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REVIEW OF LITERATURE

The literature pertaining to the present study **"OBESITY RELATED HEALTH RISKS AND ITS IMPACT ON DIETARY INTERVENTION AND LIFE STYLE MODIFICATION**" is reviewed under the following headings:

A. Obesity – The Global health issue

a. Prevalence
b. Etiology
c. Complications

B. Review on obesity and its management

a. Dietary management
b. Physical exercise
c. Lifestyle modification
d. Prevention of obesity

C. Nutritional benefits of selected foods

a. Oat bran
b. Wheat bran
c. Green gram
d. Whole wheat

D. Dietary fiber- boon for health and well being

India is gaining weight. Traditionally known for malnutrition (Kalra and Unnikrishnan, 2012), Indians now report more and more frequently with overweight, obesity, and their consequences. Indians exhibit unique feature of obesity, this phenomenon is a global one; India is unique in that it has to grapple with both over- and under nutrition at the same time.

Obesity can be seen as the first wave of a defined cluster of non communicable diseases called "New World Syndrome," creating an enormous socioeconomic and public health burden in poorer countries (Pednekar, 2008). The World Health Organization has described obesity as one of today's most neglected public health problems, affecting every region of the globe.

Obesity may be defined as excess accumulation of adipose tissue in the body. It is a chronic disease in which body weight exceeds the normal by at least 20 per cent, which becomes a psychosomatic, social economic and aesthetic problem. There is a growing concern due to its high prevalence and association with morbidity. Obesity is linked to increasing adult morbidity through predisposing to a variety of conditions such as insulin resistance, lipoprotein abnormalities, diabetes mellitus Type II, cardiovascular disease, deep vein thrombosis and elevated blood pressure.

There are several standardized types of obesity that have been classified by the World Health Organization (WHO, 2008). The types of obesity range from class I to class III, but have since been subdivided by other organizations into categories such as “mild obesity” and “super obesity”.

A. Obesity – The Global health issue

a. Prevalence

Obesity is an emerging problem in urban and semi urban Indian children (Suresh *et al*., 2011). It is associated with several health problems and social consequences. Overweight and obesity are the fifth leading risk for global deaths. At least 2.8 million adults die each year as a result of being overweight or obese. Poor eating habits in all the children plays major role in the development and increases in childhood overweight and obesity.

Obesity is a chronic relapsing condition associated with significant morbidity and premature mortality. The prevalence of obesity has increased dramatically over the last 20 years and continues to do so, primarily as a result of changes in dietary intake and exercise patterns (Cannon *et al*., 2009).

Recent statistics by Jean and Angelo (2009) indicate that overweight and obesity have become an increasingly serious clinical and socioeconomic problem worldwide, and one of the greatest public health challenges of our time. The International Obesity Task Force (IOTF) estimates that, worldwide at least 1.1 billion adults are overweight, including 312 million who are obese.

How obesity affects people (NCHS, 2012)

- **Being short of breath** –If the body weight is heavy, moving around may be a difficult and people may get out of breath. If there is lot of fat around neck and chest, obese persons need to take short, shallow breaths. The extra fat makes it difficult for air to flow easily in and out of lungs.
- **Feeling tired** -If there is difficulty and hard to breathe, people may not be getting enough oxygen into the blood and make them feel tired. Carrying extra weight can be tiring too. Some people find that everyday activities become a struggle. It may take a lot of effort to walk upstairs or carry shopping.
- **Sore joints or muscles** - As the body weight increases by putting on weight, ankles and knees need to work harder. These joints and the muscles in the lower back may become sore and stiff and posture may suffer too.
- **Skin problems** -If there is a fold of fat, the skin underneath the folds can stay moist from perspiration. This makes it more likely that people may get skin infection. The skin under large breasts and buttocks can also rub and become sore.
- **Varicose veins** -Varicose veins are swollen, twisted blood vessels. They often look lumpy and blue. They aren't dangerous but they can look unattractive. And they may make legs ache. They're partly caused by the strain of carrying extra weight.
- **Irregular periods** -Some larger women find that their periods become irregular and may stop altogether. This is because the extra fat can upset the balance of hormones in the body.

Obesity and arthritis are critical public health problems with high prevalence and medical costs. In the United States, an estimated 72.5 million adults aged more than 20 years are obese, and 50 million adults have arthritis **(**www.cdc.gov.com**).**

In India more than 15 per cent of adults are obese every state, and in nine states over 30 per cent of adults are obese. New federal initiatives are helping to change our communities into places that strongly support healthy eating and active living. According to the National Family Health Survey (NFHS) about 30 million Indians are obese and around 20 per cent of school-going children are overweight.

No state in India has met the nation's Healthy People 2010 goal to lower obesity prevalence to 15 per cent. The number of states with an obesity prevalence of 30 or more has increased to 12 states in 2010. In 2009, nine states had obesity rates of 30 per cent or more. In 2000, no state had an obesity prevalence of 30 per cent or more (www.cdc.gov).

In U.S. today, the healthcare provider who treats women, from adolescence through the post reproductive and geriatric years, sees a population particularly vulnerable to the ramifications of obesity and excessive weight gain. The prevalence of overweight and obesity among women in the United States has reached the point where it is more common than a normal body weight (Jessica Nolen, 2006). The combined prevalence of overweight and obesity in women over the age of twenty years is about 51 per cent.

India is the second most populous country in the world that comprises approximately17 per cent of the world's population and contributes to 16 per cent of the world's deaths (Kalra and Unnikrishnan, 2012). Nutritional status of the Indian population varies significantly across the regions. Certain regions are associated with extremely high rates of childhood under nutrition (ranging from 20 to 80), whereas others have a high prevalence of adult under nutrition (more than 50), and some have both.

According to National Health and Nutrition Examination Survey (NHANES) 2009-2010, the prevalence of obesity in United States was 35.5 among adult men and 35.8 among adult women.

India is currently in the fourth phase of nutritional transition which is the shift of nutritional intake from basic to diet-related non-communicable diseases. These shifts are largely associated with behavioral changes in dietary profile and lifestyle and decreased indulgence in physical activity (Wang *et al*., 2009). The transitions are more rapid in young individuals. This increasing trend of childhood overweight and obesity may further increase the enormous burden of Type 2 diabetes and cardiovascular diseases in India (Misra *et al*., 2007) and impact the economy of the nation and its growth.

Published literature by Premanath *et al*., (2010) on the prevalence of obesity revealed that in India, cross-sectional studies in different regions of the country, reporting its burden at a specified time. Studies from South India have reported an obesity prevalence of 3.6 per cent in adolescents of age-group 13–18 years of Chennai in the year 2002 and 3.4 per cen in children and adolescents of age-group 5–16 years of Mysore in the year 2009.

Ramachandran and Snehalatha (2010) opines that the increasing trend in obesity among the urban and also in the rural population (>20 years) was found in Chennai, South India. In a decade, the prevalence of obesity had increased by 1.7-fold in the city. Obesity rates were higher among women, as reported from many other countries. The prevalence of overweight was lower among the urbanizing rural population, than in the urban areas. However, the rural population had a more rapid change nearly 8.6-fold increase in a period of 14 years.

According to a study projected by Kelly *et al*., (2008) the estimated total numbers of overweight and obese adults in 2005 were 937 million and 396 million respectively. By 2030, the respective number of overweight and obese adults was projected to be 1.35 billion and 573 million individuals without adjusting for secular trends. If recent secular trends continue unabated, the absolute numbers were projected to total 2.16 billion overweight and 1.12 billion obese individuals.

Excess abdominal fat is an independent predictor of the risk factors and the morbidity of obesity related diseases such as Type 2 diabetes, hypertension,

dyslipidemia and cardiovascular diseases. A study by Anuradha *et al*., (2012) reveals that abdominal obesity among the urban slum women is on the rise. The abdominal obesity was found to be significantly higher among the slum women with increasing age and in those who belonged to the muslim religion and to a higher socio-economic status.

The age of women who are overweight or obese is highest in Punjab (30%), followed by Kerala (28%) and Delhi (26%), all of which are relatively richer states. The prevalence of underweight and overweight among men shows similar variations by age, education and wealth index (NFHS, 2012).

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

Obesity results from the energy imbalance that occurs when a person consumes more calories than their body burns. Choquet and Meyre (2011) revealed that in recent decades, obesity has reached epidemic proportions in populations whose environments promote physical inactivity and increased consumption of high-calorie foods. Genetic changes in human populations occur too slowly to be responsible for the obesity epidemic. Nevertheless, the variation in how people respond to the same environment suggests that genes do play a role in the development of obesity.

There is growing evidence that dietary habits interact with genes to modulate predisposition to obesity. Studies by Andreasen *et al*. (2008) suggest that a high fat diet can amplify the effect of the FTO genotype on obesity risk. An interaction between the Apolipoprotein A-II and high-saturated fat in relation to BMI and obesity has been reported suggesting that some associations restricted to specific environments may be missed in global analyses.

It is more likely due to a changing social and physical environment that encourages consumption and discourages expenditure of energy, behaviors that

are poorly compatible with the genome that we have inherited. Research by Bouchard (2010) shows that female obesity is a result of several factors culminated together. Most of the time weight is gained by intake of more calories than what the body actually needs. Compared to men, women suffer a disproportionate burden of disease attributable to overweight and obesity.

