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Evaluation of Fasting Insulin and C-peptide Levels in Newly Diagnosed Diabetes Mellitus Among Adults Aged 18-35 Years

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Abstract

Background

Diabetes mellitus (DM) is increasingly being diagnosed in young adults, and its varied clinical presentation and differences in pancreatic β-cell function can make diagnosis and treatment challenging. Fasting insulin and C-peptide levels may provide useful information about endogenous insulin secretion and β-cell reserve. This study aimed to assess fasting insulin and C-peptide levels in young adults aged 18-35 years with newly diagnosed DM.

Methods

This cross-sectional observational study was conducted over six months at Vinayaka Mission's Kirupananda Variyar Medical College and Hospital, Salem. Fifty patients aged 18-35 years with newly diagnosed DM were included. Detailed clinical and anthropometric assessments were performed for all participants. Blood samples were collected during the fasting assessment for the measurement of fasting blood sugar (FBS), serum insulin, C-peptide, and glycated hemoglobin (HbA1c). Postprandial blood sugar (PPBS) was measured two hours after a meal. Data were analyzed using the SPSS software (IBM Corp., Armonk, NY). Correlations among insulin, C-peptide, body mass index (BMI), and glycemic parameters were evaluated. A p-value of <0.05 was considered statistically significant.

Results

The mean age of the participants was 27.8 ± 5.1 years, and 29 (58.0%) were men. The mean fasting insulin and C-peptide levels were 14.8 ± 7.1 µIU/mL and 2.18 ± 0.96 ng/mL, respectively. C-peptide levels increased significantly across BMI categories ($p < 0.001$), as did fasting insulin levels ($p < 0.001$). C-peptide showed a significant positive correlation with BMI ($r = 0.612$; $p < 0.001$) and significant negative correlations with HbA1c ($r = -0.386$; $p = 0.006$) and FBS ($r = -0.352$; $p = 0.012$). Based on the study-defined C-peptide categories, 24 (48.0%) participants were classified as having adequate C-peptide levels, 20 (40.0%) as having borderline levels, and six (12.0%) as having low levels.

Conclusions

At the time of assessment, a substantial proportion of young adults with newly diagnosed DM had measurable endogenous insulin secretion. Fasting insulin and C-peptide levels were associated with BMI and glycemic parameters, suggesting that they may provide useful information about endogenous insulin secretion and β-cell reserve.

Categories: Family/General Practice, Internal Medicine, Endocrinology/Diabetes/Metabolism
Keywords: beta-cell reserve, c-peptide, diabetes mellitus, fasting insulin, young adults

Introduction

Diabetes mellitus (DM) is one of the fastest-growing noncommunicable diseases (NCDs) worldwide. Its high prevalence, increasingly early age of onset, and associated complications have made it a major global public health concern. The International Diabetes Federation (IDF) reported that 589 million adults were living with diabetes in 2024, and this number is expected to rise considerably over the coming decades. India has one of the largest populations of people living with diabetes worldwide, with more than 101 million affected individuals. Of particular concern is the increasing occurrence of diabetes among young adults, who face a greater lifetime risk of developing microvascular and macrovascular complications [1,2].

Diagnosing diabetes in individuals aged 18-35 years presents a clinical challenge, as this age group may be affected by different forms of diabetes, including type I diabetes; slowly progressive autoimmune diabetes in adults, commonly referred to as latent autoimmune diabetes in adults (LADA); type II diabetes; monogenic

forms such as maturity-onset diabetes of the young (MODY); and other specific forms of diabetes [2,3]. The clinical presentation of these conditions may overlap, making accurate classification difficult without a detailed clinical evaluation. Misclassification may result in inappropriate treatment, delays in initiating insulin therapy when indicated, suboptimal glycemic control, and an increased risk of complications. Therefore, assessing endogenous insulin secretion and pancreatic β-cell function using biochemical markers such as C-peptide, alongside appropriate clinical and diagnostic investigations, may provide useful information to support the evaluation of diabetes subtypes [2,4].

