

Review of Literature

II REVIEW OF LITERATURE

The Review of Literature pertaining to the study entitled “**Development and Promotion of Low Glycemic Foods among Employees of Tamil Nadu State Transport Corporation, Coimbatore division**” is presented under the following heads:

- A. Diabetes Mellitus – The growing epidemic
- B. Etiology of Diabetes Mellitus – The emerging facts
- C. Complications of Diabetes Mellitus – A major threat
- D. Low glycemic index foods – A science based diet
- E. Therapeutic lifestyle counselling

A. DIABETES MELLITUS – THE GROWING EPIDEMIC

1. Global Scenario

According to Sridhar *et al.*, (2005) the total number of people world wide with Type II diabetes in 2000 were more than 176 million. By the year 2030, the number is estimated to rise to 370 million. In 2025, the worldwide prevalence of diabetes among adults is expected to increase by 35 percent and total diabetics by 122 percent. It is also estimated that the countries with the largest number of diabetics in 2030 will be India (80.9 million), followed by China (42 million) and United States (30 million). Type II diabetes affects 15 million people in the United States and approximately 150 million diabetics around the world. Diabetes is said to be the seventh leading cause of death in the United States (Ornish, 2004).

The global prevalence of diabetes is set to double over the next 25 years. The prevalence of diabetes for the age group 20 to 79 years worldwide was 5.1 percent (194 million) in 2003 and it is estimated to be 6.3 percent (333 million) in 2025 (International Diabetes Federation, 2003). In 1985, an estimated 30 million people

worldwide had diabetes, in 2000, a little over a decade later, the figure had risen to 171 million, in 2007 it rose to 246 million and by 2030, the figure is expected to rise to 366 million (Radhika *et al.*, 2007).

According to the study by International Diabetes Federation (2006), Western Pacific region had the highest number of people with diabetes (67 million) compared to the European region with 53 million diabetics, North American region with 23 million diabetics and south and central American region with 14 million diabetics. African region had the least number of people with diabetes (7.1 million). The top ten countries with highest number of diabetics given by International Diabetes Federation (2006) were India (40 million), China (23.8 million), USA (16 million), Russia (9.7 million), Japan (6.7 million), Germany (6.3 million), Pakistan (6.2 million), Brazil (5.7 million), Mexico (4.4 million) and Egypt (3.9 million).

The World Health Organization has projected that the global prevalence of Type II diabetes mellitus is on the increase, the degree of which differ between countries and ethnic groups within the country. Diabetes Mellitus is a major health problem throughout the world and is the third most common disease in the world next to cardiovascular disease and oncological diseases (WHO, 2005).

Green *et al.*, (2003) estimated the current global prevalence of Type II diabetes as 150 million. Projections suggest that by the year 2025 the number of diabetic patients in the world will reach approximately 800 million.

Forouhi *et al.*, (2005) state that prevalence of diabetes in England was 4.41 percent in 2001. Among them 92.3 percent had Type II diabetes and 7.7 percent had Type I diabetes. Diabetes prevalence was estimated to be higher in women (5.17%) than men (3.61%). People from ethnic minority groups had higher crude prevalence than white Europeans. Prevalence increased sharply with age (0.33, 3.37 and 13.92% respectively in those aged 0 – 29, 30 – 59 and 60+ years).

In Japan, the total diabetic population is estimated as seven million wherein 95 percent of diabetics have Type II diabetes. It is considered as an increasingly important problem and life style related disease (Matsuoka, 2000).

2. Indian Scenario

India had largest number of persons with diabetes with 23 million cases in 2000, rising to 57 million by the year 2025 (Hilarg, 2003). As for the projections of The Hindu (2006), in 2035 India will top the list with 69.9 million diabetics.

Recent studies show that upto 10 percent of India's urban population and two percent of the rural population above the age of 15 years have diabetes (Elizabeth and Makol, 2005).

A high prevalence of metabolic syndrome was reported in Indian cities namely, Bangalore (38.8 percent), Trivandrum (37.9 percent), Hyderabad (33.0 percent), Lucknow (29 percent), Coimbatore (28.2 percent) and Delhi (22.9 percent) by Prabhakaran *et al.* (2006). A study by Misra (2007) stated that diabetes mellitus in adult urban Indian populations varied from a low 5.4 percent in northern state to a high 12.4 to 15.5 percent in Chennai, South India and 12.3 to 16.8 percent in Jaipur, Central India.

Type II diabetes mellitus in urban Indian adults had increased from less than three percent in 1970s to greater than 12 percent by 2000 while in rural population it has increased to seven percent.

World Health Organization estimates show that diabetes in India would increase to 57.2 million in 2025, from 30 million in 2002 and India will become the diabetic capital of the world (Alberti, 2001). Prasad (2002) cautions that 21 million Indians are presently suffering from diabetes and by 2010 India's contribution to the diabetic global population would be a whopping 60 million.