Lack of sleep may also contribute to obesity. Recent studies suggest that people with sleep problems may gain weight over time. On the other hand, obesity may contribute to sleep problems due to medical conditions such as sleep apnea, where a person briefly stops breathing at multiple times during the night **(**http://www.win.niddk.nih.gov**).**

Keith *et al.,* (2006) put for the following ten additional explanations for obesity

- **Sleep debt**: Getting too little sleep can increase body weight.
- **Pollution**: Hormones control body weight. And many of today's pollutants affect our hormones.
- **Air conditioning**: More calories are burnt if our environment is too hot or too cold for our comfort. But more people than ever live and work in temperature-controlled homes and offices.
- **Decreased smoking**: Smoking reduces weight. Americans smoke much less than they used to.
- **Medicine**: Many different drugs including contraceptives, steroid hormones, diabetic drugs, some anti depressants, and blood pressure drugs can cause weight gain. Use of these drugs is on the upswing.
- **Population age, ethnicity**: Middle-aged people and Hispanic-Americans tend to be more obese than young European-Americans. Americans are getting older and more than Hispanic.

- **Older moms**: There's some evidence that the older a woman is when she gives birth, the higher her child's risk of obesity.

- **Ancestors' environment**: Some influences may go back two generations. Environmental changes that made a grandparent obese may "through a fatally driven positive feedback loop"

- **Fertility**: There's some evidence that obese people are more fertile than lean ones. If obesity has a genetic component, the age of obese people in the population should increase.

- **Unions of obese spouses**: Obese women tend to marry obese men. If there are fewer thin people around - and if obesity has a genetic component- there will be still more obese people in the next generation.

Certain drugs such as steroids, some anti depressants, and some medications for psychiatric conditions or seizure disorders may cause weight gain. These drugs may slow the rate at which the body burns calories, stimulate appetite, or cause the body to hold on to extra water (Choquet and Meyre 2011).

Haslam and James (2005) reveals that certain medications may cause weight gain or changes in body composition; these include insulin, sulfonylureas, antipsychotics, antidepressants, steroids, certain anticonvulsants (phenytoin and valproate), pizotifen and some forms of hormonal contraception.

Obesity is becoming increasingly prevalent in developed countries and significantly elevates human disease and mortality risk factors (Bell *et al*., 2005). While environmental factors contribute to the increase in the age of obese individuals in the population, heredity is also a very strong component. The most compelling evidence that obesity is genetically determined comes from twin adoption, and family studies suggesting that hereditary factors could contribute to the development of obesity, with heritability estimates of 40–70 per cent. Hence, the majority of the variance in the incidence of obesity is thought to be attributed to genetic factors.

The increase in obesity over the past 30 years has been fueled by a complex interplay of environmental, social, economic, and behavioral factors, acting on a background of genetic susceptibility (NIH, 2012).

A study of obese people with binge eating problems found that 51 per cent had a history of major depression. Additional research shows that obese women with binge-eating disorder who experienced teasing about their appearance later developed body dissatisfaction and depression (www.flexmodo.com).

Although a person's genetic makeup may contribute to obesity, it's not the primary cause. Environmental and behavioural factors have a greater influence - consuming excess calories from high-fat foods and doing little or no daily physical activity over the long run will lead to weight gain. Psychological factors may also foster obesity. Low self-esteem, guilty feeling, emotional stress, or trauma can lead to overeating as a means to cope up with the problem (www.webmed.com).

According to World Health Organisation (WHO, 2008) people worldwide are taking up less active recreational pursuits, while a study from Finland found an increase in obesity and a study from the United States found leisure-time physical activity has not significantly changed the condition.

Brownson *et al*., (2005) opines that certain physical and mental illnesses and the pharmaceutical substances used, can increase risk of obesity. Medical illnesses that increase obesity risk includes several rare genetic syndromes as well as some congenital or acquired conditions such as hypothyroidism, Cushing's syndrome, growth hormone deficiency, and the eating disorders: binge eating disorder and night eating syndrome.

Obesity is not regarded as a psychiatric disorder. Serag *et al*.,(2008) states that the risk of overweight and obesity is higher in patients with psychiatric disorders than in persons without psychiatric disorders. In both children and adults, there is an association between television viewing time and the risk of obesity. A study by Diaz *et al*., (2004) found that 86 per cent of the children had an elevated rate of childhood obesity with excess media exposure, with rates increasing proportionally to time spent in watching television.

In children, there appear to be declines in levels of physical activity due to less walking and physical education. World trends in active leisure time physical activity are less clear (Chiles and Wattum, 2010).

Besides being overweight or obese, here are other risk factors to consider:

- Cigarette smoking
- High blood pressure (hypertension)
- High LDL-cholesterol ("bad" cholesterol)
- Low HDL-cholesterol ("good" cholesterol)
- High triglycerides
- High blood glucose (sugar)
- Physical inactivity
- Family history of premature heart disease

C. Complications

The health problems and complications associated with obesity are numerous. Obesity is not just a cosmetic problem. It is a health hazard. Someone who is 40 per cent overweight is twice as likely to die prematurely as is an average-weight person (www.webmd.boots.com). This is because obesity has been linked to several serious medical conditions, including:

- Heart disease and stroke
- High blood pressure
- Diabetes
- Cancer
- Gallbladder disease and gallstones
- Osteoarthritis
- Gout
- Breathing problems, such as sleep apnea (when a person stops breathing for a short time during sleep) and asthma.

The prevalence of overweight and obesity is increasing worldwide. Comparison of data from 1999–2000 shows that the prevalence of overweight increased from 46 per cent to 64.5 per cent and the prevalence of obesity doubled

by 30.5 per cent. The epidemic of obesity is not just isolated to the US, but is worldwide including less affluent countries.

Obesity negatively impacts the health of women in many ways. A study by Haslam and James (2005) states that being overweight or obese increases the relative risk of diabetes and coronary artery disease in women. Women who are obese have a higher risk of low back pain and knee osteoarthritis. Obesity negatively affects both contraception and fertility as well.

Overweight and obese patients are at an increased risk for developing numerous cardio metabolic complications, including hypertension, Type 2 diabetes mellitus, dyslipidemia, and cardiovascular diseases, as well as different types of cancers. Owing to the major health risks and complications associated with obesity which negatively affect quality of life and reduce average life expectancy, in addition to placing an enormous burden on health care resources, the treatment of overweight and obesity is a public health imperative.

Direct associations between obesity and several diseases, including diabetes mellitus, hypertension, dyslipidemia and ischaemic heart disease, are well recognized. Despite this, the relationship between body weight and all-cause mortality is more controversial. A very high degree of obesity (BMI above 35 kg/m^2) seems to be linked to higher mortality rates (Malnick and Knobler 2006).

Obesity has also been associated with an increased risk of mortality in women. Studies by Gu *et al*., (2006) showed a significant association between body weight or BMI and mortality.

In the INTERHEART study, high hip circumference had a negative predictive value for myocardial infarction, while high waist circumference was associated with high rates of myocardial infarction, implying that considering only the BMI and ignoring fat distribution may be misleading (Yusuf *et al*., 2005).

It has been estimated by Diaz *et al.,* (2005) that the excess mortality associated with obesity in the Framingham study is due to the effect of weight cycling, and that those with stable body weights were not at increased risk.

A similar finding has been reported in the National Health and Nutrition Examination Survey (NHANES).

Flegal *et al*., (2005) opines that increased mortality associated both with being underweight and obese. Notably, the increased mortality was found in subjects with a BMI above 35 kg/m^2, but there was no increase in mortality in the less obese groups. In addition, there was a decline in the relative risk of mortality according to BMI categories from NHANES I to NHANES III.

More than 65 million adults and 10 million children suffer from obesity, considered one of the leading causes of life-threatening diseases. Being morbidly obese can compromise the health, shorten our life, and even cause death. The probability of developing heart disease, diabetes, and high blood pressure increases significantly with obesity and over weight.

Type II diabetes develops when either the body does not produce enough insulin in the blood or cells ignore the insulin produced. As obesity diminishes insulin's ability to control blood sugar, there is an increased risk of developing diabetes because the body begins overproducing insulin to regulate blood sugar levels. Over time, the body is no longer able to keep blood sugar levels in the normal range (www.diabetes.co.uk).

The most recent findings shows that diabetes, obesity, high blood pressure and kidney disease all remain major challenges. (Tanamas *et al*., 2012) has confirmed that simple risk factors can often be used to identify those most at risk of developing these conditions.

The importance of obesity as a risk factor for diabetes in the presence of other risk factors is underlined by a recent report by Tirosh *et al.*, (2005) from Israel. In a cohort study of relatively young men in the Israel Defence Forces who were subjected to regular physical examinations, the combination of a fasting plasma glucose in the high-normal range (91–99 mg/dl) and a BMI of >30 kg/m^2 was associated with a hazard ratio of 8.29 for developing diabetes, compared to those men with a BMI <25 kg/m^2 and a fasting plasma glucose <86 mg/dl.

Kushner and Robert (2007) states that risk of diabetes mellitus increases with the degree and duration of being overweight or obese and with more central or visceral distribution of body fat. Increased visceral fat enhances the degree of insulin resistance associated with obesity. In turn, insulin resistance and increased visceral fat are the hallmarks of metabolic syndrome, an assembly of risk factors for developing diabetes and cardiovascular disease.

Obesity is probably the most important factor in the development of insulin resistance, but Science's understanding of the chain of events is still spotty. Now, researchers at the Salk Institute for Biological Studies have filled in the gap and identified the missing link between the two. (www.sciencedaily.com).

The UK is the 'fattest' country in Europe. The number of obese adults is forecast to rise by 73 per cent over the next 20 years, resulting in more than a million extra cases of Type 2 diabetes, heart disease and cancer (www.diabetes.co.uk).

