The Egyptian Journal of Hospital Medicine (October 2022) Vol. 89, Page 4754- 4761

Proportion And Determinants of Glycemic Control in Type 1 Diabetes Mellitus among Children and Adolescents Attending Assiut Health Insurance Clinic

Mahmoud A. Abdelaty, Faten M. Rabei, Mennatallah M. Abdelhakem*
Department of Public Health and Community Medicine, Faculty of Medicine Assiut University, Egypt
***Corresponding author:** Mennatallah Mostafa, **Mobile:** (+20) 0102124040, **E-Mail:** mennamostafa6206@gmail.com

ABSTRACT

Background: Long-term health issues associated with type 1 diabetes mellitus (T1DM), such as renal impairment, retinal affection, as well as heart and neurological conditions, can have an impact on a patient's quality of life. The degree of control of diabetes and its complications are known to be directly correlated, and achieving optimal blood glucose levels lowers the risk of long-term complications.

Objective: The aim of the present study is to evaluate the proportion of uncontrolled T1DM and factors that influence glycemic control in children and adolescents with T1DM in the Assiut Governorate of Egypt.

Patients and methods: A total of 500 participants with TIDM for at least three years, ranging in age from 3 to 18 were recruited. We conducted a thorough history taking that covered sociodemographic factors, disease-related factors, disease management plans, and the level of patient disease knowledge. All study participants had their body mass indexes evaluated. We divided the study participants into two groups; those with controlled T1DM and those without, based on the glycosylated haemoglobin (HbA1c) targets.

Results: The mean age was 13.56 (SD 3.49) years, and 52% of the study participants were female and 48% were males. Only 38% of participants lived in urban area, while 62% lived in rural area**.** Only16.8% of the studied diabetic children and adolescents had controlled T1DM while 83.2% had uncontrolled T1DM. Predictors for uncontrolled T1DM in children and adolescents were female gender, irregular treatment and poor level knowledge. **Conclusion:** Most of the diabetic children and teenagers in this study had uncontrolled T1DM. Poor knowledge about diabetes was the most risk factor for uncontrolled T1DM. Health education programs for T1DM patients are needed to achieve good glycemic control.

Keywords: Predictors, Children, Type 1 Diabetes Mellitus, glycemic control.

INTRODUCTION

Type 1 diabetes mellitus (T1DM) is a common chronic disease in children and adolescents. It is caused by insulin deficiency as a result of destruction of the insulin-producing beta cells in the pancreas. It accounts for 75%–80% of newly diagnosed diabetes in patients younger than 18 years [1].

Due to the fact that children need to constantly inject insulin and monitor their blood glucose levels, involvement of parents, lifestyle adaptation, and good communication with the treating physicians, nurses, and dieticians are essential. The responsibility for attaining the appropriate glycated hemoglobin (HbA1c) goal rests upon the children and their caregivers, with close and continuing support from the clinic [2].

T1DM carries a long-term burden of increased micro- vascular and macrovascular complications. As the incidence of T1DM continues to rise, the load of microvascular complications will also in- crease and negatively influence the prognosis of young patients. Microvascular complications of diabetes include retinopathy which is the leading cause of blindness in working age people [3].

Here, in this work, we aimed to determine the proportion of uncontrolled T1DM predictors of glycemic control among children and adolescents with T1DM in Assiut Governorate-Egypt.

PATIENTS AND METHODS

Study setting and design

A cross-sectional study conducted on children and adolescents with type I DM attending Sidi-Galal Health Insurance Clinic in Assuit City in Upper Egypt**,** which provides health care to all diabetic children and adolescents from Assiut governorate during the period between 2017 and 2018.

Inclusion and exclusion criteria

All children and adolescents with a proven diagnosis of T1DM with 3 years' duration or more were eligible to participate in the study. Any patients with age less than 3 years old or more than 18 years old, and/ or with type 2 DM was excluded from the study.

Sample size calculation

The sample size was calculated using Epi-Info, version 7. Based on a previous study, the proportion of uncontrolled children and adolescents with T1DM was 50%, with a power of 80% and a confidence level of 95%. The sample needed for the study was estimated to be about 322 children and adolescents. To compensate for the dropouts, 20% was added, giving a final sample size of about 500 children and adolescents.

Received: 25/05/2022
Accepted: 02/08/2022

Methodology

We classified the participants in to two groups; Group I controlled T1DM and Group II with uncontrolled T1DM according to the target level of HgA1c for age, recommended by the American Diabetes association [4]. Body mass index (BMI), random blood sugar and glycosylated hemoglobin were assessed in all patients

Data were collected through interviewing questionnaires of patients or caregivers and medical record reviews. The questionnaire consisted of five sections:

1. Sociodemographic variables:

Personal data such as name, gender, and educational class were recorded. Sociodemographic data such as family size, crowding index, education, and occupation of both parents, and family income were also registered. These data were summed in a total socio-economic scale prepared by **Abdel-Tawab** [5], divided into three classes high class, middle class, and Low class. Other family factors were included, such as the family history of diabetes mellitus.

