Significance of HbA1c Test and Different Sociodemographic Factors in The Development of Complications in Type 1 Diabetes in Children

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Abstract

Background	Despite adequate treatment, about 50% of patients with type 1 diabetes mellitus (T1DM) usually develop a serious complication during their lifetime. The level of hemoglobin A1c (HbA1c) reflects glycemic control, the screening of which is particularly helpful in community-based care settings where tests requiring fasting are not that practical.
Objective	To describe the difference in HbA1c level among a sample of children with T1DM and to identify the most common type of compilations and its association with HbA1c and different sociodemographic factors.
Methods	A cross sectional study, included 96 children with T1DM, their age ranged between 8-18 years, that attended Medical City Complex in Baghdad in the Pediatrics outpatients Clinic and Endocrine Outpatient Clinic during period from 1st of July 2021 to 30th of October 2021.
Results	Males formed 47.9%, 45.8% of them were in school age group, the mean HbA1c level was (10.74±2.974) mg/dl. Employed fathers formed 52.1%. Family history of T1DM was among 13.5% and that of T2DM was among 34.4%. Complication appeared among 71.9% of children, mainly neuropathy found among 50% of them. Children with retinopathy, positive family history have significantly poor controlled DM (last reading HbA1c ≥7 mg/dl).
Conclusion	HbA1c level in children with T1DM is found to be associated with family history, parents' education and employment, in addition a significant association with development of retinopathy in those children was also found in this study.
Keywords	Type 1 DM, HbA1c, retinopathy
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List of abbreviations: DM = Diabetes mellitus, T1DM = Type 1 diabetes mellitus, T2DM = Type 2 diabetes mellitus. ISPAD = International Society for Pediatric and Adolescent Diabetes

Introduction

Type 1 diabetes mellitus (T1DM) is a metabolic disease causing many complications and pathological changes due to β-cell destruction. It is associated with high morbidity and mortality. Despite adequate treatment, about 50% of patients usually develop a serious complication during their lifetime [1]. Some will lose eyes vision, and others may develop nephropathy, cataracts, gastroparesis, hypertension, neuropathy, coronary disease increased susceptibility to infections, and peripheral vascular disease are common complications. For patients who pass the first 20 years safely, the prognosis is good [2].

Maintaining euglycemia is associated with severe anxiety and depression for both

patients and their parents; for many patients with T1DM, the quality of life is unsatisfying [3]. The level of hemoglobin A1c (HbA1c) reflects glycemic control. The screening of which is particularly helpful in community-based care settings where tests requiring fasting are not that practical. HbA1c screening should be used whenever possible to diagnose diabetes. HbA1c ≥6.5% is the most reliable indicator of the diagnosis and follow up of diabetes [4]. Patients with an HbA1c level between 6% and 6.4% in screening programs are considered to be at high risk for developing diabetes, while HbA1c levels of around 7% had the best outcomes especially regarding long-term complications. That's why most clinicians aim for HbA1c values of 7-9%. for all children. The International Society for Pediatric and Adolescent Diabetes (ISPAD) recommends and suggest a target level of 7.5% (58 mmol/mol) or less for good glycemic control [5,6].

This study aimed to describe the difference in HbA1c level among a sample of T1DM children and to identify the most common type of compilations and its association with HbA1c and other different socio-demographic factors.

Methods

A cross sectional study, included T1DM patients (age range of 8-18 years) that attended Pediatrics Outpatients Clinic and Endocrine Outpatient Clinic in the Medical City Complex and during period from 1st of July 2021 to 30th of October 2021. Data collection was planned for follow up of their condition; for 2 consecutive months, 2 days/week, 5 hours/ day were included. A normal HbA1c level cutoff is below 5.7%

The complications were diagnosed by a specialist endocrinologist, nephrologist, neurologist, in addition to ophthalmologist and confirmed in the patient record.

The main complications were followed up were:

Retinopathy: often refers to retinal vascular disease, or damage to the retina caused by abnormal blood flow [5].

Nephropathy: which is the deterioration of kidney function. According to the CDC, diabetes is the most common cause of end stage renal disease [5].

Hypoglycemia: A state low blood sugar level that cause symptoms [2].

Poor weight gain and short stature: measured according to growth chart of appropriate age and gender [3].