More than 80 per cent of people with Type 2 diabetes, the most common form of the disease are obese or overweight. Data from the Centers for Disease Control and Prevention (CDC) National Health and Nutrition Examination Survey (NHANES III) shows that two-thirds of adult men and women in the U.S. diagnosed with Type 2 diabetes have a body mass index (BMI) of 27 or greater, which is classified as overweight and unhealthy (www.obesityinamerica.org).

A systematic review by Sweeting (2007) included more than 135,000 patients (80 per cent women) found that bariatric surgery resulted in complete resolution of diabetes in 78 per cent of patients and improvement in diabetic control in more than 86 per cent of patients. These patients had improvements in insulin levels, fasting glucose levels, and glycosylated hemoglobin levels.

Doctors and researchers have found that obesity and diabetes are connected. Persons who are obese are at high risk for developing Type 2 diabetes (also known as "insulin-resistant" or "adult-onset" diabetes), particularly if a close

family member is affected with diabetes, there seems to be a strong connection between abdominal fat and diabetes (www.medschool.com)

High blood pressure is the primary cause of death among Americans older than 25 years of age. About 75 million people suffer from high blood pressure or hypertension, which is a major risk factor for heart disease. Blood pressure tends to increase with weight gain and age. It is not known why obesity is a major cause of high blood pressure. However, research has shown that obese patients displayed an increase in blood volume and arterial resistance (www.mediweightlossclinics.com).

An important cause of high blood pressure is diet and physical activity. Increased salt intake, obesity, and inactivity can all contribute to high blood pressure. High blood pressure contributes too many medical problems including heart and kidney disease. Even though high blood pressure is often not curable, it can usually be treated (www.healthcentral.com).

Hypertension is strongly linked to obesity. The Swedish Obesity Study by Sjostrom *et al*., (2004) showed hypertension to be present at baseline in 44–51 per cent of obese subjects. In the Nurses' Health Study, BMI at age of 18 years and in mid-life were both positively associated with the occurrence of hypertension.

Obesity is also considered as one of the causes of hypertension and this has been proved in a number of researches. According to the population studies, it has been indicated that almost two-thirds of the people suffering from obesity are at risk of hypertension. Apart from an increased risk of hypertension, there are also risks associated to sleep apnea, coronary heart disease and congestive cardiac failure.

Obesity is found to affect a number of hormonal levels in our body, the worst affected is the renin-angiotensin-aldosterone system. This system is responsible for controlling the blood volume of the body and along with the sympathetic nervous system; it controls the level of sodium and water retention in the body. Both these factors are responsible for the proper regulation of blood pressure and

with obesity interfering with these systems; it can lead to hypertension (www.healthguidance.org).

According to National Health and Nutrition Examination Surveys (NHANES) approximately a decade apart, prevalence of hypertension increased from 24.4 per cent to 28.9 per cent between 1988–1994 and 1999–2004. The increase was greater for women than men and occurred in all racial/ethnic groups. The analysis by (Theodore and Kotchen, 2008) further suggests that an increase in body mass index (BMI) accounted for nearly all of the increased hypertension prevalence in men and for a portion of the increased prevalence in women.

Kotsis *et al.,* (2010) opines that the relationship between obesity and hypertension is well established both in children and adults. The mechanisms through which obesity directly causes hypertension are still an area of research. Activation of the sympathetic nervous system has been considered to have an important function in the pathogenesis of obesity-related hypertension.

There is strong correlation among hypertension, obesity, hyperlipidemia and hyperuricemia which are important risk factor for the cardiovascular disease. Hypertension is an important risk factor for cardiovascular disease and it becomes even more important when associated with other risk factors like obesity and hyperlipidemia (Ahmed *et al*., 2009).

Obesity is associated with an unfavourable lipid profile. A report by WHO (2004) reveals that lipid abnormalities related to obesity include an elevated serum concentration of cholesterol, low-density-lipoprotein cholesterol, very low density lipoprotein cholesterol, triglycerides and apolipoprotein B, as well as a reduction in serum high-density-lipoprotein cholesterol.

The dyslipidemia associated with obesity no doubt plays a major role in the development of atherosclerosis and CVD in obese individuals. All of the components of the dyslipidemia, including higher triglycerides, decreased HDL levels, and increased small dense LDL particles, have been shown to be atherogenic (Howard *et al*., 2008). According to Molly *et al*., (2005) Regional body

fat distribution has an important influence on metabolic and cardiovascular risk factors. Increased abdominal (visceral) fat accumulation is a risk factor for coronary artery disease, dyslipidemia, hypertension, stroke, and Type 2 diabetes.

There is an apparent profile of cardiometabolic and inflammatory biomarkers that emerges as BMI increases from normal weight to obesity (Costa *et al*., 2012). Understanding these profiles may permit developing an effective approach for early risk prediction for cardio metabolic disease.

High cholesterol is one of the leading cause of heart attacks. Cholesterol is transported through the blood in two ways: the low –density lipoprotein (LDL), which transports cholesterol to the cells that need it, and the high-density lipoprotein (HDL) which is the healthy cholesterol that reduces the risk for heart attack. Having high LDL levels raises the risk of having heart disease by 20 per cent.

Heart disease and stroke are the leading causes of death and disability for people in the UK. Overweight people are twice as likely to have high blood pressure - a major risk factor for heart disease and stroke - than people who are not overweight. Very high blood levels of cholesterol can also lead to heart disease and are often linked to being overweight. Being overweight also contributes to angina and sudden death from heart disease or stroke without any signs or symptoms (www.webmd.boots.com).

According to the American Heart Association, obesity is a major risk factor for developing coronary heart disease, which can lead to heart attack or stroke. People who are overweight are at a greater risk of suffering from heart attack before the age of 45. Obese adolescents have a greater chance of having heart attack before the age of 35 than non-obese adolescents (www.mediweightlossclinics.com).

Overweight and obesity are health problems of epidemic proportions, increasing the risk not only of cardiovascular disease and Type 2 diabetes mellitus but also of various types of cancer. Obesity is strongly associated with changes in the physiological function of adipose tissue, leading to insulin resistance, chronic

inflammation, and altered secretion of adipokines. Several of these factors, such as insulin resistance, increased levels of leptin, plasminogen activator inhibitor-1, and endogenous sex steroids, decreased levels of adiponectin, and chronic inflammation, are involved in carcinogenesis and cancer progression (Rob *et al.,* 2009).

Overweight and obesity are associated with an increased all-cause mortality and cancer accounts for a substantial proportion of obesity-related deaths. In 2003, it was estimated that overweight and obesity were responsible for 14 per cent of all cancer deaths in men and 20 per cent of those in women in the United States which is consistent with the poorer outcome of cancer in overweight and obese subjects. Excess bodyweight is not only associated with cancer mortality but is also associated with an increased incidence of several types of cancer (Renehan *et al*., 2008).

Although BMI is an adequate indicator of overweight and obesity in clinical studies, it does not reflect the obesity-induced metabolic changes that may be involved in carcinogenesis. The presence of metabolic syndrome defined as a cluster of abdominal obesity, hypertension, hyper-triglyceridemia, low HDL-cholesterol, and hyperglycemia, might be a better qualitative indicator of the carcinogenic potential of obesity (Cowey and Hardy, 2006).

Adipose tissue dysfunction, as a consequence of obesity, is likely to play a role in carcinogenesis, by affecting insulin resistance and the production of several adipokines and inflammatory cytokines. Though the precise mechanisms may differ between different types of cancer, it is plausible that these mechanisms synergistically contribute to the increased cancer risk.

B. Review on obesity and its management

Nutritious diet, regular exercise, spiritual growth (positive attitude) form the only remedy for a healthy and happy life free from all diseases and stress (Muesing *et al.,* (2006). Weight reduction through dietary modification and regular physical activity improves metabolism and control diabetes mellitus. Bhatnagar

(2005) concluded that the chief tools in the treatment of obesity are diet, exercise, and suitable medication to keep the symptoms in check.

Successful weight management to improve overall health for adults requires a lifelong commitment to healthful lifestyle behaviors emphasizing sustainable and enjoyable eating practices and daily physical activity.

a. Dietary Management

The main contributory factors for obesity and diabetes are life style, faulty dietary habits, lack of exercise, inheritance and environment. Among these, diet and life style have direct bearing on the onset of the disease. Diet management supported by suitable changes in lifestyle, plays a pivotal role in the prevention and control of obesity and diabetes (Lau *et al*., 2007).

A healthy eating plan gives our body the nutrients it needs every day. It provides enough calories for good health. A healthy eating plan is low in saturated fat, trans fat, cholesterol, sodium (salt), and added sugar. Following a healthy eating plan will lower the risk for heart disease and other conditions.

Healthy foods include (www.nhlbi.nih.gov):

- Fat-free and low-fat dairy products, such as low-fat yogurt, cheese, and milk.
- Protein foods, such as lean meat, fish, poultry without skin, beans, and peas.
- Whole-grain foods, such as whole-wheat bread, oatmeal, and brown rice. Other grain foods include pasta, cereal, bread, tortillas and crackers.
- Fruits, which can be fresh, canned, frozen or dried.
- Vegetables, which can be fresh, canned (without salt), frozen or dried.

Successful weight loss depends on correction of energy imbalance through increased energy expenditure from physical activity, and changes in food habits to reduce overall energy intake. It is important to understand that a reduction in

energy intake can be achieved through multiple strategies – not simply by reducing dietary fat (WHO, 2012).

