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EVALUATION OF THE ASSOCIATION BETWEEN C-PEPTIDE AND HBA1C IN PAEDIATRIC TYPE 1 DIABETES MELLITUS

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ABSTRACT

Introduction: Type 1 diabetes mellitus is a chronic autoimmune disorder characterized by progressive destruction of pancreatic β-cells, resulting in reduced endogenous insulin secretion. Serum C-peptide is a reliable biomarker of residual β-cell function, while HbA1c reflects long-term glycaemic control. This study was conducted to evaluate the association between serum C-peptide and HbA1c among paediatric patients with type 1 diabetes mellitus.

Methods: This hospital-based cross-sectional study was conducted in the Department of Paediatrics, Government Cuddalore Medical College and Hospital, over a period of 18 months. A total of 45 children and adolescents aged 1–18 years with type 1 diabetes mellitus receiving regular insulin therapy were included by consecutive sampling. Demographic details, disease duration, BMI, daily insulin requirement, serum C-peptide, and HbA1c levels were recorded. Data were analyzed using descriptive statistics, comparison of means, and correlation analysis.

Results: The majority of participants belonged to the 6–10 years age group (37.8%), and males constituted 53.3% of the study population. Serum C-peptide levels ≤0.6 ng/mL were observed in 64.4% of children, while 35.6% had levels >0.6 ng/mL. The mean HbA1c was 8.94 ± 1.42%. Mean HbA1c declined progressively with increasing C-peptide categories, from 10.5 ± 1.0% among children with C-peptide <0.2 ng/mL to 7.8 ± 1.0% among those with C-peptide >0.6 ng/mL, and this difference was statistically significant ($p < 0.001$). Serum C-peptide showed significant negative correlations with HbA1c, duration of diabetes, and daily insulin dose, and significant positive correlations with age at diagnosis and BMI.

Conclusion: Serum C-peptide was significantly associated with HbA1c among paediatric patients with type 1 diabetes mellitus. Lower C-peptide levels were associated with poorer glycaemic control and higher insulin requirement. C-peptide estimation may be useful as a supportive biomarker for individualized diabetes management.

KEYWORDS: Type 1 diabetes mellitus, C-peptide, HbA1c, residual β-cell function, paediatric diabetes.

INTRODUCTION

Type 1 diabetes mellitus is one of the most common chronic endocrine disorders affecting children and adolescents.[1] It is characterized by autoimmune destruction of pancreatic β-cells, leading to progressive loss of endogenous insulin secretion and lifelong dependence on exogenous insulin therapy. [2] In paediatric patients, maintaining optimal glycaemic control is often challenging due to variations in growth, puberty, dietary intake, physical activity, infections, and adherence to insulin therapy. [3] Poor glycaemic control during childhood can increase the risk of acute metabolic complications as well as long-term microvascular and macrovascular complications. [4]

Although type 1 diabetes mellitus is traditionally considered a state of absolute insulin deficiency, residual β-cell function may persist in a proportion of patients even after clinical diagnosis. [5] This residual endogenous insulin secretion has important clinical relevance because even small amounts of β-cell activity may contribute to better metabolic stability. [6] Children with preserved residual β-cell function may have lower glycaemic variability, reduced insulin requirement, and better overall glycaemic outcomes compared with those who have marked β-cell depletion. [7]

C-peptide is a useful biomarker for assessing endogenous insulin secretion. [8] It is released in equimolar amounts with insulin during the cleavage of proinsulin and reflects pancreatic β-cell secretory capacity. [9] Unlike insulin, C-peptide is not present in exogenous insulin preparations and is less affected by hepatic first-pass metabolism, making it a more reliable indicator of endogenous insulin production. [10] Therefore, measurement of serum C-peptide provides valuable information regarding the degree of residual β-cell function in patients receiving insulin therapy. [11]

HbA1c remains the standard marker for assessing long-term glycaemic control in diabetes mellitus. [12] It reflects average blood glucose levels over the preceding two to three months and is widely used to monitor treatment adequacy and risk of complications. [13] However, HbA1c does not provide information on endogenous insulin secretion or residual pancreatic function. Hence, evaluating serum C-peptide along with HbA1c may provide a more comprehensive understanding of metabolic status in children with type 1 diabetes mellitus. [14]

The relationship between C-peptide and HbA1c is clinically important in paediatric diabetes care. Lower C-peptide levels may indicate greater β-cell loss, higher dependence on exogenous insulin, and poorer glycaemic control. [15] Conversely, preserved C-peptide levels may be associated with better HbA1c values and reduced insulin requirements. Studying this association can help identify children at higher risk of poor metabolic control and may support more individualized treatment strategies. [16]

In resource-limited tertiary care settings, simple and feasible biomarkers are needed to guide clinical decision-making in paediatric type 1 diabetes mellitus. Assessment of serum C-peptide in relation to HbA1c can help evaluate residual β-cell function and its influence on glycaemic control. Therefore, the present study was conducted at Government Cuddalore Medical College and Hospital to evaluate the association between serum C-peptide levels and HbA1c among paediatric patients with type 1 diabetes mellitus.

