2. REVIEW OF LITERATURE

The review of literature related to the children with Diabetes is discussed under the following headings:

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2.1. Demographic profile

At the start of the 20th century, childhood diabetes was rare however, by end of century 3–4 children per 1,000 in western countries were on insulin therapy. Though the prevalence of juvenile Diabetes in India is less than one per cent (Anoop Mishra, 2011) the morbidity and mortality on account of this is a huge burden on childhood.
In the past, Type 2 Diabetes Mellitus was considered a disease of adults and older individuals not a pediatric condition. In the last decade in USA and other countries of the world, there has been a disturbing trend of increasing cases of Type 2 Diabetes in children due to increasing trends of obesity. The risk factors for pediatric Type 2 Diabetes are obesity and increased body mass index, family history of Type 2 Diabetes, membership of ethnic minority, puberty (mean age of diagnosis is ~13.5 years), female gender and features of 'syndrome X'. The common link among these risk factors is insulin resistance which plays a pivotal role in the patho-physiology of Type 2 Diabetes. Both insulin resistance and β-cell failure are present in the fully established diabetes state (Arslanian, 2002).

Sridhar and Nagamani (2002) stated in their study that many studies on Indians living abroad did show that Asian Indian children when exposed to adverse environmental factors developed Type 1 Diabetes as much as the white Caucasian children.

Higher prevalence of ketoacidosis and more prolonged hospitalization was found in case of diabetic children from low socio-economic status. Hence, intensive programs to improve their health and to decrease the total health care costs forms an important issue in their health care (Keenan et al., 2002) and Icks et al., (2003).

Myśliwiec et al., (2006) stated that the higher incidence of diabetes observed in the children aged 5-9 years old in the year 2002 was shifted to the age group of 0–4 years in the year 2003 while the incidence rate of diabetes in the age group of 10–15 years remained stable. However, higher incidence of diabetes was found among girls when compared with the boys.

According to Anoop Mishra (2011) the average age of onset of diabetes among Indians is a decade earlier than other races. According to Matziou et al., (2011) the QOL of young diabetics was influenced by demographic, somatometric and other characteristics of Diabetes.
Amutha et al., (2012) stated that childhood and adolescent onset Type 2 Diabetes mellitus appeared to be increasing in urban India and prevalence of micro vascular complications was also found high in females at younger ages of < 15 years.

The results of the study by Sjoberg et al., (2012) showed that the age of onset of Diabetes is associated with the pattern of reproduction in both diabetic men and women. Both the men and women were diagnosed with diabetes at the age of 17 or under and had smaller number of live births compared to the controls.

Vanelli et al., (2012) found Type 1 Diabetic children belonging to ethnic minority had poor glycemic control compared with native patients which may be probably due to the difference in their cultural, economic and educational background.

2.2 Types of Diabetes

Diabetes Mellitus is a group of metabolic diseases characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both.

2.2.1 Type 1 Diabetes: Type 1 Diabetes is usually caused by autoimmune destruction of the pancreatic beta cells that produce insulin. There is no known preventive measure that can be effectively used in Type 1 Diabetes as most people affected are otherwise healthy when onset occurs. However, Type 1 Diabetes can affect both children and adults, it has a nickname of "juvenile diabetes" because the majority of Type 1 Diabetes cases are found in children (Darrell Miller, 2007).

2.2.2 Type 2 Diabetes: Type 2 Diabetes, once considered an “adult-only” disease, is appearing in children and teens in epidemic proportions. An expert panel of American Diabetes Association, (2000) estimated that on average 20 per cent of newly diagnosed Diabetes in children were Type 2, and 85 per cent of those children were obese. T2DM is a non-autoimmune, complex, heterogeneous and polygenic metabolic
disease condition in which the body fails to produce enough insulin, characterized by abnormal glucose homeostasis (Gupta et al., 2008). T2DM occurs when impaired insulin effectiveness (insulin resistance) is accompanied by the failure to produce sufficient insulin by β-cell (Permutt et al., 2005). Treatment is based on change in physical activity, diet and weight loss. These measures can restore insulin sensitivity, allowing Type 2 Diabetics to regain satisfactory glucose control for years.

The Type 2 Diabetes in children occurs even in developing countries. In concurrence with the reports from the developed countries, obesity, female sex, parental history of Type 2 Diabetes, and pubertal age appeared to be strongly associated with the disease in Asian children. Clinical conditions associated with insulin resistance like acanthosis nigricans and polycystic ovary syndrome were common in the young Type 2 Diabetic patients. Unlike in the children with Type 1 Diabetes who had acute onset of the disease with severe symptoms and ketonuria, lean body weight, and lack of familial aggregation, the Type 2 Diabetic children showed features similar to classic adult-onset Type 2 Diabetes. Insulin resistance is a common feature even in non-obese Asian-Indian subjects (Ramachnadran et al., 2003).