According to Banerjee *et al*., (2004), although there are multiple factors that could contribute to obesity, the primary cause is due to an increase in the energy absorption: energy expenditure ratio. Therefore, limiting energy absorption is critical when treating obesity. Scientists have taken this a step further and studied the effect of other dietary aspects that may serve in weight regulation, including dietary fiber. Increasing dietary fiber consumption may decrease energy absorption by way of diluting a diet's energy availability while maintaining other important nutrients.

To lose weight, most people need to cut down on the number of calories (units of energy) they get from food and beverages and increase their physical activity. For a weight loss of 1–2 pounds per week, daily intake should be reduced by 500 to 1,000 calories (US Department of Health Services, 2005). In general:

- Eating plans containing 1,000–1,200 calories will help most women to lose weight safely.
- Eating plans between 1,200 calories and 1,600 calories each day are suitable for men and may also be appropriate for women who weigh 165 pounds or more or who exercise regularly.

Foods that can be eaten more often include those that are lower in calories, total fat, saturated and trans fat, cholesterol, and sodium (salt). Examples of these foods include fat-free and low-fat dairy products; lean meat, fish, and poultry; high-fiber foods such as whole grains, breads, and cereals; fruits; and vegetables. Canola or olive oils and soft margarines made from these oils are heart healthy and can be used in moderate amounts. Unsalted nuts can also be built into a healthy diet (US Department of Health Services, 2005).

Reduction of energy intake is a key factor in weight loss, whereas the particular macronutrient composition of diets for weight loss is still being identified.

While much emphasis has been placed on very low carbohydrate diets for weight loss, their long term safety and effects on weight are in doubt (Strychar, 2006).

According to (WHO, 2012), to reduce energy intake, the key is to reduce consumption of energy dense (e.g. high fat, high sugar and high starch) foods and drinks (e.g. high sugar drinks) and consume mainly low energy dense foods (e.g. fruits and vegetables).

Current evidence suggests that high fiber especially soluble variety and soluble fiber supplements may offer more improvement in carbohydrate metabolism, lower cholesterol and reduce the insulin demand. Slowly absorbed carbohydrates such as starches are preferable than rapidly absorbed carbohydrates (Tonsin *et al.,* 2003).

Soluble food fibers have certain important physiological functions and metabolic consistent and curative health benefits, such as regulation of absorption and metabolism of sugar, control of lipid absorption, energy balance, control of weight (Jenkins, 2004).

A systematic review by Harland and Garton (2008), conducted in the United Kingdom, examined the relationship between whole grain consumption and body weight. It was concluded that a higher intake of whole grains (approximately three servings per day) was associated with lower BMI and central adiposity.

A systematic review conducted in Australia by Williams *et al*., (2008), evaluated existing evidence regarding the role of cereal grains and legumes in the prevention or management of overweight and obese. There was strong evidence that a diet high in whole grains was associated with lower body mass index, smaller waist circumference and reduced risk of being overweight.

Very low calorie diets provide 200–800 kcal/day, maintaining protein intake but limiting calories from both fat and carbohydrates. They subject the body to starvation and produce an average weekly weight loss of 1.5–2.5 kilograms (3.3–5.5 lb). These diets are not recommended for general use as they are associated with adverse side effects such as loss of lean muscle mass, increased

risks of gout, and electrolyte imbalances. People attempting these diets must be monitored closely by a physician to prevent complications (Strychar, 2006).

Diets to promote weight loss are generally divided into four categories: low-fat, low-carbohydrate, low-calorie, and very low calorie. A meta-analysis of six randomized controlled trials found no difference between three of the main diet types (low calorie, low carbohydrate, and low fat), with a 2–4 kilogram (4.4–8.8 lb) weight loss in all studies. After two years of the study period these three methods resulted in similar weight loss irrespective of the macronutrients emphasized (Sacks, 2009).

An apple a day can keep weight gain at bay. People who chomped an apple before a pasta meal ate fewer calories overall than those who had a different snack. Addition of antioxidants in apples may help to prevent metabolic syndrome, a condition marked by excess belly fat or an "apple shape." (www.self.com). Not only do fish fats keep heart healthy, but they shrink our waist too. Omega-3 fatty acids improve insulin sensitivity which helps build muscle and decrease belly fat.

All-natural peanut butter is loaded with protein and fiber. Research has shown that people who added 500 calories of peanuts to their regular diet consumed less at meals and increased their resting metabolism by 11 per cent (www. foxnews.com).

Healthy eating tips for achieving a healthy weight:

Foods and drinks lower in energy (to be included)

- Foods that are packed with vitamins, minerals and fiber as well as providing some energy: vegetables, fruit and legumes (e.g. split peas, kidney beans, baked beans, lentils, chick peas). These foods help to feel full without supplying too much energy.
- Low fat or reduced fat, milk and yoghurt.
- Lean meat (e.g. meat trimmed of fat before cooking, chicken without the skin) and fish.

- Whole grain or whole meal bread and breakfast cereals.
- Plain pasta (preferably whole meal), plain rice (preferably brown), plain noodles or grains, Plain water as first-choice drink. Other suitable choices include plain mineral water or soda water.

High energy foods and drinks (to be restricted)

- Chocolate, confectionery
- Potato crisps, corn chips, other savoury snack foods
- Cakes, sweet biscuits
- Pastries (including sweet and savoury)
- Take-away foods such as deep-fried foods, creamy pasta dishes, cheesy dishes, hamburgers
- Soft drinks, fruit juices, fruit drinks and alcohol. When drinking alcohol, use low energy mixers e.g. diet tonic.

Studies have shown the beneficial effects of green tea, not only on cardiovascular diseases but also on obesity and Type 2 diabetes itself. Taiwanese subjects who had habitually consumed tea for more than 10 years showed lower body fat composition and smaller waist circumference. Evidences from epidemiological studies suggest the possibility of green tea being a novel strategy for treatment or prevention of obesity and diabetes (Kim and Kim, 2013).

Pears contain 12 per cent of daily suggested intake of vitamin C, research suggests that pears can help to maintain a low body fat percentage. When choosing pears and apples, aim to eat organic – they have been shown to contain less pesticide residues (www. foxnews.com).

Black pepper contains a compound called piperine, recent research has shown that it may increase energy expenditure and may prevent the formation of new fat cells. More research is needed before confirming pepper's effects on weight loss. Still, other peppers, such as jalapenos or chili peppers, have been

shown to have modest effects on metabolism because of the compound which gives them their infamous heat, capsaicin (www. foxnews.com).

A study by University of South Australia reveals that taking a daily dose of omega-3 enriched fish oil combined with regular exercise provides significantly greater benefits in the fight against obesity than exercise or fish oil alone. Omega-3 fatty acids in fish oil are polyunsaturated fats that can switch on enzymes specifically involved in oxidising or burning of fat, but they need a driver (i.e., exercise) to increase the metabolic rate in order to lower body fat.

Air-popped popcorn contains few calories and is full of fiber, which will keep feeling full. The hull of popcorn contains poly-phenols, which are antioxidants that may also have disease-fighting properties. When preparing popcorn, don't add tons of butter and salt. Instead, choose sodium-free seasonings or herbs to keep it healthy (www. foxnews.com).

b. Physical exercise

Physical exercise is any bodily activity that enhances or maintains physical fitness and overall health and wellness. It is performed for various reasons including strengthening muscles and the cardiovascular system, strong athletic skills, weight loss or maintenance, as well as for the purpose of enjoyment. Frequent and regular physical exercise boosts the immune system, and helps to prevent the "diseases of affluence" such as heart disease, cardiovascular disease, Type 2 diabetes and obesity (Hu *et al*., 2001).

Physical activity also appears to have an independent effect on health-related outcomes when compared with body weight, suggesting that adequate levels of activity may counteract the negative influence of body weight on health outcomes. Thus, it is important to target intervention strategies to facilitate the adoption and maintenance of an adequate amount of physical activity to control body weight (Hainer *et al*., 2008).

Physical exercises are generally grouped into three types, depending on the overall effect they have on the human body (NHLBI, 2007):

- Flexibility exercises, such as stretching, improve the range of motion of muscles and joints.
- Aerobic exercises, such as cycling, swimming, walking, skipping rope, rowing, running, hiking or playing tennis, focus on increasing cardiovascular endurance.
- Anaerobic exercises, such as weight training, functional training, eccentric training or sprinting and high-intensity interval training, increase short-term muscle strength.

Physical exercise is important for maintaining physical fitness and can contribute positively to maintain healthy weight, building and maintaining healthy bone density, muscle strength, and joint mobility promoting physiological well-being, reducing surgical risks, and strengthening the immune system (Pedersen, 2013).

Vigorous exercise induces a greater degree of physiological cardiac hypertrophy than moderate exercise, but it is unknown whether this has any effects on overall morbidity and/or mortality (Wislett *et al*., 2009). Frequent and regular aerobic exercise has been shown to help to prevent or treat serious and life-threatening chronic conditions such as high blood pressure, obesity, heart disease, Type 2 diabetes, insomnia, and depression (Jason, 2008).

Endurance exercise before meals lowers blood glucose more than the same exercise after meals. According to the World Health Organization, lack of physical activity contributes to approximately 17 per cent of heart disease and diabetes, 12 per cent falls in the elderly, and 10 per cent of breast cancer and colon cancer (Borer *et al*., 2009).

The key to managing body weight is energy balance. When energy expenditure is equal to energy intake, theoretically body weight will be maintained, which should be the goal for prevention of initial weight gain or prevention of weight

regain after weight loss. However, to promote weight loss, it is necessary to create an energy imbalance that elicits an energy deficit. Physical activity in the form of structured exercise contributes to the creation of an energy deficit by increasing total energy expenditure, and this can promote weight loss, although exercise is an important component of weight loss interventions (AIHW, 2006).