Insulin is synthesized in pancreatic β-cells as proinsulin, which is subsequently cleaved into insulin and connecting peptide (C-peptide) in equal amounts before secretion into the circulation. C-peptide is a more stable and reliable marker of endogenous insulin secretion because it is not removed by the liver and has a longer half-life than insulin [5,6]. Fasting C-peptide levels provide information about the function of insulin-producing β-cells and may be useful in distinguishing insulin deficiency from insulin resistance. Typically, patients with type I diabetes have either undetectable or very low C-peptide levels, whereas patients with type II diabetes have measurable C-peptide levels because they continue to produce some insulin endogenously [6,7]. C-peptide measurement has an established role in evaluating insulin deficiency and supporting diabetes classification, although its interpretation depends on the clinical context and testing conditions [7,8].

Fasting insulin measurement can provide additional information about insulin secretion and insulin resistance, particularly in individuals with newly diagnosed diabetes mellitus. In type II diabetes, insulin resistance may initially be accompanied by compensatory hyperinsulinemia, while progressive β-cell dysfunction may subsequently impair insulin secretion [9]. Therefore, fasting insulin may be assessed alongside fasting glucose and C-peptide to provide additional information about insulin secretion and metabolic function. Fasting glucose and insulin concentrations are also used to calculate insulin resistance indices, such as the Homeostatic Model Assessment of Insulin Resistance (HOMA-IR), which is widely used in metabolic research. Glucose-, insulin-, and C-peptide-derived indices have also been investigated for their associations with metabolic syndrome in young adults [10].

Factors such as urbanization, physical inactivity, dietary changes, overweight and obesity, and genetic predisposition have contributed to the increasing prevalence of early-onset type II diabetes mellitus (T2DM) in India. Young-onset diabetes (YOD) differs from late-onset diabetes in its more aggressive clinical course, poorer glycemic control, more rapid progression of β-cell impairment, and earlier development of cardiovascular, renal, retinal, and neurological complications [2]. The assessment of insulin secretory capacity may provide additional information when considering treatment strategies for patients with type II diabetes mellitus. Identifying patients with marked β-cell dysfunction may be relevant to decisions regarding the timing of insulin therapy, although further evidence is needed to establish the role of fasting insulin and C-peptide measurements in guiding treatment selection [5,11].

Although fasting insulin and C-peptide measurements have demonstrated clinical value, they are not routinely performed in many Indian healthcare centers for young adults with newly diagnosed diabetes. Most patients are classified based primarily on clinical findings, which may increase the likelihood of misdiagnosis and inappropriate management. Furthermore, data on fasting insulin and C-peptide levels in young adults with newly diagnosed diabetes in South India remain limited. Therefore, this study aimed to determine fasting insulin and C-peptide levels in patients aged 18-35 years with newly diagnosed diabetes and to evaluate their associations with clinical and biochemical parameters. The findings may provide additional information about endogenous insulin secretion and β-cell reserve, potentially supporting the clinical assessment and metabolic characterization of young adults with newly diagnosed diabetes.

Materials And Methods

Study design

A hospital-based cross-sectional observational study was conducted to assess fasting insulin and C-peptide levels among patients aged 18-35 years with newly diagnosed diabetes mellitus (DM). A cross-sectional design was selected because it allows the simultaneous assessment of fasting insulin, C-peptide, anthropometric characteristics, and glycemic parameters, facilitating the evaluation of associations between endogenous insulin secretion, β-cell reserve, and metabolic status. Furthermore, this design was considered appropriate for assessing the relationship between these parameters within the defined study period without requiring longitudinal follow-up.

Study setting

The study was carried out in the Department of General Medicine at Vinayaka Mission's Kirupananda Variyar Medical College and Hospital, Salem, Tamil Nadu.

Study duration

The study was conducted over six months following approval from the Institutional Ethics Committee (IEC).