Aims and Objectives

Aim

The aim of the study was to evaluate the association between serum C-peptide levels and glycaemic control, as assessed by HbA1c, among paediatric patients with type 1 diabetes mellitus attending a tertiary care hospital.

Objectives

- To estimate serum C-peptide levels and HbA1c status among paediatric patients with type 1 diabetes mellitus.
- To determine the association between serum C-peptide levels and HbA1c, and to assess the correlation of C-peptide with disease duration, age at diagnosis, BMI, and daily insulin requirement.

REVIEW OF LITERATURE

Khazaal et al. (2023) conducted a case–control study among children with type 1 diabetes mellitus to assess serum C-peptide levels and their relationship with clinical and biochemical variables. The study reported that children with type 1 diabetes had significantly lower C-peptide levels compared with healthy controls, indicating impaired residual β-cell function. C-peptide levels were significantly associated with age at diagnosis, duration of diabetes, body mass index, and fasting blood glucose, suggesting its usefulness as a marker of endogenous insulin secretion in paediatric diabetes [1].

Novac et al. (2023) performed a longitudinal retrospective study to evaluate changes in C-peptide levels during the first three years after diagnosis of type 1 diabetes mellitus in children and adolescents. The study showed that C-peptide levels declined progressively over time and that lower C-peptide levels were associated with younger age at onset, lower baseline C-peptide, diabetic ketoacidosis, and acute infection at diagnosis. The authors concluded that early C-peptide levels may help predict preservation of residual β-cell function [2].

Jamiołkowska-Sztabkowska et al. (2021) reviewed the role of C-peptide in paediatric diabetes and emphasized its value as a reliable marker of residual β-cell function. The authors highlighted that C-peptide estimation is useful for classification of diabetes, assessment of partial remission, and monitoring endogenous insulin secretion. They also noted that C-peptide interpretation may be influenced by age, body mass, physical activity, and diabetes management methods [3].

Cimbek et al. (2022) studied factors associated with preservation of C-peptide levels in children with newly diagnosed type 1 diabetes mellitus. The study found that children with preserved C-peptide levels were older, more frequently pubertal, and had higher BMI standard deviation scores. A positive correlation was observed between BMI and C-peptide levels, suggesting that nutritional and anthropometric status may influence residual β-cell function at diagnosis [4].

Hwang et al. (2017) evaluated factors associated with rapid decline of C-peptide levels among children with newly diagnosed type 1 diabetes mellitus. Children with rapid β-cell decline were younger at diagnosis, had lower BMI, more severe clinical presentation, and lower initial C-peptide levels. The study concluded that younger age, lower BMI, diabetic ketoacidosis, and reduced baseline C-peptide may predict faster loss of residual β-cell function [5].

Cimbek et al. (2025) examined the influence of pubertal stage, age, and BMI on C-peptide levels at diagnosis among children with type 1 diabetes mellitus. The study demonstrated that fasting and prandial C-peptide levels were significantly associated with age, BMI, and pubertal status. These findings supported the concept that residual β-cell function in paediatric type 1 diabetes is influenced by developmental and metabolic factors [6].

Sørensen et al. (2013) assessed residual β-cell function among children and adolescents with type 1 diabetes of 3–6 years' duration. The study reported that children with preserved residual β-cell function had better glycaemic control, lower insulin requirement, and reduced risk of severe hypoglycaemia. The authors concluded that even modest endogenous insulin secretion has clinically meaningful benefits in children with type 1 diabetes [7].

Sahraian et al. (2025) studied the association between C-peptide levels, HbA1c, and disease duration in paediatric patients with type 1 diabetes mellitus. The study found a significant inverse relationship between serum C-peptide levels and both HbA1c and duration of diabetes. The authors concluded that declining C-peptide levels reflect progressive β-cell loss and poorer glycaemic control, supporting the role of C-peptide as a clinically relevant biomarker [8].

