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# Dyslipidemia in insulin dependent diabetic children

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## Abstract

**Background:** Children and adolescents with insulin-dependent diabetes mellitus (IDDM) are at high risk of metabolic disorders that may interfere with lipid metabolism and predispose to dyslipidemia.
**Objective:** To detect the incidence of dyslipidemia and associated factors in children with IDDM in Diyala.
**Patients and Methods:** This was a case-control study that included a total of 100 children with type 1 diabetes mellitus(T1DM) and 100 age- and gender-matched non-diabetic children who presented to the Pediatric Department/Al-Batool Teaching Hospital during the period from April 2022 to April 2023. Demographic data included the child's age, gender, weight, mother's educational level, mother's job, child's educational level, school attendance, and physical activity. Clinical data included systolic and diastolic blood pressure, HbA1c, family history of illness, disease duration, type of insulin, and insulin dose. Fasting lipid profile and hemoglobin A1c investigations were done for the study groups, and the data were statistically analyzed.
**Results:** The overall dyslipidemia in IDDM children and controls was 46% and 8%, respectively, with a highly significant difference. The mean age and weight in diabetic patients with dyslipidemia were 8.23±3.63 years and 28.96±13.31 kg, respectively, which was higher than that of normolipidemic diabetic patients (10.72±3.23 years and 34.22±12.14 kg, respectively) with significant differences. Furthermore, 28.26% of mothers of dyslipidemia-.diabetic patients were employed, compared with only 11.11% of normolipidemic-diabetic patients, a significant difference. A family history of DM was reported in 47.83% and 27.78% of dyslipidemic and normolipidemic diabetic patients, respectively, with a significant difference.
**Conclusion:** The incidence of dyslipidemia among diabetic children in Diyala is 46%. Older age, increased body weight, and a mother's job as an employer are significantly associated with the development of dyslipidemia in insulin-dependent diabetes mellitus patients.
**Keywords:** Dyslipidemia, Diabetes mellitus, Children, Diyala.

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## Introduction

The prevalence of dyslipidemia (DLP) in the general population, including diabetic children, has recently increased [1].The increased prevalence of DLP may be attributed to lifestyle changes such as sedentarism and high-carbohydrate and fat diets [2]. Dyslipidemia is not a mandatory component of type 1 diabetes, and in well-

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controlled cases, the lipid profile is often normal [3]. Poorly controlled T1DM often presents atherogenic lipid abnormalities, including elevated triglycerides, low HDL-C levels, and an increased prevalence of small, dense low-density lipoprotein particles [4]. VLDL levels can be influenced by increased liver VLDL production, reduced catabolism, or both [5]. Insulin resistance causes unchecked lipolysis of triglycerides in adipocytes and myocytes, causing a flood of fatty acids to return to the liver [6] .The liver's production of VLDL increases due to the increased return of fatty acids [7]. Insulin inhibits hormone-sensitive lipase in adipose tissue, reducing free fatty acid secretion. Postprandial, enterocytes produce large lipoproteins, chylomicrons, which are hydrolyzed by lipoprotein lipase (LPL) in the circulation. Insulin influences postprandial lipid metabolism by reducing chylomicron production, increasing LPL activity, and enhancing chylomicron-remnant catabolism [8].Insulin increases LDL-receptor expression and activity, promoting LDL catabolism by binding to the plasma membrane of hepatic or other tissues [9]. Patients with type 1 diabetes mellitus and diabetic ketoacidosis often exhibit quantitative lipid abnormalities due to insulin deficiency [8]. Insulin deficiency reduced triglyceride-rich lipoprotein catebolism, leading to hypertriglyceridemia and reduced LDL-cholesterol levels. The results are low HDL cholesterol levels,which resolve rapidly after adequate insulin therapy [9]. Epidemiological studies have shown quantitative lipid disorders such as hypertriglyceridemia and elevated LDL-cholesterol and non-HDL cholesterol levels in patients with suboptimal glycemic controls [10,11]. Aim of the study to detect the incidence of dyslipidemia and associated factors in children with type 1 DM in Diyala.

## Patients and Methods

This was a case-control study that included a total of 100 children with T1DM and 100 age- and gender-matched non-diabetic children who presented to the Pediatric Department/Al-Batool Teaching Hospital during the period from April 2022 to April 2023. It included children with IDDM from 3 to 15 years old, excluding those with chronic diseases and nutritional problems. An interview questionnaire was used to collect information from the child's parents. A written consent from each child's parent was obtained prior to data collection after explaining the aim of study. The confidentiality of data throughout the study was guaranteed and the parents were assured that data will be used for research purpose only. Demographic data included the child's age, gender, weight, mother's educational level, mother's job, child's educational level, school attendance, and physical activity. Clinical data included systolic and diastolic blood pressure, HbA1c, family history of illness, disease duration, type of insulin, and insulin dose. Blood samples were collected after an eight-hour fasting period and analyzed by Erba XL-200 German using standard methods. Total cholesterol (TC), triglycerides (TG), and HDL-C levels were measured. LDL-C levels were calculated by the Friedewald formula LDL-C=(TC)-(HDL-C)-(TG/5) using the available lipid data. Hemoglobin A1c (A1c) measurement was performed using the Erba XL-200 German. Dyslipidemia was defined by the American