The epidemiological survey has revealed the prevalence of Type II diabetes mellitus in semi urban areas to be almost the same as urban areas (PODIS, 2005). Bhattacharjee, (2004) reports that India has the largest number of diabetic patients in the world. Diabetes prevalence in urban India range from 16 to 20 percent and in rural it is about four percent. As high as 63 percent of diabetics in India are not aware of the fact that they have diabetes and hence exposed to diabetes related complications.

The prevalence of diabetes and impaired glucose tolerance were 12.1 percent and 14 percent respectively in urban areas, with no gender difference. Diabetes and impaired glucose tolerance showed an increasing trend with age. The national study shows that the prevalence of diabetes is high in urban India (www.springerlink.com).

According to Sarah *et al.* (2004) the prevalence of diabetes is higher in men than in women. The most important demographic change to diabetes prevalence across the world appears to be the increase in the proportion of people, greater than 65 years of age.

Insulin dependent diabetes mellitus (IDDM) accounts for about 10 percent of diabetics. Non insulin dependent diabetes mellitus (NIDDM) is the most common type accounting for over 90 percent of all cases of diabetes. About 80 percent of people with Type II diabetes are overweight (www.diabeticindia.com, 2006).

B. ETIOLOGY OF DIABETES MELLITUS – THE EMERGING FACTS

1. Heredity

Kakuri *et al.*, (2001) have concluded from their study that age, gender and heredity play an important role in the onset of diabetes and makes diabetics more prone to chronic complications.

Neelam and Elizabeth (2005) opine that non-insulin dependent diabetes has a genetic predisposition and the chances of developing diabetes if someone in the family has diabetes is 20 percent, if one parent has diabetes – 40 percent; if one parent

has diabetes and the other parent is from a diabetic family – 70 percent; and if both parents are diabetics – 90 percent. Study by Vimalaswaran *et al.* (2005) reported that Indians have a higher percentage of familial aggregation upto 14 percent.

International Diabetes Federation (2003) had stated that strong family history was observed among affected youth, with 45 to 80 percent having atleast one parent with diabetes and 74 to 100 percent having a first (or) second degree relative with type II diabetes mellitus.

Velumani (2005) states that the cause of metabolic syndrome that leads to diabetes is both genes and bad environment. Insulin resistance is an important risk factor for Type II diabetes and coronary heart disease. Genetic factors, intra - uterine environment, early childhood and adult environment are the factors relevant in determining adult insulin resistance (Ebrahim *et al.*, 2004). Genetic characteristics and faulty life style behaviour were the reasons for increased diabetic patients in diabetes family (Nicolette *et al.*, 2004). Yajnik (2003) opines that susceptibility to Type II diabetes could be due to genetic factors, intra-uterine programming, accelerated childhood growth and life style factors.

2. Overweight and obesity

Obesity is an escalating threat to human health worldwide. According to Matvienko *et al.*, (2001) and Mokded *et al.*, (2003) obesity is associated with clinical problems like cardiovascular disease, high blood pressure and Type II diabetes.

In grossly obese adolescents both insulin resistance and impaired insulin secretion contribute to the elevation of glycaemia and the degree of obesity is related to cardiovascular risk factor independently of insulin resistance (Invitti, *et al.*, 2004).

The concurrent rise in weight and obesity, which accompanies Type II diabetes in 80 percent of cases interferes with diabetes treatment and exacerbates the likelihood of hypertension, dyslipidemia, atherosclerosis, and polycystic ovarian

syndrome (Hensrud, 2005). Overweight (or) obese individuals have a higher risk of developing insulin resistance, the metabolic syndrome, diabetes (Fernandez, 2007).

Type II diabetes mellitus is a culmination of two seemingly distinct processes, insulin resistance and beta cell failure, both of which had been closely linked to obesity (Eldor, 2007).

Mohan *et al.* (2007) opine that high fat diets and decreased physical activity and sedentary occupational habits that had accompanied the process of modernization resulted in the doubling of the prevalence of obesity and type II diabetes in less than a generation. The prevalence of diabetes was almost three times higher in individuals with light physical activity compared to those having heavy physical activities.

Study by Banga *et al.* (2005) reported that Indians have characteristic features of insulin resistance such as high central adiposity and high percentage of body fat in comparison with many other populations which worsened with small increments in weight and also with lack of physical activity, both of which were encouraged by modern living.

Dudeja *et al.*, (2001) opine that the association of obesity with Type II diabetes is complex and is compounded by several heterogenous factors. BMI is directly associated with glucose intolerance. This suggests that increase in body weight, although within the ideal levels of BMI, confers a high risk to Type II diabetes. Obesity is considered to be a risk factor for Type I diabetes in children, acting as an accelerator for the clinical manifestation (Mainouse and Koopman, 2004).

3. Life style pattern

Lack of exercise, a poor diet and smoking were associated with significantly increased risk of diabetes, even after adjustment of the body mass index. The majority of cases of Type II diabetes could be prevented by the adoption of healthier life style practices (Hu, *et al.*, 2002).

