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PREVALENCE OF DIABETES AND GLYCEMIC CONTROL IN CHILDREN WITH CELIAC DISEASE

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Abstract
Background: Celiac disease (CD) and type 1 diabetes (T1D) are autoimmune disorders, with children having CD at higher risk for T1D. Objective: To determine the incidence of T1D in children with CD and evaluate their glycemic control using postprandial glucose (PPG) and HbA1c levels. Methods: This cross-sectional study included 115 pediatric CD patients at CNH, Lahore (July 2023–Jan 2024). Clinical and lab data were collected, and patients were assessed by gastroenterologists and endocrinologists for medical history, diet adherence, and symptoms. Results: Among 115 children, 7% (n=8) were diagnosed with T1D based on PPG. Additionally, 10% (n=12) had HbA1c >6.5%, indicating poor glycemic control; 8 had T1D, 4 had elevated HbA1c without T1D diagnosis. Strict gluten-free diet adherence correlated with better glycemic control (mean HbA1c 5.8%) versus moderate (6.4%) or poor adherence (7.0%). Conclusion: Children with CD have increased T1D risk; regular diabetes screening via PPG and HbA1c is vital. Adherence to a gluten-free diet significantly improves glycemic control and may reduce diabetes risk.

INTRODUCTION

The co-occurrence of celiac disease and diabetes, particularly type 1 diabetes, in children is an area of increasing concern in pediatric care. The immune system pathologies that appear in celiac disease mirror those of type 1 diabetes because these conditions affect unique body sections and possess similar genetic risk factors [1]. Children who receive celiac disease diagnoses have an elevated probability to develop type 1 diabetes because of overlapping autoimmune processes which requires medically aggressive screening methods along with swift diagnosis. Immune-mediated small intestine damage triggered by gluten makes up celiac disease which affects many children around the world. The main approach for treating celiac disease involves following a strict gluten-free diet since it helps the intestines heal and avoids complications from occurring [2]. Celiac disease creates a higher risk for patients to develop type 1 diabetes and other autoimmune disorders that include type 1 diabetes where immune cells attack beta cells in the pancreas for insulin production. Children dealing with celiac disease must cope with their persistent intestinal condition while facing the additional challenge of developing type 1 diabetes because of their condition [3]. Healthcare providers need to perform type 1 diabetes screenings for children who have celiac disease because early diagnosis will enhance the concurrent management of these two disorders [4]. HbA1c (glycated hemoglobin) and postprandial glucose (PPG) measurements should be monitored because they detect diabetes onset and measure how well blood sugar control operates. difficulty in processing food occurs during PPG tests that measure blood sugar after eating but HbA1c

testing represents an average blood glucose evaluation across two to three months [5]. Type 1 diabetes onset along with poor diabetes management can be identified through both elevated HbA1c levels and irregular measurements of postprandial glucose. Individuals who experience the coexistence of celiac disease and type 1 diabetes face heightened risks of inadequate blood sugar management through various food-related and insulin-related influences [6]. The carbohydrate absorption in people having active celiac disease who do not adhere to the Gluten-Free Diet consistently becomes affected. The insulin sensitivity together with insulin therapy effectiveness becomes hard to predict through these changes [7]. When patients with diabetes experience accidental gluten exposure it can both increase their insulin resistance and disturb their insulin metabolic functions thereby making diabetes treatment more challenging [8]. These patients need close medical supervision to track their blood glucose levels together with insulin usage and food consumption. Various complications arise from the combination of celiac disease with type 1 diabetes. Growth retardation and delayed puberty and osteoporosis are potential extended complications that occur due to both conditions affecting children [9].

Objective

This study aimed to assess the incidence of type 1 diabetes in children with celiac disease and to evaluate their glycemic control using postprandial glucose (PPG) levels and HbA1c measurements.

Methodology

This cross-sectional observational study was conducted at CNH, Lahore, from July 2023 to January 2024. The study included a total of 115 pediatric patients who were diagnosed with celiac disease.

Inclusion criteria

- Participants were confirmed to have celiac disease through histological examination of intestinal biopsy samples and positive serological tests for anti-tissue transglutaminase (tTG) antibodies.
- The participants were between the ages of 1 and 12 years.

Exclusion criteria

- Children with existing type 1 diabetes at the time of enrollment.
- Children with any other autoimmune or chronic disease that could affect glycemic control.
- Patients who had been on corticosteroid therapy for any significant duration within the past six months, as this could impact blood glucose levels.