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Diabetes Association (ADA) as having LDL-C >100 mg/dl, HDL-C < 40 mg/dl (males) and<50 mg/dl (females), TC ≥200 mg/dl, and TG ≥150 mg/dl, and dyslipidemia was considered present if one or more of these lipid or lipoprotein levels are abnormal [28].

## Statistical Analysis

The data were analyzed using IBM SPSS version 25 (SPSS Inc., Chicago, Illinois, USA). The descriptive data was reported in number and percentage form for categorical data and mean and standard deviation (SD) for continuous data. Differences were evaluated using the Student's t test for continuous parametric data and the Pearson chi-squared test for categorical data. Pearson's correlation test was used to explore the possible correlation between the lipid profile and other variables. A P value of ≤ 0.05 was considered statistically significant.

## Results

### Demographic characteristics of the study population

Table (1) shows the demographic characteristics of the study population. The mean age of patients was 9.37±3.65 years compared with 9.73±2.28 years for control, with no significant difference. Likewise, there were no significant differences between the two groups in terms of gender, weight, mother's educational level, mother's job, child's educational level, and child's physical activity. However, first and second consanguinity were more frequent among patients (35% and 8%, respectively) than controls (19% and 3%, respectively), with a highly significant difference.

**Table (1):** Demographic characteristics of the studied group.

| Demographic characteristics | Patients (n=100) | Controls (n=100) | *p*-value |
|---|---|---|---|
| **Age, years** | | | |
| Mean ±SD | 9.37±3.65 | 9.73±2.28 | 0.471 |
| Range | 3.0-15 | 3.0-15 | |
| **Gender** | | | |
| Male | 48(48%) | 54(54%) | 0.396 |
| Female | 52(52%) | 46(46%) | |
| **Weight, kg** | | | |
| Mean ±SD | 31.38±13.0 | 28.54±11.92 | 0.113 |
| Range | 12.5-60 | 12-60 | |
| **Consanguinity** | | | |
| None | 57(57%) | 78(78%) | **0.006** |
| 1st relative | 35(35%) | 19(19%) | ** |
| 2nd relative | 8(8%) | 3(3%) | |
| **Mother educational level** | | | |
| Illiterate | 30(30%) | 26(26%) | |
| Primary | 37(37%) | 32(32%) | 0.626 |
| Secondary | 21(21%) | 26(26%) | |
| Higher | 12(12%) | 16(16%) | |
| **Mother job** | | | |
| House wife | 81(81%) | 82(82%) | 0.856 |
| Employee | 19(19%) | 18(18%) | |
| **Child educational level** | | | |
| Illutrant | 13(13%) | 7(7%) | |
| Kindergarten | 12(12%) | 14(14%) | 0.261 |
| Primary | 50(50%) | 44(44%) | |
| Secondary | 25(25%) | 35(35%) | |

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| | | | |
|---|---|---|---|
| **School attendance** | | | |
| Regular | 71(71%) | 78(78%) | |
| Interrupted | 18(18%) | 16(16%) | 0.654 |
| Stopped | 11(11%) | 6(6%) | |
| **Physical activity** | | | |
| Active | 90(90%) | 93(93%) | 0.613 |
| Non-active | 10(10%) | 7(7%) | |

*P value: significant* , high significant** , very high significant

**Clinical Characteristics of the studied group** Both SBP and DBP were comparable between patients and controls, with no significant differences. On the other hand, HbA1c, as a marker for diabetes, was much higher in patients than controls (10.86%±2.37 and 5.71%±0.54), respectively, with a highly statistically significant difference. Furthermore, 37% of patients who had a family history of DM compared with 23% of controls with such a history showed a significant difference. The mean duration of T1DM was 3.02±2.71 years (range: 2–12 years). In the majority of patients (86%), soluble lente was the mode of treatment. The mean insulin dose was 25.15±14.39 Table (2).