According to Parvez Hossain et al., (2007) in the past 20 years, the rates of obesity have tripled in developing countries that have been adopting a western lifestyle involving decreased physical activity and over-consumption of energy-dense food. The prevalence of overweight among them ranged from 10 to 25%, and the prevalence of obesity ranged from 2 to 10 per cent. Some developing countries face the paradox of families in which the children are underweight and the adults are overweight. This combination has been attributed by some people to intrauterine growth retardation and resulting low birth weight, which apparently confer a predisposition to obesity later in life through the acquisition of a "thrifty" phenotype that, when accompanied by rapid childhood weight gain, is conducive to the development of insulin resistance and the metabolic syndrome.
Both Type 1 and 2 Diabetes are incurable chronic conditions. However, they have been treatable ever since insulin became medically available and are usually managed today with a combination of dietary treatment, tablets and insulin supplementation.

2.2.3 Other specific types: Gestational Diabetes, is high blood glucose that develops at any time during pregnancy in a woman who does not have diabetes. Women who have Gestational Diabetes are at high risk of Type 2 Diabetes later in life. Other forms of Diabetes develop due to genetic defects of β-cell function, genetic defects in insulin action, diseases of the exocrine pancreas, endocrinopathies, drug or chemical induced, infections, uncommon forms of immune-mediated diabetes and other genetic syndromes sometimes associated with Diabetes (Jeffrey, 2007).

An increase in the number of children and adolescents with a mixture of the two types of Diabetes has recently come to light (i.e., subjects who are obese and/or with signs of insulin resistance as well as positive for markers of autoimmunity to β-cells), although the epidemiological data supporting such a conclusion are sparse. Under the current classification, it is difficult to define the type of diabetes affecting these young subjects, who might be classified as T2D because they are obese and insulin resistant but also as T1D because of the presence of autoantibodies to β-cells. These subjects show an overlapping Diabetes phenotype typical of both T1D and T2D, suggesting that the current classification of diabetes should be revised to take into account this new form of Diabetes, which has been called ‘Double Diabetes’ or ‘Hybrid Diabetes’ (Pozzilli et al., 2007).

2.3. Diagnostic tests

According to Diabetes Medline Plus Medical Encyclopedia (2011), the diagnosis is confirmed by measurement of the blood sugar level. A child is considered to have diabetes from any of the tests, Fasting plasma glucose level at or above 7.0 mmol/L (126 mg/dl), Plasma glucose at or above 11.1 mmol/L (200 mg/dl) two hours after a 75g oral glucose load as in a glucose tolerance test. Levels between 100 and 126 mg/dl are referred to as impaired fasting glucose or pre-diabetes and these levels are
considered to be risk factors for type 2 diabetes and its complications. If glycated haemoglobin (haemoglobin A1C) at or above 6.5 (American Diabetes Association, 2010) is considered to have diabetes. The HbA1c is a measure of average blood glucose during the previous 2-3 months.

2.4. Self-Monitoring of Blood Glucose (SMBG)

Self-Monitoring of Blood Glucose (SMBG) by using gluco-meter a simple method is a key component of the treatment regimen and it can play an important role in improving metabolic control in patients with diabetes. It is recommended for patients treated with insulin to improve glycemic control.

The Diabetes Control and Complications Trial (DCCT), a landmark clinical study found that strict control of blood glucose levels using SMBG significantly reduced the risk of diabetes-related complications. SMBG helps to assess how effective medication or insulin in controlling blood glucose levels and it is an invaluable tool for adjusting the timing of medication to ensure the best possible control. Perhaps, most important SMBG can avoid life-threatening blood sugar emergencies. In order to teach self management, the needs of the individual and family should be considered and medical care in the absence of self-care is rarely adequate for managing chronic illness (Von Kroff et al., 1997).

Karter et al., (2001) concluded that people with Type 1 Diabetes who monitored three or more times a day had better HbA1c results. According to Jones et al., (2002) people should learn to self-monitor their blood glucose levels, interpret the results and know how to respond to them and to improve glycemic control with SMBG data. SMBG helps to evaluate if the therapy is working and to evaluate the treatment plan and make changes if needed in medication or insulin, meal plans and exercise.

The writing team (2003) for the Diabetes Control and Complications Trial (DCCT), Epidemiology of Diabetes Interventions and Complications Trial (EDIC), and the UK Prospective Diabetes Study (UKPDS) suggested that SMBG test at least four times daily along with other intensive management decreased the micro-vascular and
macro-vascular complications particularly diabetic nephropathy in Type 1 Diabetes mellitus.

As per the report of global consensus conference on glucose monitoring on the role of SMBG in the care of people with diabetes, SMBG can be used to help prevent and minimize acute complications such as episodes of hypoglycemia, hyperglycemia (or) diabetic ketoacidosis (Bergenstal and Gavin, 2005).

Hill-Briggs and Gemmell (2007) in their systematic review study stated that there was significant improvement in HbA1c level when people with diabetes were taught to use SMBG test results to adjust insulin doses whether or not received reminders from their health care team.

Svein Skeie et al., (2009) found that the HbA1c levels had decreased in the subjects using SMBG technique compared to control hence, it was suggested that SMBG intervention can be applied in regular out-patient setting.

Funnell (2008) in the study on quality of life and insulin therapy in Type 2 Diabetes Mellitus children concluded that, educating on SMBG resulted in improving the quality of life beyond clinical outcomes.

In the field study Gonder- Frederick et al., (2008) it was noted that SMBG, incorporated into the self-management regimen with an effective educational intervention, can also minimize the risk of complications since, symptoms of hypoglycemia may not be recognized by young children or their parents.