Participants

Participants were selected based on predefined eligibility criteria, which are presented in Table 1.

Inclusion Criteria	Exclusion Criteria
Patients aged 18-35 years	Patients with known type I diabetes mellitus or maturity-onset diabetes of the young (MODY)
Patients diagnosed with diabetes mellitus within the previous six months	Patients receiving insulin therapy for more than one month
Patients willing to provide written informed consent for participation	Patients with a history of chronic kidney disease, chronic liver disease, or endocrine disorders affecting glucose metabolism
-	Pregnant women

TABLE 1: Inclusion and exclusion criteria

Study sampling

A consecutive sampling technique was used to recruit participants. All patients aged 18-35 years who attended the general medicine outpatient (OPD) or inpatient (IPD) services of the hospital during the study period and had been diagnosed with diabetes mellitus (DM) were screened for eligibility. Patients who met the inclusion criteria and none of the exclusion criteria were consecutively enrolled until 50 participants had been recruited. Eligible patients were enrolled in the order of their presentation. This approach helped reduce arbitrary participant selection, although it may not eliminate selection bias or ensure that the sample is fully representative of the study population.

Study sample size

A total of 50 patients were included in the study. No formal statistical sample size calculation was performed before study initiation. The sample size was determined based on the feasibility of recruiting eligible participants during the six-month study period, considering the available study resources and expected patient flow in the Department of General Medicine. All eligible patients who provided informed consent were consecutively recruited until the target of 50 participants was reached. The available sample was used to assess fasting insulin and C-peptide levels and explore their associations with clinical and biochemical parameters in young adults with newly diagnosed diabetes mellitus.

Study parameters

Demographic, anthropometric, clinical, and biochemical parameters were assessed. Demographic data included age and sex, while anthropometric measurements included height, weight, and body mass index (BMI). Clinical information included presenting complaints, the duration of symptoms, provisional diagnosis, and final diagnosis.

The biochemical parameters assessed were fasting blood sugar (FBS), postprandial blood sugar (PPBS), glycated hemoglobin (HbA1c), fasting serum insulin, and serum C-peptide. Fasting insulin and C-peptide levels were considered the primary outcome variables. Their associations with BMI, fasting blood glucose, postprandial blood glucose, and HbA1c were evaluated as secondary outcomes.

Study procedure

The study was initiated after obtaining approval from the Institutional Ethics Committee. Patients attending the Department of General Medicine were screened according to the predefined inclusion and exclusion criteria. Written informed consent was obtained from all participants before enrolment.

Clinical information was collected using a structured data collection form that included age, presenting symptoms, the duration of diabetes, family history, and coexisting medical conditions. A detailed physical examination was performed, and anthropometric measurements, including height and weight, were recorded using standard procedures. BMI was subsequently calculated.

Participants were instructed to fast overnight, and blood samples were collected after 8-10 hours of fasting. Fasting venous blood samples were collected under aseptic conditions for the assessment of fasting insulin, fasting blood glucose, and C-peptide concentrations. Postprandial blood glucose levels were measured two hours after a meal, while HbA1c was assessed to evaluate longer-term glycemic status.

Fasting insulin and C-peptide concentrations were measured in serum using the electrochemiluminescence immunoassay (ECLIA) method on the Roche Cobas e411 analyzer (Roche Diagnostics, Ludwigsburg, Germany). The Elecsys Insulin assay was used to determine fasting insulin concentrations, while the Elecsys C-Peptide assay was used to measure C-peptide concentrations. According to the manufacturer's specifications, the analytical measuring range of the Elecsys C-Peptide assay in serum and plasma is 0.010-40.0 ng/mL [12]. The manufacturer's expected reference interval for fasting insulin is 2.6-24.9 µIU/mL [13]. The laboratory-specific reference interval was used for C-peptide interpretation. For descriptive analysis, fasting C-peptide concentrations were categorized using study-defined cutoffs as low (<0.8 ng/mL), borderline (0.8-2.0 ng/mL), and adequate (>2.0 ng/mL). These categories were used for exploratory descriptive purposes and should not be interpreted as universally validated clinical thresholds for pancreatic β-cell reserve or diabetes subtype classification.