**Table (2):** Clinical characteristics of the studied group.

| **Clinical characteristics** | **Patients (n=100)** | **Controls (n=100)** | ***p*-value** |
|---|---|---|---|
| **Systolic blood pressure, mmHg** | | | |
| Mean ±SD | 103.3±9.32 | 105.46±10.46 | 0.124 |
| Range | 80-120 | 90-120 | |
| **Diastolic blood pressure, mmHg** | | | |
| Mean ±SD | 66.0±8.4 | 76.8±8.94 | 0.146 |
| Range | 50-90 | 50-90 | |
| **HbA1c, %** | | | |
| Mean ±SD | 10.86±2.37 | 5.71±0.54 | **<0.001** |
| Range | 4.6-16.9 | 3.8-6.1 | *** |
| **Family history of illness** | | | |
| Diabets mellitus | 37(37%) | 23(23%) | **0.031*** |
| Hypertention | 17(17%) | 9(9%) | 0.093 |
| Congenital heart disease | 5(5%) | 4(4%) | 0.733 |
| **Disease duration, years** | | | |
| Mean ±SD | 3.02±2.71 | -------- | ----- |
| Range | 0.2-12 | | |
| **Type of insulin** | | | |
| Soluble-lente | 86(86%) | -------- | ----- |
| Mixture | 14(14%) | | |
| **Insulin dose, Unit** | | | |
| Mean ±SD | 25.15±14.39 | | |
| Range | 7.0-80 | | |

* P value: significant* , high significant** , very high significant

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**Lipid Profile**

The mean serum level of total cholesterol TC in patients was 4.31±1.3 mmol/l, which was higher than that of controls (3.97±1.0 mmol/l) with a significant difference. Borderline and high levels of TC were reported in 18% and 8% of patients, respectively, compared with 13% and 0% in controls, respectively, with a significant difference. Similarly, the mean serum level of triglyceride TG was higher in patients than controls (1.46±0.83 mmol/l vs. 1.26±0.5 mmol/l). Furthermore, 16% and zero of patients and controls had a high level of TC, with a highly significant difference. Likewise, the mean LDL-c in patients was 3.0±0.93 mmol/l, which showed a higher level than that of controls (2.54±0.5 mmol/l) with a highly significant difference, while 35% vs. 8% of patients and controls had a higher level of LDL-c with a highly significant difference. Finally, patients demonstrated a lower serum level of HDL-c than controls (1.4±0.6 mmo/l vs. 1.62±0.28 mmol/l), with a highly significant difference. Interestingly, normal HDL-c was reported in only 29% of patients compared with 81% of controls, with a highly significant difference. The overall incidence of dyslipidemia was 46% among cases and 8% among controls Figure (1).

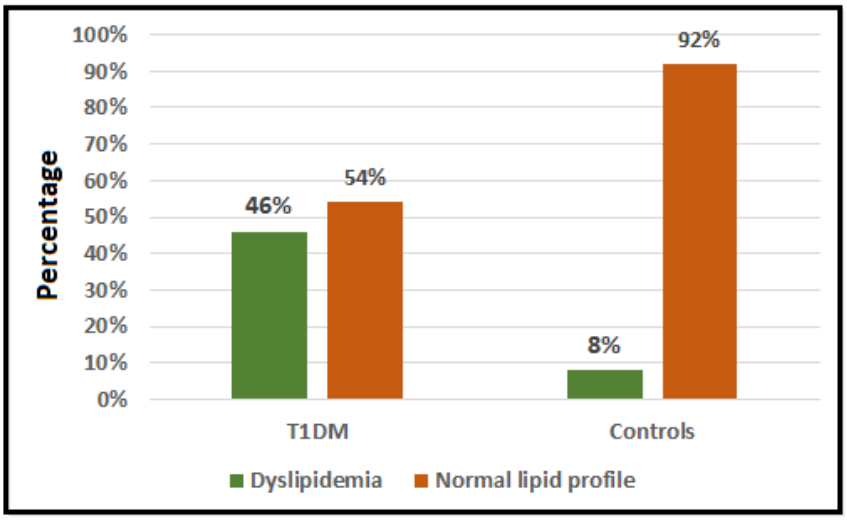


**Figure (1):** The incidence of dyslipidemia in T1DM patients and controls.

The overall dyslipidemia of T1DM patients and controls was 46% and 8%, respectively, with a highly significant difference Table (3).

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**Table (3):** Lipid profile and dyslipidemia rate in T1DM patients and controls.

| Lipid profile | Patients (n=100) | Controls (n=100) | *p*-value |
|---|---|---|---|
| **Total cholesterol, mmol/l** | | | |
| Mean ±SD | 4.31±1.3 | 3.97±1.04 | **0.41** |
| Range | 1.15-8.05 | 120-340 | |
| Normal | 74(74%) | 87(87%) | |
| Borderline | 18(18%) | 13(13%) | **0.007**** |
| High | 8(8%) | 0(0%) | |
| **Triglycerides, mmol/l** | | | |
| Mean ±SD | 1.46±0.83 | 1.26±0.5 | **0.043*** |
| Range | 0.2-4.1 | 0.52-2.2 | |
| Normal | 69(69%) | 74(74%) | **<0.001 ***** |
| Borderline | 15(15%) | 26(26%) | |
| High | 16(16%) | 0(0%) | |
| **LDL-c, mmol/l** | | | |
| Mean ±SD | 3.0±0.93 | 2.54±0.5 | **<0.001 ***** |
| Range | 0.9-5.37 | 0.2-3.9 | |
| Normal | 36(36%) | 64(64%) | |
| Borderline | 29(29%) | 28(28%) | |
| High | 35(35%) | 8(8%) | **<0.001 ***** |
| **HDL-c, mmol/l** | | | |
| Mean ±SD | 1.4±0.6 | 1.62±0.28 | **0.001 ***** |
| Range | 0.2-4.02 | 1.0-1.98 | |
| Normal | 29(29%) | 81(81%) | |
| Borderline | 71(71%) | 19(19%) | **<0.001 ***** |
| **Overall dyslipidemia** | 46(46%) | 8(8%) | **<0.001 ***** |

