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Prevalence of Dyslipidemia at Onset and During Follow-Up in Pediatric Patients with Type 1 Diabetes Mellitus

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ABSTRACT

Objectives: This study assessed the prevalence of dyslipidemia in pediatric patients with type 1 diabetes mellitus (T1DM) at diagnosis and after one year, examining the effects of glycemic control on lipid levels.

Material and methods: A retrospective analysis was conducted on 56 T1DM patients (30 males, 26 females) aged 10-18 years. These patients were monitored every three months for at least one year. Data on lipid profiles and glycemic control were collected at baseline and after one year.

Results: Dyslipidemia prevalence significantly decreased from 60.7% at baseline to 26.8% after one year ($p < 0.001$). At follow-up, hemoglobin A1c (HbA1c), low-density lipoprotein (LDL), and triglyceride (TG) levels were significantly lower compared to baseline (7.95 ± 1.73% vs. 13.45 ± 2.45%, 84.07 ± 27.55 mg/dl vs. 94.84 ± 27.87 mg/dl, and 78.75 ± 29.93 mg/dl vs. 105.98 ± 58.95 mg/dl, respectively) ($p < 0.001$, $p = 0.007$, $p = 0.001$). Total cholesterol (TC) also decreased, though the difference was near significance (151.20 ± 25.55 mg/dl vs. 159.79 ± 29.78 mg/dl, $p = 0.05$). High-density lipoprotein (HDL) levels increased significantly (55.60 ± 11.10 mg/dl vs. 49.63 ± 13.46 mg/dl, $p < 0.001$). Females had higher HDL levels than males (60.08 ± 12.37 mg/dl vs. 51.71 ± 8.24 mg/dl, $p = 0.004$). HbA1c levels showed a positive correlation with TC, LDL, and TG, and a negative correlation with HDL.

Conclusion: This study highlights a significant reduction in dyslipidemia in pediatric T1DM patients after one year, linked to improved glycemic control. Effective HbA1c management is crucial for better lipid profiles and reduced cardiovascular risk.

Keywords: type 1 diabetes mellitus, dyslipidemia, childhood

Tip 1 Diyabetes Mellitus Olan Pediatrik Hastalarda Tanı ve İzlemde Dislipidemi Prevalansı

Araştırma Makalesi

Süreç

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ÖZET

Amaç: Bu çalışmada, tip 1 diabetes mellituslu (T1DM) pediatrik hastalarda tanı anı ile bir yıllık izlem sonundaki dislipidemi prevalansı değerlendirildi ve glisemik kontrolün lipid seviyeleri üzerindeki etkileri incelendi.

Materyal ve yöntem: 10-18 yaş aralığındaki 56 (30 erkek, 26 kız) T1DM hastasının verileri retrospektif olarak analiz edildi. En az bir yıl boyunca her üç ayda bir görülen hastaların başlangıçtaki ve bir yıl sonraki lipid profilleri ve glisemik kontrol ile ilgili verileri değerlendirildi.

Bulgular: Dislipidemi prevalansı başlangıçtaki %60.7 iken bir yıl sonra anlamlı bir azalma göstererek %26.8'e geriledi ($p < 0.001$). Takipte hemoglobin A1c (HbA1c), düşük yoğunluklu lipoprotein (LDL) ve trigliserid (TG) düzeyleri başlangıç değerlerine göre anlamlı azalma gösterdi (%7.95 ± 1.73'e karşı %13.45 ± 2.45, 84.07 ± 27.55 mg/dl'ye karşı 94.84 ± 27.87 mg/dl ve 78.75 ± 29.93 mg/dl'ye karşı 105.98 ± 58.95 mg/dl) ($p < 0.001$, $p = 0.007$, $p = 0.001$). Total kolesterol (TK) değerlerinde istatistiksel anlamlılık sınırında azalma görüldü (151.20 ± 25.55 mg/dl'ye karşı 159.79 ± 29.78 mg/dl, $p = 0.05$). Yüksek yoğunluklu lipoprotein (HDL) seviyeleri anlamlı artış gösterdi (55.60 ± 11.10 mg/dl'ye karşı 49.63 ± 13.46 mg/dl, $p < 0.001$). Kızların HDL seviyeleri erkeklerden daha yüksekti (60.08 ± 12.37 mg/dl'ye karşı 51.71 ± 8.24 mg/dl, $p = 0.004$). HbA1c seviyeleri TK, LDL ve TG seviyeleri ile pozitif korelasyon, HDL ile negatif korelasyon gösterdi.