Study data collection

Data were collected using a pre-constructed and pre-evaluated case record form. The form included demographic information, clinical history, anthropometric measurements, laboratory findings, fasting insulin levels, fasting C-peptide levels, and HbA1c values. Laboratory results were verified before being entered into the database. The collected data were subsequently reviewed for completeness, consistency, and accuracy before statistical analysis.

Data analysis

The collected data were entered into Microsoft Excel (Microsoft Corp., Redmond, WA) and analyzed using SPSS software version 26.0 (IBM Corp., Armonk, NY). Continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR), as appropriate, while categorical variables were presented as frequencies and percentages. Associations between fasting insulin and C-peptide concentrations and continuous variables, including fasting blood sugar (FBS), body mass index (BMI), glycated hemoglobin (HbA1c), and postprandial blood sugar (PPBS), were evaluated using Pearson's or Spearman's correlation coefficient, depending on the distribution of the variables. Group comparisons were performed using the independent Student's t-test or Mann-Whitney U test for continuous variables and the chi-square test or Fisher's exact test for categorical variables, as appropriate. Differences in fasting insulin and C-peptide levels across BMI categories were assessed using one-way analysis of variance (ANOVA). Multiple linear regression analysis was performed to identify factors independently associated with fasting C-peptide levels. A p-value of <0.05 was considered statistically significant.

Ethical considerations

The study was conducted with the approval of the Institutional Ethics Committee of Vinayaka Mission's Kirupananda Variyar Medical College and Hospital, Salem, India (approval number: VMKVMC&H/IEC/25/253). Written informed consent was obtained from all participants before enrolment, after the study objectives and procedures had been explained in their preferred language. Participation was voluntary, and participants were informed of their right to withdraw from the study at any time without affecting their medical care.

Participant confidentiality was maintained throughout the study by assigning unique identification numbers and removing personal identifiers from the database. Blood samples were collected by trained personnel using standard aseptic techniques. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and Good Clinical Practice guidelines.

Results

The majority of participants belonged to the 23-27-year age group, comprising 16 (32.0%) participants, followed by the 28-31-year age group, comprising 13 (26.0%) participants. Participants aged 18-22 years and 32-35 years accounted for 11 (22.0%) and 10 (20.0%) participants, respectively (Table *2*).

Age Group (Years)	Frequency (n)	Percentage (%)
18-22	11	22.0
23-27	16	32.0
28-31	13	26.0
32-35	10	20.0
Total	50	100.0

TABLE 2: Age distribution of study participants (n = 50)

Among the 50 participants, 29 (58.0%) were men, and 21 (42.0%) were women. The findings indicate a slight male predominance among patients with newly diagnosed diabetes mellitus in the study population (Table *3*).

Gender	Frequency (n)	Percentage (%)
Male	29	58.0
Female	21	42.0
Total	50	100.0

TABLE 3: Gender distribution (n = 50)

The largest proportion of participants were overweight (21; 42.0%), followed by those who were obese (15; 30.0%), while 14 (28.0%) had a normal BMI. These findings indicate that excess body weight was common among young adults with newly diagnosed diabetes mellitus (Table *4*).

BMI Category	Frequency (n)	Percentage (%)
Normal (18.5-24.9)	14	28.0
Overweight (25-29.9)	21	42.0
Obese (≥30)	15	30.0
Total	50	100.0

TABLE 4: Body mass index (BMI) classification

The study population had a mean age of 27.8 ± 5.1 years and a mean BMI of 27.9 ± 4.2 kg/m². The elevated mean fasting blood glucose (176.4 ± 39.8 mg/dL), PPBS (278.9 ± 61.7 mg/dL), and HbA1c (8.9% ± 1.5%) indicated poor glycemic control. The mean fasting insulin concentration was 14.8 ± 7.1 µIU/mL, while the mean C-peptide concentration was 2.18 ± 0.96 ng/mL (Table *5*).