India Diabetes Educator Project by International Diabetes Federation (IDF), (2008) stated that, Diabetes is a chronic disease that requires attention to the variables that affect blood glucose control. The diabetes educator has a crucial role in supporting patients in self-managing their diabetes. Studies have shown that self-monitoring of blood glucose results in improved HbA1c for both people with Type 1 and Type 2 Diabetes.
Tomky et al., (2008) stated that SMBG on timely basis will provide immediate information than HbA1c on all factors which affects glycemic control and helps in clinical decision making and healthcare outcomes. SMBG provides critical feedback on the consequences of recent activity including medicine taking, meals and physical activity in non insulin treated Type 2 Diabetes to act upon glycemic abnormalities (Polonsky et al., 2009).

2.5. Diabetes management

2.5.1 Insulin Therapy

Type 1 Diabetics require insulin injections to live and many Type 2 patients who are on hypoglycemic drugs initially end up needing insulin to control their disease. Insulin comes in several different strengths and actions. Insulin currently is available in four basic types for clinical use and are classified into rapid-acting, very rapid-acting, short-acting, intermediate-acting and long-acting. In addition, there are two different types of combination insulin including intermediate-acting plus rapid–acting and intermediate-acting plus short-acting, based on the number of hours until their "peak" action. Peak action occurs when the concentration of insulin is greatest in the blood and has its greatest glucose-lowering effect. The onset, peak time and duration of the action are the three criteria considered while choosing an insulin for the treatment.

According to Holl (2003), the daily insulin dose (ID) is a substantial parameter for the management of Type 1 Diabetes Mellitus (DM1) in children and adolescents. Allard et al., (2003) found that childhood and adolescence cover phases of growth and pubertal development with substantial changes of metabolic condition. However, during puberty physiological insulin resistance increases to some degree.

Eesh Bhatia and Ajay Agarwal (2007) emphasized the importance of strict glycemic control in the prevention and delay of micro-vascular chronic complications of Diabetes Mellitus which will lead to increasing efforts in devising means of physiological insulin delivery, in which basal insulin and meal related boluses of
insulin are separately given and insulin doses are approximately altered based on frequent blood glucose testing, meal size and exercise.

Wiegand et al., (2008) found that insulin dose percentiles were significantly different during various periods of childhood and were influenced by gender, body weight and insulin injection regimes. It varied among 0.67 IU/kg (age 3 years), 0.93 IU/kg (13 years) and 0.70 IU/kg (23 years) increasing from early childhood to adolescence and decreasing toward adulthood. Highest insulin dose was found at 12 years in females (0.94 IU/kg) and at 14 years in males (0.92 IU/kg) and was found to be significantly (P>0.001) associated with age, gender and insulin delivery regime.

Dias et al., (2012) in their study concluded that the effect of insulin intensification on glycemic control and lipid levels in children and young persons with Type 1 Diabetes was found to be in relation to ethnic group. By the end of the study (after 2 years) it was observed that the black ethnicity was associated with poorer glycemic control as against South Asian ethnicity which was associated with higher triglyceride levels independent of HbA1c.

A systematic review of randomized clinical trials by Golden and Sapir (2012) revealed that continuous subcutaneous insulin infusion and multiple daily injections had similar effect on glycemic control and severe hypoglycemia in children.

Realsen et al., (2012) in their study concluded that the most common risk factor for DKA was lack of adherence to insulin treatment and is one of the most common, costly and dangerous acute complications in people with Type 1 Diabetes (T1D). Although DKA

has been reported to occur with less frequency than severe hypoglycemia, it is associated with a higher mortality rate and is the leading cause of diabetes-related deaths in children and adolescents.
2.5.2. Carbohydrate counting

Carbohydrate counting is an approach to glycemic control which focuses on the carbohydrate ingestion as the primary determinant of blood glucose. The patient was taught to match insulin doses to carbohydrate amounts consumed. This method provides greatest flexibility in terms of food choices, portion size and timing of meals. Increasing the carbohydrate content of a meal does not result in deterioration of control as long as the pre-meal insulin dose is adjusted accordingly. An alternate approach is to give patients a meal plan based on carbohydrate servings or “exchanges” along with a fixed pre-meal insulin dose which was considered to be a rigid approach.

Mehta et al., (2009a) concluded that precision with carbohydrate counting and increased blood glucose monitoring was associated with lower A1c in children with Type 1 Diabetes. Carbohydrate adjusting for child age, sex and Type 1 Diabetes duration, precision and more frequent blood glucose monitoring, but not accuracy were associated with lower A1c. A1c was 0.8 per cent lower among youth whose parents demonstrated precision.

Mehta et al., (2009b) studied the association between parent carbohydrate counting knowledge and glycemic control in youth with Type 1 Diabetes and found that carbohydrate counting and increased blood glucose monitoring were associated with lower A1C in children with Type 1 Diabetes.