According to Bensimhon *et al.* (2006), physical activity is well established as a key component of any weight loss programme. Sufficient regular physical activity is crucial to prevent weight gain and successfully maintain weight loss.

For health benefits, everyone should do at least 30 minutes of moderate intensity physical activity on most of the days, if not all days of the week. This amount can be accumulated in shorter bouts, such as three 10-minute walks. For weight loss and to prevent regaining weight, at least 60 minutes moderate intensity physical activity every day is usually needed (NHF of Australia, 2007)

Walking, running, and cycling are the most effective means of exercise to reduce body fat. Exercise affects macronutrient balance. During moderate exercise, equivalent to a brisk walk, there is a shift to greater use of fat as a fuel. To maintain health the American Heart Association recommends a minimum of 30 minutes of moderate exercise at least 5 days a week (Sahlin *et al*., 2008).

Physical activity also appears to have an independent effect on health-related outcomes when compared with body weight, suggesting that adequate levels of activity may counteract the negative influence of body weight on health outcomes. Thus, it is important to target intervention strategies to facilitate the adoption and maintenance of an adequate amount of physical activity to control body weight (Jakicic and Otto, 2005).

Exercise is good for health, whether there is weight reduction or not, because it can help to increase muscle mass, improve artery function and decrease the risks of heart attack, stroke and diabetes. Recent studies suggest that obese people who develop some level of fitness have a lower cardiovascular disease and

death risk than those who are lean but unfit. Exercise is especially good at preventing diabetes in obese people, who are at higher risk of developing this disease (www. medicalxpress.com).

Physical activity plays a critical role in improving cardiovascular health in both average-weight and obese individuals. In the absence of significant weight loss, regular bouts of aerobic activity have been found to reduce blood pressure and lipids as well as visceral fat, the latter which is associated with improved glucose tolerance and insulin sensitivity in non-diabetic individuals and glycemic control in patients with Type 2 diabetes (Leskinen *et al* ., 2009).

c. Life style modification

Changing behavior and lifestyle are the only ways to change a person's weight permanently (win.niddk.nih.gov). These changes focus on gradual, permanent changes in eating and exercise habits. There are six ways to change behavior and lifestyle that will help to maintain weight loss:

- Learning about health and nutrition
- Change in eating habits
- Increase in physical activity
- Join a weight loss progra
- Change attitudes about selection and eating of foods
- Develop support systems
- Following any drug therapies ordered by the doctor.

In the system of yoga, the physical body is called annamaya kosha or the food sheath. The word annam means that which is eaten. Food is the essence of the physical body and for the same reason, food is also medicine for the body. The practices from the Shakti Bandha series are also effective in reducing obesity. Asanas like gatyatmak meru vakrasana (dynamic spinal twist), chakki chalana (churning the mill), and nauka sanchalana (rowing the boat), massage the abdominal organs and help mobilize the extra fat tissue stored around them. These practices also help to eliminate energy blockages in the abdominal/pelvic area and to release the power of the manipura chakra, the source of willpower and self-assertiveness, (which is often weak in the obese patient) and that governs all our metabolic processes (www.yogamag.net).

Certain yoga asanas, if practiced regularly, are known to have beneficial effects on human body findings of the study by the researchers at the University College of Medical Sciences suggest that better blood sugar control and pulmonary functions can be obtained in Type I diabetics when they stick to a daily schedule of yoga asanas and pranayama (www. yogahealthfoundation.org).

While almost any exercise is good for the heart, experts speculate yoga's meditative component may give it an extra boost by helping to stabilize the endothelium, the lining of the blood vessels that, when irritated, contributes to cardiovascular disease. Since the lining is reactive to stress, and meditation can lower stress hormones, yoga may be causing a cascade of events that could reduce the risk of heart attack or stroke. Regular yoga practice can benefit individuals who wish to maintain or lose weight (Kristal *et al*., 2005).

The relationship between obesity and alcohol consumption is complex. Associations between the two are heavily influenced by a number of factors including: patterns and levels of drinking, types of alcoholic drinks consumed, gender, body weight, diet, genes, physical activity levels and other lifestyle factors (Yeomans, 2010).

Smoking and drinking interact to influence weight. Research involving over 37,000 non-smokers found that men and women who consumed one alcoholic drink per day with the greatest frequency (three to seven days per week) had the lowest body mass index (Breslow and Smothers, 2005).

The researchers found that consuming alcohol increased the number of calories burned after both high and low carbohydrate meals. Consumption of alcohol after dinner reduces the health risk of insulin and glucose related diseases such as diabetes in postmenopausal women (Greenfield *et al*., 2005)

Research shows that smoking and obesity together may pose a triple health threat in addition to the increased risks for heart disease, cancer and diabetes (American Chemical Society, 2013).

Stopping smoking can lead to a gain in life expectancy of about 10 years, far more than a smoker could expect to gain from weight control (Richard and Gary, 2010). It is well established by 1995 japanese workers, cessation of smoking leads to weight gain, the estimated risk of coronary heart disease was decreased markedly by smoking cessation (Tamura *et al.,* 2010).

b. Prevention of obesity

Obesity is a serious, chronic medical condition, which is associated with a wide range of debilitating and life threatening conditions. The fact that obesity prevalence continues to increase at an alarming rate in almost all regions of the world is of major concern. Hence, an effective control of obesity requires the development of coherent strategies that tackle the main issues related to preventing overweight and obesity.

The prevention of obesity involves action at several levels i) Primary ii) Secondary iii) Tertiary. Objective of primary prevention is to decrease the number of new cases, secondary prevention is to lower the rate of established cases in the community and tertiary prevention is to stabilize or reduce the amount of disability associated with the disorder (Srinivas *et al*., 2004)**.**

When the attention is focused on the multi-factorial condition such as coronary heart disease (CHD), primary prevention of this involves national programmes to control blood cholesterol levels and secondary prevention deals with reducing CHD risk in those with existing elevated blood cholesterol levels while tertiary action would be associated with preventing re-infarction in those who had a previous heart attack. However, this classification system for prevention of obesity results in a great deal of ambiguity and confusion. To avoid this, the US institute of medicine (www. shp.missouri.edu) has proposed alternative classification of system. The new system separates prevention efforts into 3 levels. Universal (or) public health measures (directed at every one in the population), selective (for a sub-group who may have an above average risk of developing obesity) and indicated (targeted at high risk individuals who may have a detectable amount of

excess weight which fore-shadows obesity). However, preventive measures for any disorder may not be helpful in all cases hence, proper management strategies can be integrated along with prevention programmes.

Strategies based on behavioural change theories that assist patients/clients to comply with dietary or exercise therapy help to achieve both weight loss and maintenance. The NIH Guidelines reported that behavior strategies targeted to reinforce the necessary changes in diet and physical activity produced weight losses of approximately 10 per cent over 4 to 12 months (yogahealthfoundation.org).

- Weight loss
- Health improvement
- Increased energy and sense of well-being
- Self-monitoring,
- Cognitive restructuring,
- Stimulus control and Social support.

The ideal preventive strategy for obesity is to prevent children with a normal, desirable BMI from becoming overweight or obese. Preventive strategies should start as early as newborn period.

The strategies may be attempted at the individual, community or physician's level. Those at the individual level backed by consistent evidence include limiting sugar sweetened beverages, reducing daily screen time to less than two hours, removing television and computers from primary sleeping areas, eating breakfast regularly, limiting eating out especially at fast food outlets, encouraging family meals and limiting portion sizes (Spear *et al*., 2007).

Community level interventions include advocacy to increase physical activity at schools and at home through the creation of environments that support physical activity (Huus *et al*., 2007). These efforts could include creation and maintenance of parks, inclusion of child friendly walking and bicycle paths as well as creating awareness about locally available physical activity options.

At the physician's level it is essential to engage families with parental obesity or diabetes, because these children are at increased risk for developing obesity later in life (Davis *et al*., 2007).

b. Treatments

Along with diet, exercise and behavior modification, drug therapy may be a helpful component of treatment for overweight or obese patients. The role of drug therapy has been questioned, however, because of concerns about efficacy, safety, and the observation that body weight slows and then plateaus with continued treatment, and most patients regain weight when their weight-loss drugs are stopped.

Although obesity, especially abdominal obesity, is the commonest cause of complications such as Type 2 diabetes, hypertension, dyslipidaemia, and cardiovascular diseases, doctors most often use drugs to treat these complications.

According to Bray and Ryan (2012), Anti-obesity drugs can be useful adjuncts to diet and exercise for obese adults with a BMI greater than 30 kg/m^2, who have failed to achieve weight loss goals through diet and exercise alone. A trial of drug therapy is also warranted in patients with a BMI of 27 to 29.9 kg/m^2 with comorbidities, gastrointestinal bypass surgery is being considered.

The new generation of antiobesity drugs offers hope for the management of obesity, although no single agent is likely to be a panacea. If sustained success is to be achieved, obesity will need to be managed like many other chronic diseases, with combination therapies and long-term treatment (Powell *et al*., 2011).