Variable	Mean ± SD
Age (years)	27.8 ± 5.1
BMI (kg/m²)	27.9 ± 4.2
Fasting blood sugar (mg/dL)	176.4 ± 39.8
PPBS (mg/dL)	278.9 ± 61.7
HbA1c (%)	8.9 ± 1.5
Fasting insulin (µIU/mL)	14.8 ± 7.1
C-peptide (ng/mL)	2.18 ± 0.96

TABLE 5: Baseline clinical and biochemical characteristics

BMI, body mass index; SD, standard deviation; PPBS, postprandial blood sugar; HbA1c, glycated hemoglobin

Mean fasting C-peptide levels increased progressively across BMI categories, from 1.46 ± 0.52 ng/mL in normal-weight participants to 2.18 ± 0.61 ng/mL in overweight participants and 3.01 ± 0.83 ng/mL in obese participants. The difference was statistically significant ($F(2, 47) = 25.19$; $p < 0.001$), with a large effect size ($\eta^2 = 0.517$) (Table *6*).

BMI Category	Mean C-peptide (ng/mL)	SD	F-statistic	Degrees of Freedom	P-value	Effect Size (η²)
Normal weight	1.46	0.52				
Overweight	2.18	0.61	25.19	2, 47	<0.001	0.517
Obese	3.01	0.83				

TABLE 6: Fasting C-peptide levels according to BMI

BMI, body mass index; SD, standard deviation

Mean fasting insulin levels increased progressively from 9.6 ± 3.2 µIU/mL in normal-weight participants to 14.9 ± 4.8 µIU/mL in overweight participants and 21.2 ± 6.5 µIU/mL in obese participants. The difference was statistically significant ($F(2, 47) = 19.45$; $p < 0.001$), with a large effect size ($\eta^2 = 0.453$) (Table *7*).

BMI Category	Mean Insulin (µIU/mL)	SD	F-statistic	Degrees of Freedom	P-value	Effect Size (η²)
Normal weight	9.6	3.2				
Overweight	14.9	4.8	19.45	2, 47	<0.001	0.453
Obese	21.2	6.5				

TABLE 7: Fasting insulin levels according to BMI

BMI, body mass index; SD, standard deviation

Nearly half of the participants, 24 (48.0%), had adequate β-cell reserve, while 20 (40.0%) had borderline reserve, and six (12.0%) had low C-peptide levels. These findings indicate that most young adults with newly diagnosed diabetes mellitus had measurable endogenous insulin secretion at diagnosis (Table *8*).

C-peptide Category	Frequency (n)	Percentage (%)
Low (<0.8 ng/mL)	6	12.0
Borderline (0.8-2.0 ng/mL)	20	40.0
Adequate (>2.0 ng/mL)	24	48.0
Total	50	100.0

TABLE 8: Beta-cell reserve based on C-peptide

C-peptide showed a significant positive correlation with BMI ($r = 0.612$; $p < 0.001$) and significant negative correlations with HbA1c ($r = -0.386$; $p = 0.006$) and fasting blood sugar ($r = -0.352$; $p = 0.012$). These findings indicate that higher C-peptide concentrations were associated with higher BMI and lower HbA1c and fasting blood sugar levels (Table *9*).

Variable	Pearson's r	P-value
BMI	0.612	<0.001
HbA1c	-0.386	0.006
Fasting blood sugar	-0.352	0.012
Age	0.271	0.057

TABLE 9: Correlation of C-peptide with clinical variables

BMI, body mass index; HbA1c, glycated hemoglobin

Fasting insulin showed a strong positive correlation with BMI ($r = 0.648$; $p < 0.001$) and C-peptide ($r = 0.582$; $p < 0.001$). A significant positive correlation was also observed with fasting blood sugar ($r = 0.332$; $p = 0.019$), while a significant negative correlation was observed with HbA1c ($r = -0.291$; $p = 0.040$). These findings indicate that fasting insulin concentrations were positively associated with BMI, C-peptide, and fasting blood sugar and negatively associated with HbA1c (Table *10*).