*P value: significant* , high significant** , very high significant

**Association of Demographic Factors with Dyslipidemia in T1DM Patients**

Three demographic factors were significantly associated with dyslipidemia in T1DM patients. The mean age and weight in patients with dyslipidemia were 8.23±3.63 years and 28.96±13.31 kg, respectively, which was higher than that of normolipidemic patients (10.72±3.23 years and 34.22±12.14 kg, respectively) with significant differences. Furthermore, 28.26% of mothers of dyslipidemia patients were employed compared with only 11.11% of normolipidemic patients, with a significant difference Table (4).

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**Table (4):** Association of demographic factor with dyslipidemia in T1DM patients.

| Variables | Normolipidemia (N=54) | Dyslipidemia (N=46) | p-value |
|---|---|---|---|
| **Age, years** | | | |
| Mean ±SD | 8.23±3.63 | 10.72±3.23 | **0.001** |
| Range | 3.0-14.0 | 3.0-15.0 | *** |
| **Gender** | | | |
| Male | 26(48.15%) | 22(47.83%) | 0.974 |
| Female | 28(51.85%) | 24(52.17%) | |
| **Weight, kg** | | | |
| Mean ±SD | 28.96±13.31 | 34.22±12.14 | **0.043** |
| Range | 13.0-59.0 | 12.5-60.0 | * |
| **Consanguinity** | | | |
| None | 32(59.26%) | 25(54.35%) | 0.686 |
| 1st relative | 17(31.48%) | 18(39.13%) | |
| 2nd relative | 5(9.26%) | 3(6.52%) | |
| **Mother educational level** | | | |
| Illiterate | 16(29.63%) | 14(30.43%) | |
| Primary | 23(42.59%) | 14(30.43%) | 0.358 |
| Secondary | 8(14.81%) | 13(28.26%) | |
| Higher | 7(12.96%) | 5(10.87%) | |
| **Mother job** | | | |
| House wife | 48(88.89%) | 33(71.72%) | **0.029** |
| Employee | 6(11.11%) | 13(28.26%) | * |
| **Child educational level** | | | |
| Not educated | 9(16.67%) | 4(8.7%) | |
| Kindergarten | 9(16.67%) | 3(6.52%) | 0.145 |
| Primary | 26(48.15%) | 24(52.17%) | |
| Secondary | 10(18.52%) | 15(32.61%) | |
| **School attendance** | | | |
| Regular | 9(16.67%) | 4(8.7%) | |
| Interrupted | 31(57.41%) | 35(76.09%) | 0.315 |
| Stopped | 3(5.56%) | 4(8.7%) | |
| **Physical activity** | | | |
| Active | 6(11.11%) | 4(8.7%) | 0.688 |
| Non-active | 48(88.89%) | 42(91.3%) | |

* P value: significant* , high significant** , very high significant

**Association of Clinical Factors with Dyslipidemia in T1DM Patients**

Three clinical factors demonstrated a significant association with dyslipidemia in patients with T1DM. Family history of DM was reported in 47.83% and 27.78% of dyslipidemic and normolipidemic patients, respectively with a significant difference. Dyslipidemic patients had longer disease duration than normolipidemic patients (4.14±1.25 years vs. 2.06±1.67 years) with a significant difference. Finally, the mean insulin dose in dyslipidemic and normolipidemic patients was 29.26±15.4 U and 21.65±12.58 U, respectively, with a significant difference Table (5).