The children who admitted to the wards or emergency units for other reasons were excluded from the study.
A questionnaire paper was filled by researcher; included the socio-demographic and clinical features (age, gender, parents' job, parents' education, family history, age at diagnosis, complications, in addition to laboratory test of HbA1c.

Statistical analysis

Microsoft Excel 2010 and IBM SPSS (statistical package for social sciences) version 24 were used for data entry, management, and analysis. Descriptive analyses of the variables were expressed as frequencies and percentage for categorical data. While mean of standard deviation was used for quantitative data that is normally distributed, represented by figures and tables. To compare qualitative variables, we utilized the chi-square test, and we used P at level 0.05 to determine statistical significance.

Ethical approval

This study was approved by Ministry of Health, Medical city Directorate, and Medical City Hospital ethics committee and the requirement for informed consent was waived by the Ethics Commission due to the observational nature of the study. Verbal consents were taken from parents.

Results

Table 1 shows that males formed 47.9% of the 96 children with T1DM enrolled in this study, their mean age was 10.85±3.35 years and

mean HbA1c level at diagnosis 10.74±2.97 mg/dl; while females formed 52.1%, their

mean age 10.8±3.03 years and mean HbA1c level at diagnosis 10.95±3.19 mg/dl.

Table 1. Gender distribution of patients according to the mean age and mean level of HbA1c at diagnosis

Gender	N	%	Age (years) Mean±SD	HbA1c at diagnosis Mean±SD
Male	46	47.9	10.85±3.35	10.74±2.97
Female	50	52.1	10.8±3.03	10.95±3.19
Total	96	100%	P=0.94	P=0.74

The socio-demographic features of the patients are represented in table 2; which revealed that employed fathers formed 52.1%, and 79.2% of them with secondary school education or less. Employed mothers formed 11.5%, and 81.3%

of them with secondary school education or less. Family history of T1DM was among 13.5% and that of T2DM was among 34.4%. Complication appeared among 71.9% of patients.

Table 2. Socio-demographic features of type 1 diabetes mellitus patients

Socio-demographic features		N	%
Age Group	<10 years	14	14.6
	School age (10 to 15 years)	44	45.8
	>15 years	38	39.6
Father Occupation	Employed	50	52.1
	Not employed	46	47.9
Father Education	> Secondary school	20	20.8
	≤ Secondary school	76	79.2
Mother Occupation	Employed	11	11.5
	Not employed	85	88.5
Mother Education	> Secondary school	18	18.7
	≤ Secondary school	78	81.3
Family History of DM	No	50	52.1
	T1DM	13	13.5
	T2DM	33	34.4
Complications	No	27	28.1
	Yes	69	71.9
Total		96	100

T1DM: Type 1 diabetes mellitus, T2DM: Type 2 diabetes mellitus

Figure 1 shows types of complications among children. The commonest complications found

in children was neuropathy (50%) followed by nephropathy (40.6%). Other complications

were hypoglycemia, which found among 12.5% of children, retinopathy found among 9.4% of children, and poor weight gain found among 9.4% of children. While the least complication was short stature, which found among 8.3% of children.
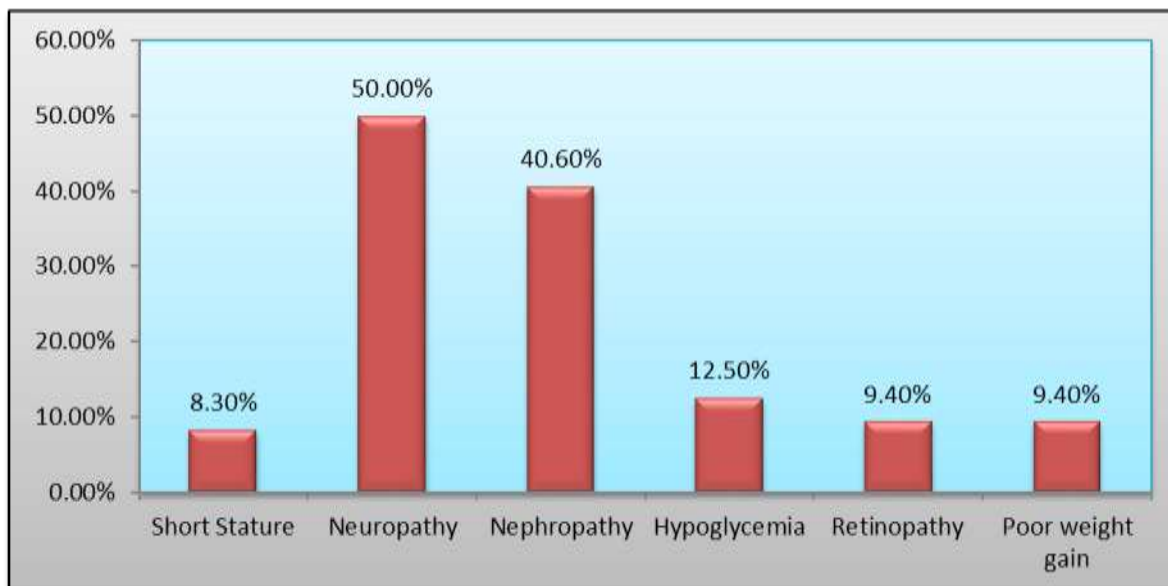