Currently most promising approach to mitigate Type II diabetes in lifestyle intervention is weight reduction, decreased total and saturated fat consumption, increased physical activity with appropriate pharmacotherapy (Knowler and Mcaulay, 2005). Weight reduction and dietary modification are the two main lifestyle factors that can be modified to have an impact on metabolic syndrome (Fernandez, 2007).

Ambros *et al.* (2007) state that weight loss (with reduction in energy intake and increase in physical activity) is an important therapeutic strategy in all overweight or obese individuals who have type II diabetes mellitus. Weight loss, which is a treatment for type II diabetes mellitus improved insulin sensitivity and glycemic control, lowered blood pressure levels, reduced low density lipoprotein cholesterol and triglycerides and increased high density lipoprotein cholesterol (Joobert, 2007).

The lifestyle programme by Corpelfhn *et al.* (2007) was effective in reducing the intake of total and saturated fats, increasing physical activity, reducing obesity and improving insulin sensitivity and glucose tolerance.

People living in cities and urbanized states have a higher risk of developing diabetes as they are less active, lead more stressful lives and have a more fatty diet (Pillai, 2006). Losing weight and taking more exercise could reduce the danger of developing diabetes by nearly 60 percent in people at risk.

Cigarette smoking causes specific effects on people with diabetes and are even more intricate and macro vascular and micro vascular complications ensue more quickly in smokers with diabetes (Justin and Sherman 2005). Janka and Michaelis (2003) point out that diabetes risk factor can be reduced by non- smoking campaigns and low cholesterol diets. Rossing *et al.*, (2003) state that cigarette smoking has been associated with development of persistent micro albuminuria as well as nephropathy in diabetic patients.

Tiffany and Joshu (2002) suggest that smoking can result in devastating health consequences for patients with diabetes. Prevention and treatment of smoking should be of high priority for diabetes care providers. Avoidance of smoking, regulating life style practices, relaxation by meditation and yoga and stress free life diminishes the risk of diabetes mellitus (Deccan Chronicle, 2005).

Lando, *et al.*, (2005) indicate that alcohol consumption is a life style factor that has been suggested to be relevant with respect to the risk of diabetes mellitus. Alcohol intake increases the risk of hyperglycemia and may induce keto acidosis, lactic acidosis and may contribute to peripheral neuropathy (Sahay and Rakesh, 2002). Moderate to high alcohol consumption was positively associated with incidence of diabetes (Waki *et al.*, 2005).

Regular physical activity is an important lifestyle factor associated with a reduced incidence of both cardiovascular disease and Type II diabetes (Andersen *et al.*, 2003). Stress has a major role to play in the causation and progression of diabetes, particularly in developing countries (www.diabetescare.com). With increasing affluence and mechanization of civilized societies, people are becoming increasingly sedentary (Sengupta and Maju 2005). Studies from World Health Organisation indicate that upto 80 percent of cardiovascular diseases and upto 90 percent of Type II diabetes mellitus and one third of cancers could be prevented through healthy life style changes (Patel, 2002).

Diet alone or exercise alone or diet and exercise combined have all shown promise in reducing incidence of Type II diabetes mellitus, (Jayakumar and Nisha 2005). The exercise training is effective in preventing the depression in myocardial glucose metabolism observed in diabetic rat. This may explain the benefits of exercise in preventing cardiac dysfunction in diabetics (Broderick *et al.*, 2005). Kapur (2002) cautions that only a structured lifestyle with diet control and exercise can curb the complications in diabetics.

Lifestyle interventions including moderate to intense physical activity such as walking for two and a half hours every week and exercise for 20 to 30 minutes is effective in preventing the diabetic complications (www.nih.gov/index.html).

According to RSSDI (2007) release, Type II diabetes is responsible for 90 to 95 percent of diabetes and 80 percent of Type II diabetes is preventable by changing diet, increasing physical activity and improving the living environment. Increased physical activity is associated with significant reduction of mortality (Trichopoulou *et al.*, 2007).

4. Incidence among transport workers

Szuber *et al.*, (2005) state that the temporary work disability due to sickness based on chronic disease like diabetes mellitus, causes absenteeism among 43 percent of bus drivers, 27 percent of tram drivers, and 27 percent of transport service workers. The study conducted by Stein *et al.*, (2001) state that trends in diabetes risk prevalence among male transport workers in Bulgaria, increased with smoking, and an increase of 15 or more cigarettes per day leads to the prevalence of diabetes among transport workers. Ahumad *et al.*, (2001) opine that drivers and conductors in transport work show high prevalence in diabetes mellitus in Mexico City.