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**Table (5):** Association of clinical factors with dyslipidemia in 100 patients with T1DM.

| Clinical factors | Normolipidemia (N=54) | Dyslipidemia (N=46) | *p*-value |
|---|---|---|---|
| **Systolic blood pressure, mmHg** | | | |
| Mean ±SD | 101.85±8.92 | 105.0±9.6 | 0.093 |
| Range | 80-120 | 90-120 | |
| **Diastolic blood pressure, mmHg** | | | |
| Mean ±SD | 65.0±8.18 | 67.17±8.6 | 0.199 |
| Range | 50-80 | 50-90 | |
| **HbA1c, %** | | | |
| Mean ±SD | 10.03±2.28 | 10.37±2.48 | 0.474 |
| Range | 6.0-14 | 4.6-16.9 | |
| **Family history of illness** | | | |
| Diabetes mellitus | 15(27.78%) | 22(47.83%) | **0.038*** |
| Hypertension | 10(18.52%) | 7(15.22%) | 0.661 |
| Congenital heart disease | 3(5.56%) | 2(4.35%) | 0.782 |
| **Disease duration, years** | | | |
| Mean ±SD | 2.06±1.67 | 4.14±1.25 | **<0.001 *** ** |
| Range | 0.2-7.0 | 0.25-12.0 | |
| **Type of insulin** | | | |
| Soluble-lente | 46(85.19%) | 40(86.96%) | 0.799 |
| Mixture | 8(14.81%) | 6(13.04%) | |
| **Insulin dose, Unit** | | | |
| Mean ±SD | 21.65±12.58 | 29.26±15.4 | **0.008 ** ** |
| Range | 7.0-80 | 10-72 | |

* P value: significant* , high significant** , very high significant

## Incidence of Dyslipidemia

### Correlation of lipid profile with other factors in T1DM patients

Pearson's correlation was used to explore the possible correlation of lipid profile with other variables in patients. Total cholesterol had a significant positive correlation with each of age (r= 0.340, p= 0.001) and weight (r= 0.289, p= 0.004), disease duration (r= 0.377, p<0.001) and insulin dose (r= 0.328, p= 0.001). On the other hand, TG demonstrated a significant positive correlation with each of age (r= 0.355, p<0.001), weight (r= 0.251, p= 0.012), disease duration (r= 0.249, p= 0.012), DBP (r= 0.239, p= 0.017) and insulin dose (r= 0.435, p<0.001). Finally, LDL-c displayed a significant positive correlation with DBP (r= 0.215, p= 0.031) as shown in Table (6).

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**Table (6):** Correlation of lipid profile with other factors in T1DM patients.

| Factors | TC | | TG | | LDL-c | | HDL-c | |
|---|---|---|---|---|---|---|---|---|
| | R | p-value | R | p-value | R | p-value | R | p-value |
| Age | **0.340** | **0.001 ***** | **0.355** | **<0.001 ***** | 0.174 | 0.083 | 0.100 | 0.323 |
| Weight | **0.289** | **0.004**** | **0.251** | **0.012*** | 0.054 | 0.591 | 0.181 | 0.072 |
| Duration | **0.377** | **<0.001 ***** | **0.249** | **0.012*** | 0.155 | 0.122 | 0.058 | 0.567 |
| HbA1c | 0.176 | 0.080 | 0.143 | 0.155 | 0.011 | 0.914 | 0.162 | 0.108 |
| SBP | 0.146 | 0.148 | 0.119 | 0.238 | 0.137 | 0.175 | 0.134 | 0.184 |
| DBP | 0.127 | 0.208 | **0.239** | **0.017*** | **0.215** | **0.031** | 0.114 | 0.261 |
| Ins. Dose | **0.328** | **0.001 ***** | **0.435** | **<0.001 ***** | 0.100 | 0.324 | 0.002 | 0.985 |

* P value: significant* , high significant** , very high significant

**Association of Lipid Profile with Categorical Variables in T1DM Patients**

Serum concentrations of different components of the lipid profile were comparable between different categories of consanguinity, mother's educational level, mother's job, school attendance, physical activity, family history of hypertension, family history of CHD, and insulin dose, with no significant differences. However, females had a higher level of TG than males (1.63±0.97 mmol\l vs. 1.27±0.61 mmol\l) with significant differences. Furthermore, children with secondary school levels had a higher mean of TC (5.09±1.2 mmol/l) than other levels, with a significant difference. Additionally, the presence of a family history of DM is associated with higher levels of TG, LDL-c (1.71±0.89 mmol/l and 3.82±0.86 mmol/l, respectively), and a low level of HDL-c (1.29±0.40 mmol/l) than those without such a history (1.31±0.77 mmol/l, 2.8±0.93 mmol/l, and 1.57±0.82 mmol/l, respectively) with significant differences Table (7).