MATERIALS AND METHODS:

Study Design and Setting

This study was conducted as a hospital-based cross-sectional study in the Department of Paediatrics, Government Cuddalore Medical College and Hospital, Cuddalore. Data were collected from paediatric patients with type 1 diabetes mellitus attending the outpatient department and those admitted to the inpatient ward or paediatric intensive care unit.

Study Population
The study population included children and adolescents diagnosed with type 1 diabetes mellitus who were receiving regular insulin therapy. Both newly diagnosed and known cases of type 1 diabetes mellitus were included, provided they fulfilled the eligibility criteria.

Study Duration
The study was carried out over a period of 18 months after obtaining approval from the Institutional Ethics Committee.

Inclusion and Exclusion Criteria
Children aged 1–18 years with diagnosed type 1 diabetes mellitus and receiving regular insulin therapy exclusively were included in the study. Children aged below 1 year or above 18 years, those receiving native or alternative treatment along with insulin, children with severe acute malnutrition, developmental delay, or significant comorbidities, and children with haemoglobin levels less than 11 g/dL were excluded from the study.

Sample Size and Sampling Technique
The sample size was calculated based on the standard deviation of serum C-peptide levels reported by Khazaal et al. (2023) [1], in which the standard deviation of C-peptide among children with type 1 diabetes mellitus was 0.18 ng/mL [1]. Considering a 95% confidence level, Zα/2 value of 1.96, standard deviation (σ) of 0.18 ng/mL, and absolute precision (d) of 0.055 ng/mL, the sample size was calculated using the formula for estimating a mean: $n = (Z\alpha/2)^2 \times \sigma^2 / d^2$. Substituting the values, $n = (1.96)^2 \times (0.18)^2 / (0.055)^2 = 3.84 \times 0.0324 / 0.003025 = 41.1$. Therefore, the minimum required sample size was approximately 42 participants. After adding 10% to account for possible non-response or incomplete data, the final sample size was rounded to 45 participants. Consecutive sampling was used, and all eligible children who attended the hospital during the study period were enrolled until the required sample size was achieved.

Study Procedure
After obtaining informed consent from parents or guardians and assent from eligible children, relevant demographic and clinical details were collected using a pretested semi-structured proforma. Details regarding age, sex, age at diagnosis, duration of diabetes, body mass index, and daily insulin requirement were recorded. Venous blood samples were collected for estimation of serum C-peptide and HbA1c levels. Non-fasting C-peptide samples were used, as this method was feasible in routine outpatient practice and provided a practical estimate of residual endogenous insulin secretion. HbA1c was used to assess long-term glycaemic control. The relationship between serum C-peptide levels and HbA1c was analyzed, along with other clinical variables such as disease duration, BMI, age at diagnosis, and insulin requirement.

Operational Definitions
Type 1 diabetes mellitus was defined as diabetes diagnosed in childhood or adolescence requiring regular insulin therapy for glycaemic control. Serum C-peptide was used as a biomarker of residual endogenous insulin secretion and residual β-cell function. C-peptide levels were categorized as <0.2 ng/mL, 0.2–0.4 ng/mL, 0.4–0.6 ng/mL, and >0.6 ng/mL. Residual β-cell function was considered reduced when C-peptide was ≤0.6 ng/mL and preserved when C-peptide was >0.6 ng/mL. HbA1c was used as a marker of long-term glycaemic control and was categorized as excellent or good control when <7.0%, suboptimal or fair control when 7.0–9.0%, and poor control when >9.0%. Daily insulin requirement was expressed as units/kg/day.

Statistical Analysis
Data were entered in Microsoft Excel and analyzed using SPSS software version 26. Descriptive statistics were used to summarize demographic, clinical, and biochemical variables. Categorical variables were expressed as frequency and percentage, while continuous variables were expressed as mean and standard deviation. The comparison of mean HbA1c levels across C-peptide categories was performed using appropriate inferential statistical tests. Correlation analysis was used to assess the relationship between serum C-peptide levels and HbA1c, disease duration, age at diagnosis, BMI, and daily insulin dose. A p value of less than 0.05 was considered statistically significant.

Ethical Consideration
The study was conducted after obtaining approval from the Institutional Ethics Committee of Government Cuddalore Medical College and Hospital. Written informed consent was obtained from the parents or guardians of all participants, and assent was obtained from children whenever applicable. Confidentiality of participant information was maintained throughout the study, and data were used only for research purposes.