Nagawa *et al.*, (2005) had suggested that shift work is a risk factor for the onset of diabetes mellitus among transport workers in Japan. Naganishi *et al.*, (2001) states that cigarette smoking and alcohol among transport workers increase the incidence of diabetes among young adults in Asian Indians. The study made by Neri *et al.*, (2005) compared the health condition between transport workers and general population and the result showed high risk of diabetes and cardiovascular diseases among transport industry than normal people in United States of America. According to Koda *et al.*, (2004) health problem among truck drivers were found to be high due to work load, stress and depression which lead to chronic diseases like diabetes and cardiovascular diseases.

A study conducted by Hannerz *et al.*, (2001) convey that prevalence of diabetes was more among drivers of passenger transport than the drivers of goods vehicles among Denmark population.

Obelenis *et al.*, (2003) state that the prevalence of diabetes is more in employees of public bus and trolley bus transport in Lithuania and it is caused due to 46 percent of smoking, 83 percent having bad nutrition regimen and 27 percent suffering from tension. According to Morikawa *et al.*, (2001) incidence of Type II diabetes among workers in transport is high due to increased body mass index, smoking and alcohol and family history of diabetes mellitus.

According to Joshi *et al.*, (2003) in many developing countries like India only five to 10 percent of workers give importance to nutritional aspects. Haldiya *et al.*, (2005) opine that proper suggestions on diet reduced the risk of diabetes among transport workers by providing various nutritional programmes in Rajasthan.

C. COMPLICATIONS OF DIABETES MELLITUS – THE MAJOR THREAT

1. Cardiovascular diseases

Diabetes mellitus and hypertension are both major health problems in India which co-exist frequently resulting in significant morbidity and mortality. The leading cause of morbidity and mortality in people with non – insulin dependent diabetes mellitus is cardiovascular disease caused by macro and micro vascular degeneration (Rube and McDonald, 2002).

Coronary artery disease mortality and the incidence of non fatal coronary artery disease events were 2 to 4 times higher in Type II diabetics compared to age matched non diabetic subjects (Haffener *et al.*, 2002).

Hu and Manson (2001) opine that Type II diabetes and cardiovascular diseases are important causes of concern due to their near epidemic incidence. The diabetic

related complications include cardiovascular diseases, stroke, nephropathy, retinopathy, neuropathy and amputations.

People with diabetes are twenty five times more likely to develop blindness, seventeen times more likely to undergo amputations, two to four times more likely to develop myocardial infarction and twice as likely to develop a stroke than non-diabetics (Pradeepa *et al.*, 2002). Patients with diabetes are two to three times more likely to develop cardiovascular disease than the individuals without diabetes but proper diabetes management and metabolic control can reduce this risk (Abraham 2004). Cardio vascular diseases are responsible for 70 to 80 percent of mortality among type II diabetic subjects (International Diabetes Federation, 2006).

Hypertension is a major threat to diabetics and is caused due to increased peripheral vascular resistance, hyperinsulinemia and insulin resistance. Manchanda (2000) states that people with diabetes mellitus have higher risk for heart attacks. The reason for higher incidence of heart attacks in diabetics are clustering of cardiovascular disease factors like abnormal blood pressure, elevated cholesterol, obesity or overweight that predisposes an individual to development of blocks in the blood vessels of the heart (Prasad, 2002). Impaired glucose metabolism is associated with an increased risk of cardiovascular events and cardiovascular associated mortality (Zeymer, 2006).

Diabetes doubles the risk of stroke in the diabetics. If blood pressure is prevailing the risk is even greater. World Health Organization (2002) cautions that heart diseases accounts for approximately 50 percent of all deaths among people with diabetes in industrialized countries. The burden of cardiovascular diseases and disability among people with diabetes is growing at an alarming rate and World Health Organization predicts that by 2010 India will have 60 percent world's cardiovascular diseases below the age of 40 years.

Heart disease strike people with diabetes twice as often as people without diabetes. People with diabetes are five times more likely to have heart disease and stroke and once having had a stroke, are two to four times as likely to have a recurrence. Seventy percent of people with diabetes have high blood pressure. Over the past 30 years, deaths from heart disease in men with diabetes have increased by 13 percent compared to 36 percent decrease in men without diabetes (<http://w3.whosea.org/women/chap2-1html#diabetes>).

2. Neuropathy

Mafauzy (2005) evaluated the status of diabetes care and prevalence of diabetic complications in Asia. He found that there was a high complication rate with the commonest being neuropathy (30.1%) followed by background retinopathy (23.5%), albuminuria (22.9%) and microalbuminuria (20.4%). He concluded that the majority of diabetic patients treated at the primary care level were not satisfactorily controlled and this was associated with a high prevalence of complications.

Diabetic neuropathy is the most common complication of diabetes. This can lead to sensory loss and damage to the limbs and it is the leading cause of lower extremity amputations not related to injury. About 67,000 people undergo diabetes related lower extremity amputations each year (www.healingnutrition.com). Fifty percent of diabetics have some form of neuropathy, and develop nerve problems at any time, but longer a person has diabetes, the greater the risk. The highest rates of neuropathy are among people who have had the disease for atleast 25 years.

