33.5%) and obesity (6.8%) in five cities of India (Moradabad, Trivandrum, Kolkata, Nagpur and Bombay). The prevalence of overweight and obesity among 12-19 years old school children in Manipur is 4.2 percent and 0.8 percent respectively (Bishwalata et al. 2010).

According to NFHS-3, the occurrence of overweight or obese among women and men is 12.6 percent and 9.5 percent respectively (IIPS 2007). Among the Indian state, the prevalence of overweight or obese (22.2%) among men and overweight or obese (29.9%) among women is reported highest in Punjab followed by Kerala where the percentage of overweight or obese is 17.8 percent among men and 28.1 percent. Delhi rank third where the reported frequency of overweight or obese among men and women is 16.8 percent and 26.4 percent respectively (IIPS 2007). In North-East India, the prevalence of overweight or obese among men (11.9%) and women (15.4%) is highest in Sikkim. The prevalence of overweight or obese among men and women in Manipur is 9.2 percent and 13.3 percent that is more or less the same with the national value. Mizoram also shows high prevalence of overweight or obese among men (11.4%) and women (10.6%). The prevalence of overweight or obese (10.8%) among women aged 15-49 years found in NFHS-2 (IIPS 2000) is increased to overweight or obese (13.3%) in Manipur by NFHS-3 (IIPS 2007).

**Obesity in relation to socio-economic status**

Prevalence of overweight and obesity has emerged across different socio-economic groups and the relationship between socio-economic conditions and obesity has been showed inconsistent in various studies in both developed and developing countries. A consistent and strong inverse relationship has been established between economic conditions and obesity in the United States (Albrighth et al. 2005; Bove and Olson 2006; Mauro et al. 2008), Australia (Dollman et al. 2007), China (Zhang et al. 2007), Finland (Huurre et al. 2002), France (Lioret et al. 2007), Great Britain (Wardle and Griffith 2001; Brodersen et al. 2007), Ireland (Share and Strain 2008), Italy (La Torre et al. 2006), New Zealand (Metcalf et al. 2007), Scotland (Inchley et al. 2005), Spain (Serra-Majem et al. 2006) and Sweden (Lindstrom et al. 2001).
However, other investigators have reported the relationship between economic conditions and obesity in developing countries to be positive and strong; implying that the higher the economic conditions the more the obesity (Bunker et al. 1992; Gilbert et al. 1994; Bovet et al. 2003). Sobal and Stunkard (1989) after reviewing 144 published papers dealing with economic conditions and obesity has found that in developing societies, the wealthy are more likely to be obese. The positive relationship between obesity and economic status are reported from the studies in Brazil (Montiero et al. 2004), Cameroon (Fezeu et al. 2006), India (Reddy et al. 2002) Jordan (Montiero et al. 2004) and Madagascar (Montiero et al. 2004). The prevalence of obesity and overweight among Delhi school children in the age group of 5-18 years belonging in low income group is 0.1 and 2.7 percent respectively, amongst middle income group, it is 0.6 and 6.5 percent and in high income group, it is 6.8 and 15.3 percent respectively (Kaur et al. 2008). A study in Bangalore school girls shows that the prevalence of overweight (15.1%) and obesity (2.6%) are reported higher in high-income group (Sood et al. 2007). However, Fezeu et al. (2006) has submitted that the reported positive relationship between economic conditions and obesity might not be true for all developing societies. It has even been suggested that the obesity rates in various segments of the population can be used to describe the developmental status of a nation in that as a country’s GNP increases, obesity shifts to the lower income segment of the population (Sobal and Stunkard 1989; Montiero et al. 2004). Lack of food and high-energy expenditure are less frequent once a society reaches a certain level of economic growth, particularly among its poorer sections (Montiero et al. 2004). Despite the reported positive relationship between economic conditions and obesity in developing countries, recent studies have shown that the increasing economic and social development of each country, the burden of obesity shift towards the poor (Popkin 2002; Monteiro et al. 2004; Song 2006). Once considered problems only in higher-income countries, overweight and obesity are now dramatically raise in low and middle income countries (Brewis 2011).