2.5.3 Oral hypoglycemic drugs

Oral hypoglycemic drugs work by stimulating the pancreas to release additional insulin or to help the cells of the body to utilize the insulin efficiently. The oral hypoglycemic drugs available are Sulfonylureas (e.g. glimipiride) to stimulate the pancreas to make more insulin. Biguanides (e.g. metformin) to decrease the amount of glucose produced by liver. Alpha-glucosidase inhibitors (e.g. acarbose) these agents slows down the absorption of the starches and thus slow down the glucose production. Thiazolidinediones (e.g., rosiglitazone), increase sensitivity to insulin and
are beneficial to metabolism. Metformin is safely suppresses glucose production in
the liver without the risk of hypoglycemia. This drug reduces the risk of type 2
diabetes by 31 per cent in the Diabetes Prevention Program (DPP).

Ramachandran et al., (2003) in their study, children were tested for the presence of
anti-GAD (65) antibodies and for pancreatic beta-cell reserve by measuring serum C-
peptide response. The clinical, immunological and biochemical profile showed that
the children had Type 2 Diabetes and the profile of Type 2 Diabetes was similar to
that in children in many other countries.

Mishra (2006) suggested that treatment of Type 2 Diabetes depends on level of
elevated blood sugar at the time of diagnosis. Usually regular exercise along with
proper diet plan is suggested. However, insulin is recommended if the blood glucose
levels are not controlled with oral medications. In a single-blind comparative study by
Gottschalk et al., (2007) concluded sulfonylureas have shown weight gain in
comparison with biguanides in children with Type 2 Diabetes in 26 weeks.

Abdelghaffar and Attia (2009) evidenced in their Cochrane review that there will be
improvement of metabolic control with addition of metformin to insulin therapy. A
systematic review and meta-analysis evidenced that metformin improved markers of
insulin sensitivity and reduced body mass index in children and adolescents with
clinical insulin resistance or pre-diabetes (Quinn et al., 2010). Park and Sanjay (2010)
noticed that metformin reduced BMI in comparison with placebo in their randomized
double blind, placebo-controlled study.

Alba and Stephen (2011) stated that safety and efficacy of the oral hypoglycemic
therapy for children and adolescents with Type 2 Diabetes has not been established
and only metformin is recommended according to U.S Food and Drug Administration
(FDA). A similar school of thought has been supported by Muna et al., (2011)
explaining that metformin reduces hepatic gluconeogenesis while promoting insulin
uptake by muscle and fat.
2.5.4 Dietary intake

What, when and how much a diabetic child eat can send their blood sugar sky rocketing or make it plummet. For better or worse, “diet and diabetes go together like salt and pepper”. Energy intake varies greatly within subjects on a daily basis due to age, growth rate, energy expenditure and other environmental factors such as the type and availability of food. Energy intake should be sufficient to achieve optimal growth and maintain an ideal body weight. Three balanced meals a day, with appropriate healthy snacks will supply all essential nutrients, maintain a healthy weight, prevent bingeing and provide a framework for regular monitoring of blood glucose levels.

According to the American Diabetes Association and the American Dietetic Association (1996), there was no singular diet or meal plan that works for everyone with Diabetes. Research studies indicate that the total amount of carbohydrate consumed is the strongest predictor of blood glucose response and is typically the first tool used in the managing of blood glucose levels. For individuals requiring greater blood sugar control, choosing low-glycemic carbohydrates along with a carbohydrate-controlled diet plan may produce modest results. In Nutritionvista Newsletter (2008), it was stated that the most important thing to avoid extreme variations in blood glucose levels due to a careless diet in diabetes management. The children with Type 1 Diabetes should follow the dietary recommendations based on age, sex and body size. In case of being overweight or obese, weight control strategies should be applied (Claudio Maffeis, 2008).

Lyn et al., (2003) in their study stated that whole grain intake is associated with lower body mass index, greater insulin sensitivity among adolescents. It was also found that body weight decreased non-significantly and subjects reported being less hungry on whole grain diet.

When compared the dietary intake of diabetes children one year after diagnosis with that of control Virtanen et al., (2000) found that more energy was derived from protein (19 vs 15 %) and carbohydrates (53 vs 50 %) and less from fat (28 vs 35 %) in
the diets of both children with diabetes and control respectively. The findings also showed that the diet of the subjects with diabetes met their dietary recommendations except the protein content which was higher than necessary.

Virtanen et al., (2011) in his study implicated early introduction of supplementary foods for development of β-cell autoimmunity. Independent association of early introduction of root vegetables with increased risk of β-cell autoimmunity among Finnish children with increased genetic susceptibility to Type 1 Diabetes is also reported.

2.5.5 Glycemic index (GI), Glycemic response (GR) and Glycemic load (GL)

**Glycemic Index (GI)** – Glycemic Index (GI) is a ranking of carbohydrate containing foods according to their effect on blood glucose levels. Carbohydrate foods that are digested quickly and rapidly release glucose into the blood stream have a high GI. The foods digested slowly or partially and gradually release glucose into the blood stream have a low GI. The glycemic index is a system of classification in which the glycemic response of various foods are indexed against a standard, either 50 g of dextrose or white bread over a standard 120 minutes time course. The glycemic index is a marvellous tool for ranking carbohydrate-containing foods. The factors affect in the glycemic index of a given food are ripeness, storage time, processing, preparation and the other foods ingested along with it. A GI of 70 or more is considered high, a GI of 56 – 69 as medium and a GI of 55 or less as low. Foods that have high GIs will raise the blood glucose level more rapidly and may require adjustments in the timing or dosing of insulin therapy (Glycemic Research Institute, 2012).

