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# IMPACT OF DIET AND PHYSICAL ACTIVITY ON THE GLYCEMIC CONTROL OF DIABETIC CHILDREN: A REVIEW

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**ABSTRACT**

Although there are lots of improvements are being done in the clinical care of the patients with Type 1 diabetes mellitus but still there is an increase in the prevalence, incidence, and mortality because of diabetes mellitus in children. Diabetes mellitus is a public health problem in both developed and developing countries. It has increased putting this disease in the dimension of an epidemic. Diabetes is associated with several complications which increase the risk of many serious health problems . Therefore, this review was aimed to discuss the antidiabetic effects of diet and physical activity (PA) on children by summarizing the significant studies on this topic.

This review found that several studies have been recommended that physical activity , exercise and dietary management are important criterion for the effective management of DM in children . PA is a non-pharmacologic therapy which is a significant strategy for the management of TI DM and is an appropriate lifestyle modification approach to be practiced by these patients. The studies showed that PA has antidiabetic effects which are evidenced by its substantial role in improving the blood glucose (BG) levels of the individuals with TI DM where it helps them to control their levels of glucose in the blood. It plays a significant role in glycemic control . Finally, this review concludes that PA is the cornerstone in the management of T2DM. It also suggests that more attention is needed to its significance in the prevention, glycemic control, and its role in the management of the morbidity and mortality associated with TIDM. Practical PA recommendations and suggestions for the future direction of research in this area are also provided.

**KEYWORDS :** Diabetes , Glycemic control, Dietary Management, Physical Activity

## INTRODUCTION

Diabetes mellitus is the most common endocrine disorder, affecting more than 100 million people worldwide (6% of the population) and it is estimated that in the next10 years it may affect five times more people than it does now (World Health Organization and American Diabetes Association). The three major symptoms that are suggestive of diabetes mellitus in children are excessive thirst (polydypsia), excessive hunger (polyphagia), and increased urination (polyuria). At present, diabetes mellitus (DM) is a serious issue , and complications associated with the disease are a serious threat to human health. Diabetic nephropathy (DN) and diabetic retinopathy (DR) are the main microvascular complications, causing kidney failure and blindness, respectively. Metabolic syndrome (MS) is a group of metabolic disorders centered around insulin resistance (IR), with basic features including abnormal glucose metabolism, central obesity, lipid disorders and hypertension. The characteristics of MS vary among different ethnic groups on a global scale and among different provinces within the same country. However, the overall prevalence of MS has increased.

Diabetes mellitus is becoming a fast growing metabolic disorder in children affecting their growth and mental development. Type 1 diabetes is much more common in young people than type 2 diabetes. However, the rates of both types in young people are increasing. Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels.

### *CLASSIFICATION OF DIABETES MELLITUS*

Diabetes Mellitus can be classified into three major types:

- Type I Diabetes Mellitus
- Type II Diabetes Mellitus
- Gestational Diabetes Mellitus

Type 1 diabetes is one of the most common metabolic disorders which occurs due to total insulin deficiency. The disease shows an acute onset, with severe symptoms including weight loss. Positive family history of diabetes is uncommon but ketonuria is a positive symptom .The patients are dependent on exogenous insulin for metabolic and glycemic control . Type-I diabetes occurs during childhood or adolescence, which was previously known as juvenile diabetes. Type-I diabetes mellitus is a chronic metabolic disorder, in which the pancreas secretes little or no insulin. (Guyton AC. Hall John E. Medical Physiology)

Type II diabetes, which accounts for 90% of those with diabetes, previously referred to as non-insulin-dependent diabetes, or adult-onset diabetes which is usually diagnosed in patients >45 years but can occur in children and early adulthood. Type 2diabetes is caused due to interaction of certain genetic abnormalities with adverse environmental factors. Type 2 diabetes is a genetic disorder, caused by a collection of susceptible genes. These patients have relative insulin deficiency due to insulin resistance.

Glucose intolerance that develops during pregnancy and typically resolves with delivery, occurs in about 7% of all pregnancies. This occurs because of insulin resistance due to pregnancy, overweight, obesity and genetic predisposition. It is a strong risk factor for later development of type 2 Diabetes.

### Role Of Hba1c (glycosylated Haemoglobin Levels) In Diabetes

The American Diabetes Association has recommended glycated hemoglobin (HbA1c) as a possible substitute to fasting blood glucose for diagnosis of diabetes. HbA1c is an **important indicator of long-term glycemic control** with the ability to reflect the cumulative glycemic history of the preceding two to three months. HbA1c: Hemoglobin A1c is a blood test done to diagnose diabetes and monitor glycemic control in patients with diabetes. The higher the number, the worse control of the diabetes. The glycosylated Haemoglobin is that haemoglobin in which the glucose molecule get attached to the haemoglobin molecule. This means that haemoglobin has become glycosylated and is often referred as HbA1c.