Various studies also show the relationship between obesity and other socio-economic variables such as education and occupation (Shah 1989; Dressler 1990). The Scottish Health Survey (1998) found that women in manual classes are more likely to be obese than women in non-manual classes. A recent Australian population
study found that women in low status employment are more likely to have a high BMI, and are more likely to be overweight than women in high status employment (Ball et al. 2002). Professional and white-collar workers have lower volumes of occupational physical activity compared to blue-collar workers (Steele and Mummery 2003; Mark et al. 2008). Studies among north Indian women working as professional/technical/managers show that they are more prone to be overweight and obese than those working in other fields (Agrawal et al. 2001). In contrast, obesity is uncommon among occupational groups that undertake high levels of physical activity during working hours. In one population with high levels of obesity, Keighley et al. (2006) found that adults in American Samoa who were engaged in farm work have lower BMIs than those not engage in such work. With development and advance in technology, most of the occupational work can now be perform with minimum physical activities (Lakdawalla and Philipson 2002). Furthermore, with ever-increasing urbanization and technological advance continues in its social and economic transformation, increasing sedentariness in both occupational and domestic work appears to be inevitable (Monda et al. 2008). Technological advancements are prominent in worksites, including photocopiers, elevators, computers, and e-mail, and these time and energy saving devices have drastically reduced the habitual level of physical activity accumulation in a normal working day, particularly amongst professional and white-collar occupations (Philipson and Posner 2003).

Education is sometimes used as an alternative to income as an indicator for socio-economic conditions and studies have demonstrated associations between obesity and educational level. A strong inverse association between obesity and educational level has been reported in numerous affluent populations especially among women (Sobal and Stunkard 1989; Bennett 1995; Wamala et al. 1997; Rahkonen et al. 1998; Stam-Moraga et al. 1999; Wardle and Griffith 2001). Molarius et al. (2000) found that lower education is associated with higher BMI in almost all of the WHO MONICA populations and women with higher education tended to be leaner than those with lower education. Similarly, Rosmond and Bjorntorp (1999) reported that Swedish women who are overweight are more likely to have a lower educational level, be unemployed and have jobs involving shift work compared to women who are not overweight. Another Swedish study found a relationship between
level of education and BMI, where participants with the highest BMI have the lowest level of education in both men and women (Sundquist and Johansson 1998). The prevalence of obesity is three times higher among men with a low level of education compared to men with a high level of education. Among women, the prevalence of obesity is more than five times higher among those with a low level of education compared to high level education (Visscher et al. 2002). In a Finnish study, subjects with low education were more likely to gain weight compared to well-educated men and women during a five-year period (Rissanen et al. 1991). However, there are also figures that show an increase in prevalence of obesity during the last decade of the 20th century among high-educated men and women (Visscher et al. 2002). A positive association between obesity and educational level has been shown in some eastern and central European countries (Molarius et al. 2000). There seems to be strong evidence that lack of physical activity is of great importance for the increase in overweight and obesity (Cutler et al. 2003). The differences between the educational groups are observed to increase in about two-thirds of the WHO MONICA populations over the past ten years (Molarius et al. 2000).

Marital status has been found to be associated with BMI and obesity, although this relationship is not well established. Several (Kahn et al. 1991; Rosmond et al. 1996), but not all (Tavani et al. 1994; Wamala et al. 1997) cross-sectional studies have shown married or cohabiting subjects to have a higher BMI than subjects living alone. A study carried out in the European Union suggests single subjects (data on men and women analysed together) are less likely to be obese than married or previously married subjects (Martinez et al. 1999). In a US study, married men are found to be more likely obese than those who never married or were previously married. In women, however, marital status was not associated with obesity (Sobal et al. 1992). In contrast, in Belgium and Spain, married women but not men have a higher BMI compared to single women (Stam-Moraga et al. 1999; Aranceta et al. 2001). In a few longitudinal studies, the BMI of those who got married during the follow-up period has increased more than those retaining the same marital status at the beginning of the study (Kahn et al. 1991; Rissanen et al. 1991; Sundquist and Johansson 1998). In a US study, men getting married or remain unmarried are shown to be more likely to gain weight over a ten-year period than men who are consistently
married. However, a marriage ending (divorced, widowed) is associated with weight loss (Kahn and Williamson 1990).

