Dyslipidemia in Egyptian children and adolescents with type 1 diabetes mellitus
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Introduction
Type 1 diabetes mellitus (T1DM) is the most prevalent childhood endocrine disorder [1]. It is well known that type 1 diabetes in children is often associated with increased risk for cardiovascular disease (CVD), which manifests early in childhood [2]. CVD risk factors such as dyslipidemia, increased blood pressure, and diabetes cause damage to arterial vessels because of atherosclerosis. This process that takes many years to occur, beginning in childhood and appearing as coronary artery disease and stroke in adulthood [3].

Atherosclerosis in young adults is linked to the prediabetic state. Autopsies showed that the atherosclerotic process at the endothelial level starts in childhood and progresses rapidly in the presence of other risk factors [4,5].

Overweight and obesity have emerged as common complications in young adults that may increase the risk of CVD. Obesity predispose to CVD, likely acting both directly through insulin resistance and indirectly through the actions of other components of the metabolic syndrome [6,7].

Background
Increased cardiovascular morbidity in type 1 diabetes mellitus (T1DM) may be due to vascular endothelial dysfunction, accelerated thickening of arterial intima, and changes in the ventricular functions.

Aim
The study aimed to describe the frequency and the pattern of dyslipidemia in children and adolescents with T1DM, and its relation to the degree of glycemic control, regular activities, and the duration of diabetes.

Patients and methods
This case–control study included 50 patients with T1DM, aged more than or equal to 9 years, with more than 1-year duration of diabetes, and 39 healthy age-matched and sex-matched children as controls. All participants were subjected to the following: full history taking, full clinical examination, and investigations including glycated hemoglobin, total cholesterol, low-density lipoprotein-cholesterol (LDL-C), high-density lipoprotein-cholesterol (HDL-C), and triglycerides.

Results
There was a high statistically significant increase in the frequency of dyslipidemia in diabetic patients (64.0%). Twenty (50%) patients had elevated LDL-C, with a mean of 102.0±34.4 mg/dl; the most common type of dyslipidemia was high LDL-C and low HDL-C in eight (25.0%) patients followed by isolated high LDL-C in six (18.75%) patients, isolated low HDL-C in five (15.63%) patients, and hypercholesterolemia and high LDL-C in four (12.50%) patients. There was no statistically significant difference between the dyslipidemia group and the normolipidemic group regarding BMI ($P=0.070$), but waist circumference showed statistically significant increase in the dyslipidemic group compared with the normolipidemic group ($P=0.045$). As regards the degree of activity affecting the lipid profile, as in the normolipidemic group, 94.4% were practising mild regular activities, whereas in the dyslipidemic group, only 62.5% were practicing mild regular activities ($P=0.041$).

Conclusion
Our study support the hypothesis that LDL-C is the ‘cornerstone’ for assessment of lipoprotein-related cardiovascular risk. In addition, activity is important for the prevention of dyslipidemia, and waist circumference is an easily obtainable measure of abdominal adiposity.

Keywords:
dyslipidemia, glycated hemoglobin, type 1 diabetes mellitus

Introduction
Type 1 diabetes mellitus (T1DM) is the most prevalent childhood endocrine disorder [1]. It is well known that type 1 diabetes in children is often associated with increased risk for cardiovascular disease (CVD), which manifests early in childhood [2]. CVD risk factors such as dyslipidemia, increased blood pressure, and diabetes cause damage to arterial vessels because of atherosclerosis. This process that takes many years to occur, beginning in childhood and appearing as coronary artery disease and stroke in adulthood [3].

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The aim of this study was to describe the frequency and the pattern of dyslipidemia in children and adolescents with T1DM, and its relation to the degree of glycemic control, body habitus, and the duration of diabetes.

**Patients and methods**

This case–control study was based on the retrospective data of children and adolescents diagnosed with T1DM attending to the diabetes outpatient pediatric clinic of the Pediatrics Department, Benha University Hospital. The study included 50 children and adolescents with an established diagnosis of T1DM and 39 healthy age-matched and sex-matched patients as a control group.