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**Table (7):** Association of lipid profile with the binomial variables in 100 patients with T1DM.

| Variables | TC, mmol/l | TG, mmol/l | LDL-c, mmol/l | HDL-c, mmol/l |
|---|---|---|---|---|
| **Gender** | | | | |
| Males | 4.85±1.27 | 1.27±0.61 | 2.92±0.93 | 1.39±0.62 |
| Females | 4.34±1.35 | 1.63±0.97 | 3.03±0.94 | 1.4±0.59 |
| p-value | 0.844 | **0.028*** | 0.543 | 0.978 |
| **Consanguinity** | | | | |
| None | 4.35±1.36 | 1.44±0.82 | 3.07±0.89 | 1.43±0.6 |
| 1st relative | 4.25±1.31 | 1.6±0.87 | 2.9±1.0 | 1.37±0.64 |
| 2nd relative | 4.34±0.9 | 0.96±0.55 | 2.7±0.95 | 1.25±0.54 |
| p-value | 0.946 | 0.155 | 0.487 | 0.715 |
| **Mother education level** | | | | |
| Illiterate | 4.12±1.57 | 1.45±0.71 | 3.06±1.03 | ١.٤±0.37 |
| Primary | 4.13±1.21 | 1.41±0.84 | 2.72±0.87 | 1.35±0.35 |
| Secondary | ٤.٧٢±1.07 | 1.6±1.07 | 3.33±0.61 | ١.٦6±0.92 |
| Higher | 4.01±0.67 | 1.37±0.66 | 2.94±1.16 | 1.52±0.41 |
| p-value | 0.١23 | 0.830 | 0.111 | 0.١34 |
| **Mother job** | | | | |
| House wife | 4.24±1.31 | 1.42±0.81 | 2.87±0.91 | 1.4±0.56 |
| Employee | 4.63±1.21 | 1.62±0.94 | 3.32±0.92 | 1.38±0.78 |
| p-value | 0.234 | 0.338 | 0.068 | 0.891 |
| **Child education level** | | | | |
| Not educated | 3.98±0.92 | 1.65±0.41 | 2.71±0.90 | 1.22±0.43 |
| Kindergarten | 3.97±1.19 | 1.38±0.59 | 2.64±1.05 | 1.38±0.63 |
| Primary | 4.09±1.33 | 1.49±0.79 | 3.12±0.89 | 1.33±0.49 |
| Secondary | 5.09±1.2 | 1.79±1.0 | 3.0±0.94 | 1.62±0.81 |
| p-value | **0.006**** | 0.115 | 0.290 | 0.157 |
| **School attendance** | | | | |
| Regular | 3.95±1.21 | 1.43±0.75 | 2.57±0.98 | 1.44±0.76 |
| Interrupted | 4.44±1.4 | 1.6±0.9 | 3.1±0.93 | 1.42±0.61 |
| Stopped | 4.54±1.0 | 1.18±0.46 | 3.15±0.78 | 0.27±0.24 |
| p-value | 0.458 | 0.417 | 0.159 | 0.826 |
| **Physical activity** | | | | |
| Active | 3.88±0.98 | 1.29±0.90 | 3.04±0.63 | 1.3±0.65 |
| Non-active | 4.36±1.33 | 1.48±0.83 | 2.97±0.96 | 1.41±0.60 |
| p-value | 0.269 | 0.505 | 0.826 | 0.602 |
| **Family Hx of DM** | | | | |
| No | 4.13±1.24 | 1.31±0.77 | 2.8±0.93 | 1.57±0.82 |
| Yes | 4.62±1.37 | 1.71±0.89 | 3.82±0.86 | 1.29±0.40 |
| p-value | 0.071 | **0.022** | **0.012** | **0.026** |
| **Family History of Hypertention** | 4.34±1.35 | 1.5±0.88 | 2.98±0.97 | 1.93±0.63 |
| No | 4.18±1.08 | 1.25±0.53 | 2.96±0.75 | 1.44±0.45 |
| Yes | | | | |
| p-value | 0.658 | 0.253 | 0.937 | 0.734 |
| **Family History of CHD** | | | | |
| No | 4.3±1.3 | 1.46±0.83 | 2.98±0.93 | 1.41±0.61 |
| Yes | 4.5±1.58 | 1.39±0.96 | 2.98±1.1 | 1.19±0.36 |
| p-value | 0.773 | 0.853 | 0.998 | 0.436 |
| **Type of insulin** | | | | |
| Soluble-lente | 4.34±1.29 | 1.51±0.86 | 2.96±0.95 | 1.4±0.63 |
| Mixture | 4.11±1.44 | 1.17±0.62 | 3.09±0.84 | 1.38±0.41 |
| p-value | 0.541 | 0.160 | 0.637 | 0.934 |