**Obesity in relation to lifestyles**

Differences in the predominant lifestyles and developmental status of nations and regions also influence overweight and obesity patterns (Van Itallie 1994). Physical activity is a key factor in maintaining healthy weight status because of its potentially major impact on body composition, metabolism, and increasing expenditure (Nowicka and Flodmark 2007). Participating in regular physical exercise has many beneficial physiological outcomes like increasing bone mineral density, cardio-respiratory capacity, muscular strength and endurance, as well as flexibility (Fraser-Thomas et al. 2005). Physical activity also puts adolescents at a decreased risk of cardiovascular disease risk factors and metabolic syndrome development by helping to maintain normal blood pressure, lipid profiles, and insulin sensitivity (Eisenmann et al. 2007) and are less likely to experience symptoms of depression, experience higher life satisfaction, increased self-esteem, and decreased stress (Sallis et al. 2000; Fraser-Thomas et al. 2005). A review published by Atlantis et al. (2006) found that higher amount of physical exercise may see a larger reduction in body fat. Many studies have reported an inverse relationship between physical activity and obesity among adulthood (Van Der Horst et al. 2007). However, in some studies, no association between physical exercise and BMI has been found (Tremblay et al. 1995) or an inverse association has been observed only in women (Fentem and Mockett 1998). Low levels of physical activity are associated with an increased risk of obesity (Erlichman et al. 2002). In an American study, it is found that much of the increase in overweight and obesity in men and women, adolescents and adults are related to inactivity with television viewing being one factor that has been shown to be positively correlated to excess weight gain. A study by Saw and Rajan (1997) contributed the rising trend of overweight and obesity to such factors as low levels of physical activity. The obesogenic environments not only discourage physical activity but also encourage inactivity both occupationally and during leisure time (Hill and Peters 1998; Brownell 2002; Hill and Wyatt 2005). There has been a great decline in occupationally related activity since the turn of the twentieth century (Popkin et al.
In industrialized nations and urban areas of developing countries, jobs requiring heavy manual labour have been largely replaced by jobs in service and high technology sectors, which require minimal physical exertion (French et al. 2001). The increased usage of automobiles and public transportation systems encourages inactivity, whereas increasing time spent on watching television, playing electronic games, and/or using computers has increased sedentary behaviour of both adults and children (Hill and Peters 1998; Jeffrey and French 1998; Brownell 2002). A study performed on 3,132 individuals at seven health centres delineated the association between exercise and obesity among Japanese. This study shows that the prevalence of obesity is lower among individuals who are in the habit of performing exercise, and that the risk of obesity in this group is low (Hiraoka et al. 1998). Many studies have shown that the prevalence of obesity, the mean BMI, or the body weight decreases as the amount of exercise increases (Williamson et al. 1993; French et al. 1994; Williamson 1996).