This study was conducted according to the guidelines of the Helsinki Declaration and approved by the Research Ethics Committee of Benha University Hospitals. An informed consent was obtained from the parents before enrollment of the patients. Patients younger than 9 years, patients with type 2 DM, and patients receiving lipid lowering drugs were excluded from the study.

All patients were subjected to full clinical examination including weight, BMI percentiles for age and sex, calculated from weight in kilograms divided by the square of height in meters (kg/m²), and waist circumference (WC), measured with a tape measure at the end of expiration at the lateral border of the ilium. Investigations included glycated hemoglobin (HbA1c), total cholesterol (TC), low-density lipoprotein-cholesterol (LDL-C), high-density lipoprotein-cholesterol (HDL-C), and triglycerides (TG) (after a 12 h overnight fast). Dyslipidemia was defined by the American Diabetes Association [6] as having LDL-C greater than 100 mg/dl, HDL-C less than 40 mg/dl (males) and less than 50 mg/dl (females), TC greater than 200 mg/dl, and TG greater than 150 mg/dl. Dyslipidemia cutoff points: TC greater than or equal to 200 mg/dl, HDL-C less than 40 mg/dl (males) and less than 50 mg/dl (females), LDL-C greater than or equal to 100 mg/dl, and TG greater than or equal to 150 mg/dl.

**Statistical analysis**

Data were analyzed using the statistical program for social science SPSS version 16 software (Spss Inc., Chicago, ILL Company). Quantitative data were expressed as mean±SD. Qualitative data were expressed as frequency and percentage.

**Results**

The study included 50 children and adolescents with T1DM. There were 24 (48.0%) females and 26 (52.0%) males, with a mean±SD age of 13.18±2.29 years (range: 9.0–19 years). In addition, there were 39 healthy children (nondiabetic control group) – 21 (53.85%) males and 18 (46.15%) females, with a mean±SD age of 11.97±2.23 years (range: 9.0–19.0 years). No statistically significant difference was found between the patients and controls regarding their age ($P>0.172$).

In the patients group, the mean duration of diabetes was 4.78±2.56 years (range: 1.2–11.2 years); the mean age of onset of diabetes was 8.39±2.65 years (range: 3.2–14.0 years); and the mean insulin dose was 1.13 ±0.37 IU/kg/day (range: 0.7–2.7 IU/kg/day).

There was a high statistically significant increase in the frequency of dyslipidemia in children and adolescents with T1DM (32) (64.0%) compared with the healthy control group (11) (28.2%) ($P<0.002$).

Regarding the values of the fasting lipid profile in the study groups, 25 (50.0%) patients had elevated LDL-C levels ($\geq 100$ mg/dl), 19 (38.0%) patients had low HDL-C levels ($<40$ mg/dl in males and $<50$ mg/dl in females), nine (18.0%) patients had elevated TC levels ($\geq 200$ mg/dl), and four (8.0%) patients had elevated TG concentrations ($\geq 150$ mg/dl), compared with six (15.4%), 10 (25.6%), four (10.3%), and two (5.1%), respectively, in the control group (Table 1).

In this study the most common type of dyslipidemia was high LDL-C and low HDL-C in eight (25.0%) patients, followed by isolated high LDL-C in six (18.75%) patients, isolated low HDL-C in five (15.63%) patients, and hypercholesterolemia and high LDL-C in four (12.50%) patients (Fig. 1).

The study revealed no statistically significant difference between the dyslipidemia group and the normolipidemic group regarding BMI ($P=0.070$), but WC showed statistically significant increase in the dyslipidemic group compared with the normolipidemic group ($P=0.045$) (Table 2).

<table>
<thead>
<tr>
<th>Lipids (mg/dl)</th>
<th>Cases (n=50) [N (%)]</th>
<th>Control (n=39) [N (%)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC1</td>
<td>9 (18)</td>
<td>4 (10.3)</td>
</tr>
<tr>
<td>TG1</td>
<td>4 (8)</td>
<td>2 (5.1)</td>
</tr>
<tr>
<td>HDL-C1</td>
<td>19 (38)</td>
<td>10 (25.6)</td>
</tr>
<tr>
<td>LDL-C1</td>
<td>25 (50)</td>
<td>6 (15.4)</td>
</tr>
</tbody>
</table>