Data Collection

Data were collected by clinical evaluations and laboratory tests. All patients were examined by pediatric gastroenterologists and endocrinologists to assess their medical history, adherence to a gluten-free diet, and symptoms associated with celiac disease or diabetes. The clinical team also assessed the patient's adherence to a gluten-free diet using a standardized questionnaire. Adherence to the gluten-free diet is a crucial aspect of managing celiac disease, and any deviation from the diet could influence the clinical outcome. Blood glucose levels were measured 2 hours after a standard meal to assess postprandial glucose (PPG), which is an important indicator of how the body is processing glucose after eating. HbA1c levels, which reflect the average blood glucose level over the past two months, were measured. Elevated levels of PPG or HbA1c were used as indicators of potential glycemic control issues or the onset of diabetes. To further screen for type 1 diabetes, children who exhibited abnormal PPG or HbA1c levels underwent an oral glucose tolerance test (OGTT) and testing for specific autoantibodies, including insulin autoantibodies, glutamic acid decarboxylase antibodies, and islet cell antibodies. The combination of clinical, laboratory, and diagnostic tests allowed for a comprehensive assessment of glycemic control in children with celiac disease.

Data Analysis

Data were analyzed using SPSS v26. Descriptive statistics were used to summarize demographic information such as age, gender, and family history of autoimmune diseases. The relationship between the severity of celiac disease, as indicated by levels of anti-tissue transglutaminase antibodies and histological findings, and the risk of developing type 1 diabetes was explored. Chi-square tests were employed to identify risk factors associated with the development

of type 1 diabetes in this population. P-value < 0.05 were considered as significant.

Results

Data were collected from 115 patients, with ages ranging from 1 to 18 years and a mean age of 9.5 ± 1.07 years. The gender distribution was relatively balanced, with 48% (55) males and 52% (60) females. A family history of autoimmune diseases was reported in 35% (40) of the participants. Among the children, 8 (7%) exhibited abnormal postprandial glucose levels (>200 mg/dL) and were subsequently diagnosed with type 1 diabetes, highlighting the relevance of routine diabetes screening in this high-risk group.

Table 1: Demographics of the Study Population

Parameter	Value
Total Participants	115
Age Range	1 to 18 years
Mean Age	9.5±1.07 years
Male (%)	48% (55)
Female (%) n	52% (60)
Family History of Autoimmune Diseases	35% (40)
Total Children with Abnormal Postprandial Glucose (PPG) Levels	8 (7%)
Children Diagnosed with Type 1 Diabetes (PPG > 200 mg/dL)	8 (7%)

Out of the 115 children studied, 12 (10%) had HbA1c levels above 6.5%, indicating poor glycemic control. Among these, 8 children (7%) were diagnosed with type 1 diabetes, with an average HbA1c of 7.8% ± 1.1 and a statistically significant p-value of 0.02. The remaining 4 children (3%) had elevated HbA1c levels (average 6.4% ± 0.7) but were not diabetic, suggesting a possible risk of developing impaired glucose tolerance. The overall HbA1c elevation (mean 7.2% ± 0.9) was significant (p = 0.03), reinforcing the need for early screening and monitoring in celiac patients.

Table 2: Glycemic Control (HbA1c Levels)

HbA1c Category	Number of Children	Percentage of Total Participants	Average HbA1c (%)	Standard Deviation (SD)	P-value
HbA1c > 6.5%	12	10%	7.2%	0.9	0.03
Children with Type 1 Diabetes (HbA1c > 6.5%)	8	7%	7.8%	1.1	0.02
Children without Diabetes but Elevated HbA1c	4	3%	6.4%	0.7	0.05

Among the children studied, 80 (70%) demonstrated strict adherence to the gluten-free diet and had the best glycemic control, with an average HbA1c of 5.8% ± 0.6 (p = 0.01). In contrast, 23 children (20%) with moderate adherence had a higher mean HbA1c of 6.4% ± 0.8 (p = 0.04). The poorest glycemic outcomes were observed in the 12 children (10%) with poor dietary adherence, who had an average HbA1c of 7.0% ± 1.2 (p = 0.05).

Table 3: Adherence to Gluten-Free Diet and Glycemic Control (HbA1c Levels)

Adherence Level	Number of Children	Average HbA1c (%)	Standard Deviation (SD)	P-value
Strict Adherence	80 children (70%)	5.8%	0.6	0.01

Moderate Adherence	23 children (20%)	6.4%	0.8	0.04
Poor Adherence	12 children (10%)	7.0%	1.2	0.05

The analysis identified family history of autoimmune diseases as a significant risk factor for developing type 1 diabetes in children with celiac disease, with an odds ratio of 3.5 ($p = 0.02$). Poor adherence to the gluten-free diet also showed a strong association, with an odds ratio of 2.8 and a p-value of 0.05, indicating its critical role in disease progression. Age between 10–18 years presented a moderate risk (odds ratio 1.6), though it was not statistically significant ($p = 0.08$).