Sonuç: Bu çalışma, pediatrik T1DM hastaların bir yıllık izleminde dislipidemi prevalansındaki azalmanın, iyileşen glisemik kontrolle bağlantılı olduğunu vurgulamaktadır. Daha iyi lipid profilleri ve kardiyovasküler riskin azalması için etkili HbA1c yönetimi çok önemlidir.

Anahtar Kelimeler: tip 1 diyabetes mellitus, dislipidemi, çocukluk çağı

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Introduction

The autoimmune disease referred to as type 1 diabetes mellitus (T1DM) is defined by the body's immune system attacking beta cells in the pancreas, which causes little or no insulin production. In genetically predisposed people with particular human leukocyte antigen (HLA) types, this process generally begins with viral infections, chemical agents, or toxic exposures. The most common chronic endocrine condition in children is type 1 diabetes.[1] T1DM is responsible for 80–95% of childhood-onset diabetes cases. There are variations in incidence rates between nations and within a single country, ranging from 2 to 50 cases per 100,000.[2]

Microvascular problems, such as retinopathy, nephropathy, and neuropathy, and macrovascular disorders, like atherosclerosis and coronary heart disease, are the two categories of long-term complications of T1DM. The growing number of cases of T1DM in adolescents and the increasingly early ages at which it is diagnosed are raising concerns that this may result in a greater burden of the illness and a greater occurrence of early-onset macrovascular consequences.[3-5] Vascular and atherosclerotic heart conditions are the leading causes of death in diabetics.[6] Atherosclerosis remains the most common cause of morbidity and mortality in developed cultures. High plasma levels of total cholesterol (TC), low-density lipoprotein (LDL), and triglycerides (TGs), as well as lower concentrations of high-density lipoprotein (HDL), constitute significant modifiable risk factors for atherothrombotic vascular disorders.[7]

While T1DM by itself increases the risk of cardiovascular diseases (CVDs), dyslipidemia increases the risk even more. According to numerous studies, elevated serum cholesterol levels are the initial indication of atherosclerosis in children.[8] 8 A risk factor for coronary artery disease has been found to be dyslipidemia in children and adolescents with T1DM. For this reason, T1DM patiets are advices to check their lipid levels frequently in order to lower the risk of CVD.[9,10] Cardiovascular risk factors, including dyslipidemia, hypertension, and elevated body mass index (BMI), are more commonly linked to poor glycemic control in children with T1DM. Furthermore, even when blood pressure and BMI are normal, a rise in the frequency of dyslipidemia has been reported.[11,12]

The purpose of this study was to find out the prevalence of dyslipidemia in T1DM patients at the time of diagnosis and at the one-year follow-up. The study also sought to examine variations in lipid levels by maintaining glycemic control throughout the follow-up period.

Materials and Methods

56 children between the ages of 10 and 18 who were diagnosed with T1DM at a pediatric endocrinology outpatient clinic between 2006 and 2013 and who received follow-up visits every three months for a minimum of a year were included in the study. Informed consent was not taken because the study was retrospective observational and used anonymous clinical data. This study was approved by the ethics committee of Trakya University School of Medicine (TÜTF-TÜBAPK 2015-134).

In this study, the medical records of patients with T1DM who were being followed-up in our pediatric endocrinology outpatient clinic were retrospectively reviewed. The following individuals were not included in the study out of the 286 T1DM patients: five patients (1.8%) with diseases affecting lipid metabolism (hypothyroidism), one patient (0.3%) taking antilipidemic medication, 75 patients (26.3%) diagnosed at an external center with missing initial data, 77 patients (24.9%) not attending routine follow-ups, and 72 patients (25.2%) not in the appropriate age range. As a result, the study comprised 56 patients who met the criteria for inclusion.