Variable	Pearson's r	P-value
BMI	0.648	<0.001
HbA1c	-0.291	0.040
C-peptide	0.582	<0.001
Fasting blood sugar	0.332	0.019

TABLE 10: Correlation of fasting insulin with clinical variables

BMI, body mass index; HbA1c, glycated hemoglobin

The study of multiple linear regression indicated that BMI ($p < 0.001$), HbA1c ($p = 0.018$), and fasting blood glucose ($p = 0.041$) were significantly associated with fasting C-peptide levels, whereas age did not reach statistical significance ($p = 0.146$) (Table *11*). The model accounted for 53% ($R^2 = 0.53$) of the variability in C-peptide concentration (Table *12*).

Variable	β Coefficient	Standard Error	P-value
BMI	0.083	0.021	<0.001
HbA1c	-0.192	0.078	0.018
Age	0.028	0.019	0.146
Fasting blood sugar	-0.004	0.002	0.041

TABLE 11: Multiple linear regression for factors associated with C-peptide

BMI, body mass index; HbA1c, glycated hemoglobin

Parameter	Value
R^2	0.53
Adjusted R^2	0.49
F-statistic	12.64
Overall p-value	<0.001

TABLE 12: Model statistics

Discussion

The present study examined fasting insulin and C-peptide concentrations in 50 patients with newly diagnosed diabetes mellitus aged 18-35 years and evaluated their associations with anthropometric and glycemic parameters. The largest proportion of participants belonged to the 23-27-year age group, comprising 16 (32.0%) participants, followed by those aged 28-31 years, comprising 13 (26.0%) participants. The study population showed a male predominance, with 29 (58.0%) male participants. A high prevalence of excess body weight was observed, with 21 (42.0%) participants classified as overweight and 15 (30.0%) as obese, indicating that overweight and obesity were common among young adults with diabetes.

The mean age of the study participants was 27.8 ± 5.1 years, and the mean BMI was 27.9 ± 4.2 kg/m². The participants had inadequate glycemic control, as indicated by a mean fasting blood glucose level of 176.4 ± 39.8 mg/dL and a mean HbA1c level of 8.9% ± 1.5%. The mean fasting insulin concentration was 14.8 ± 7.1 µIU/mL, while the mean fasting C-peptide concentration was 2.18 ± 0.96 ng/mL, indicating measurable endogenous insulin secretion in the study population at the time of diagnosis. These findings are consistent with those of Hosen et al., who reported a median fasting C-peptide level of 2.67 ng/mL (IQR: 1.06-4.07) in individuals with young-onset diabetes [14]. They observed that elevated fasting C-peptide levels were associated with increased BMI and waist circumference, whereas lower C-peptide levels were associated with higher fasting plasma glucose and HbA1c levels. Similarly, Uzunlulu et al. reported a mean fasting C-peptide level of 1.95 ± 1.37 ng/mL in individuals with type II diabetes, which was comparable to that observed in the present study [15]. C-peptide is increasingly recognized as a useful biomarker for assessing endogenous insulin secretion and residual β-cell function, although its clinical interpretation should consider the patient's glycemic status and clinical characteristics [6].