* P value: significant* , high significant** , very high significant***

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## Discussion

The present study aimed to detect the incidence of dyslipidemia and associated factors in children with T1DM in Diyala. Alrasheed [12] looked into the parameters that are related to dyslipidemia and its prevalence among 234 Saudi patients with T1DM. According to the current study, dyslipidemia was present in around half (50%) of the individuals who were included. In a cross-sectional investigation, Abed[13] found that 64% of 129 young people with T1DM had dyslipidemia. Similar findings were made by Mona [14], who examined 60 kids and teens and found that the incidence of dyslipidemia in diabetic patients and controls was, respectively, 65% and 28.2%. In Iraq, 66% of children with T1DM had dyslipidemia, compared to 34% of the non-diabetic control group, according to [15]. In 202 Turkish children and adolescents with T1DM, Bulut [16] assessed the prevalence of dyslipidemia and its correlation with clinical and laboratory results. A relatively low rate (26.2%) of dyslipidemia was reported among those patients. In contrast, a 72.5% rate of dyslipidemia was reported in a Brazilian study including 239 patients with T1DM. The authors attributed the significant prevalence of dyslipidemia to the individuals' wide age range, as well as the rise in sedentary behavior, diets heavy in carbohydrates, and obesity with advancing years. There are a number of reasons why various studies may differ from one another, but the most significant ones are dietary practices, variations in the patients' clinical and demographic features, treatment regimens, and reference ranges for lipid profiles. The increased prevalence rate of dyslipidemia among T1DM patients could be explained by several factors, mainly related to carbohydrate metabolism and insulin deficiency. These factors may cause fat cells to break down from their stored triglyceride forms and result in a greater release of free FA into the circulation. Increased FAs in the plasma lead to increased uptake of these acids by the liver. The liver then synthesizes triglycerides from these FAs. The presence of increased triglycerides stimulates the secretion and assembly of apolipoprotein B and vLDL-C [17]. High LDL-C was the most common kind of dyslipidemia in the current study, accounting for the majority of cases. Within the dyslipidemic group, high LDL-C and low HDL-C were the most common types of dyslipidemia found in the Alakkad study [18]. These were followed by isolated high LDL-C in 6 patients (18.75%), isolated low HDL-C in 5 patients (15.63%), and hypercholesterolemia and high LDL-C in 4 patients (12.50%). According to the study by Mona [14], and Kantoosh [19], hypertriglyceridemia predominated among children with diabetes in Egypt. According to Patiakas [20], among diabetic patients, hypercholesterolemia is the most common form, while hypertriglyceridemia is the least common type. According to Alrabaty [21], the most prevalent dyslipidemia pattern in children and teenagers with T1DM is hypertriglyceridemia. These variations in the types of dyslipidemia between researchers could be attributed to glycemic management, comorbidities, and lifestyle variables. In the present study, older age, increased body weight, and a mother's job as an employee were significantly associated with dyslipidemia in patients with T1DM, while

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there was no significant impact of HbA1c, physical activity, sex, blood pressure, or type of insulin. These results are, at least, partially in accordance with many previous studies. This is consistent with the findings of Moayeri and Oloomi [22], who discovered a significant correlation between lipid concentrations and the length of diabetes. It was shown by Patiakas [20] and Alrabaty [21] that gender had no discernible effect on lipid abnormalities in children and teenagers with type 1 diabetes. Moreover, dyslipidemia did not significantly correlate with age, BMI, the duration of diabetes, or the presence or absence of hypertension, according to Alrasheed [12] .Unlike the current findings, Mona [14] found no significant correlation between dyslipidemia and age or length of diabetes. Nonetheless, they discovered a strong correlation between dyslipidemia and BMI ($P = 0.024$). Marcovecchio [15] also found significant correlations with age ($P < 0.001$), BMI ($P < 0.05$), length of diabetes ($P < 0.001$), and HbA1c ($P < 0.001$), which is similar to the findings of this investigation. In a retrospective analysis of 806 children and adolescents with type 1 diabetes, Soliman and Ibrahim [23] found that higher levels of dyslipidemia (TG, TC, and LDL-c) were substantially correlated with poorer glycemic control, longer diabetes duration, and older age. Abed [13] likewise found a significant ($P < 0.043$) correlation between dyslipidemia and a higher mean HbA1c. It was discovered by Muchacka-Bianga [24] that children with T1DM may have lipid problems regardless of how well their metabolism is controlled. Conversely, Teles and Forne´s [25] as well as Guy [16] discovered a link between elevated blood lipid levels and subpar (inadequate) glycemic management. The absence of a significant impact of glycemic control on dyslipidemia in the present study may be attributed to differences in age and insulin doses between the included patients. According to Alakkad [18], there was no statistically significant difference in the mean duration of diabetes between the dyslipidemic and normolipidemic groups (5.7± 3.1 years and 5.5± 2.60 years, respectively). Similar to the present study, Wiltshire [26] and Ladeia [27] found that serum TG correlates positively with insulin dose in children and adolescents with T1DM. This effect of insulin dose may reflect the hyperglycemic status of patients with dyslipidemia who require a higher dose of insulin. An interesting finding in the present study that was not indicated in the previous studies was that T1DM children of employee women are more prone to dyslipidemia than those of housewife women. This may be explained by two main factors, First, there is more time for the supervision of child lifestyle when the mother is a housewife. Secondly, most employee women use ready-to-eat foods and chunks from the market, which usually have high lipid contents. In contrast, housewives may pay more attention to preparing healthy food for their children.