The prevalence of autonomic nervous system dysfunction is not precisely known, however tests of autonomic function have shown impairment in nearly 20 to 40 percent of diabetic patients (Mehta *et al.*, 2002).

World Health Organisation (2002) studies suggest that up to 50 percent of people with diabetes are affected with neuropathy. To some degree neuropathy can lead to sensory loss and damage to the limbs.

Diabetic neuropathy, a peripheral nerve disease in diabetes is the most prevalent type of neuropathy in Japan and contributes to various disabled status in diabetics (Kikkawa, 2000). The overall prevalence of neuropathy in India appears to be lower than Europeans. In a study conducted at Chennai with urban population, the prevalence of neuropathy was 7.7 percent (Ramu *et al.*, 2000). About 60 to 70 percent of people with diabetes have mild to severe forms of nervous system damage and severe nerve disease (www.niddk.com).

Weiman (2005) points out that diabetes mellitus affects five to 10 percent of the U.S. population and it produces one of the serious chronic complication, peripheral neuropathy. The peripheral neuropathy in the lower extremities leads to plantar foot ulceration. Secondary infection of these ulcers is the leading cause of major amputations of feet and legs.

Diabetic patients have 12 times higher risk of amputations when compared with non-diabetic subjects. Also patients with impaired glucose tolerance are associated with dysfunction in peripheral nerves and abnormal nerve function. Increased thickening of the small blood vessel is associated with neuropathy in impaired glucose tolerance and diabetic subjects (The Hindu, 2006). Cardiovascular autonomic neuropathy (CAN) is the most clinically important and well studied form of diabetic autonomic neuropathy because of its association with a variety of adverse outcomes including cardiovascular deaths (Kaveer *et al.*, 2004).

3. Diabetic foot infections

Neuropathy places the foot at increased risk for developing corns, calluses, blisters and ulcerations. If left untreated serious infections may result (www.actas).

com). Diabetic foot ulcers precede 85 percent of non traumatic lower extremity amputations. Approximately, three to four percent individuals with diabetes currently have foot ulcers and develop infections (www.emedicine.com).

In India, of the total diabetic population, 15 to 20 percent have foot problems. The loss of limb in these patients is preventable as majority of diabetic foot problems in India is neuropathy (Bal, 2002). It is one of the costly complications of diabetes, especially in communities with inadequate foot wear. It results from both vascular and neurological disease process, concludes World Health Organization (2002).

More than 60 percent of non traumatic lower limb amputations occur among people with diabetes. The risk of a leg amputation is 15 to 40 times greater for a person with diabetes. Amputation rates are 1.4 to 2.7 times higher in men than women with diabetes (<http://www.sandylake diabetes.com/prevalence> (2006).

4. Nephropathy

Larry (2007) states that diabetic nephropathy goes along with other complications including hypertension, retinopathy and blood vessel damages.

Diabetic nephropathy is a very important cause and contributor for chronic renal failure in India (Agarwal, 2002). Strict dietary measures and lifestyle changes in newly detected Type II diabetic patients could yield very good results in controlling and further progression of micro albuminuria, hyper glycemia and proteinuria (Singh *et al.*, 2002). Diabetes control and complications trial has clearly shown that intensive therapy reduces the occurrence of microalbuminuria by 39 percent, proteinuria by 54 percent and clinical nephropathy by 60 percent (Buse, 2001).

Nilka *et al.*, and Burrows *et al.*, (2005) conclude that between 1990 and 2001, the annual number of new patients starting treatment for diabetes related end stage renal disease in the south west American Indians total population increased from 154

to 320, per 10,000 population. The increasing incidence of diabetes related renal diseases parallels the growing prevalence of diabetes.

According to Chennai Urban Population study by Unnikrishnan *et al.* (2006), the prevalence of diabetic nephropathy was 2.2 percent and microalbuminuria 26.9 percent among type II diabetic subjects. Host etter and Lising (2003), opine that diseases largely contributing to the end stage renal disease populations are diabetes, mainly Type II diabetes and hypertension. Further, the micro vascular complications of diabetes can be mitigated by careful glyceemic therapy.

From 1988 to 1997, the incidence rate of the number of early stage renal disease patients doubled in United States, and the two important factors associated with this dramatic rise are the increasing prevalence of diabetes and high blood pressure (Rodgers, 2003).

Each year about 28,000 people with diabetes develop kidney failure, and an annual total of nearly 100,000 people with diabetes receive treatment for this condition. (www.healingnutrition.com). Dietary protein intake, salt restriction and restricted intake of saturated fatty acids may have an important role in the prevalence and treatment of diabetic nephropathy (Holler *et al.*, 2000).