Sedentary activities like the time spent on television, playing digital games, or using computers are the most frequently studied sedentary activities in the field of obesity research (Must and Tybor 2005; Koezuka et al. 2006; Shields 2006; Vicente-Rodriguez et al. 2008). There have been mixed findings in reports on the associations between time spent in various sedentary behaviours and weight status (Rey-Lopez et al. 2008). However, most studies reported an association between time spent on television with overweight and obesity (Koezuka et al. 2006; Shields 2006; Schneider et al. 2007; Vicente-Rodriguez et al. 2008). In 1985, the classical study by Dietz and Gortmaker (1985) based on skin fold measurements produce both cross-sectional and longitudinal evidence of a positive association between time spent on watching television and prevalence of obesity. Since that time, several cross-sectional studies have demonstrated that increased television viewing is positively associated with the prevalence of adolescence overweight and obesity. However, studies with no association also exist. In 2001/2002 Health Behaviour in School Aged Children (HBSC) study, a positive association between increase television viewing time and prevalence of overweight is observed in 23 out of 35 countries and regions studied, and in the remaining countries or regions no association is detected (Janssen et al. 2005). In a Spanish case control study, time spent watching television is associated
with higher odds of obesity (Ochoa et al. 2007). Hancox and Poulton (2006) followed New Zealand children from the age of 3 years to the 15 years and found a positive association between time spent on television viewing and later overweight among girls but not among boys. A study by Shields (2006) found that children who spent two or more hours on television are twice as likely to be overweight and obese compared to children less involved in these activities. The same study also reported that 35 percent of adolescents who watch 30 or more hours of television per week are overweight and obese compared to 23 percent of adolescents watching less than 10 hours of television per week. A recent study suggests that sedentary behaviour moderates the relationship between physical activity and overweight (Wong and Leatherdale 2009). A study by Koezuka et al. (2006) shows that increase television time is very closely associated with physical inactivity, which may contribute to increase weight status. Rey-Lopez et al. (2008) state that there is sufficient evidence to recommend that the time children and adolescents, especially younger children, spend watching television be limited. A study in Australia reported that watching television more than four hours a day are twice as likely to be overweight than subjects watching television less than one hour per day (Salmon et al. 2000). Hours of television watching is also observed to be positively associated with BMI in Swedish men (Rosmonds et al. 1996) and US women but not men (Jeffery and French 1998).

The relationship between sleep and obesity has become a topic of great interest as obesity rates reach record levels and chronic sleep deprivation affects increasing numbers of adolescents and adults (Marshall et al. 2008; Ogden et al. 2010). A number of cross-sectional studies conducted in Australia, US, Europe and Asia have found that short sleep is associated with an increased risk of obesity (Cappuccio et al. 2008; Magee et al. 2010b). These cross-sectional findings have been supported by longitudinal studies demonstrating that short sleep at baseline predicts modest weight gain at follow up several years later (Hasler et al. 2004; Gangwisch et al. 2005; Patel et al. 2006; Chaput et al. 2008; Lopez-Garcia et al. 2008). Other studies show that even modest reductions in sleep duration are associated with significant increases in obesity risk among adults (Vioque et al. 2000; Hasler et al. 2004; Gangwisch et al. 2005; Vorona et al. 2005). Sleep restriction has been linked to alterations in leptin and ghrelin levels and impaired glucose tolerance, suggesting that
long-term reductions in sleep may set up hormonal changes that lead to weight gain (Spiegel et al. 2004). A number of studies have found sex differences in the association between sleep duration and obesity. The link between sleep duration and obesity has been well established among adults (Hasler et al. 2004; Gangwisch et al. 2005; Vorona et al. 2005), but comparatively little is known about this relationship in adolescents and younger children. Ko et al. (2007) found that short sleep is associated with obesity in men, but there is no association in women. However, studies in Japanese children of the Toyama Birth Cohort show an association between shorter sleep duration and increase overweight (Kagamimori el al. 1999; Sekine et al. 2002; Sugimori el al. 2004). Similar findings are reported among the British children (Reilly et al. 2005). Among 60 overweight children aged 10 to 17 years compared with matched control subjects, overweight is significantly associated with short sleep duration (Beebe et al. 2007) and among 383 children aged 11 to 16 years, decreased sleep duration is associated with increased overweight risk, independent of age, gender, and race (Gupta et al. 2002). The single US study that evaluated the potential longitudinal relationship between sleep and overweight found that among 150 children, shorter sleep duration is associated with increased overweight risk (Agras et al. 2004).