An important observation in the present study was the significant association between BMI and endogenous insulin secretion. Mean fasting C-peptide levels increased progressively from 1.46 ± 0.52 ng/mL in normal-weight participants to 3.01 ± 0.83 ng/mL in obese participants ($p < 0.001$). Similarly, fasting insulin levels were significantly higher with increasing BMI, rising from 9.6 ± 3.2 µIU/mL in normal-weight participants to 21.2 ± 6.5 µIU/mL in obese participants ($p < 0.001$). These findings are consistent with those of Thunander et al., who demonstrated a significant increase in fasting C-peptide levels with age and BMI [16]. The mean BMI of antibody-positive patients was 26.0 ± 4.8 kg/m², compared with 28.9 ± 5.3 kg/m² in antibody-negative patients, with higher fasting C-peptide levels observed in the latter group. Additionally, Hosen et al. reported a positive correlation between fasting C-peptide levels and BMI [14]. Uzunlulu et al. reported a positive association between C-peptide and fasting blood glucose, whereas the present study found a significant negative correlation between these variables ($r = -0.352$; $p = 0.012$) [15]. The difference could be due to differences in the study populations or other variables related to the studies. The current study also demonstrated a negative correlation between C-peptide and HbA1c ($r = -0.386$; $p = 0.006$). This indicates

that higher C-peptide was associated with lower measures of glycemia in the participants in this study. These results are only associations and not causality [15].

It was revealed in the current study that among the participants, 24 (48.0%), 20 (40.0%), and six (12.0%) had adequate reserve, borderline reserve, and low C-peptide levels, respectively. This suggests that a considerable proportion of young adults suffering from newly diagnosed diabetes mellitus have an endogenous insulin production capacity. Similarly, Uzunlulu et al. observed that 57%, 37%, and 6% of their patients had borderline, adequate, and inadequate β-cell reserve, respectively [15]. Likewise, Thunander et al. found that most adults with newly diagnosed autoimmune diabetes had normal or high C-peptide levels at presentation [16]. Residual C-peptide secretion has also been reported in individuals with long-standing type I diabetes. Vollenbrock et al. found that 25% of participants had detectable fasting C-peptide, while an additional 10% showed detectable C-peptide only after a mixed-meal tolerance test [17]. These findings highlight the potential usefulness of C-peptide in assessing endogenous insulin secretion and supporting the clinical evaluation of diabetes subtypes. However, C-peptide measurements alone cannot definitively establish diabetes classification, and additional clinical, immunological, and genetic investigations may be required where appropriate [2,16,17]. Recent literature has further emphasized the clinical utility of C-peptide measurement in evaluating residual β-cell function and supporting diabetes classification, particularly when interpreted alongside other clinical and biochemical findings [6].

The correlation analysis in the present study also highlighted the importance of fasting C-peptide as a marker of endogenous insulin secretion. C-peptide was significantly associated with several clinical and biochemical parameters. A significant positive correlation was observed between C-peptide and BMI ($r = 0.612$; $p < 0.001$), while significant negative correlations were found between C-peptide and HbA1c ($r = -0.386$; $p = 0.006$) and fasting blood glucose ($r = -0.352$; $p = 0.012$). These findings suggest a relationship between endogenous insulin secretion and glycemic status, with higher C-peptide levels associated with higher BMI and lower HbA1c and fasting blood glucose levels.

Fasting insulin also showed significant positive correlations with BMI ($r = 0.648$; $p < 0.001$) and C-peptide ($r = 0.582$; $p < 0.001$). These findings are in line with those of Hosen et al., who reported positive correlations between C-peptide levels and BMI or waist circumference [14]. They also observed lower fasting glucose and HbA1c levels among individuals with higher C-peptide levels. Similarly, Uzunlulu et al. reported significant positive correlations between C-peptide levels and BMI, waist circumference, fasting glucose, and triglyceride levels [15].