Anti-obesity drugs affect different targets in the central nervous system or peripheral tissues and aim to normalize regulatory or metabolic disturbances that are involved in the pathogenesis of obesity. Currently, only three anti-obesity drugs have been successfully used in long-term weight management (Gaal *et al., 2005).*

Obinepitide is a synthetic analog of two naturally occurring human hormones: PYY3-36 and pancreatic polypeptide. These hormones are normally

released during a meal and are known to play a role in the regulation of food intake and appetite, acting as satiety signals. Initial studies in humans have shown that infusion of PYY3-36 reduced food intake in both obese and lean subjects, besides reducing perceived hunger prior to a meal (Batterham, *et al*., 2003).

Patients treated with orlistat and lifestyle modification exhibited a greater weight loss and a significant reduction in diabetes incidence compared with those who underwent lifestyle modification and received placebo. A study of Toplak *et al*., (2005) in which a lifestyle intervention was combined with different dietary interventions, patients showed very good weight loss and exhibited beneficial effects on components of the metabolic syndrome.

A Randomized trial of lifestyle modification and pharmacotherapy for obesity by Wadden *et al*., (2005), clearly demonstrated that the combination of sibutramine and lifestyle modification resulted in more weight loss than either medication or lifestyle modification alone.

Recently, the anti-epileptic drug topiramate was discovered to have beneficial effects on weight control and was investigated as a weight loss drug. It even proved to have a beneficial effect on diabetes control (Toplak *et al.,* 2007).

Psychological and behavioral predictors of weight loss have also been evaluated in the context of pharmacological treatments of obesity, including fenfluramine, phentermine, mazindol, and caffeine plus ephedrine (Hainer, *et al*., 2008), usually administered as combined therapy.

Bariatric surgery, also known as weight-loss surgery or obesity surgery is widely accepted as the only known effective treatment for severe obesity. This procedure was introduced in the 1950s and involves surgical manipulation of the gastrointestinal tract to induce long-term weight loss in severely obese individuals (www.nhs.uk).

As bariatric surgery for the treatment of morbid obesity enters its sixth decade, much has been evolved and continues to be learned from the results of several key

bariatric operations, particularly the Roux-en-Y gastric bypass. Because of the epidemic of obesity and development of the laparoscopic approach, bariatric procedures have increased exponentially in the past decade and are now among the more commonly performed gastrointestinal operations (Brian *et al*., 2011).

Bariatric surgery has been shown to substantially improve or resolve many common obesity-related comorbid conditions, including Type II diabetes, hypertension, sleep apnea, and dyslipidemia. A recent report with 10-year outcome data from the observational Swedish Obese Subjects (SOS) study showed marked benefits in patients treated surgically compared with matched control subjects treated medically, including recovery from diabetes, lipid abnormalities, sleep apnea, and quality of life (Sjostrom *et al*., 2007).

The Vertical Banded Gastroplasty (VBG) consists of constructing a small gastric pouch based on the lesser curvature of the stomach, with the outlet restricted with a prosthetic band or mesh (Brian *et al*., 2011). The VBG is a purely restrictive bariatric procedure and the mechanism of weight loss is primarily related to caloric restriction. The VBG became popular because it is a simple operation and has a low perioperative risk profile. Although short-term results have been reported to be excellent, longterm results are less favorable.

In addition to the well-documented long-term efficacy of bariatric surgery in achieving sustainable weight loss, numerous studies have also evaluated the efficacy of bariatric surgery in ameliorating specific obesity-related comorbidities; particularly Type 2 diabetes, hypertension, and dyslipidemia (Pontiroli *et al*., 2005).

C. Nutritional benefits of selected foods

a. Oat bran

Oats, known scientifically as *Avena sativa*, are a hardy cereal grain able to withstand poor soil conditions in which other crops are unable to thrive. Oats gain part of their distinctive flavor from the roasting process that they undergo after being harvested and cleaned (www.whfoods.com).

Bran is the hard outer layer of grain and consists of combined aleurone and pericarp. Along with germ, it is an integral part of whole grains, and is often produced as a by-product of milling in the production of refined grains. When bran is removed from grains, the grains lose a portion of their nutritional value (Baron and John 2010).

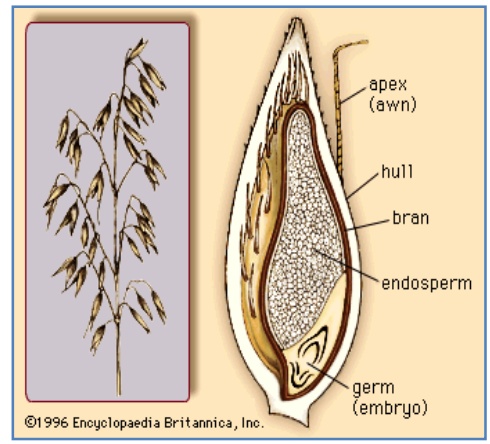
Bran is present in and may be milled from any cereal grain, including rice, corn (maize), wheat, oats, barley and millet. Bran should not be confused with chaff, which is coarser scaly material surrounding the grain, but not forming part of the grain itself.

Different types of processing are then used to produce the various types of oat products, which are generally used to make breakfast cereals, baked goods and stuffings:

- Oat groats: unflattened kernels that are good for using as a breakfast cereal or for stuffing
- Steel-cut oats: featuring a dense and chewy texture, they are produced by running the grain through steel blades that thinly slices them.
- Old-fashioned oats: have a flatter shape that is the result of their being steamed and then rolled.
- Quick-cooking oats: processed like old-fashioned oats, except they are cut finely before rolling.
- Instant oatmeal: produced by partially cooking the grains and then rolling them very thin. Oftentimes, sugar, salt and other ingredients are added to make the finished product.
- Oat bran: the outer layer of the grain that resides under the hull. While oat bran is found in rolled oats and steel-cut oats, it may also be purchased as a separate product that can be added to recipes or cooked to make a hot cereal.
- Oat flour: used in baking, it is oftentimes combined with wheat or other gluten-containing flours when making leavened bread.

Bran is particularly rich in dietary fiber and essential fatty acids and contains significant quantities of starch, protein, vitamins, dietary minerals and phytic acid, which is an anti nutrient that prevents nutrient absorption (Ellegard and Anderson, 2007). Bran is a byproduct of the milling process and it contains various antioxidants that impart beneficial effects on human health.

Structure of Bran



Properties of oat bran

- **Oat bran is tasteless-**Like most grains available in the market. Oat bran does not have taste of its own. It is almost tasteless.

- **Oat bran is lighter-**Because of rich fibre available in oat bran. It is very easy on the stomach and intestines. People who want something simple to eat after long duration of fasting may consider eating oat bran.

- **Oat bran is rich in nutrients-**The nutrients in oat bran can help in reducing weight and cholesterol levels in the body. It increases bile production and helps in burning the excess fat and cholesterol in the body. If there are problems related to high blood pressure or heart related ailments then consider going to oat bran as it can help in getting the best benefits in least time without any side effects.

Meydani (2006) states that oat bran's heart health benefits in maintaining healthy cholesterol levels due in part to a component of oats called beta-glucan which can help to maintain healthy liver function and healthy insulin levels. Finally, antioxidants in oats called avenanthramides helps to keep blood vessels healthy.

Oatmeal and oat bran are significant sources of dietary fiber. This fiber contains a mixture of about half soluble and half insoluble fibers. One component of

the soluble fibre found in oats is beta-glucans, a soluble fiber which has proven effective in lowering blood cholesterol levels (www.whfoods.com).

Eating oats can spread the rise in blood sugars over a longer time period. Control of blood glucose and insulin levels is essential in preventing many of the complications associated with diabetes. Oat beta-glucan slows the rise in blood glucose levels following a meal and delays its decline to pre-meal levels. Here's how it works. As the beta-glucan in the soluble fiber of oats is digested, it forms a gel, which causes the viscosity of the contents of the stomach and small intestine to be increased. This in turn slows down digestion and prolongs the absorption of carbohydrates into the bloodstream (Van *et al*., 2006).

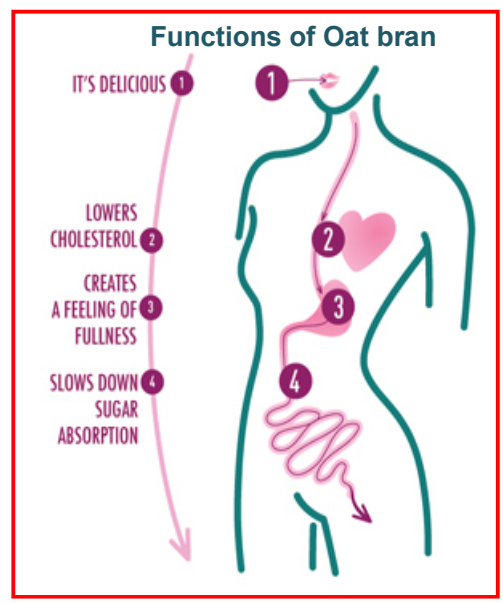
Oats, like other grains and vegetables, contain hundreds of phytochemicals (plant chemicals). Many phytochemicals are thought to reduce a person's risk of getting cancer. Phytoestrogen compounds called lignans in oats have been linked to decreased risk of hormone-related diseases such as breast cancer. Most of the research has been focused on breast cancer, but similar effects are expected on other hormone-related cancers such as prostate, endometrium and ovarian cancer. International research has shown that women with a higher intake of dietary fibre have lower circulating oestrogen levels, a factor associated with a lower risk of breast cancer. The insoluble fibers in oats are also thought to reduce carcinogens in the gastrointestinal tract (Suzuki *et al*., 2008).

Maki (2006), shows that daily serving of whole oats rich in soluble fiber can reduce hypertension, or high blood pressure, and so reduce the need for anti-hypertensive medication. Nearly 1 in 3 American adults has high blood pressure. It usually has no symptoms, but can cause serious problems with the heart and blood vessels, leading to other complications.