Figure 1. Complications among children with type 1 diabetes mellitus

According to the current HbA1c levels, there were 13 (76.5%) children with employed fathers have significantly good controlled DM (last reading HbA1c <7 mg/dl), 44 (88%) children with negative family history have significantly poor controlled DM (last reading HbA1c ≥7 mg/dl), and 74 (93.7%) children with retinopathy have significantly poor controlled DM (last reading HbA1c ≥7 mg/dl), with P=0.027, P=0.014, and P=0.02 respectively. (Table 3).

The association between having complications and other features of children was shown in table 4. There was a significant difference between family history of DM type 2 and having complications, P<0.001.

Table 3. Sociodemographic distribution of patients according to current HbA1c level

Parameter		Controlled DM (HbA1c.mg/dl)				P value
		Good (HbA1c <7)		Poor (HbA1c ≥7)		
		N	%	N	%	
Age Group	<10 years	1	5.9%	13	16.5%	0.17
	10 to 15 years	6	35.3%	38	48.1%	
	>15 years	10	58.8%	28	35.4%	
Gender	Male	6	35.3%	40	50.6%	0.25
	Female	11	64.7%	39	49.4%	
Father Occupation	Employed	13	76.5%	37	46.8%	0.027
	Not employed	4	23.5%	42	53.2%	
Father Education	> secondary school	4	23.5%	16	20.3%	0.76
	≤ secondary school	13	76.5%	63	79.7%	
Mother Occupation	Employed	3	17.6%	8	10.1%	0.37
	Not employed	14	82.4%	71	89.9%	
Mother Education	> secondary school	3	17.6%	15	19.0%	0.9
	≤ secondary school	14	82.4%	64	81.0%	
Family History of DM	No	6	12%	44	88%	0.014
	T1DM	6	46.2%	7	53.8%	
	T2DM	5	15.2%	28	84.3%	
Complications	No	4	23.5%	23	29.1%	0.64
	Yes	13	76.5%	56	70.9%	
Short Stature	No	15	88.2%	73	92.4%	0.56
	Yes	2	11.8%	6	7.6%	
Neuropathy	No	9	52.9%	39	49.4%	0.78
	Yes	8	47.1%	40	50.6%	
Nephropathy	No	13	76.5%	44	55.7%	0.11
	Yes	4	23.5%	35	44.3%	
Hypoglycemia	No	16	94.1%	68	86.1%	0.36
	Yes	1	5.9%	11	13.9%	
Retinopathy	No	13	76.5%	74	93.7%	0.02
	Yes	4	23.5%	5	6.3%	
Poor weight gain	No	15	88.2%	72	91.1%	0.71
	Yes	2	11.8%	7	8.9%	

Table 4. Association between having complications and sociodemographic features of children

Parameter		Complications				P value
		No		Yes		
		N	%	N	%	
Age Group	< 10 years	7	25.9%	7	10.1%	0.13
	(10to 15 years)	10	37.0%	34	49.3%	
	>15 years	10	37.0%	28	40.6%	
Gender	Male	12	44.4%	34	49.3%	0.67
	Female	15	55.6%	35	50.7%	
Father Occupation	Employed	15	55.6%	35	50.7%	0.65
	Not employed	12	44.4%	34	49.3%	
Father Education	> secondary school	6	22.2%	14	20.3%	0.83
	≤ secondary school	21	77.8%	55	79.7%	
Mother Occupation	Employed	2	7.4%	9	13.0%	0.43
	Not employed	25	92.6%	60	87.0%	
Mother Education	> secondary school	3	11.1%	15	21.7%	0.23
	≤ secondary school	24	88.9%	54	78.3%	
Family History of DM	No	18	36%	32	64%	<0.001
	Type 1 DM	9	69.2%	4	30.8%	
	Type 2 DM	0	0.0%	33	100%	