The patients' baseline and one-year follow-up clinical and laboratory data were taken from their medical records. Age, gender, age at diagnosis of T1DM, height standard deviation score (SDS), weight SDS, BMI SDS, prevalence of overweight/obesity, pubertal status, clinical presentation (diabetic ketoacidosis, diabetic ketosis, or hyperglycemia) at diagnosis, hemoglobin A1c (HbA1c), HDL, LDL, TG, and TC levels, frequency of dyslipidemia, glycemic control status, 24-hour urine microalbumin levels, electromyography (EMG), and fundus examination results were among the recorded data. Using the International Society for Pediatric and Adolescent Diabetes (ISPAD) standards, dyslipidemia was diagnosed when fasting venous blood HDL levels were less than 40 mg/dL, LDL levels were greater than 100 mg/dL, or TG levels were greater than 150 mg/dL.[13] Glycemic control was used for sorting patients into three groups: good (HbA1c < 7.5%), moderate (7.5% ≤ HbA1C < 9%), and bad (HbA1c ≥ 9%).[13] The diagnosis of neuropathy includes changes in heart rate, postural blood pressure, or reduced nerve conduction velocity on the EMG. A 24-hour urine microalbumin level of 30–300 mg/day was used to identify microalbuminuria, and fundus photography and/or direct ophthalmoscopy were used to diagnose retinopathy at an outpatient clinic for eye diseases.[13-15]

BMI values were classified based on percentile ranges: normal weight (5th–85th percentile), overweight (85th–95th percentile), obesity (≥95th percentile), and underweight (<5th percentile). For Turkish children, measurements of body mass index (BMI) were based on percentile curves that were specific to age and gender.[16] Tanner staging was used to stage pubertal development; for boys, the onset of puberty was defined as a testicular volume of 4 mL, while for girls, the initiation of breast development.[17]

A SECA scale (GMBH & CO KG, Hamburg, Germany) was used to measure the children's body weight at admission. They were fasted and only wearing their underwear. A 0.1 cm precision Harpenden stadiometer (Holtain Limited, Crymych, Dyfed, U.K.) was used to measure height. Following a 12-hour fast, blood samples were drawn, and once glycemic control was achieved, measurements were made. Using column chromatography on a Premier Hb9210 device, HbA1c levels were determined; the typical range is 3.6% to 5.8%. A Bayer Advia Reagent Packs device was used to assess the levels of TC, LDL, TG, and HDL in accordance with the standard value ranges suggested by ISPAD guidelines.[13]

Statistical Analysis

SPSS version 19.0, licensed under license number 10240642, was used to carry out statistical analysis of the study's findings. The mean ± standard deviation (SD) is used to describe continuous variables, whereas the number of cases (n) and percentages (%) are used to describe categorical variables. The Shapiro-Wilks and Levene's tests were used to evaluate the homogeneity of variances and the normality of the distribution, respectively. The independent samples t-test

was employed to assess group differences and the chi-squared test for categorical variables. The means of two related groups were compared using the dependent samples t-test. The McNemar test and the marginal homogeneity test were used for categorical dependent variables. Pearson's correlation coefficient was used to examine the relationships between the variables. A two-sided p-value of less than 0.05 was considered statistically significant.

Results

The study comprised fifty-six T1DM patients, aged ten to eighteen (30 males and 26 females). 78.6% of the patients were pubertal, and their average age was 12.4 ± 1.5 years. The mean decimal age, height SDS, weight SDS, BMI SDS, frequency of being overweight or obese, pubertal status, clinical presentations (diabetic ketoacidosis, diabetic ketosis, or hyperglycemia), laboratory results (HbA1c, TC, HDL, LDL, TG), and frequency of dyslipidemia did not significantly differ between male and female patients based on the baseline data at the time of T1DM diagnosis ($p > 0.05$). In neither group were microvascular problems found (Table 1).

Fifty-three patients (94.6%) were at the pubertal stage at the one-year follow-up. The mean height SDS, weight SDS, BMI SDS, frequency of being overweight or obese, pubertal status, mean levels of HbA1c, TC, LDL, and TG, frequency of dyslipidemia, and glycemic control status did not differ significantly between male and female patients ($p > 0.05$). Nonetheless, the mean HDL levels of females were significantly greater than those of males ($p < 0.05$). In neither group were microvascular problems found (Table 2).

At the one-year follow-up, mean weight SDS, BMI SDS, and HDL values were significantly higher, while mean HbA1c, LDL, and TG levels were significantly lower than baseline ($p < 0.05$). TC also decreased, though the difference was near significance ($p = 0.05$). Dyslipidemia prevalence also decreased from 60.7% to 26.8% ($p < 0.05$), whereas mean height SDS and overweight/obesity prevalence showed no significant change ($p > 0.05$) (Table 3).