Cultural variations of appropriate and preferable body image also may have contributed to obesity rates (de Garine and Pollock 1995). In some societies, larger body size has traditionally been seen as attractive and indicative of attributes such as health, fertility, beauty, wealth, and power. In a cross-cultural comparison of appropriate body size in different traditional societies, Brown (1991) found that the vast majority favour plumpness as being attractive. Such societies include ones in Nauru, Samoa, and Malaysia (de Garine and Pollock 1995). Various societies across the world practice or have practiced ritual fattening to promote fertility, marriage ability, and embodied social status. These include groups in Africa, Central and North America (Mexican Americans and African Americans in particular), Japan, and the Pacific (de Garine and Pollock 1995). Among these, only populations in the Pacific now experience widespread obesity. Relationships between obesity and perceived attractiveness vary among communities and societies. African American women prefer body size that is larger, on average, than similar groups of European American
women (Stevens et al. 1994; Flynn and Fitzgibbon 1998; Becker et al. 1999; Fitzgibbon et al. 2000). Furthermore, overweight and obese African American women perceive themselves as healthier and more attractive to the opposite sex than white women of similar weight and age (Stevens et al. 1994; Flynn and Fitzgibbon 1998; Becker et al. 1999). European Americans experience dissatisfaction with their own body size at lower BMIs than either Hispanic Americans or African Americans (Fitzgibbon et al. 2000). Studies showing an increase value of thinness and increase awareness of the risk factors associated with overweight and obesity suggest that socio-cultural factors, such as participation in the global economy and exposure to western ideas, may influence body image perceptions worldwide. A number of communities and societies in which obesity has raised in recent decades and that previously are shown to desire and/or accept larger bodies and obesity now prefer thinner bodies (Madrigal et al. 2000; Anderson et al. 2002; Tur et al. 2005). This has been observed among African American girls (Katz et al. 2004), Turkish adolescents (Canpolat et al. 2005), Pacific Islanders (Wilkinson et al. 1994; Craig et al. 1996; Brewis et al. 1998; Becker et al. 2005), the Ojibway-Cree in Canada (Gittelsohn et al. 1996), urban Native American youth (Rinderknecht and Smith 2002), and Korean children (Lee et al. 2004). Among Europeans, the desire for thinner body size is increasingly observed in children and adolescents and is not confined to women of upper-socioeconomic status (Story et al. 1995; Katz et al. 2004; Lee et al. 2004; Canpolat et al. 2005).

**Obesity in relation to food habits**

Food habits are the way in which individuals or groups of person respond to social and cultural pressures, choose, consume, and make used of available foods (Mead 1962). As populations become more westernized, dietary composition changes to include more saturated fat and less fibre. Major dietary changes include a large increase in the consumption of fat and added sugar in the diet, high calorie liquids with a fall in total cereal intake and fibre (Popkin 2009). However, there are many exceptions and foods that drive these changes differ by regions. For instance, for Asia a major component appears to be increased in amount of edible oils in the diet. According to de Garine (1969), urban food habits depend first on traditional food
habits at home and second on new influences, for instances eating in workers canteens. Where nutrition transitions occur, the impacts are usually seen first among the affluent, than among the lower income classes (Delpeuch and Marie 1997).

Many studies report a negative relationship between fruit and vegetable intake and overweight and obesity (Janssen et al. 2004; Shields 2006; Roseman et al. 2007). However, in USA, fruit and vegetable intake has been associated consistently with overweight and obesity in adolescents, yet intake among US adolescents remains low (Eaton et al. 2008; Zapata et al. 2008). Fruits and vegetables are generally low in fat, calories, and added sugar while having high concentrations of nutrients and fibre, which makes them a good choice for promoting a healthy diet and weight status (Bes-Rastrollo et al. 2006; Lowry et al. 2008). There is also evidence that sufficient fruit and vegetable intake can help maintain healthy weight status (Bes-Rastrollo et al. 2006). A 5-year longitudinal study of 11,000 adults found a significant inverse relationship between fruit/vegetable consumption and weight gain (Bes-Rastrollo et al. 2006). In 2008, researchers examine fruit and vegetable preference and weight status in a group of over 300 black children in south eastern Louisiana (Lakkakula et al. 2008). The results of the study show that children with a very low preference of fruits and vegetables are 5.5 times more likely to be overweight or obese when compared to children that have a high preference for fruit and vegetable intake.