Dyslipidemia cutoff points: TC greater than or equal to 200 mg/dl, TG greater than or equal to 150 mg/dl, HDL-C less than 40 mg/dl in males, less than 50 mg/dl in females, LDL-C greater than or equal to 100 mg/dl, HDL-C, high-density lipoprotein-Cholesterol; LDL-C, low-density lipoprotein-cholesterol; TC, total cholesterol; TG, triglycerides.
Anthropometric measures of the study groups are shown in Table 3. Regarding BMI, four (12.5%) patients in the dyslipidemic group were obese (more than +2 SD) (mean±SD=0.86±1.07), whereas in the normolipidemic group, one (5.56%) patient was obese (mean±SD=0.35±1.24), with no statistically significant difference (P=0.136).

As regards the degree of activity affecting the lipid profile, in the normolipidemic group, 94.4% were practising mild regular activities, whereas in the dyslipidemic group, only 62.5% were practicing mild regular activities (P=0.041) (Table 4).

### Discussion

In this study, a high statistically significant increase was found in the frequency of dyslipidemia in children and adolescents with T1DM (32) (64.0%) compared with the healthy control group (11) (28.2%) (P<0.002). These results were in agreement with Rahma et al. [9] who found that 66% of the children with T1DM showed dyslipidemic pattern compared with 34% of the nondiabetic control group. Furthermore, these results were in agreement with Wiltshire et al. [10] and Patiakis et al. [11].

The study shows that the most frequent type of dyslipidemia was high LDL-C and low HDL-C (25.0%). Al-Naama et al. [12] and Rahma et al. [9] stated that the most common forms of dyslipidemia in children and adolescents with T1DM were high LDL-C and hypercholesterolemia with and without hypertriglyceridemia (33.0 and 31.0%, respectively).

In the present study, most in the dyslipidemic group were females (59.38%), whereas in the normolipidemic group only 27.78% were females (P=0.047). This was in agreement with Krantz et al. [13] and Schwab et al. [14], but in contrast to the results reported by Alrabaty et al. [15] and Patiakis et al. [11] who found no significant difference in the lipid profile in children and adolescents with T1DM regarding sex.

In the present work, there was no significant difference between the dyslipidemic group (4.98±2.57 years) and the normolipidemic group (4.41±2.57 years) regarding the mean duration of diabetes. These results were in agreement with Kanagalakshmi and Sultana [16] and Guy et al. [17] who found that dyslipidemia in children and adolescents with T1DM is present despite the short duration of diabetes, whereas were in contrast to...
the results reported by Moayeri and Oloomi [18] who found that lipid concentrations correlate positively with the duration of diabetes.

In the present study, the mean WC showed a statistically significant increase in the dyslipidemic group (80.50±11.75 cm) compared with the normolipidemic group (72.89±13.92 cm) \( (P=0.045) \). This finding was in concordance with Teles and Fornés [1] study and Kanagalakshmi and Sultana [16] who found that the dyslipidemic group showed higher WC compared with the normolipidemic group of pediatric and youth populations with T1DM.

In this study, there was no statistically significant difference between these groups regarding glycemic control, as in the dyslipidemic group, 43.75% showed suboptimal glycemic control (mean HbA1c=7.96±1.13%), whereas in the normolipidemic group, most patients (55.56%) had optimal control (mean HbA1c=8.12±1.81%). This was in concordance with Muchacka-Bianga et al. [19] and Kantoosh et al. [20] who found that glycemic control did not affect the lipid disorders in children with T1DM. Teles and Fornés [1] and Guy et al. [17] found that decreased (inadequate) glycemic control was significantly related to high serum lipids levels. Moreover, Ladeia et al. [21] and Krantz et al. [13] found significant correlations between glycemic control and the lipid profile. In this study, the degree of activity has an important role in prevention of dyslipidemia and WC is an important factor in the prevention of dyslipidemia in children and adolescents with T1DM.

Conclusion
Our study support the hypothesis that LDL-C is the ‘cornerstone’ for assessment of lipoprotein-related cardiovascular risk. Moreover, activity is important for the prevention of dyslipidemia, and WC is an easily obtainable measure of abdominal adiposity.

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Nil.

Conflicts of interest
There are no conflicts of interest.

References