**Glycemic Response (GR)** - Glycemic Response is not formally defined, but generally refers to the changes in blood glucose after consuming a carbohydrate-containing food. The glycemic index and the glycemic response are non-synonymous terms and should not be used interchangeable. The glycemic response to a food or meal is determined by quantifying the area under the curve generated by plotting postprandial blood glucose values over time. The glycemic response to foods may differ among non-diabetic, type 2 diabetic, and type -1 diabetic patients respectively (Hubrich and O’Brien, 2006).
**Glycemic Load (GL)** – Glycemic Load is a measure of the degree of glycemic response and insulin demand elicited by a given amount of a certain food. Glycemic load reflects both quality and quantity of dietary carbohydrates (Barclay *et al.*, 2005).

The glycemic load takes into consideration both the glycemic index of a food and the amount of carbohydrate in the portion of food eaten. The glycemic load is calculated by multiplying the glycemic index value by the number of grams of carbohydrate, then dividing by 100. In general, a serving of food with a glycemic load of 1–10 is considered to have a low glycemic load, 11–19 is a medium glycemic load and 20 or higher is a high glycemic load.

More flexible dietary instructions with an emphasis on the use of low GI foods does not result in a deterioration of dietary quality on the contrary resulted in improvements in glycemic control as well as the quality of life in the children with Type 1 Diabetes Mellitus. The findings are based on large long term prospective study by Gilbertson *et al.*, (2003).

Malachy and John (2010) noticed in their study that glycemic control was worse in children aged >10 years compared with those aged 5-9 years and < 5 years. However, gender had no effect on the glycemic control.

Based on the findings of his study, Queiroz (2012) concluded that the intake of reduced GI/GL diet favors the glycemic control and the author reasoned out that high protein content of the low GI diet might have contributed to the attenuation of the postprandial glycemic response and better glycemic control in children.

Ebbeling *et al.*, (2003) observed in their randomized control trial with a 6-month intervention and a 6-month follow-up study that GL decreased significantly in the experimental group compared to conventional group. They concluded that an *ad libitum* reduced-GL diet appears to be a promising alternative to a conventional diet in obese adolescents. Large-scale randomized controlled trials are needed to further evaluate the effectiveness of reduced-GL and low-GI diets in the treatment of obesity and prevention of Type 2 Diabetes.
Slyper et al., (2005) in their study on children aged 11 – 25 years found that the children with the diets of lower glycemic load had higher levels of the "good" HDL cholesterol which may have positive implications on their long term heart health.

Queiroz et al., (2012) evaluated the influence of the glycemic index (GI) and glycemic load (GL) of the diet in the glycemic control of children and teenagers with Type 1 Diabetes mellitus and noticed that good glycemic control subjects consumed diets with significantly lower GI/GL compared to intermediate and poor glycemic control subjects. The low GI diet consumed subjects also had higher protein content, which might have contributed to the attenuation of the postprandial glycemic response and better glycemic control of these patients. Study concluded the intake of a reduced GI/GL diet favors the glycemic control of the studied population.

2.5.6 Physical activity and diabetes management

Physical activity is a global term referring to any bodily movement produced by skeletal muscle that results in a substantial increase over the resting energy expenditure. Physical inactivity or sedentary behavior can be defined as “a state when body movement is minimal and energy expenditure approximates resting metabolic rate (RMR)”. The American Diabetes Association (ADA) recommends exercise as the most effective way of controlling Diabetes. Physical activity has a beneficial effect on insulin sensitivity and increase the sensitivity of the body to insulin by more than 30 per cent. In Type 1 Diabetes, exercise is able to increase skeletal muscle sensitivity to insulin and adjustments in dietary intake and/or insulin dosages are required to accommodate changes in physical activity level in order to prevent metabolic complications of either hypoglycemia or worsening hyperglycemia and ketosis.

Anura Kurpad (2004) presented evidence-based guidelines at National Task Force for Childhood Prevention of Adult Diseases and concluded with the role of physical activity as one of the preventive measures in combating the childhood obesity and thereby reducing the risk of developing chronic diseases at later stages of life.
Sarnblad (2005) conducted the prospective cohort study and found that girls with Type 1 Diabetes often gain excessive weight during puberty due to lower physical activity and similar energy intake compared to their age-matched controls.

Edmunds (2007) in the study found that there was no significant associations between psychological well-being and physical activity, or HbA1c and physical activity thus, suggesting that physical activity does not directly relate to psychological well-being in children with Type 1 Diabetes.

Anoop Mishra (2012) recommended lifestyle interventions like physical exercise to improve diabetes management in increasing the receptivity of muscles to insulin and increases the body’s cell sensitivity to insulin to improve glucose control.

Arya (2008) reported that outdoor activities like swimming, playing games and walking are a must for diabetic children. Children spend more time on computers playing games, chatting or surfing it reduces the metabolic activities and leads to obesity and other disorders.