Of the nutritional factors related to obesity, dietary fat intake is widely believed to be the primary determinant of body fat (Bray and Popkin 1998). A positive association between dietary fat intake and weight gain has been observed in many (Klesges et al. 1995; Coakley et al. 1998; Sherwood et al. 2000), but not all studies (Colditz et al. 1990; Jorgensen et al. 1995). High-fat diets have been suggested to promote obesity by increasing energy intake (Ravussin and Tataranni 1997; Hill et al. 2000). This has been proposed to be due to the greater flavour and palatability of high-fat foods and their high-energy density (Poppitt 1995) but weak effect on satiation (Blundell and Macdiarmid 1997; Rolls 2000). From epidemiological studies, however, evidence for a high-fat diet promoting a positive energy balance and development of obesity is not definitive (Lissner and Heitmann 1995; Seidell 1998). As review by Lissner and Heitmann (1995), most of the cross-sectional studies have
shown a positive association between the percentage of dietary fat and BMI. Some recent studies support this finding (Tremblay et al. 1995; Doucet et al. 1998), although in other studies this association has been found in men only (Macdiarmid et al. 1996; Blokstra et al. 1999; Stam-Moraga et al. 1999). Interestingly, an inverse association is reported in a study that shows that women with a higher BMI reported a lower fat intake than women with a lower BMI (Hjartaker and Lund 1998).

The growing popularity of fast food is just one of many cultural changes that have been brought about by globalization (Schlosser 2002). Jebb (2003) has proposed a possible mechanistic link between fast foods, energy density and obesity. Fast food has characteristics that favour the development of obesity, including its high-energy density, fat, and fructose content (Isganaitis and Lustig 2005). In the United States, portion sizes of pre-packaged and restaurant-prepared foods have increased greatly across the past two decades (Harnack et al. 2000; McConahy et al. 2002; Young and Nestle 2002; Smiciklas-Wright et al. 2003; Kral and Rolls 2004). Increased snacking and decreased structure of meals have also taken place in many industrialized and industrializing nations (Decarli et al. 2000; Samuelson 2000; Jahns et al. 2001; Zizza et al. 2001; Crooks 2003; St-Onge et al. 2003). Children in the United States eat more food away from home, drink more soft drinks, and snack more frequently than 20 years ago (Jahns et al. 2001; Nielsen et al. 2002; St-Onge et al. 2003). Snack foods are often densely caloric, prepared, processed, and packaged foods (Nielsen et al. 2002). Both adults (Tucker and Friedman 1989; Tucker and Bagwell 1991; Jeffrey and French 1998) and children (Dietz and Gortmaker 1985; Del Toro and Greenberg 1989; Renders et al. 2004; van den Bulck and van Mierlo 2004) often snack without feeling physically hungry, especially when distracted by an external stimulus, such as watching television (Stroebele and de Castro 2004). It is more difficult for humans to accurately monitor how much they have eaten when distracted (Wansink 2004). Besides these, increasing time constraints on home cooking in food-secure nations also likely contribute to obesity rates because of high women engagement in the workforce and because most cooking remains to be done by women (St-Onge et al. 2003). A consequence of this has been the emergence and rise in demand for pre-packaged convenience foods with short preparation times (Schluter and Lee 1999), and food consumption away from the home (Lin et al. 1996; McCrory et al. 1999;
French et al. 2001; Nielsen et al. 2002; Critser 2003; St-Onge et al. 2003). The globalization of fast food is beginning to affect the eating patterns in many countries undergoing nutrition transition (Adair and Popkin 2005). Despite insufficient employment, overcrowding, inadequate cooking facilities and expensive housing, many comparisons with country folk show that town folk have more varied food, including fruits and vegetables, more meat and less seasonal influence on diet (de Garine 1969). However, this general impression is subjective, as the situation may differ from country to country, and between socio-economic groups in one town.