RESULTS

Table 1. Baseline Characteristics of Paediatric Patients with Type 1 Diabetes Mellitus (N = 45)

Variable	Category / Measure	n (%) / Mean ± SD
Age group (years)	1–5	6 (13.3)
	6–10	17 (37.8)
	11–15	16 (35.6)
	16–18	6 (13.3)
Sex	Male	24 (53.3)

	Female	21 (46.7)
Duration of diabetes	<2 years	9 (20.0)
	2–5 years	18 (40.0)
	>5 years	18 (40.0)
BMI category	Underweight	12 (26.7)
	Normal weight	25 (55.6)
	Overweight	8 (17.8)
Daily insulin requirement	0.5–1.0 U/kg/day	30 (66.7)
	>1.0 U/kg/day	15 (33.3)
Mean daily insulin requirement	—	0.96 ± 0.21 U/kg/day

Table 1 presents the baseline characteristics of paediatric patients with type 1 diabetes mellitus included in the study (N = 45). The highest proportion of participants belonged to the 6–10 years age group, accounting for 37.8% (n = 17), followed by the 11–15 years age group, which comprised 35.6% (n = 16). Children aged 1–5 years and 16–18 years each accounted for 13.3% (n = 6). Males constituted 53.3% (n = 24) of the study population, while females accounted for 46.7% (n = 21). Regarding disease duration, 40.0% (n = 18) had diabetes for 2–5 years and another 40.0% (n = 18) had diabetes for more than 5 years, while 20.0% (n = 9) had a duration of less than 2 years. Most participants had normal BMI, accounting for 55.6% (n = 25), followed by underweight children at 26.7% (n = 12) and overweight children at 17.8% (n = 8). The majority of children required 0.5–1.0 U/kg/day of insulin, comprising 66.7% (n = 30), while 33.3% (n = 15) required more than 1.0 U/kg/day. The overall mean daily insulin requirement was 0.96 ± 0.21 U/kg/day.

Table 2. Distribution of Serum C-Peptide Levels and HbA1c Categories Among Study Participants (N = 45)

Variable	Category	Frequency (n)	Percentage (%)
Serum C-peptide (ng/mL)	<0.2	12	26.7
	0.2–0.4	10	22.2
	0.4–0.6	7	15.6
	>0.6	16	35.6
HbA1c category	Excellent / good control (<7.0%)	5	11.1
	Suboptimal / fair control (7.0–9.0%)	20	44.4
	Poor control (>9.0%)	20	44.4

*Statistically significant

Table 2 shows the distribution of serum C-peptide levels and HbA1c categories among the study participants (N = 45). Serum C-peptide levels of <0.2 ng/mL were observed in 26.7% (n = 12) of children, while 22.2% (n = 10) had levels between 0.2 and 0.4 ng/mL and 15.6% (n = 7) had levels between 0.4 and 0.6 ng/mL. C-peptide levels >0.6 ng/mL were observed in 35.6% (n = 16) of participants, indicating preserved residual β-cell function in nearly one-third of the study population. Based on HbA1c categories, excellent or good glycaemic control (<7.0%) was observed in 11.1% (n = 5), while suboptimal or fair control (7.0–9.0%) was seen in 44.4% (n = 20). Poor glycaemic control (>9.0%) was also observed in 44.4% (n = 20). These findings indicate that most children had reduced C-peptide levels and a considerable proportion had suboptimal or poor glycaemic control.

Table 3. Comparison of HbA1c Levels Across C-Peptide Categories (N = 45)

C-Peptide Category (ng/mL)	n	Mean HbA1c (%) ± SD	p value
<0.2	12	10.5 ± 1.0	<0.001*
0.2–0.4	10	9.6 ± 1.1	
0.4–0.6	7	8.8 ± 0.9	
>0.6	16	7.8 ± 1.0	
Total	45	8.94 ± 1.42	

*Statistically significant

Table 3 presents the comparison of HbA1c levels across different serum C-peptide categories among the study participants (N = 45). The highest mean HbA1c level was observed among children with C-peptide levels <0.2 ng/mL (10.5 ± 1.0%), followed by those with C-peptide levels between 0.2 and 0.4 ng/mL (9.6 ± 1.1%) and 0.4 to 0.6 ng/mL (8.8 ± 0.9%). Participants with C-peptide levels >0.6 ng/mL had the lowest mean HbA1c level (7.8 ± 1.0%). The overall mean HbA1c level of the study population was 8.94 ± 1.42%. The difference in HbA1c levels across C-peptide categories was statistically significant ($p < 0.001$), indicating that lower C-peptide levels were associated with poorer glycaemic control.