5. Retinopathy

Nearly all patients who have Type I diabetes for about 20 years is likely to have evidence of diabetic retinopathy. Up to 21 percent of people with Type II diabetes have retinopathy when they are first diagnosed with diabetes, and most would eventually develop some degree of retinopathy glaucoma, cataract and corneal disease that contribute to the high rate of blindness. In diabetes cases occurring before the age of 30, men develop retinopathy more rapidly than women. Retinopathy is a progressive vision disorder that can lead to blindness (<http://www.who.int/hpr/gr.fs.diabetes.html>, 2005).

Vivian (2003) opines that three year screening interval could be safely adopted for patients with out retinopathy, but yearly or more frequent screening is needed for patients with higher grades of retinopathy. Marianne *et al.*, (2003) reveals that despite modern diabetes management, 39 percent of young adult diabetic patients develop retinopathy within the first 10 years of the disease.

James *et al.*, (2004) points out that the most severe stage of retinopathy, proliferative retinopathy was evident 15 years after diagnosis in 30 percent with Type I diabetes, 10 to 15 percent with Type II diabetes treated with insulin and five percent not treated with insulin.

Charytan (2007) states that diabetic retinopathy caused due to prolonged hyperglycemia, leads to further complications namely glaucoma, retinal detachment, visual impairment and blindness if left untreated.

The prevalence of retinopathy, the leading cause of blindness in diabetics is around 30 per cent in type II diabetic subjects (Diabetes Atlas, 2006). Gardiner *et al* (2007) states that diabetic retinopathy is one of the most widespread complications of diabetes mellitus and a major cause of blindness in the working population of developed countries. They also further affirm that many neural and micro vascular abnormalities occur in the retina of short-term diabetic animals but it remains uncertain how closely these acute changes relate to chronic human disease.

D. LOW GLYCEMIC INDEX FOODS – A SCIENCE BASED DIET

The glycemic index of a food stuff is defined as the blood glucose response of a food stuff in comparison with glucose or some other standard. (e.g.) white bread. This index measures how much blood glucose increases in two or three hours after eating. The glycemic index ranks foods on how they affect blood glucose levels, and it is about the quality of the carbohydrates and not the quantity.

Glycemic index is a ranking system for carbohydrates based on their effect on blood glucose levels. It compares available carbohydrates gram for gram in individual foods, providing a numerical, evidenced based index of post prandial (post-meal) glycemia. The concept was invented by Dr. David J. Jenkins and colleagues in 1981 at the University of Toronto (Browns *et al.*, 2005).

The glycemic load (GL) is a ranking system for carbohydrate content in food portions based on their glycemic index and the portion size. Glycemic load is the amount of carbohydrate in a food multiplied by the glycemic index of that carbohydrate. Glycemic load provides a more accurate measurement of the type and amount of carbohydrate eaten, making it a more accurate gauge to use for examining foods in the context of a healthful diet (Jorge *et al.*, 1997).

From controversial beginnings in the 1980s, the Glycemic Index has stood the test of time and scientific scrutiny. The current recommendations of FAO / WHO (1998) and major diabetes associations, including Diabetes UK 2003, the Canadian Diabetes Association (2000), and diabetes Australia (2001) refer to glycemic index. Most recently, the American Diabetes Association recognized that the use of the GI can provide an additional benefit over that observed when total carbohydrate is considered alone (Sheard *et al.*, 2004).

A study by Higginbotham's *et al.*, (2004) support the relationship of high GI diets with colon cancer. Studies by Brand-Miller (2003) with Type II diabetes demonstrated that the use of a low-GI diet in the treatment of diabetes improved control by a significant decrease in HbA_{1c}. Improvements in cardiovascular risk factors also have been demonstrated by Opperman *et al.*, (2004).

Rizkalla *et al.*, (2003) state that, diet with low glycemic index value improve the prevention of coronary heart disease in diabetic and healthy subjects. In obese or over weight individuals, low glycemic index meals increase satiety and facilitate the

controlled food intake with beneficial effect on post prandial glucose and lipid metabolism.

According to Grylls and McKenzie (2004), reducing dietary saturated fat and excess body weight may be useful means of improving glycemic control in older adults with diabetes. Increasing physical activity and reducing energy from dietary source may assist weight control, the former particularly in women.

A study on low glycemic index lunch on satiety in over weight and obese people with Type II diabetes, suggest the need to promote culturally based combined foods with high fiber and low glycemic index. This approach might contribute to the prevention of obesity increasing the perception of satiety while also improving metabolic control of diabetes. In addition, this is a low cost approach for people with limited financial resources (Jimenez *et al.*, 2005).

Daily incorporation of low glycemic index carbohydrates in meal planning can be an effective diabetes self management strategy for glycemic control and weight management. The documented responses to the subject's conceptual and practical knowledge of the glycemic index, confirm their acceptance of this approach as a permanent behavioral life style change and not a "diet". Positive results of this study attest to what worked for these subjects inviting educators to consider offering low glycemic index dietary advice to their diabetic patients (Burani, 2006).