Using pooled data, correlations between patients' BMI SDS, TC, HDL, LDL, and TG values and their HbA1c levels at baseline and at the one-year follow-up were examined. HbA1c levels had a significant negative correlation with HDL levels ($r = -0.240$, $p = 0.011$) and a significant positive correlation with TC, LDL, and TG levels ($r = 0.269$, $p = 0.004$; $r = 0.314$, $p = 0.001$; and $r = 0.344$, $p < 0.001$, respectively). There was no significant correlation between HbA1c levels and BMI SDS ($r = -0.122$, $p = 0.200$).

Table 1. *Clinical and Laboratory Characteristics of the Study Subjects at Baseline (Time of Type 1 Diabetes Mellitus Diagnosis)*

	Total (n=56)	Male (n=30)	Female (n=26)	p
Age (decimal)	12.36±1.49	12.67±1.58	12.01±1.34	0.099[a]
Height SDS	0.31±1.07	0.37±0.97	0.24±1.20	0.641[a]
Weight SDS	-0.39±1.05	-0.24±1.06	-0.57±1.03	0.246[a]
BMI SDS	-0.18±1.48	-0.17±1.60	-0.20±1.35	0.947[a]
Overweight / obese	9 (16.1)	5 (16.7)	4 (15.4)	0.896[b]
Pubertal status				
Prepubertal	12 (21.4)	9 (30.0)	3 (11.5)	0.093[b]
Pubertal	44 (78.6)	21 (70.0)	23 (88.5)	
Clinical presentation				
Diabetic ketoacidosis	31 (55.4)	15 (50.0)	16 (61.5)	0.416[b]
Diabetic ketosis	20 (35.7)	13 (43.3)	7 (26.9)	
Hyperglycemia	5 (8.9)	2 (6.7)	3 (11.6)	
HbA1c %	13.45±2.45	12.97±2.18	14.02±2.66	0.112[a]
TC (mg/dl)	159.79±29.78	157.43±27.04	162.50±32.99	0.530[a]
HDL (mg/dl)	49.63±13.46	47.08±13.56	52.58±12.99	0.129[a]
LDL (mg/dl)	94.84±27.87	93.62±21.33	96.25±34.31	0.728[a]
TG (mg/dl)	105.98±58.95	103.80±62.95	108.50±55.11	0.769[a]
Dyslipidemia	34 (60.7)	18 (60.0)	16 (61.5)	0.906[b]
Glycemic control				
Good	0 (0.0)	0 (0.0)	0 (0.0)	
Moderate	1 (1.8)	0 (0.0)	1 (3.8)	0.464[b]
Poor	55 (98.2)	30 (100.0)	25 (96.2)	
Microvascular complications				
Retinopathy	0 (0.0)	0 (0.0)	0 (0.0)	-
Microalbuminuria	0 (0.0)	0 (0.0)	0 (0.0)	-
Neuropathy	0 (0.0)	0 (0.0)	0 (0.0)	-

SDS: Standard deviation score, BMI: Body mass index, HbA1c: Hemoglobin A1c, TC: Total cholesterol, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, TG: Triglyceride.

Continuous variables are reported as the mean ± standard deviation, and categorical variables are expressed as the number of cases (n) and percentage (%). [a]Independent samples t-test; [b]Chi-square test.

***Table 2**. Clinical and Laboratory Characteristics of the Study Subjects at 1-Year Follow-Up*

	Total (n=56)	Male (n=30)	Female (n=26)	p
Age (decimal)	13.36±1.49	13.67±1.58	13.01±1.34	0.101[a]
Height SDS	0.36±0.93	0.45±0.87	0.27±1.01	0.484[a]
Weight SDS	0.14±1.15	0.07±1.13	0.21±1.20	0.664[a]
BMI SDS	0.14±1.12	0.24±1.27	0.03±0.93	0.486[a]
Overweight / obese	13 (23.2)	7 (23.3)	6 (23.1)	0.982[b]
Pubertal status				
Prepubertal	3 (5.4)	2 (6.7)	1 (3.8)	0.640[b]
Pubertal	53 (94.6)	28 (93.3)	25 (96.2)	
HbA1c %	7.95±1.73	7.95±1.72	7.95±1.78	0.999[a]
TC (mg/dl)	151.20±25.55	147.20±21.99	155.81±28.88	0.212[a]
HDL (mg/dl)	55.60±11.10	51.71±8.24	60.08±12.37	**0.004[a]**
LDL (mg/dl)	84.07±27.55	82.18±22.09	86.26±33.09	0.585[a]
TG (mg/dl)	78.75±29.93	82.40±36.97	74.54±18.72	0.331[a]
Dyslipidemia	15 (26.8)	8 (26.7)	7 (26.9)	0.983[b]
Glycemic control				
Good	26 (46.4)	14 (46.7)	12 (46.1)	
Moderate	17 (30.4)	7 (23.3)	10 (38.5)	0.312[b]
Poor	13 (23.2)	9 (30.0)	4 (15.4)	
Microvascular complications				
Retinopathy	0 (0.0)	0 (0.0)	0 (0.0)	-
Microalbuminuria	0 (0.0)	0 (0.0)	0 (0.0)	-
Neuropathy	0 (0.0)	0 (0.0)	0 (0.0)	-