Oats have high fiber content. Fiber is necessary in keeping bowel movements regular. Oats are high in both soluble and insoluble fiber. Insoluble fiber does not dissolve in water. It is spongy and absorbs many times its own weight of liquid. It makes stools heavier and speeds their passage through the gut, relieving constipation (www.whfoods.com).

As the soluble fiber of oats is digested, it forms a gel, which causes the viscosity of the contents of the stomach and small intestine to be increased. The gel delays stomach emptying making us feel full longer which helps with weight loss. New research suggests that children between ages 2-18 years old who have a constant intake of oatmeal lowered their risk of obesity (www.eatmoreoats.com). The research found that the children who ate oatmeal were 50 per cent less likely to become overweight, when compared to those children that did not eat it.

Oats are a good source of essential vitamins such as thiamin, folic acid, biotin, pantothenic acid and vitamin E. They also contain zinc, selenium, copper, iron, manganese and magnesium. Oat beta glucan also appears to help speed up response to infection, which may result in faster healing. According to a new study, it was discovered that beta glucan can enhance the ability of certain human immune cells to navigate to the site of a bacterial infection, resulting in faster healing (Jensen, 2004). Oats are a very good source of manganese and selenium. In addition, oats are a good source of, dietary fiber, magnesium, zinc and phosphorus.



In many studies, eating whole grains, such as oats, has been linked to protection against atherosclerosis, ischemic stroke, diabetes, insulin resistance, obesity, and premature death. Whole grains are excellent sources of fiber. Diets of those with highest dietary fiber intake had a 29% lower risk of cardiovascular disease compared to those with the lowest fiber intake (whfoods.com).

Studies also show that beta-glucan has beneficial effects in diabetes as well. Type 2 diabetic patients given foods high in this type of oat fiber or given oatmeal or oat bran rich foods experienced much lower rises in blood sugar (Andon, 2008).

One type of phytochemical especially abundant in whole grains including oats are plant lignans, which are converted by friendly flora in our intestines into mammalian lignans, including one called entero lactone that is thought to protect against breast and other hormone-dependent cancers as well as heart disease (www.eatmoreoats.com).

One of these essential amino acids is phenylalanine. Phenylalanine plays vital roles in neurological health and thyroid function. Oat bran is a rich source of phenylalanine. Phenylalanine deficiency can cause confusion, lack of energy and anorexia (www. healthyeating.sfgate.com).

Oatmeal seems to be most effective in lowering LDL cholesterol ("bad" cholesterol) levels. According to the studies in adults by Kristensen (2011), LDL cholesterol may be lowered by 10 per cent. A diet rich in oat bran improves blood lipids and hemostatic factors, and reduces apparent energy digestibility in young.

b. Wheat Bran

Most grains, like wheat and oats, have a hard outer layer. When they are processed, this layer becomes a byproduct, and is called bran. In the case of processing wheat to make wheat flour, we get miller's or wheat bran (www.fiberfacts.com).

Wheat bran is the tough outer layer of a wheat grain that has been processed into bran. Also called miller's bran, wheat bran is commonly found in breakfast cereals like bran flakes and raisin bran, as well as popular health snacks like bran muffins. As with normal wheat flour, wheat bran should be stored in a refrigerator or vacuum-sealed compartment to prevent rancidity. If the bran tastes somewhat bitter, then it is likely to be rancid and should be thrown away regardless of how well it was stored (www. spiritfoods.net/wheat-bran)

The outer bran layer is composed of non-digestible, mainly insoluble, poorly fermentable carbohydrates (such as cellulose, hemicelluloses, arabinoxylan), and the inner germ and starchy endosperm contain viscous soluble fibers, fermentable

oligosaccharides, resistant starch (RS), lignans, vitamins, minerals (Okarter and Liu 2010),

One cup of wheat bran contains 35 per cent of our RDI of iron. Iron is an essential constituent of hemoglobin, the protein found in red blood cells that carry oxygen to our body's tissues. One cup of wheat bran also provides us with the following nutrients: 18 per cent of our RDI of protein, 20 per cent of our RDI of thiamine, riboflavin, and potassium, 38 per cent of our RDI of niacin and vitamin B6, 89 per cent of our RDI of magnesium, 28 per cent of our RDI of copper and zinc, 64 per cent of our RDI of selenium, 33 per cent of our RDI of manganese, and 59 per cent of our RDI of phosphorous. Moreover, it is low in fat and calories, and contains no sodium or cholesterol (www. spiritfoods.net/wheat-bran).

Wheat bran is high in fiber. Fiber can decrease the absorption and decrease the effectiveness of digoxin (Lanoxin). A single cup (58g) of wheat bran provides the human body with 100 per cent of an adult's RDI of fiber,

Wheat bran has a sweet taste, but not all find it appealing. It's also important to start slow when adding wheat bran to foods. A little too much can easily translate to diarrhea. Further, as with all wheat sources, those who have celiac disease should not use wheat bran (www. fibrefacts.com).

Wheat bran is possibly effective for:

- Treating mild constipation and restoring normal bowel function, but it doesn't seem to soften stools.
- Reduce stomach pain and improve bowel function in people with mild to moderate IBS. However, it may not be as effective as guar gum.
- Seems to produce modest, but significant reductions in blood pressure.
- Prevents stomach cancer and hemorrhoids.

Wheat bran is possibly ineffective for:

- Preventing cancer of the colon (bowels) or rectum. Several large well-designed studies showed that fiber, including wheat-bran fiber, does not prevent the recurrence of pre-cancerous tumors, despite earlier evidence that suggested fiber might help.

- Does not seem to consistently improve blood sugar control. Also, it does not improve blood pressure, blood fats, clotting factors, homocysteine, C-reactive protein, or other factors associated with heart disease in patients with Type 2 diabetes (www.rxlist.com).

Wheat bran can help:

- Provides 100 per cent of the natural fiber that is needed.
- Help maintain regularity
- Help maintain normal bowel function
- Relieve occasional constipation, caused by changes in dietary habits or travel (www.fibrefacts.com).

The bran has minerals necessary for insulin excretion, which is good for diabetics (www.ultimatelifestyleblog.com). In addition, there are new studies that affirm the importance of bran in prevention of cancer, other studies verified that whole wheat is considered a suitable food for children and it can prevent asthma in them.

When people start removing the bran of the wheat, diseases spread and after long time it was verified that this bran has many medical benefits. Many researches and studies also confirmed that these husks have many vitamins and minerals necessary for human body, and when they are removed we lose them. So, doctors today advice that everyone, especially patients having diabetes, heart disease and high blood pressure, should have whole wheat with husk, these advices were clarified only in the 20th century. The bran has minerals necessary for insulin excretion, which is good for diabetics. In addition, there are new studies that

affirm the importance of bran in prevention of cancer, other studies verified that whole wheat is considered a suitable food for children and it can prevent asthma in them. There are number of antioxidants in the bran that are beneficial in activating cells and preventing cancer. Recent studies confirmed that intake of whole wheat helps in the treatment of heart diseases, arteriosclerosis, and other diseases (www. www.kaheel7.com/eng).

c. Green Gram

Green gram (*Vigna radiata)* is one of the important pulse crops in India. It has been reported that Green gram has been cultivated in India since ancient times**.** Green gram is a protein rich staple food. It contains about 25 per cent protein, which is almost three times that of cereals. It supplies protein requirement of vegetarian population of the country.

The green gram forms a very nutritious article of diet. It is consumed in the form of whole dried seeds and in the form of dal prepared by splitting the seeds in a mill. The sprouted mung beans are a highly nutritious food (www.ikisan.com).

Natural Benefits and Curative Properties

- Applied in the form of powder. It is said to be useful in relieving the heat or burning of the eyes.
- A poultice of this powder is useful for checking secretion of milk and reducing distention of the mammary glands
- Water in which green grams are soaked is an excellent medicine during cholera, measles, chicken-pox, small-pox, typhoid and all types of fevers. It can be given in a small quantity even during acute phase of appendicitis.
- Flour of the green gram is an excellent detergent and can be used as a substitute for soap. It removes the dirt and does not cause any skin irritation. Its application over the face bleaches the colour and gives good complexion. Black gram flour is also used for washing the hair with green gram paste to lengthen hair and prevent dandruff.

According to Yamini (2013), the health benefits of green gram are:

- It is rich in Vitamin A, B, C and E and also in many minerals including iron, calcium, and potassium.
- It is considered a healthy weight loss food as it is a low fat food rich in proteins and fiber. It curbs cravings and keep us full for a long time. It detoxifies the body and benefits the metabolism as well as immune system.
- It helps to lower the high cholesterol level in the blood system. Regular intake of green gram reduces bad cholesterol and improves the flexibility of arteries and veins. It also regulates the blood pressure.
- Green gram is full of complex carbohydrates in form of high fiber, which aids digestion. Complex carbohydrates also stabilize blood sugar and control its sudden rise after meal, while keeping body's energy at a balanced level. Green gram can be highly beneficial for people having a high blood sugar level.
- Green gram contains Vitamin B-1, Vitamin C and Vitamin B-6 (pyridoxine). Regular consumption of diets rich in Vitamin-B6 help to develop resistance against contagious agents that causes diseases. As per ancient Chinese medicine it also contains anti-cancer properties.