2. Lifestyle:

Diet (mainly sugar and carbohydrates –snacks), physical activity, and smoking.

3. Medical history of diabetes:

Including age of onset of diabetes, duration of disease, number of glucose monitoring, types of insulin, number of hypo/hyperglycemia attacks within the last 12 months, number of hospital admission in the last three years, and presence of comorbid disease and time of onset which is before or after diagnosis of diabetes, home care and follow up protocol.

4. Complications:

Acute: hypoglycemia, diabetic ketoacidosis (DKA), history of outpatient visits, emergency, or hospital admission, Knowledge of patient or caregiver. This assessment tool was divided into five main categories: General knowledge, risk factors, signs and symptoms, complications, and treatment and management. The score was designed to be the total number of points, 40 awarded for correct answers and zero for wrong or unsure responses. The scoring system was positive, which means that the greater the number of points, the greater the diabetes knowledge level.

Ethical Considerations

Our study was approved by the Ethical Review Committee Faculty of Medicine at Assiut University [IRB number 17101731]. Every guardian signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

Data collected was revised, entered, and cleaned, and then analysis was carried out using SPSS version 20. Quantitative variables were presented in terms of mean ± SD, and qualitative variables were expressed as frequency and percentage. Chi square test ($\chi 2$) and Fisher's exact test to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean and standard deviation (SD). Independent samples t-test was used to compare between two independent groups of normally distributed variables. Logistic regression model was calculated to identify the determinants of glycemic control. P value ≤ 0.05 was considered significant.

RESULTS

Baseline data of enrolled patients (table 1, figure 1):

Only16.8% of the studied diabetic children and adolescents had controlled T1DM, while 83.2% had uncontrolled T1DM. Baseline data revealed significant differences between both groups as regard age, age of diagnosis, social class, mother work and education, sex and education level. All other parameters showed no significant value.

Table (1): Baseline data of the enrolled patients

Socio-demographic characteristics	HbA1c				P-value
	Controlled (n= 74)		Uncontrolled (n= 366)		
	No.	%	No.	%	
Age (years)	12.31 ± 3.77		13.76 ± 3.47		0.001
Gender:					
Male	44	21.6	160	78.4	0.013
Female	30	12.7	206	87.3	
Residence:					
Urban	30	18.4	133	81.6	0.495
Rural	44	15.9	233	84.1	
Educational level:					
Kindergarten	5	33.3	10	66.7	
Primary	28	23.5	91	76.5	0.002
Preparatory	23	16.3	118	83.7	
Technical secondary	11	11.2	87	88.8	
General secondary	7	10.4	60	89.6	
Social class:					
Low	12	15.6	65	84.4	
Middle	32	11.7	241	88.3	0.001
High	30	33.3	60	66.7	
Father education:					
Illiterate/ Read & write	16	13.4	103	86.6	
Basic education	11	17.7	51	82.3	0.091
Secondary (general & technical)	24	14.5	141	85.5	
University/ Institute	23	24.5	71	75.5	
Mother education:					
Illiterate/ Read & write	22	12.4	156	87.6	
Basic education	11	17.5	52	82.5	0.011
Secondary (general & technical)	25	17.5	118	82.5	
University/ Institute	16	28.6	40	71.4	
Mother work:					
Housewife	57	15.0	322	85.0	0.011
Working for cash	16	28.6	40	71.4	
No. of family members:					
2 – 5	20	18.3	89	81.7	0.386
6 – 7	35	17.7	163	82.3	
> 7	19	14.3	114	85.7	
Family history of type 1 DM:	24	18.0	109	82.0	0.651
Age at diagnosis/years:					
< 6	39	24.1	123	75.9	0.008
6 – 9	20	12.5	140	87.5	
> 9	15	12.7	103	87.3	

Data expressed as frequency (percentage), mean (SD). *P* value was significant if ≤0.05. DM: diabetes mellitus; HbA1C: glycosylated hemoglobin.