BMI, HbA1c, and fasting blood glucose were independently associated with fasting C-peptide levels in the multiple linear regression analysis, whereas age was not a significant predictor. The findings of the present study highlight the significance of BMI and blood glucose levels in relation to insulin secretion. Thunander et al. found that fasting C-peptide levels increased with higher BMI and age [16]. Additionally, the authors stated that the performance of C-peptide was better than age and BMI in terms of discriminatory ability (receiver operating characteristic area under the curve {ROC AUC}: 0.78, 0.68, and 0.66, correspondingly). Furthermore, the role of C-peptide in diagnosing diabetes was confirmed by Alemán-Contreras et al., who discovered that the levels of C-peptide significantly differed between people with type I diabetes (0.2 ng/mL), type II diabetes (2.4 ng/mL), MODY (1.14 ng/mL), and LADA (1.87 ng/mL) [18]. Moreover, the study by Foteinopoulou et al. [19] revealed that C-peptide testing resulted in diabetes reclassification in 6.8% of patients, while Bogun et al. [20] reported progressive lowering of C-peptide levels after the diagnosis of diabetes, which emphasizes the potential value of assessing endogenous insulin secretion. The involvement of insulin resistance and endogenous insulin secretion was also confirmed by Suleiman et al., who suggested that the insulin and C-peptide responses were stronger in subjects with lower insulin sensitivity [21].

According to the results of the present study, most young people with a new diagnosis of diabetes mellitus had endogenous insulin production. Fasting insulin and C-peptide concentrations showed significant associations with BMI and glycemic status, highlighting their potential value in assessing endogenous insulin secretion and β-cell reserve. However, these measurements should be interpreted alongside clinical and other relevant diagnostic findings rather than used independently to classify diabetes subtypes or determine treatment strategies.

The present study has several limitations that should be considered when interpreting the findings. First, the hospital-based cross-sectional design and relatively small sample size of 50 participants may limit the generalizability of the findings to the broader population of young adults with newly diagnosed diabetes mellitus and reduce the statistical power to detect certain associations, particularly in subgroup analyses. Second, the cross-sectional design precludes the establishment of causal relationships and does not allow changes in β-cell function or endogenous insulin secretion to be assessed over time. Third, the absence of a healthy control group limits direct comparisons of fasting insulin and C-peptide levels between individuals with and without diabetes. Additionally, the absence of pancreatic islet autoantibody testing limits the ability to distinguish autoimmune diabetes from other diabetes subtypes. The absence of genetic testing also limits the identification of monogenic forms of diabetes, such as maturity-onset diabetes of the young (MODY), where clinically indicated. Incorporating additional diagnostic investigations, including GAD65, IA-2, and ZnT8 autoantibodies and genetic testing where appropriate, may improve diabetes classification in future studies [2,12]. Furthermore, differences in C-peptide assay methods and the influence of

concurrent blood glucose levels on C-peptide secretion may affect the interpretation and comparability of measured concentrations [8]. Finally, the lack of longitudinal follow-up prevents the evaluation of the long-term clinical implications of the observed findings. Future studies involving larger and more diverse populations, appropriate control groups, comprehensive diabetes classification assessments, and longitudinal follow-up are warranted to validate these findings and clarify the clinical utility of fasting insulin and C-peptide measurements in young adults with newly diagnosed diabetes mellitus.

Conclusions

In this study, fasting insulin and C-peptide levels were positively associated with BMI among young adults with newly diagnosed diabetes mellitus. Lower C-peptide levels were associated with higher fasting blood glucose and HbA1c levels. BMI, HbA1c, and fasting blood glucose were independently associated with C-peptide levels, whereas age was not statistically significant. These findings suggest that fasting insulin and C-peptide measurements may provide additional information about endogenous insulin secretion and metabolic status in this study population. However, the findings should be interpreted in view of the cross-sectional design and relatively small sample size. Further studies involving larger populations, comprehensive diabetes classification assessments, and longitudinal follow-up are needed to clarify the clinical relevance of these associations.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Sharvari G, Rangabashyam Seetharaman Ranganathan, Moogaambiga Solai Raja

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. The Institutional Ethics Committee (IEC) of Vinayaka Mission's Kirupananda Variyar Medical College and Hospital (VMKVMCH), Salem, Tamil Nadu, India, issued approval VMKVMC&H/IEC/25/253, dated 6 December 2025. The study was conducted in accordance with the ethical principles for biomedical research involving human participants. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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