Unlike other pulses, green gram is free of flatulence-causing agents. This makes it an acceptable food for convalescents and pleasant weaning food for babies. The protein is especially rich in the amino acid, lysine. The seeds are rich in calcium, phosphorous, magnesium, potassium, folate and other B Vitamins. They also contain appreciable amounts of Vitamin C (www. Alternative_method_for _better_health.com).

d. Whole wheat

Whole grains are defined by the American Association of Cereal Chemists International (2010) and the FDA as consisting of the "intact, ground, cracked or flaked fruit of the grain whose principal components, the starchy endosperm, germ

and bran, are present in the same relative proportions as they exist in the intact grain.

According to USDA Agricultural Research Services (2009), the most common types of whole grains in the American diet are wheat, corn, oats, barley, and rice, with wheat being the most prominent grain consumed on a daily basis.

Whole grains such as wheat are rich sources of vitamins, minerals, dietary fiber, lignans, beta glucan, inulin, numerous phytochemicals, phytosterols, phytin, and sphingolipids (Okarter and Liu 2010). Dietary phytochemicals are defined as bioactive, non-nutrient plant compounds that are associated with reduced risk of chronic diseases. Prospective cohort studies consistently suggest that when consumed in whole foods, these phytochemicals may contribute to important protection against chronic diseases, such as CVD and certain cancers.

Andreasen *et al*., (2001) showed that human gastrointestinal esterase, from the intestinal mucosa and intestinal microbiota can release ferulic acid and diferulics from cereal bran, thereby potentially contributing to the lower risk of certain cancers, such as colon cancer, that have been associated with whole grain consumption.

Carotenoids are another group of compounds found in whole grains. Lutein, zeaxanthin, beta cryptoxanthin, beta carotene, and alpha-carotene are the most common carotenoids and are commonly concentrated in the bran or germ portion of whole grains (Adom *et al*., 2005) In addition to providing pigmentation, they play an important role in reproduction and protection of the whole grains, while also acting as antioxidants and having provitamin A activity in the body.

Whole grains also contain tocotrienols, tocopherols, and oryzanols. Vitamin E, as tocopherols and tocotrienols, is found in whole grains in varying proportions and is concentrated in the germ fraction of the grain. Beta-tocotrienol is the predominant form of vitamin E in whole wheat grain. An important function of vitamin E in the body is its antioxidant activity and maintenance of cellular membrane integrity (Slavin, 2004). Lignans found in whole grains have strong

antioxidant and phytoestrogenic effects. Intestinal microflora play a role in converting these plant lignans into the mammalian lignans, enterolactone and enterodiol, which may provide protection against chronic diseases such as hormone-related cancers, diabetes, and heart disease.

Cross-sectional studies, conducted in the US, have found that higher intake of whole wheat (a daily intake of approximately 3 servings) is associated with lower BMI (kg/m^2) in adults; studies observed that adults who consumed higher intakes of whole grains had smaller waist circumferences (McKeown *et al*., 2009).

Prospective studies suggest that weight gain and increases in abdominal adiposity over time are lower in people who consume more whole wheat. Analyses of the Physicians Health Study (Banerjee et al., 2004) and the Nurses Health Study showed that those who consumed more whole grain foods consistently weighed less than those who consumed fewer whole grain foods.

Higher wheat intake has been associated with reduced risk of hypertension in prospective epidemiological and intervention studies. (Wang *et al*., 2007) in the Health Professionals Study observed 23 per cent less likelihood of having hypertension among men who reported consuming at least 4 daily servings of whole grain foods compared with those who consumed less than one-half serving per day.

Evidence from epidemiological studies shows an inverse association between whole grain consumption and risk of Type 2 diabetes. In a prospective cohort study, (Liu 2002) found that increased intake of whole grains significantly lowered the risk of Type 2 diabetes.

Many dietary components can positively affect gastrointestinal health, including fiber, oligosaccharides, phytochemicals, antioxidant vitamins, and minerals. Of the myriad of foods available, whole grains provide most of these beneficial components. Whole grains play an important role in digestive health and this is attributed to not only the fiber component but also the other nutrients and phytonutrients present in the whole grains (Schatzkin *et al*., 2007).

The health benefits of wheat depend entirely on the form in which it is consumed (www.wholegrainscouncil.org). The main benefits of whole grains include:

- Stroke risk reduced by 30-36 per cent
- Type 2 diabetes risk reduced by 21-30 per cent
- Heart disease risk reduced by 25-28 per cent
- Reduction of inflammatory disease risk
- Healthier carotid arteries
- Better weight maintenance
- Lower risk of colorectal cancer
- Healthier blood pressure levels
- Less gum disease and tooth loss
- Reduced risk of asthma

D. Fiber- boon for health and wellbeing

As per WHO (2013), effective weight management for individuals and groups at risk of developing obesity involves a range of long-term strategies. These include prevention, weight maintenance, management of co-morbidities and weight loss.

Dietary fiber intake provides many health benefits. A generous intake of dietary fiber reduces risk for developing the following diseases: coronary heart disease, stroke, hypertension, diabetes, obesity, and certain gastrointestinal disorders. Increased consumption of dietary fiber improves serum lipid concentrations, lowers blood pressure, improves blood glucose control in diabetes, promotes regularity, aids in weight loss, and appears to improve immune function (Petruzziello *et al*., 2006).

Increased intake of soluble fiber improves glycemia and insulin sensitivity in non-diabetic and diabetic individuals (James *et al*., 2009). Fiber supplementation in obese individuals significantly enhances weight loss.

The intake of 25 g of fibers added favorable effects, mainly by reducing phytosterolemia. Additional benefits include improvement in blood glucose and anthropometric parameters (Silvia *et al.,* 2011).

A study by Anderson and Conley (2007) opines that, the effects of cereal fiber intake or whole-grain intake on CHD prevalence suggest that whole-grain intake may be the most protective source of fiber consumption.

Higher intakes of whole grains are associated with a significant of 26 per cent reduction in prevalence of ischemic strokes (Wu et al., 2003). Other studies suggest that fruit and vegetable intake is associated with a lower risk for ischemic stroke and with favorable effects on the progression of carotid artery atherosclerosis.

A study on French adults by (Lairon *et al*., 2005) predicts that higher intakes of dietary fiber were associated with a lower prevalence of hypertension and with lower serum cholesterol and triglyceride values than lower fiber intakes.

In addition to having favorable effects on serum lipoproteins and blood pressure, dietary fiber consumption has favorable effects on body weight, visceral adiposity, and insulin sensitivity, as well as on inflammatory markers (Bo *et al*., 2006).

Psyllium and oat beta glucan are the most widely used sources of soluble fiber and have been approved for health claims related to protection from CHD by the FDA. They do not significantly affect serum HDL cholesterol or triglyceride values (Anderson *et al*., 2007).

Increasing consumption of dietary fiber is often accompanied by a reduction in systolic and diastolic blood pressure with decreases in systolic blood pressure of 1.1 mm of Hg and diastolic blood pressure of 1.3 mm of Hg especially in hypertensive individuals (Delzenne and Cani, 2005).

Studies by Anderson (2008), indicates that increasing dietary fiber consumption without altering the energy intake from carbohydrates, proteins or fats significantly improves glycemic control and reduces the need for medication and insulin in individuals with Type 1 or Type 2 diabetes.

A prospective study by Garcia *et al*., (2007) reveal that after 5 weeks of treatment, two studies reported significant reductions in fasting plasma glucose values (-3.8per cent) and one study reported significant reductions in fasting plasma insulin values (-9.0per cent); insulin sensitivity was reported to be significantly improved in two of the studies.

Moderate increases in fiber intake improve glycemic control. A cohort study by Lindstrom *et al*. (2006) suggest that increased consumption of fiber from high-fiber foods or supplements is likely to also improve serum lipoproteins and blood pressure as well as assist in weight management for diabetic individuals.

Epidemiological studies indicate that individuals who have higher levels of fiber consumption have lower weights by approximately 30 per cent than those with the lowest fiber intakes (Anderson, 2008). For millennia, keen observers have noted that high-fiber foods were more filling than low-fiber foods. Clinical trials initiated over 50 years ago used fiber supplements as an aid to weight loss.

The role of dietary fiber in preventing and managing obesity in humans is strongly supported by epidemiological and physiological studies. Clinical trials using high fiber foods also provide support for the hypothesis that higher-level fiber consumption has a beneficial role in weight management (Andreason *et al*., 2008). Diet high in complex carbohydrates and higher in dietary fiber provides persuasive data that this type of diet promotes greater weight loss than a high simple-carbohydrate and lower fiber diet. Increased fiber intakes are associated with increases in satiating gut hormones.

Dietary fibers affect the entire gastrointestinal tract from the mouth to the anus. High-fiber foods usually have lower energy density and take longer to eat. Soluble fibers usually delay gastric emptying. Soluble fibers may act to slow transit of food materials through the small intestine while insoluble fibers tend to create “intestinal hurry” (Wu *et al*., 2007). In the colon, fermentable fibers increase bacterial mass with some acting as prebiotics to promote health-promoting bacteria

such as lactobacilli and bifidobacteria. Insoluble fibers are especially effective in increasing fecal mass and promoting regularity.

Increased intake of dietary fiber is commonly used for the prevention and management of constipation or hemorrhoids. Wheat bran, high-fiber cereals, and fiber supplements widely acknowledge of their beneficial effects (Vos *et al*., 2007).

High-fiber diets are associated with improved lipid profiles. A prospective cohort study conducted at the State University of New York at Buffalo from 2005 to 2007 followed 259 healthy women for up to 2 complete menstrual cycles. Reductions were observed in total and low density lipoprotein cholesterol in women with higher fiber intakes (Mumford *et al*., 2011).