## Conclusions

There is a marked increase in dyslipidemia in patients with T1DM compared with non-diabetic children. Older age, increased body weight, and a mother's job as an employer are significantly associated with the development of dyslipidemia in T1DM patients.

The presence of a family history of DM, longer T1DM duration, and a higher dose of

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insulin could be considered risk factors for dyslipidemia in T1DM patients.

## Recommendations

Regular monitoring of blood lipid levels in diabetic patients.Urging parents to commit to nutritional education and follow-up of diabetic patients.Early identification of dyslipidemia in diabetic patients will decrease its consequences.

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**Ethical clearance:** The study was approved by the Arab Council for Medical Specialization NO.2243 at 16/11/2022.

This study was conducted according to the approval of College of Medicine/ University of Diyala and in accordance with the ethical guidelines of the Declaration of ethical committee of the College (Document no. 2024BNA853).

**Conflict of interest:** Nil

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# عسر شحميات الدم لدى الاطفال المصابين بداء السكري في محافظة ديالى

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## الملخص

**خلفية الدراسة:** الأطفال والمراهقون المصابون بداء السكري من النوع الأول معرضون بشكل كبير لخطر الإصابة باضطراب التمثيل الغذائي الذي قد يتداخل مع استقلاب الدهون ويؤدي إلى الإصابة بعسر شحميات الدم.

**اهداف الدراسة:** لكشف عن حدوث عسر شحميات الدم والعوامل المرتبطة به لدى الأطفال المصابين بالسكري من النوع الأول في ديالى.

**المرضى والطرائق:** شملت هذه الدراسة ما مجموعه ١٠٠ طفل مصاب بداء السكري من النوع الأول و١٠٠ طفل سليم مماثل من حيث العمر والجنس. تم جمع البيانات الديموغرافية بما في ذلك عمر الطفل، والجنس، والوزن، والمستوى التعليمي للأم، ووظيفة الأم، والمستوى التعليمي للطفل، والالتحاق بالمدارس، والنشاط البدني، والبيانات السريرية بما في ذلك ضغط الدم الانقباضي والانبساطي، ونسبة السكر التراكمي، والتاريخ العائلي للمرض، ومدة المرض، ونوع الأنسولين وجرعة الأنسولين. تم قياس مستوى الدهون في عينات الدم التي تم جمعها بعد صيام ٨ ساعات.

**النتائج:** بلغ معدل عسر شحميات الدم في مرضى الداء السكري من النوع الأول مجموعة السيطرة ٤٦٪ و٨٪ على التوالي وبفرق معنوي. وكان متوسط العمر والوزن لدى المرضى الذين يعانون من عسر شحميات الدم ٨,٢٣ ± ٣,٦٣ سنة و ٢٨,٩٦ ± ١٣,٣١ كغم على التوالي وهو أعلى من المرضى الذين لايعانون من عسر شحميات الدم (١٠,٧٢ ± ٣,٢٣ سنة و ٣٤,٢٢ ± ١٢,١٤ كغم على التوالي) وبفروق معنوية. علاوة على ذلك، فإن ٢٨,٢٦٪ من أمهات مرضى عسر شحميات الدم كن موظفات مقارنة بـ ١١,١١٪ فقط من المرضى ذوي شحوم الدم الطبيعية وبفرق معنوي. سجل التاريخ العائلي لمرض السكري في ٤٧,٨٣٪ و٢٧,٧٨٪ من مرضى عسر شحميات الدم والمرضى سويي الشحوم ، على التوالي، وبفرق معنوي. كان لدى مرضى عسر شحميات الدم مدة مرض أطول من المرضى سويي الشحوم (٤,١٤ ± ١,٢٥ سنة مقابل ٢,٠٦ ± ١,٦٧ سنة) وبفرق معنوي. أخيرًا، كان متوسط جرعة الأنسولين لدى مرضى عسر شحميات الدم والمرض سوي الشحوم ٢٩,٢٦ ± ١٥,٤ وحدة و ٢١,٦٥ ± ١٢,٥٨ وحدة على التوالي، وبفرق معنوي.

**الاستنتاجات:** إن معدل الاصابة بعسر شحميات الدم بين الأطفال والمراهقين في ديالى يقع ضمن سياق الانتشار العالمي لهذا المرض. يرتبط التقدم في السن وزيادة وزن الجسم ووظيفة الأم كموظفة بشكل معنوي بتطور عسر شحميات الدم لدى مرضى الداء السكري من النوع الأول . يمكن اعتبار وجود تاريخ عائلي لمرض السكري، ومدة طويلة للداء السكري من النوع الأول ، وجرعة أعلى من الأنسولين عوامل خطر لعسر شحميات الدم لدى مرضى الداء السكري من النوع الأول .

**الكلمات المفتاحية:** عسر شحميات الدم، داء السكري، الاطفال، ديالى

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