Cuenca-Garcia et al., (2012) reported that positive association between moderate to vigorous physical activity and glycemic control and an absence of association between physical activity and fitness. The study findings suggest that developing strategies to increased moderate-to-vigorous physical activity may prove an effective method of improving glycaemic control in young people with diabetes. Moderate-to-vigorous physical activity was associated with better glycaemic control while fitness was not.

Maggio et al., (2012) noticed regular weight-bearing physical activity (180 minutes per week, including ball games, jumping activities and gymnastics) improves total and lumbar spine bone mineral accretion in children with TIDM, in a similar magnitude to healthy subjects, concluding that children with T1DM should be encouraged to practice regular physical activity to enhance peak bone mass and prevent osteoporosis later in life.
2.6 Somatic status

Nutrition, health and environmental conditions influence the growth and development of the child to a large extent. Pediatric health care providers use height, weight and head circumference measurements to assess the growth and development and to screen the individuals and population for nutrition-related health problems. Growth charts are the improvised tools to assess the growth of infants, children and adolescents up to 20 years of age and reflect gender specific anthropometric indices.

Stene et al., (2001) study found a linear relationship between birth weight and incidence of T1D. As the birth weight increases the incidence rate of T1D increased. However, no association between gestational age and incidence of T1D was reported.

Type 1 Diabetes Mellitus (T1DM) and other chronic diseases in children are well known to adversely affect linear growth and pubertal development. In the initial years following the introduction of insulin therapy, short stature was consistently reported in children with T1DM. However, over the past 50 years significant improvement in the prognosis for growth and final height in children with diabetes has been achieved. Although pre-pubertal and post-pubertal growth are important phases in growth, puberty and its related hormonal changes represent a critical phase for growth gain and final height particularly in patients with T1DM. Growth impairment reported in diabetic patients is dependent on abnormalities in physiological bone growth and corresponds to abnormalities of the growth hormone-insulin-like growth-I (GH-IGF-I) axis. These alterations seem to be related to appropriate insulin levels and thereby to glycemic control as judged by HbA1c levels. Modern diabetes care, particularly intensified insulin regimens, might improve metabolic control in patients with T1DM, therefore preventing abnormalities of the GH-IGF-I axis and leading to normal growth and final height similar to that of their unaffected peers (Charrelli et al., 2004).
According to Ramachandran (2004) that there is an increasing prevalence of Type 2 Diabetes among children in India and in other countries which has been attributed to the epidemic of obesity among children. Prevalence of overweight was 17.8 per cent in boys and 15.8 per cent in girls aged 14-19 years in urban southern India. A strong association of overweight with lack of physical inactivity and higher socio-economic background was evident.

2.7. Complications

The complications of Diabetes Mellitus are far less severe in people who have well controlled blood sugar levels. Diabetic complications can be classified broadly as micro-vascular or macro-vascular diseases. Micro-vascular complications include neuropathy, nephropathy and vision disorders. Macro-vascular complications include heart disease, stroke and peripheral vascular disease. Other complications of Diabetes include infections, metabolic difficulties, impotence, autonomic neuropathy and pregnancy problems.

Patel (2002) noted from his population-based study, that approximately 25 per cent of newly diagnosed patients present with diabetic ketoacidosis and majority of them are hospitalized with poor control of their pre-existing diabetes.

Diabetes can develop acute as well as long-term complications. Acute complications like hypoglycemia, hyperglycemia, ketoacidosis and infections may occur if the disease is not treated and controlled. Regulating blood sugar is necessary to avoid complications (Mercola, 2003).

Wiltshire et al., (2003) noted that obesity is a rising problem in children with diabetes and insulin resistance is frequent in the obese children. Some diabetes-related
complications, for example, non-alcoholic fatty liver disease (NAFLD) or hyperlipidemia, are present in insulin resistance as well as in insulin deficiency.

Dyslipidemia is a preventable major risk factor particularly in high risk population such as people with Diabetes Mellitus. Early detection and treatment of this condition prevents complications and further decrease the morbidity and mortality (Pushpa Krishna et al., 2005).

Parvez (2007) stated that chronic complications of diabetes affect several organ systems. Micro-vascular complications result from chronic hyperglycemia. Capillaries of the eyes, the kidneys and the nerves are damaged with prolonged exposure to high levels of glucose. Risk for development and progression of diabetic nephropathy, retinopathy and neuropathy include increased glycosylated haemoglobin, hypertension, proteinurea and hyperlipidemia. Besides micro-vascular complications, the three major macro-vascular complications are due to uncontrolled Diabetes with circulating high sugar and lipids which in turn precipitate vascular diseases like coronary artery disease (CAD), cerebro-vascular disease (CVD) and peripheral vascular disease (PVD).

Family history of vitamin D deficiency was significantly higher among T1DM children when compared with non-diabetic children. The fathers and mothers occupation, family history of DM, physical activity, low duration of time under sunlight, breast feeding for less than 6 months and low vitamin D level were considered as the main factors associated with the T1DM (Bener et al., 2009).