Lifestyle management includes healthy nutrition and exercise, and training of young patients and their family members. Active life and physical fitness may represent the most effective strategies to prevent chronic diseases and to improve growth and development for children. Physical exercise, diet and adequate insulin therapy still represent the basis for the management of patients with diabetes. Several lines of evidence have shown that physical activity improves insulin sensitivity, reduces insulin dosage and increases muscular glucose uptake, exercising a positive effect on blood glucose control.

***Use Of Insulin Therapy In Maintaining The Blood Glucose Levels***

The treatment of type I Diabetes requires the administration of lifelong exogenous insulin with healthy eating habits to maintain the blood glucose levels in children and to prevent other complications due to diabetes. To achieve good glycemic control, the best therapeutic option for patients with Type1Diabetes mellitusis basal-bolus therapy either with multiple daily injections (MDI) or continuous subcutaneous insulin infusion (CSII). People with type 1 diabetes require daily insulin therapy to maintain regular blood sugar levels. However, the exact treatment and insulin administration will vary from person to person.

Insulin pump therapy is at present the best way to imitate the physiological insulin profile. Insulin is infused subcutaneously at a pre-programmed basal rate and boluses are added to counterbalance the intake of carbohydrates. CSII has mostly been compared to MDI with NPH as the long-acting insulin.

In the study comparing MDI vs. CSII, diabetes treatment satisfaction was higher with CSII. Data from a large pediatric survey showed a low incidence of acute complications at a mean HbA1c-level of 8.0% ( Danne T, Battelino T, Jarosz-Chobot P, Kordonouri O, Pankowska E, Ludvigsson J, et al. )

***Role Of Diet In Regulating The Glucose Levels:***

Diet plays a very important role in the management of diabetes and also the glucose levels of diabetic patients. The American Diabetes Association has made several recommendations regarding the medical nutrition therapy of diabetes; these emphasize the importance of minimizing macrovascular and microvascular complications in people with diabetes. Diet has been shown to improve metabolic conditions, but the degree of improvement varies from patient to patient. Therefore, it is necessary to evaluate a patient's pathophysiological characteristics in order to determine the diet that will achieve metabolic improvement in each individual. Nutrition education and lifestyle counselling should be adapted 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 assessment of nutritional status is done on the basis of the anthropometric measurements , dietary habits and nutrient intake of the patients and also to evaluate the role of diet in the glycemic control of children with diabetes who consumes a low carbohydrate diet.

According to the American Diabetes Association (ADA) classification of less than 130 g/day or 26% total energy intake (TEI) from carbohydrate led to good glycemic control. Prior to the discovery of insulin, strict low-carbohydrate diets were an accepted method for treatment of diabetes with severe carbohydrate restriction (≤10 g/day) or water-fasting also prescribed until glycosuria was eliminated .

More recently, a large observational study of 1020 European outpatients with type 1 diabetes reported that a lower intake of total carbohydrate was associated with lower levels of HbA1c The excessive use of insulin that is often required to achieve glycaemic control in type 1 diabetes increases susceptibility to severe hypoglycaemia and may lead to some measure of hyperinsulinemia. Hyperinsulinemia is associated with; excessive weight gain, development of the metabolic syndrome, inflammation and atherosclerosis, Alzheimer's Disease and cancer. Findings of the present review suggest that low-carbohydrate intakes may assist in reducing or preventing hyperinsulinemia in type 1 diabetes by decreasing the absolute amount of insulin required for tight glycaemic control.

To see the association between eating problems and glycaemic control in young adults with Type1 diabetes V. Young, C. Eiser,B. Johnson et al conducted a review study and found that Eating problems [both disordered eating behaviour (39.3 and 32.5%; *d*CI 0.10–0.94) and eating disorders (7.0 and 2.8%; 0.52, 95% =*d*1 diabetes compared with peers and both were associated with poorer glycaemic control (CI 0.10–0.81)] were more common in adolescents with Type 0.46, 95% = *d*CI 0.17–0.64). In restricted analyses involving measures adapted for diabetes, associations between eating problems and poorer glycaemic control remained (0.40, 95% = *d*CI 0.32–0.76). Disordered eating behaviour (51.8 and 48.1%; 0.54, 95%= *d*CI −0.05 to 0.21) and eating disorders (6.4 and 3.0%; 0.06, 95% = *d*1 diabetes compared with peers, but differences were non-significant. CI −0.06 to 0.91) were more common in adolescents with Type I diabetes compared with peers, but differences were non-significant.