Table 4. Correlation Between Serum C-Peptide Levels and Clinical/Biochemical Parameters (N = 45)

Variables Compared	Correlation Coefficient (r)	p value
Serum C-peptide vs HbA1c (%)	-0.46	0.002*
Serum C-peptide vs duration of diabetes	-0.62	0.001*
Serum C-peptide vs age at diagnosis	0.38	0.011*
Serum C-peptide vs BMI (kg/m²)	0.49	0.001*
Serum C-peptide vs daily insulin dose (U/kg/day)	-0.58	0.001*

*Statistically significant

Table 4 shows the correlation between serum C-peptide levels and selected clinical and biochemical parameters among the study participants (N = 45). Serum C-peptide showed a significant negative correlation with HbA1c ($r = -0.46$, $p = 0.002$), indicating that lower endogenous insulin secretion was associated with higher HbA1c levels. A strong negative correlation was also observed between C-peptide and duration of diabetes ($r = -0.62$, $p = 0.001$), suggesting progressive decline in residual β-cell function with increasing disease duration. Serum C-peptide showed significant positive correlations with age at diagnosis ($r = 0.38$, $p = 0.011$) and BMI ($r = 0.49$, $p = 0.001$), indicating better preservation of β-cell function among children diagnosed at an older age and those with higher BMI. In addition, C-peptide was negatively correlated with daily insulin dose ($r = -0.58$, $p = 0.001$), suggesting that children with lower residual β-cell function required higher doses of exogenous insulin.

DISCUSSION

In the present study, the baseline characteristics showed that the majority of paediatric patients with type 1 diabetes mellitus belonged to the 6–10 years age group, followed by the 11–15 years age group, indicating that most participants were in middle childhood and early adolescence. Males were slightly more common than females, and most children had diabetes duration of either 2–5 years or more than 5 years. These findings were comparable with Khazaal et al. (2023), who observed that children with type 1 diabetes commonly presented around school-going age, with a mean age at diagnosis of approximately eight years [1]. Novac et al. (2023) also reported that age at onset was an important clinical determinant of residual endogenous insulin secretion in children with type 1 diabetes [2]. Similarly, Hwang et al. (2017) observed that younger age at diagnosis was associated with more rapid decline in β-cell function [5]. Cimbek et al. (2025) further emphasized that age and pubertal status significantly influenced C-peptide levels at diagnosis, supporting the role of developmental stage in disease heterogeneity [6].

In the present study, the distribution of serum C-peptide showed that 64.4% of children had C-peptide levels ≤0.6 ng/mL, while 35.6% had levels >0.6 ng/mL, indicating preserved residual β-cell function in nearly one-third of the study population. This finding was consistent with Odyjewska et al. (2025), who reported clinically significant residual C-peptide levels in approximately one-third of children and adolescents with type 1 diabetes [9]. Almeida et al. (2013) also observed that nearly one-third of patients with type 1 diabetes had detectable C-peptide secretion, particularly among those with shorter disease duration [11]. Sørensen et al. (2013) reported residual β-cell function in about one-fourth of children with established type 1 diabetes of 3–6 years' duration [7]. Similarly, Kuhtreiber et al. (2015) demonstrated that measurable C-peptide may persist even in established type 1 diabetes, challenging the traditional concept of complete β-cell destruction [10]. These findings collectively suggest that residual endogenous insulin secretion persists in a meaningful proportion of patients with type 1 diabetes.

The present study showed that glycaemic control was suboptimal in a large proportion of participants, with only 11.1% having excellent or good control, while 44.4% had suboptimal or fair control and 44.4% had poor control. The overall mean HbA1c was 8.94 ± 1.42%, indicating inadequate metabolic control in many children. These findings were similar to Khazaal et al. (2023), who reported poor glycaemic control among paediatric patients with type 1 diabetes and observed lower C-peptide levels among affected children compared with controls [1]. Sahraian et al. (2025) also demonstrated that lower C-peptide levels were associated with higher HbA1c values in children with type 1 diabetes [8]. Sørensen et al. (2013) reported poorer glycaemic control among children with minimal residual β-cell function [7]. Kuhtreiber et al. (2015) similarly found that lower C-peptide levels were associated with poorer metabolic control and higher HbA1c values in established type 1 diabetes [10]. These findings support the clinical relevance of residual β-cell function in maintaining better glycaemic stability.