According to Byrd (2009) there are many variables that affect blood sugar including mood, stress, infection, illness and sleep disturbances. Findings from randomized clinical trials by Menzin et al., (2010) have shown that improved glycemic control may reduce the risk of long-term complications as long as a target for hemoglobin A1c is not set below 7 per cent for intensive glycemic control.
According to Ranjit et al., (2010) diabetes is a progressive disease and can be controlled provided it is diagnosed early and has far-reaching benefits throughout life. By managing Diabetes as soon as it is detected, one bequeaths a legacy of good control to the cells and tissues, which will stand them in good stead throughout life. Children found to have complications of diabetes even at the time of first diagnosis are the ones who might have Diabetes for at least five years.

Sowmya et al., (2011) in their cross-sectional study in normal and overweight children, both with and without T1D and found higher apolipoprotein C-III levels in TID with overweight children compared to normal weight diabetic children. Most notably, there was a direct relationship of small artery elasticity to body weight status. This seemingly paradoxical observation supports recent data and warrants further investigation.

Aguirre Castaneda et al., (2012) noticed that diabetic ketoacidosis (DKA) is a life-threatening condition and a major cause of morbidity and mortality in children with Type 1 Diabetes Mellitus. Based on this controlled population intervention study by King et al., (2012) reinforced the importance of continuous patient education, access to diabetes programmes and telephonic services by stating that the rate of DKA at initial diagnosis of diagnosis of Type 1 Diabetes in children decreased by 64 per cent after a diabetes awareness campaign.

Lee et al., (2012) stated that childhood obesity is associated with an increased likelihood for having impaired glucose tolerance, dyslipidaemia and diabetes and concluded obesity is associated with an increased risk of impaired glucose tolerance and HbA1c value of 5.8 per cent should be used as a screening tool to identify children and adolescents with impaired glucose tolerance.
Mohammed et al., (2012) concluded that poor glycemic control in diabetic children resulted in significantly higher serum cholesterol, triglycerides and low density lipoprotein cholesterol compared to the children who maintained good glycemic control. The age group of 15 years and above with disease duration of more than 5 years and high serum triglycerides level are the predictors of poor glycemic control in children with Diabetes.

Ni and Xin (2012) noticed that glycosylated haemoglobin may be an independent risk factor for cognitive function in diabetic children. Type 1 Diabetes affect adversely children's verbal intelligence quotient, resulting in a decreased full intelligence quotient in 6 – 16 years aged children.

Palomo Attence et al., (2012) observed prevalence of obesity in 18 per cent of Type 1 Diabetic cases and these patients had lower HDL cholesterol and higher LDL cholesterol levels than non-obese Type 1 Diabetic subjects with no significant differences in HbA1c between patients with over weight- obesity and rest of the subjects.

2.8. Health related quality of life
An increasing number of children with Diabetes require intensive treatment programs to reduce the risk of developing the complications. These programs can cause an extra burden on the routines and relationships of children and their families. Researchers say it is important to conduct research on how diabetes and its treatments impact the quality of life of the patient and family. "Quality of Life Research Unit, University of Toronto” defined Quality of life as the degree to which a person enjoys the important possibilities of his/her life. Possibilities result from the opportunities and limitations each person has in his/her life and reflect the interaction of personal and environmental factors.

Quality of life (QoL) in diabetic children was worse compared to a healthy sample. The mean and the latest glycosylated haemoglobin, age of patients and number of glycaemia controls were the most important parameters related to HRQoL parameters.
This multidimensional study stressed that HRQoL is influenced by the metabolic assessment. Higher number of glycaemia controls/day, better metabolic control, lower age of children and earlier onset of Diabetes produced better physical and psychological aspects of QoL. In comparison with adolescent patients, in children with Diabetes, factors as number of insulin injections and daily snacks and the level of education of the mother were not so important to influence QoL (Richard R. Rubin, 2000).

According to Ivanhoe (2003), the overall quality of life for youth with Type 1 Diabetes is very similar to the non-diabetic youth population. The study concluded that modifiable diabetes-related family interactions are appropriate targets for clinical interventions to optimize the well-being of youth with Type 1 Diabetes. Researchers report the responses from the youth with Diabetes were stable over one year and similar to the response of healthy youth. The only area that showed a diminished impact on the quality of life of the child was diabetes-specific family conflict.

Kylie et al., (2004) in the prospective cohort study stated that parents reported no significant difference in children’s Health Related Quality Of Life (HRQOL) at baseline and follow up after two years. However, poorer parent-reported psychosocial summary scores were related to higher HbA1c at both times. The HRQOL was also consistently poorer than that of their healthy peers.

Sameena Sultana et al., (2007) in their study on psychological adjustment in Juvenile Diabetics found that general self esteem of the illness scores was significantly lower in IDDM children compared to control group. It was also concluded that functional disability, self esteem and impact of illness were significantly correlated and the illness had significant impact on both the child and his family.

According to Delamater (2009), group interventions for young people with Diabetes targeting coping skills have shown positive effects on regimen adherence, glycemic control and quality of life. Individual interventions with adolescents have shown motivational interviewing to improve long-term glycemic control and psychosocial outcomes.
Haugstvedt et al., (2011a) found a significant negative association between HbA1c and education level of the mother with the higher degree of social limitations because of the child’s diabetes. The analysis of the results shown that higher child age was significantly associated with higher HbA1c and a scatter plot indicated this association to be linear.