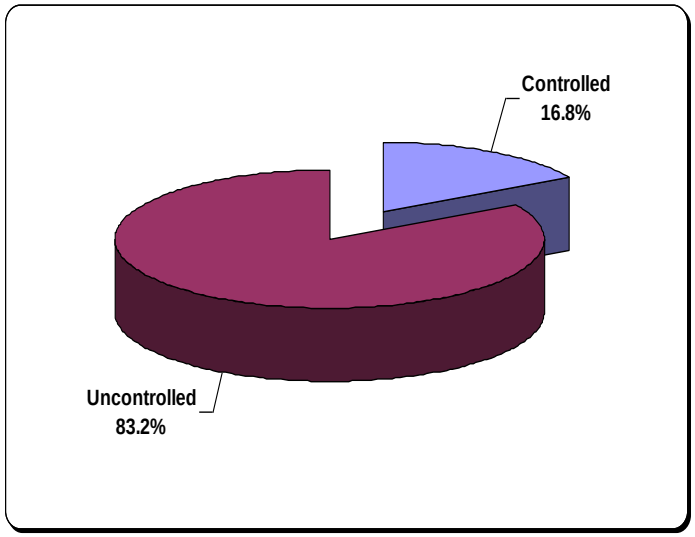

Figure (1): Control status among studied diabetic children and adolescents attending Sidi-Galal Health Insurance Diabetes Clinic

Current antidiabetic medications among enrolled patients (table 2): Both groups had significant differences as regard diet regimen, physical activity and regularity of therapy but having a glucometer and frequency of blood glucose measurements showed no significant differences between both groups.

Table (2): Current antidiabetic medications among enrolled patients

Current management	Controlled (n=74)		Uncontrolled (n=366)		P-value
	No.	%	No.	%	
Diet regimen:	46	21.1	172	78.9	0.017
Physical activity:	42	22.0	149	78.0	0.011
Regularity of treatment:	68	19.4	283	80.6	0.004
Having glucometer:	70	17.5	329	82.5	0.204
Frequency of blood glucose measurement by Glucometer:					0.092
Once daily or more	23	20.2	91	79.8	
Once weekly or more	31	18.3	138	81.7	
Once every 2 weeks	9	22.0	32	78.0	
I don't measure unless I tired	11	9.5	105	90.5	

Data expressed as frequency (percentage). *P* value was significant if ≤0.05.

Frequency of complications and hospital stay in enrolled patients (table 3): Frequency of symptoms of hypoglycemia and hyperglycemia was significantly higher among those with uncontrolled DM.

Table (3): Frequency of complications and hospital stay in enrolled patients

Symptoms & complications	HbA1c				P-value
	Controlled (n= 74)		Uncontrolled (n= 366)		
	No.	%	No.	%	
Occurrence of hypoglycemia symptoms in last 12 months					0.036
0	23	20.0	92	80.0	
1 – 3	26	21.5	95	78.5	
4 – 6	13	12.9	88	87.1	
> 6	12	11.7	91	88.3	
Occurrence of symptoms of hyperglycemia in last 12 months					0.001
0	15	30.6	34	69.4	
1-5	33	22.4	114	77.6	
6 – 12	13	11.9	96	88.1	
> 12	13	9.6	122	90.4	
Hospital admission/ 12 months:					0.059
0	51	20.5	198	79.5	
1 – 3	17	11.2	135	88.8	
> 3	6	15.4	33	84.6	

Data expressed as frequency (percentage). *P* value was significant if ≤0.05.

Class of BMI among enrolled patients (table 4): There was statistically significant difference between both groups controlled and uncontrolled as regard the BMI of studied diabetic children and adolescents (P-value 0.049), with the highest controlled among overweight participants 29.2%.

Table (4): Class of body mass index among enrolled patients

Class of body mass index	Glycosylated hemoglobin				P-value
	Controlled		Uncontrolled		
	No.	%	No.	%	
Underweight	12	20.3	47	79.7	0.049*
Normal	48	14.6	280	85.4	
Overweight	14	29.2	34	70.8	
Obese	0	0.0	5	100.0	

Data expressed as frequency (percentage). *P* value was significant if ≤0.05.

Levels of knowledge with control status among studied patients (table 5):

It was found that 16.8% of studied diabetic children and adolescents had poor knowledge about their disease and 97.6% of them had uncontrolled type I diabetes mellitus, while 55.2% had good knowledge with highest percent of controlled among them 22.5% with significant differences between both groups ($p<$ 0.001).

Table (5): Levels of knowledge with control status among studied patients

Level of Knowledge	HbA1c				Total		P-value*
	Controlled		Uncontrolled				
	No.	%	No.	%	No.	%	
Poor	2	2.4	82	97.6	84	16.8	0.001
Satisfactory	10	12.5	70	87.5	80	16.0	
Good	62	22.5	214	77.5	276	55.2	

* Chi-square for trend test was used

Predictors of uncontrolled diabetes mellitus (table 6): Based on the current study, the following were predictors for uncontrolled DM in children; female gender, irregular treatment and poor level knowledge were associated with increased risk of uncontrolled type.