A study on glycemic index of commonly consumed Indian foods proved that boiled dry peas and boiled rajmah had significantly low glycemic index values while bajra, roti and cooked sago had significantly high glycemic index values in normal subjects. On the other hand, in diabetic subjects boiled form of rajmah, cowpea, lentil and whole bengal gram had brought about significantly low glycemic responses. Hence boiled bengal gram can be advocated for consumption to the diabetic subjects due to their low glycemic indices (Nalwade *et al.*, 2003). Many whole-grain products have a high glycemic index (Brand-Miller, 2007). According to Miller (2005), the

degree of post prandial glycemia is influenced by both the quality and quantity of carbohydrate in the meal.

American Diabetes Association (2007) has recommended carbohydrate intake to range from 45 to 65 percent of the total calories, protein intake from 10 to 20 percent of the total calories and fat less than 30 to 35 percent of the total calories and fibre intake upto 50 grams per day.

Saroja (2000) recommends that 60 to 65 percent of energy requirements be derived from the complex carbohydrates contained in cereals and pulses for the effective control of diabetes. Cereals in the form of rice and wheat along with vegetable proteins in the form of pulses and legumes increases the protein content of the diet and also substantially increase the soluble fibre content of the diet. This, results in improved peripheral sensitivity to insulin and the glycemic indices of food stuff are also lowered.

Fibre rich foods delay glucose absorption from the small intestine and thus reduce post prandial blood glucose concentrations. Studies by Mohan *et al.*, (2003) indicate that by increasing the non-starchy vegetables containing three percent to four percent of energy as carbohydrate (green leafy vegetables, cucumber, cauliflower, ladies finger etc.) in the diet, the bulk of the meal was increased and this increases the fibre content of the diet. Blood glucose response to the ingestion of carbohydrate containing foods has been shown to vary dramatically depending on factors including the molecular structure of the carbohydrate, fiber content and degree of processing (Ludwig 2002). Powell (2002) opines eating white bread results in two and a half times the increase in blood sugar than eating the same amount of carbohydrate from bareley or chick pea. Long term dietary treatment with increased amounts of fibre rich low glycemic index natural foods improves blood glucose control enhances weight control and reduces the number of hypoglycemic events in Type I diabetic patients (Rosalba, 2000 and Jannette *et al.*, 2002). Replacing foods with a higher glycemic

index by those with lower glycemic index resulted in improved glycemic control and reduced fasting serum lipids. Various properties of foods such as particle size, botanical structure and properties of the starch influence the metabolic responses to carbohydrate foods (Jarvi *et al.*, 1999).

Zhang (2004) concluded that knowledge of glycemic index seems to be easily understood and accepted by diabetic subjects and is beneficial to dietary practice, blood glucose and lipids.

Jenkins (2007) stated that glycemic index had potential therapeutic utility. Slama (2007) stated that low glycemic index foods had a very significant impact on the amelioration of metabolic disturbances observed in diabetic subjects. Waldmann *et al.* (2007) state that fibre rich vegan diets characterized by a low glycemic index prevent degenerative diseases like type II diabetes. Franz (2007) stated that the total amount of carbohydrate in a meal is the primary meal planning strategy for people with diabetes and the glycemic index is used as an adjunct for the fine tuning of postprandial blood glucose responses. Features that are associated with low glycemic index foods such as viscous fibre, a high amylase to amylopectin ratio of the starch, traditional food processing such as parboiling all influence the rate of carbohydrate absorption (Henry *et al.*, 2007). Low glycemic index diets produced not only just a lower glycemic response but also significant slowing in the rate of digestion of carbohydrate and improved insulin sensitivity (Thompson, 2007). Studies by Chao Gang *et al.* (2007) showed a negative relationship between glycemic index and high density lipoprotein cholesterol. According to Wolever (2006) β cell responsiveness (the product of insulin sensitivity and insulin secretion) which is the key factor to prevent type II diabetes mellitus increased by consumption of low glycemic index foods. Studies by Lineback (2005) showed that the glycosylated haemoglobin levels are moderately reduced with the consumption of low glycemic index diet.

In large population studies, intake of whole grains and dietary fibre – generally the lower glycemic index food sources are associated with reduced risk of obesity and Type II diabetes (Edeiman, 2006).

Willet *et al.*, (2002) states that a higher intake of cereal fiber has been consistently associated with lower diabetes risk. In diabetic patients, replacing high glycemic index carbohydrates with a low glycemic forms will improve glycemic control and, among persons treated with insulin, will reduce hypoglycemic episodes. These dietary changes can be made by replacing products made with white flour and potatoes with whole-grain minimally refined cereal products, have also been associated with a lower risk of cardiovascular disease and can be an appropriate component of recommendations for an overall healthy diet.

Franz (2007) suggests that the total amount of carbohydrate in a meal is the primary meal-planning strategy for people with diabetes. The Glycemic index can be used as an adjunct for fine tuning of postprandial blood glucose responses.