***Aims of nutritional management in children***

- Encourage appropriate eating behavior and healthy eating habits
- Three balanced meals a day, with appropriate healthy snacks (if necessary), will supply all essential nutrients, maintain a healthy weight, prevent bingeing and provides a framework for regular monitoring of blood glucose levels
- Provide sufficient and appropriate energy intake and nutrients for optimal growth, development and good health
- Achieve and maintain an appropriate Body Mass Index and waist circumference. This includes the strong recommendation for children and young people to undertake regular physical activity
- Achieve a balance between food intake, metabolic requirements, energy expenditure and insulin action profiles to attain optimum glycemic control
- Prevent and treat acute complications of diabetes such as hypoglycemia, hyperglycemic crises, illness and exercise-related problems
- Reduce the risk of micro- and macro-vascular complications.

***Role of Exercise and Physical Activity on Glycemic Control of Diabetic Children***

Physical activity helps in improving fasting blood glucose levels and insulin sensitivity in patients with type 1 diabetes (type 1 DM), leading to a reduction in the required daily dose of insulin. Furthermore, exercise also benefits the metabolic, cardiovascular and neuroendocrine systems, promoting weight loss, a reduction in fat accumulation and improving cardiovascular function and blood pressure. On the other hand, patients with type 1 DM have a higher risk of developing hypoglycemia or hyperglycemia during physical activity, which may compromise their safety during exercise .(de Angelis K, da Pureza DY,etal 2006).

The current UK guidelines for exercise and physical activity are that all individuals undertake at least 150 minutes of moderate-intensity, or 75 minutes of high-intensity, aerobic physical activity per week. The American Diabetes Association has similar recommendations for all people with diabetes. Children with type 1 diabetes should engage in a minimum of 60 min of moderate to vigorous intensity physical

activity per day, the same as children without Type 1Diabetes mellitus. However, due to the inability of the body's natural response to control glucose fluctuations, care must be taken to prevent incidents of low blood glucose levels (hypoglycemia) or high blood glucose levels (hyperglycemia) during and after physical activity .

In Type 1Diabetes mellitus, regular physical activity is associated with several positive physical health effects such as improved cardiovascular fitness and blood lipid profile and also enhances psychological well-being. However, the beneficial effects on health-related outcomes induced by Physical activity has not been convincingly paralleled with improvements in glycaemic control.

In the study by McKewen et al., who investigated the effect of increased CHO-intake and its effects on exercise performance and glycemic control in individuals with type 1 diabetes, the participants increased the CHO-intake by 10%, and the total daily dose of insulin by 14%. Despite this, the mean blood glucose increased by 10% compared to normal diet 171 ± 25.2 mg/dl (9.5 ± 1.4 mmol/l) vs. 154.8 ± 30.6 mg/dl (8.6 ± 1.7 mmol/l), $p = 0.005$.

A study done by (Milena S. Nascimento & Carlina F. Espindola 2017) to see if type 1 diabetes affects the capacity of adolescents to exercise found that the two groups displayed no significant differences in anthropometric variables. They detected no significant differences in lactate threshold, $VO_2$max and heart rate during exercise between healthy adolescents and non-sedentary adolescents with type I diabetes, indicating that both groups had similar physical fitness and, therefore, that type 1 diabetes is not an obstacle for physical activity.

### *Summary*

Previous research indicates the critical role of diet in promoting long-term health among patients with type 1 diabetes, including reducing risk of cardiovascular disease and other metabolic disorders. It has been noticed in previous studies that the Diets of children with diabetes which were low in essential nutrients like fruits, vegetables, and whole grains, and high in foods of minimal nutritional value, increases the risk for future adverse health outcomes and other complications. Medical nutrition therapy is an integral component of diabetes management education to facilitate optimal glycemic control and prevention of further complications.

Diet as well as physical activity plays a important role in the nutritional management of type 1 diabetic patients . However, it is the most difficult aspect of treatment in children and adults. The main aim of recommendations for diet in children and adolescents with type 1 diabetes are basically focused on achieving normal blood glucose levels meanwhile for physical activity, they are advised to perform moderate physical activity for at least 60 minutes/per day to maintain normal body weight .

To achieve optimal physical and cognitive development, attain a healthy weight, enjoy food, and reduce the risk of chronic diseases in diabetic children. It can be achieved through appropriate eating habits and participation in regular physical activity. This paper reviews the trends in food and nutrient intake of diabetic children. Dietary recommendations and guidelines and the benefits of physical activity are also discussed in this paper. This study emphasises that social support is an important factor for adhering to a healthy lifestyle.

### *CONCLUSION*

This integrative review showed that psychosocial well-being interacted with diet as well as with physical activity in children with Diabetes Mellitus. We recommend that future studies should consider combining psychosocial well-being of children in their intervention, as observational studies demonstrated that social support and self-efficacy helped with adopting a healthy lifestyle following Diabetes mellitus diagnosis may help to control the glycemic contol in children.

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