Based on his population based survey Haugstvedt et al., (2011b) stated that lower HbA1c was associated with higher education and stronger perceptions of social limitation among the mothers. It is also found that higher child age was significantly associated with higher HbA1c both in bivariate and multivariate analysis.

According to Matziou et al., (2011) increased metabolic control, participating in sports activities and a greater number of insulin infusions resulted in better QOL. Increased patient age, duration of diabetes, HbA1c values, BMI and the coexistence of various health problems, as well as the use of an insulin pump, decreased QOL.

Malerbi et al., (2012) observed that mothers are primary care givers for children/adolescents with Diabetes. Lifestyle of family members changes along with Type 1 diabetic children after the disease is diagnosed. Diabetes has been found to affect the lives of the parents in several areas. Functional disability, self-esteem and impact of illness have been found to be significantly correlated.

2.9. Intervention – Nutrition education in the management of Diabetes

Nutritional management is one of the cornerstones of the diabetes care and education. Medical Nutrition Therapy (MNT) is important in preventing Diabetes, managing existing Diabetes, and preventing, or at least slowing, the rate of development of Diabetes complications. Nutritional advice should be based on cultural, ethnic and family traditions and psychological needs of the individual child. Likewise the choice
of insulin regimen should take into account the dietary habits and lifestyle of the child.

According to Raghuram et al., (2000) educational programmes should be made available to the children to help the children to make choice about the variety of foods they wish to eat and to take appropriate insulin dose to reduce changes in glucose levels while eating different amounts of chosen foods. During illness diabetics should be careful with their activities, diet and drugs. If usual meals cannot be eaten, at least enough liquid diet at frequent intervals should be taken. The type and amount of snacks taken between meals and at bedtime should be according to the child's insulin regime. Children and parents should be made aware of the use of high calorie and high sugar ‘treats’ and the use of foods of high glycemic index.

Heather et al., (2001) demonstrated that children with Type 1 Diabetes who were given flexible dietary instruction based on the food pyramid and low-GI choices achieved significantly better HbA1c levels after 12 months compared with those who received more traditional dietary advice.

Early years of life and adolescents are two at-risk periods in the lives of children when nutritional education procedures as well as diabetes care in general are less likely to be effective. In case of very young children, new behavioral-based intervention strategies to help parents improve mealtimes could be useful in teaching diabetic children to learn to follow a structured eating schedule, which is desirable for long-lasting efficacy in diabetes care. In adolescents, eating disorders and insulin misuse for weight control purposes are concrete and difficult problems to deal with. Appropriate nutritional education helps children with diabetes to find this balance and enjoy a better quality of life. Nutritional management is one of the corner stones of the diabetes care and education (Arslanian, 2002).

Based on the findings of large, long term prospective study, Heather Gilberston (2003) reported that low glycemic index (GI) dietary advice resulted in improvements in glycemic control as well as quality of life in children with diabetes. It is also found
that low GI advice did not affect the food choices and macronutrient composition of
the diet consumed.

Vijay Viswanathan (2007), recommended to concentrate on the food habits of children
and assist parents in providing their children with a healthy nutritious diet along with
physical activity and routines that would not stress children but help them stay fit to
prevent childhood obesity.

Adherence to recommendations should be pursued by continuous nutritional
education that should start at the onset of Diabetes to the family by means of
nutritional counselling. The second main target of nutritional intervention is to
encourage a reproducible daily meal plan that can be maintained by acquiring good
habits when making nutritional choices. Finally, children and parents should be taught
how to count carbohydrates, which would help them manage exceptions in their daily
meal plan (Claudio Maffèis, 2008).

Nutrition education and lifestyle counselling should be adopted to individual needs
and delivered in a patient-centered manner. Education can be delivered both to the
individual child and family and in small group settings. The recommendations target
healthy eating principles, optimum glycemic control, the reduction of cardio-vascular
risk factors, the maintenance of psychological well-being and family dynamics (Smart
et al., 2009).

Spiegel et al., (2012) selected 66 children with Type 1 Diabetes and all the children
were randomized to the control or intervention group at the base line visit. The
intervention group was given a training pertaining to carbohydrate counting accuracy
for a period of 3 months. However at the end of the study, the intervention effect was
not statistically significant for change in HbA1c or carbohydrate counting accuracy.
Concluding that more intensive intervention might be required to get positive results.
King et al., (2012) conducted a controlled population intervention study for a period of two years and found that the diabetes awareness campaign helped in reducing the occurrence of DKA by 64 per cent at initial diagnosis of Type 1 Diabetes in children.

Lowell et al., (2012) conducted diabetic management camps with goal to enable children with Diabetes to meet and share their experiences with one another while they learn to be more responsible for their condition. The management protocol aim was to balance insulin dosage with planned educational intervention in Type 1 Diabetics did not show significant improvement in the key aspects of the practice like adherence to the insulin regime, pre and postprandial blood glucose levels. Whereas significant difference was seen in the knowledge and attitude scores in the prospective interventional study (Vimalavathini et al., 2008).

Rewers (2012) stated that prevalence of DKA at diagnosis of Type 1 Diabetes varies around the world from 18 to 84 per cent and can be prevented with intensive community intervention and education of health care providers to raise awareness. Prevention of recurrent DKA requires continuous patient education and access to diabetic programs and telephonic services.