Kolset (2003) quotes that glycemic index is developed to help persons with diabetes improve their blood glucose control in order to avoid long term complications. He also suggests that a carbohydrate diet with low glycemic index may reduce the risk of over weight, Type II diabetes and colon cancer. Also glycemic index could be used as a tool for dieticians and physicians for counselling persons with over weight and diabetes.

There is a large bulk of evidence that using low glycemic index (GI) foods has a very significant impact on the amelioration of metabolic disturbances observed in diabetic and hyperlipidemic patients. Improvement was observed not only in post prandial blood glucose and insulin variations but also in circulating plasma lipid levels and the morphology and function of adiposities. Slama *et al.*, (2006) also suggest that the use of low glycemic index foods should be considered as one of the means and tools available to improve diabetes.

Burani and Longo (2006) in their research study evaluated the incorporation of low glycemic index carbohydrates into daily meal planning as an effective behavioural lifestyle change to improve glycemic control and weight management in diabetic patients. Low glycemic index medical nutrition therapy (LGI – MNT) counselling reduced HbA_{1C} by 19 percent and decreased BMI by eight percent. This was accomplished by the participants independently lowering the glycemic index values of their meals by 25 percent and they accepted this approach as a permanent behavioral lifestyle change and not a ‘diet’.

E. THERAPEUTIC LIFESTYLE COUNSELLING

Bastica *et al.*, (2006) state that diet counselling helps to know about the quality and quantity of food intake and importance of nutritional intake during diseases. Nutrition counselling provides appropriate feeding, contributing to better health conditions and well being.

Gallegos *et al.*, (2006) state that diet counselling was effective in improving the metabolic control in diabetic patients.

Ramachandran (2006) says that both life style modification and diet counselling significantly reduce the incidence of diabetes in Asian Indian with impaired glucose tolerance. In self management of diabetes, diabetic education plays an important role.

Nutritional counselling acts as a cornerstone in management of type II diabetes mellitus as counselling about diet modification, food frequency, increasing physical activity and about the disease significantly improved dietary intake and anthropometric parameters (Banga *et al.*, 2005).

Study by Yeje *et al.* (2007) showed that individual diabetes dietary education is a useful tool to make the patient understand their diet prescription and is an effective intervention to control body weight and blood sugar level.

Terfil and Ritenbaugh (2004) identified development of a primary prevention program gained insight in the diabetes prevention program. The program strived to enhance knowledge of diabetics and supported increased physical activity, increased fruit and vegetables intake and reduced soft drinks consumption. Results indicated a significant reduction in soft drink consumption suggesting a decline in the incidence of hyper insulinemia.

Valk *et al.*, (2005) state that ulceration of the feet, result in amputation and is one of the major health problems for people with diabetes. Therefore he assessed the effectiveness of patient education counselling on the prevention of foot ulcers in diabetics. He concluded that patient education counselling reduced foot ulceration and amputations. Foot care knowledge and behavior of patients seem positively influenced by patient education in the short term. According to Goldhaber *et al.*, (2004), glycemic control of Type II diabetes patients can be improved through community based health intervention addressing nutrition counselling and exercise.

Gucciardi *et al.*, (2007) studied the effect of individual counselling in conjunction with group education among Portuguese Canadian adults with Type II diabetes. He concluded that competent group education in conjunction with individual counselling is more efficacious in shaping eating behaviors than individual counselling alone. According to Pollock *et al.*, (2004) when patients with diabetic foot ulcers were advised on foot care, they followed better practice of foot care which led to the prevention of foot ulcers and amputations. According to the opinion of Eaton *et al.*, (2002) diet counselling on high risk patients help to improve their health status through counselling. Vikram *et al.*, (2006) opine that the early identification of simple clinical, anthropometry, and biochemical parameters which are strongly associated with early onset of Type II diabetes among young adults in India, along with providing nutrition counselling helps to improve the health status among the young diabetics.

Franz *et al.*, (2007) opines that the role of diet counsellor is to assist persons with the metabolic syndrome to make life style changes and modify factors that increase the risk of diabetes. According to Bonometti *et al.*, (2006) the impact of diet counselling for pre-diabetics can prevent or delay Type II diabetes. The diabetes prevention programme revealed a 58 percent reduction in the progression of diabetes for individual with glucose intolerance that made them incorporate life style changes resulting in weight loss and increased activity. Kanchabanga *et al.*, (2006) opine that nutrition counselling improved the dietary intake and anthropometric dimension of Type II diabetes mellitus patients, indicating the importance of counselling in the management of the disease.

According to Mansoureh *et al.* (2005) the impact of diet counselling is useful among urban diabetics than the rural diabetics, because lifestyle changes in urban area bring increased prevalence of diabetes among young adults in India. Lisa *et al.*, (2006) suggest that diet counselling improves nutritional status and medical status compared with patients who have not received diet counselling among rural Kentucky people in U.S.A. According to Feldeisen *et al.* (2007) diet counselling interaction is likely to contribute interesting information that may lead to further individualized dietary guidance in the future for diabetic patients.