Sugar-sweetened beverage consumption like soda is found to be associated with overweight and obesity in many studies (Forshee et al. 2004; Dubois et al. 2007; Wang et al. 2008). It is believed that consumption of these energy-dense beverages is often not accompanied with reduction in other areas of intake (Wang et al. 2008). This results in an increase overall caloric intake and contributes to positive energy balance and weight gain. However, there have been mixed results regarding the association of regular carbonated soft drink consumption and obesity (Dubois et al. 2007). While most of the evidence suggests that there is a positive, significant relationship between soda consumption and BMI (Stiegel-Moore et al. 2006), but some studies that have not reported a significant relationship. In a study of 12-16 year old adolescents from the NHANES III (1988-1994), consumption of regular carbonated soft drinks is not significantly associated with increased BMI (Forshee et al. 2004). Conversely, another longitudinal study found that young children regularly consuming sugar-sweetened beverages between meals are four times more likely to be overweight when compared to children that do not drink sugar-sweetened beverages between meals (Dubois et al. 2007). A study by Novotny et al. (2004) found that among girls, aged 9-14 year, increase soda consumption is associated with greater weight. The researchers in this study suggest that soda is nutrient-light, only containing sugar, which is metabolized quickly and can lead to blood glucose swings. These swings in blood glucose may trigger hunger and increase energy intake, even in the presence of excess energy. Another study by Striegel-Moore et al. (2006) analyzes the association between drink consumption and obesity. They found that of all the drinks consumed (diet and regular soda, fruit juice, fruit-flavoured drinks, and coffee/tea), regular soda is the greatest predictor of increased BMI. The researchers in this study suggest that
perhaps higher soda consumption is also associated with more fast food meals, which are often served with sodas and that this might help explain why sodas in particular are associated with high BMI. The dietary behaviours considered here are directly related to overall energy intake.

**Obesity in relation to morbidity**

The importance of obesity as a risk factor for a number of diseases including diabetes, cardiovascular disease (CVD), hypertension, gallstones and certain cancers, is well documented (WHO 1998). Several studies in India have related overweight and obesity condition with diabetes, hypertension and heart disease (Gopinath et al. 1994; Singh et al. 2000; Venkatramana and Reddy 2002; Mishra et al. 2006). The health risks of obesity depend on where the fat is distributed and abdominal obesity is associated with increased incidence of chronic heart disease (CHD) (Larsson et al. 1984; Donahue et al. 1987). However, Rimm et al. (1995) conducted a prospective study of men health professionals aged 40-75 and concluded that obesity, independent of fat distribution, was a risk factor for CHD. Several studies have demonstrated a relationship between BMI and CVD. For example, the Framingham study found a direct association between degree of overweight and CVD independent of other risk factors (Hubert et al. 1983). Likewise, the Nurses' Health Study found that a higher BMI is positively associated with CHD (Manson et al. 1990) and the British Regional Heart Study found that a higher BMI is related to the incidence of heart attacks (Shaper et al. 1997). Several studies have found that a high BMI may increase the risk of stroke (Hubert et al. 1983; Di Pietro et al. 1994; Shaper et al. 1997; Kurth et al. 2002). However, others have not found that BMI is a risk factor for stroke (Walker et al. 1996; Curb and Marcus 1991). Hypertension has been shown to be associated with increasing body weight (MacMahon et al. 1987). Further, it is estimated that hypertension is two to three times more common in obese men and than in leaner members of the population (WHO 1998). Recent research has shown that childhood overweight is also associated with CVD risk factors. For example, Freedman et al. (1999) discovered around 60 percent of overweight children aged 5-10 year old has one cardiovascular risk factor such as hypertension, hyperlipidemia (elevated levels of
fat in the bloodstream) or elevated insulin levels. Furthermore, over 20 percent of 5-10 year olds have two or more cardiovascular risk factors.