SDS: Standard deviation score, BMI: Body mass index, HbA1c: Hemoglobin A1c, TC: Total cholesterol, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, TG: Triglyceride.
Continuous variables are reported as the mean ± standard deviation, and categorical variables are expressed as the number of cases (n) and percentage (%).
[a]Independent samples t-test; [b]Chi-square test.

***Table 3.** Comparison of The Baseline and 1-Year Follow-Up Clinical Data of the Study Subjects*

	Baseline (n=56)	Follow-up (n=56)	p
Height SDS	0.31±1.07	0.36±0.93	0.426[a]
Weight SDS	-0.39±1.05	0.14±1.15	**<0.001[a]**
BMI SDS	-0.18±1.48	0.14±1.12	**0.029[a]**
Overweight / obese	9 (16.1)	13 (23.2)	0.219[b]
Pubertal status			
Prepubertal	12 (21.4)	3 (5.4)	**0.012[b]**
Pubertal	44 (78.6)	53 (94.6)	
HbA1c %	13.45±2.45	7.95±1.73	**<0.001[a]**
TC (mg/dl)	159.79±29.78	151.20±25.55	0.050[a]
LDL (mg/dl)	94.84±27.87	84.07±27.55	**0.007[a]**
HDL (mg/dl)	49.63±13.46	55.60±11.10	**<0.001[a]**
TG (mg/dl)	105.98±58.95	78.75±29.93	**0.001[a]**
Dyslipidemia	34 (60.7)	15 (26.8)	**<0.001[b]**
TC > 200 (mg/dl)	4 (7.1)	3 (5.4)	1.000
LDL > 100 (mg/dl)	23 (41.1)	11 (19.6)	**0.012**
HDL < 40 (mg/dl)	16 (28.6)	5 (8.9)	**0.003**
TG > 150 (mg/dl)	12 (21.4)	2 (3.6)	**0.002**
Glycemic control			
Good	0 (0.0)	26 (46.4)	
Moderate	1 (1.8)	17 (30.4)	**<0.001[c]**
Poor	55 (98.2)	13 (23.2)	

SDS: Standard deviation score, BMI: Body mass index, HbA1c: Hemoglobin A1c, TC: Total cholesterol, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, TG: Triglyceride.
Continuous variables are reported as the mean ± standard deviation, and categorical variables are expressed as the number of cases (n) and percentage (%). [a] Dependent samples t-test; [b] McNemar test; [c] Marginal homogeneity test.

Discussion

The findings of our study revealed a noteworthy change in lipid profiles with improved glycemic control over a one-year period, as well as a high prevalence of dyslipidemia among newly diagnosed young T1DM patients. 60.7% of the children with T1DM had dyslipidemia at baseline, and 98.2% had poor glycemic control. The findings of earlier investigations, which reported comparable early clinical and metabolic presentations in pediatric T1DM patients, are consistent with the high frequency of dyslipidemia and poor glycemic control.[9,18] Significant improvements were seen in the year prior to the follow-up: the rate of dyslipidemia dropped to 26.8%, and lipid levels improved dramatically with glycemic control. Since poor glycemic control has been linked to an increase in lipid abnormalities and cardiovascular risks, these changes are crucial.[11,19]