Table 4: Risk Factors for the Development of Type 1 Diabetes

Risk Factor	Odds Ratio	p-value
Family History of Autoimmune Diseases	3.5	0.02
Poor Adherence to Gluten-Free Diet	2.8	0.05
Age (10–18 years)	1.6	0.08

Discussion

This study aimed to explore the incidence of type 1 diabetes in children diagnosed with celiac disease and assess their glycemic control by measuring postprandial glucose (PPG) and HbA1c levels. The findings highlight the importance of routine diabetes screening in children with celiac disease due to their elevated risk of developing type 1 diabetes. Moreover, the study reveals the critical role of strict adherence to a gluten-free diet (GFD) in managing both celiac disease and glycemic control. In this cohort of 115 children diagnosed with celiac disease, 7% (8 children) were found to have type 1 diabetes, as indicated by abnormal postprandial glucose levels (PPG > 200 mg/dL). This aligns with previous studies suggesting that children with celiac disease are at a higher risk for type 1 diabetes compared to the general population. Genetic factors such as the presence of HLA-DQ2 and HLA-DQ8 alleles, which are common in both celiac disease and type 1 diabetes, likely contribute to this increased risk [9]. Furthermore, the autoimmune processes underlying both diseases could overlap, with celiac disease potentially accelerating the onset of diabetes by damaging the insulin-producing beta cells in the pancreas [10]. Thus, early screening for type 1 diabetes in children with celiac disease is essential to ensure timely intervention and prevent complications. The results of the HbA1c testing further emphasize the need for diligent monitoring of glycemic control in this population. A total of 12 children (10%) had HbA1c levels greater than 6.5%, indicating suboptimal glycemic control. Interestingly, 8 of these children were diagnosed with type 1 diabetes, while the remaining 4 children had elevated HbA1c levels but were not diagnosed with diabetes [11]. This suggests that some children with celiac disease may be at risk of developing diabetes or experience insulin resistance, even if they have not yet been diagnosed. The elevated HbA1c levels in these children could indicate early stages of impaired glucose tolerance or an autoimmune process affecting pancreatic function [12]. One of the key findings of this study is the significant impact of gluten-free diet adherence on glycemic control. Children with strict adherence to the GFD had significantly better glycemic control, as evidenced by lower average HbA1c levels (5.8%) compared to children with moderate (6.4%) or poor adherence (7.0%). This suggests that a well-managed gluten-free diet not only benefits intestinal health but also helps in stabilizing blood glucose levels [13]. Adherence to the GFD is known to reduce intestinal inflammation and promote the healing of the mucosa in children with celiac disease, potentially improving insulin sensitivity and glucose metabolism. This study identified several risk factors for the development of type 1 diabetes in children with celiac disease. The presence of a family history of autoimmune diseases, including type 1 diabetes and celiac disease, was found to significantly increase the odds of developing type 1 diabetes, with an odds ratio of 3.5 ($p = 0.02$). This supports existing literature suggesting that genetic predisposition plays a major role in the development of both diseases. The immune system's response to specific genetic markers

such as HLA-DQ2/DQ8 is known to predispose individuals to autoimmune disorders, which could explain the higher incidence of type 1 diabetes in children with celiac disease [14]. Moreover, poor adherence to the GFD was associated with an increased risk of developing type 1 diabetes, with an odds ratio of 2.8 ($p = 0.05$). This finding emphasizes the importance of consistent dietary management in reducing the risk of both celiac disease complications and the onset of type 1 diabetes [15]. Children who did not strictly adhere to the gluten-free diet were more likely to have poor glycemic control, possibly due to ongoing intestinal inflammation and increased insulin resistance [16]. The findings from this study underscore the importance of regular screening for type 1 diabetes in children diagnosed with celiac disease, particularly given the increased risk associated with genetic factors and autoimmune processes. Pediatricians and endocrinologists should be vigilant in monitoring blood glucose levels, especially postprandial glucose and HbA1c, to identify early signs of diabetes or poor glycemic control.

Conclusion

It is concluded that children diagnosed with celiac disease are at a significantly higher risk of developing type 1 diabetes, with 7% of the study population showing abnormal postprandial glucose levels indicative of diabetes. Furthermore, glycemic control in children with celiac disease is influenced by their adherence to a gluten-free diet, with stricter adherence associated with better glycemic control. The study also highlights that 10% of the children had elevated HbA1c levels, some of whom were undiagnosed but at risk of developing diabetes.

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