Research has shown that abdominal obesity is an important risk factor for developing type II diabetes (Astrup 2001). The relationship between obesity and type II diabetes is indisputable and numerous studies have confirmed that obese persons are more likely to suffer from type II diabetes. It is estimated that there are around 110 million diabetics worldwide and 80-90 percent of them have type II diabetes (Astrup and Finer 2000). In addition, around 80 percent of individuals with type II diabetes are obese (Pi-Suyner 1993). Data from the Nurses' Health study illustrate the association between BMI and type II diabetes, as obese women has a 93-fold increased risk of developing type II diabetes than women with a normal BMI. Although there are strong associations between obesity and type II diabetes, it has been highlighted that overweight and obesity do not necessarily cause type II diabetes and not all obese individuals will develop type II diabetes (Astrup and Finer 2000). Type II diabetes has genetic origins and it has been argued that the genes that cause type II diabetes also promote weight gain (Ernsberger and Koletsky 1999).

The risk of developing diabetes increases as the degree of overweight increases. Overweight and obesity are most closely related to diabetes (McKeigue et al. 1991; Seidell, 1997; Ko et al. 1999; Ishikawa-Takata et al. 2002). It is estimated that more than two-thirds of all diabetes cases can be linked to overweight condition (Seidell 1997). More than half of the world’s newly diagnosed cases of diabetes come from India and China (McLellan 2002). WHO (2002) estimated that approximately 55 percent of diabetes mellitus, 21 percent of heart disease, and 8-40 percent of certain cancers can be attributed to BMI above 21kg/m². The increase cholesterol levels excreted in the bile as obesity develops appear to be linked to the development of gallstones (Stampfer et al. 1992). Gallstones occur three or four times more often in the obese than in the general population.

Obesity is associated with a one and half to three times higher risk of developing endometrial cancer than a BMI between 20 and 25kg/m² (Visscher and Seidell 2001). Research has also shown that there is an association between BMI and colon cancer particularly among men (Caan et al. 1998; Murphy et al. 2000). Studies
investigating the relationship between obesity and breast cancer have produced different results for pre-menopausal and post-menopausal women. Pre-menopausal women with a high BMI have a reduced risk of breast cancer (Ursin et al. 1995; Kawachi 1999). Weight gain in adulthood has been consistently associated with breast cancer in postmenopausal women (Brinton and Swanson 1992; Huang et al. 1997).

Sleep apnea and asthma are regularly cited as a common consequence of obesity. Sleep apnea is strongly associated with obesity and contributes to psychosocial morbidity, as it can result in excessive sleepiness and restless sleep (Aronne 2002). Research has shown that morbidly obese men are most likely to develop sleep apnea (Vgontzas et al. 1994). However, obese women can also develop sleep apnea. For example, Young et al. (1993) estimated that two percent of obese women and four percent of obese men aged 30-60 in their study are experienced sleep apnea. Obesity and asthma are frequently linked, and an association is first reported in the 1980s (Chinn 2003). Cross-sectional studies have shown that the prevalence of asthma is higher for women, with obese women being three times more likely to develop asthma (Camargo et al. 1999). Likewise, amongst children, obese girls are more likely than obese boys to suffer from asthma (Figucroa-Munoz et al. 2001). The intervention studies have shown that weight loss in asthma patients improves lung function and asthma symptoms (Stenius-Aarniala et al. 2000; Tantisira and Weiss 2001).

Osteoarthritis has been linked to obesity (Felson 1996) and research has confirmed that it is directly caused by a high body weight. It is also thought that osteoarthritis occurs due to increased pressure on the joints (Ernsberger and Koletsky 1999). However, healthy weight individuals can also develop osteoarthritis. Osteoarthritis is more common among women than men and it is a risk factor for disability (Oliveria et al. 1999). Increase risk of back pain has also been observed in relation to obesity, particularly among women (Garzillo and Garzillo 1994; Han et al. 1997). The extra weight an obese person carries, especially fat distribution in the central portion, puts increased stress on the weight bearing joints, particularly the knees, hips and some joints of the back cause osteoarthritis of hands, knees and wrist (Carman et al. 1994).