Discussion

T1DM has a high morbidity and mortality in children. The HbA1c test is the routine index of an average blood glucose level over the past 2-3 months. The test results offer important feedback to health care providers as well as to the parents [2,7]. This study included 96 children with T1DM. Females formed more than half of the sample, the mean HbA1c level at diagnosis was high for both females and males (10.95±3.19 and 10.74±2.97) mg/dl respectively with no significant association between age and HbA1c level, which can be explained as the HbA1c level reflect the glycemic control in the last three months at any age.

This is slightly differing from a longitudinal cohort study of T1DM pediatric patients in Bart Hospital/England [8], in which 52.6% of patients were male, the mean diagnostic age was 9.0±4.1 years. HbA1c level was differed markedly across age groups, with older patients experiencing greater deterioration and higher levels than their younger counterparts (p<0.001) [9].

Glycemic control, duration of diabetes, and age, are important critical factors contributing toward development of complications. Other risk factors may include family history (genetic predisposition). In this study, complications appeared among 71.9% of children, they were mainly neuropathy found among 50% of children, nephropathy in 40.6%, hypoglycemia in 12.5%, retinopathy found among 9.4%, poor weight gain found among 9.4% and short stature among 8.3% of those children. The Diabetes Control and Complications Trial (DCCT) stated clearly the importance of glycemic control through controlled HbA1c level and emphasized the ability of improved this control to prevent and/or decrease complications such as retinopathy, neuropathy, and nephropathy using a multidisciplinary approach in addition to targeted glycemic and HbA1c values [10]. This is in agreement with a retrospective analysis by the Department of Metabolic Diseases in Krakow, in which the percentages of diabetic complications were: diabetic retinopathy in 41.5%, polyneuropathy in 29%, nephropathy in 17%, cardiovascular autonomic neuropathy 8.7%, and coronary artery disease 7.1% of patients. (71.4%) [11].

The current study found an association between poor control DM and the development of complications, it was significantly found between HbA1c level and

retinopathy, this is expected as HbA1c variability predicts the establishment of diabetes pathological changes like retinopathy, early nephropathy, and vascular problems, in addition to the presence of other risk factors, in adolescents with T1DM. That is why minimizing long term fluctuations in glycemic level could provide additional possible protection against the development and progression of microvascular complications.

These facts are agreed with a prospective cohort study from 1990 to 2014 done on 1706 adolescents of less than 20 years of age, in which HbA1c was associated with early retinopathy in those patients after adjusting other risk factors, including diabetes duration, environmental factors, blood pressure, and lipids [12].

Current study found that family history of T1DM was positive in 13.5% and that of T2DM was among 34.4% of parents. There was a significant difference between family history of DM and having complications. Employed parents formed 63.6%, and majority of them with secondary school education or less (76.5%) children of employed parents have significantly good controlled DM (last reading HbA1c <7 mg/dl)

On the other hand, Andreasson et al, on their study to evaluate the parental involvement in blood glucose monitoring through interviews with parents in 10- to 15-year-old patients with T1DM, found that that encouraging parental involvement in glycemic monitoring may help to prevent the well-documented deterioration in glycemic control and adherence to treatment that may occurs in later on in adolescence. There were significant differences in the mean HbA1c values between the groups who had more educated and oriented parents, parental knowledge and involvement was significantly related to adherence to glycemic control (number of blood sugar concentrations checked per day) in both groups of children and adolescent patients [13].

In conclusion, the most common complication associated with DM in this study was neuropathy and nephropathy. Significant association was detected between high HbA1c and both negative family history of DM in patients and patients having unemployed fathers. Also, there is significant association between poorly controlled DM and the occurrence of retinopathy. There is significant association between positive family history of type 2 DM and the occurrence of complications.

Author contribution
Dr. Qasim: Data collection and results analysis. Dr. Tawfeeq: Writing and editing of manuscript.

Conflict of interest
None.

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