Glycemic control status and the prevalence of dyslipidemia did not significantly differ between male and female patients at follow-up. Yet when compared to males, females' HDL levels were noticeably greater. This finding is in line with other research that found female T1DM patients had higher HDL values. Hormonal effects, especially estrogen, which has been demonstrated to have a positive impact on female lipid profiles during puberty, may be one of the mechanisms contributing to the gender-related variations in HDL levels.[20,21] Remarkably, male and female patients had similar BMI SDS and HbA1c levels, which may have an impact on HDL levels. Females may be somewhat protected against cardiovascular diseases by having higher HDL levels, and further research is necessary to determine the overall effects of gender-specific lipid variations. Our study assumed that the significantly greater HDL levels in pubertal girls with T1DM compared to boys were caused by the increased estrogen levels throughout puberty. Nevertheless, further extensive research is required to confirm the correctness of this finding. The greatest proportion of the cohort was at the pubertal stage, which is a crucial time for changes in metabolism and growth. Recent research has shown that puberty increases the risk of cardiovascular risk factors and lipid abnormalities, making careful monitoring and specialized management techniques vital during this time.[18,22]

The study confirmed the association between glycemic control and lipid metabolism by finding substantial relationships between HbA1c levels and lipid indicators. In particular, there was a negative correlation between greater HbA1c levels and HDL levels and a positive correlation with higher TC, LDL, and TG levels. These associations are corroborated by earlier research that revealed how poor glycemic control affects worsening lipid profiles and elevated cardiovascular risk in pediatric T1DM patients.[12,23] Researches have indicated a correlation between elevated HbA1c levels and a higher incidence of dyslipidemia in children with T1DM.[12,24-26] Despite notable progress, a subgroup of patients continue to have dyslipidemia, which is consistent with prior research that found a high incidence of dyslipidemia in pediatric T1DM populations.[24,27] These trials highlight the need for prompt treatments and routine lipid monitoring in managing dyslipidemia and averting long-term cardiovascular problems.

Our results on the frequency of cardiovascular risk factors are in line with earlier studies that highlight how important it is to identify and treat these risk factors early in order to reduce long-term health problems.[28] Other studies back this up by showing how important it is to evaluate lipid profiles early and regularly and to take preventive actions to lower cardiovascular risk in people with T1DM.[23,29] If there is a family history of hypercholesterolemia or early cardiovascular disease, or if the family history is unknown, screening is advised for children with T1DM beginning at age 2.[13,14] The noteworthy improvements in lipid profiles and glycemic control noted in our investigation underscore the efficacy of contemporary diabetes treatment approaches. Nonetheless, continuous attempts are required to tackle the high incidence of dyslipidemia and the potential risks that accompany it. In order to manage cardiovascular risk factors in pediatric T1DM patients, routine lipid screening, early intervention, and lifestyle modification education are essential.[26,28] Future studies should concentrate on understanding the fundamental processes causing these variations and creating targeted treatments that improve outcomes for all pediatric T1DM patients.

This study provides a thorough picture of patients' health conditions and changes over time through extensive data collecting at baseline and follow-up, including clinical, anthropometric, and laboratory parameters. The findings are more broadly applicable to the larger young T1DM group due to the nearly equal distribution of male and female patients and the inclusion of a wide age range. An understanding of the particular challenges and management requirements of this age group can be gained by concentrating on this critical developmental stage, especially during puberty. Designing effective treatments and monitoring strategies that address the particular physiological and psychological changes that T1DM patients go through during puberty requires an understanding of these dynamics.

It's possible that a one-year follow-up misses long-term consequences and issues related to T1DM, like the emergence of microvascular and macrovascular problems. Conducting the study in a single place may limit the findings' generalizability to different demographic and geographic groups. Due to potential differences between patients who attend follow-up appointments and those who do not, the study may contain inherent selection biases that could distort the data in favor of better outcomes. The prevalence of dyslipidemia and other cardiovascular risk factors in T1DM patients and their healthy counterparts cannot be directly compared due to the lack of a nondiabetic control cohort.

Conclusions

This study shows that with the appropriate treatment, children with T1DM can significantly improve their metabolic results. Nonetheless, continuous attempts are required to tackle the high incidence of dyslipidemia and the potential risks that accompany it. To verify these findings and look into the underlying mechanisms causing these changes, more research with bigger sample sizes and longer follow-up periods is required. Pediatric T1DM management and long-term cardiovascular risk reduction continue to depend heavily on routine monitoring and customized treatments.

Conflict of Interest

The authors report no conflicts of interest.

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Authorship Contribution

This manuscript is based on the first author's residency thesis, supervised by the second author. Both authors contributed to the manuscript from the planning stages of the research through to its publication.

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