In the present study, mean HbA1c levels showed a progressive decline with increasing C-peptide categories. Children with C-peptide levels <0.2 ng/mL had the highest mean HbA1c of 10.5 ± 1.0%, whereas those with C-peptide levels >0.6 ng/mL had the lowest mean HbA1c of 7.8 ± 1.0%. This difference was statistically significant, indicating that higher residual endogenous insulin secretion was associated with better glycaemic control. This finding was comparable with Sahraian et al. (2025), who observed a significant inverse association between C-peptide and HbA1c among paediatric patients with type 1 diabetes [8]. Odyjewska et al. (2025) also reported that children with clinically significant C-peptide levels had better glycaemic control and lower insulin requirements [9]. Rickels et al. (2020) found that individuals with higher residual C-peptide had superior glycaemic profiles, including lower mean glucose levels and greater time within the target range [12]. Similarly, Sørensen et al. (2013) demonstrated that preserved residual β-cell function was associated with lower HbA1c and better metabolic outcomes [7].

The correlation analysis in the present study showed a significant negative correlation between serum C-peptide and HbA1c, confirming that lower residual β-cell function was associated with poorer glycaemic control. A strong negative correlation was also observed between C-peptide and duration of diabetes, suggesting progressive loss of endogenous insulin secretion with increasing disease duration. These findings were consistent with Novac et al. (2023), who reported a decline in C-peptide levels during the first three years after diagnosis and identified younger age at onset as a risk factor for lower residual insulin secretion [2]. Sahraian et al. (2025) also reported significant inverse correlations of C-peptide with both disease duration and HbA1c [8]. Almeida et al. (2013) observed that detectable C-peptide secretion was more common among patients with shorter disease duration [11]. Kuhtreiber et al. (2015) further demonstrated that C-peptide levels decline progressively over several decades, although low-level secretion may persist in some patients [10]. These findings indicate that disease duration remains one of the strongest determinants of residual β-cell function.

The present study also demonstrated significant positive correlations of C-peptide with age at diagnosis and BMI, along with a significant negative correlation with daily insulin dose. These findings suggest that children diagnosed at an older age and those with relatively higher BMI had better preservation of residual β-cell function, while those with lower C-peptide required higher insulin doses. Similar findings were reported by Cimbek et al. (2022), who observed higher C-peptide levels among overweight or obese children and a positive association between BMI-SDS and C-peptide concentrations [4]. Hwang et al. (2017) also found that C-peptide levels were positively associated with age at diagnosis and BMI, while younger children and those with lower BMI had more rapid β-cell decline [5]. Cimbek et al. (2025) confirmed that age, BMI, and pubertal stage independently influenced C-peptide levels at diagnosis [6]. Sørensen et al. (2013) and Almeida et al. (2013) similarly reported that preserved C-peptide secretion was associated with lower daily insulin requirement [7,11]. These findings support the use of C-peptide as a clinically useful biomarker for individualized insulin planning and risk stratification in paediatric type 1 diabetes mellitus.

Limitations

The study was limited by its single-centre design, which may limit the generalizability of the findings to the wider paediatric type 1 diabetes population. As the study was cross-sectional and used non-fasting C-peptide estimation, longitudinal changes in residual β-cell function and stimulated C-peptide response could not be assessed.

CONCLUSION AND RECOMMENDATIONS

The present study concluded that serum C-peptide showed a significant association with HbA1c among paediatric patients with type 1 diabetes mellitus. Children with lower C-peptide levels had higher mean HbA1c values, indicating poorer glycaemic control, whereas those with preserved C-peptide levels had comparatively better glycaemic status. Serum C-peptide also showed significant correlations with duration of diabetes, age at diagnosis, BMI, and daily insulin requirement. These findings suggest that residual β-cell function plays an important role in glycaemic control and insulin requirement among children with type 1 diabetes mellitus.

Based on these findings, serum C-peptide estimation may be considered as a useful supportive biomarker in the routine assessment of paediatric type 1 diabetes mellitus, particularly for evaluating residual endogenous insulin secretion and identifying children at risk of poor glycaemic control. Regular monitoring of HbA1c, individualized insulin dose adjustment, nutritional assessment, and family-centred diabetes education are recommended to improve glycaemic outcomes. Further multicentric longitudinal studies with larger sample sizes and stimulated C-peptide estimation are recommended to better understand the progression of residual β-cell function over time.

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