Table (6): Predictors of uncontrolled diabetes mellitus

Variable	Beta	P-value	OR	95% C.I. for EXP (B)	
				Lower	Upper
Female gender (Ref: Male)	**0.779**	**0.017***	**2.180**	**1.149**	**4.135**
Social class: (Ref: High)	**0.023***				
Low	-0.181	0.800	0.835	0.207	3.374
Middle	0.894	0.075	2.446	0.914	6.545
Irregular treatment (Ref: Regular)	**1.003**	**0.048***	**2.725**	**1.007**	**7.376**
Level of knowledge: (Ref: Good)	**0.040***				
Poor	**1.964**	**0.011***	**7.131**	**1.557**	**32.651**
Satisfactory	0.266	0.529	1.304	0.570	2.986
Age: (Ref: ≤ 12 years)	0.634				
13 - < 16	-0.154	0.844	0.858	0.186	3.953
≥ 16	0.339	0.553	1.403	0.459	4.292
Educational level:	0.733				
Primary	0.286	0.700	1.332	0.310	5.713
Preparatory	0.156	0.863	1.169	0.198	6.901
Technical secondary	0.250	0.816	1.284	0.156	10.566
General secondary	0.924	0.405	2.519	0.286	22.160
Mother education:	0.906				
Illiterate/ Read & write	0.123	0.863	1.131	0.278	4.610
Basic education	0.124	0.865	1.132	0.270	4.752
Secondary	0.332	0.552	1.394	0.466	4.171
Housewife	-0.082	0.889	0.921	0.290	2.928
Age at diagnosis:	0.354				
6 – 9	0.555	0.154	1.743	0.812	3.742
> 9	0.218	0.647	1.244	0.488	3.170
No diet regimen	0.362	0.288	1.437	0.737	2.801
1-3 insulin injection times	0.394	0.210	1.482	0.801	2.744
Physically inactive	-0.449	0.098	0.638	0.375	1.086
BMI:	0.831				
Underweight	0.315	0.583	1.371	0.445	4.223
Normal	0.234	0.585	1.264	0.545	2.927
Hospital admission:	0.370				
1 – 3	0.296	0.405	1.345	0.669	2.704
> 3	-0.543	0.369	0.581	0.177	1.901

OR: odd's ratio

DISCUSSION

Since T1DM is a chronic condition, patients and their caregivers must adhere to treatment plans perfectly, be closely monitored by a variety of specialists, and have a complete understanding of the illness and its complications. The achievement of treatment objectives depends in large part on parents. This research was done to find out how many diabetic kids and teens had glycemic control and what factors were associated with glycemic control in kids and teens with T1DM.

The proportion of uncontrolled TIDM in our study according ADA target HbA1c level <7 5% [4], was 83.2 %, which is higher than the proportion in a study conducted in 2012 by **Mohammad *et al.* [6],** this study was done over 415 diabetic children and adolescents, in which 45.8% of the study participants had poor glycemic control.

This discrepancy was attributed to explained by the difference in the study settings and the quality of service between the both studies as part of the other study was done at the Pediatric Endocrinology Clinic of Assiut University Children Hospital.

The proportion of uncontrolled type I DM among children and adolescents reported in studies from Arab nations is consistent with our study. Approximately 76% of the studied children and adolescents had uncontrolled type I DM according to HbA1c level, which was quite similar to our findings. This finding was reported in a cross sectional study in Sudan by **Taha *et al.* [7]** in 2018 done with over 100 Sudanese children with T1DM aged from (1-18).

In a different study [8] conducted in Jordan with 263 participants under the age of 18 who had been diagnosed with T1DM for at least a year, the proportion of uncontrolled T1DM in children and adolescents was 79.1%, which is very similar to our findings.

A 2017 hospital-based cross-sectional study [9] of 76 children and adolescents in Cameron, Africa, found that 76% of the children and adolescents studied had uncontrolled T1DM, which is quite similar to our findings and concurs with findings from earlier studies [10-13].

In our study there was significant relation between the gender of the diabetic children and adolescents and the glycemic control, multiple variant logistic regression showed that, compared to males, females were more likely to have uncontrolled T1DM odd's ratio 2.18 (95% CI 1.149– 4.135) which differs from results of **Mohammad *et al.* [6]** who found no relation between glycemic control and gender.

These findings conflict with those of **Nelyon *et al's*** meta-analysis [13]. We discovered that female patients had a significantly higher percentage of poor glycemic control than male patients; **Setoodeh *et al.* [14]** also noted this finding, and **Danne *et al.* [15]** discovered higher HbA1C in females, attributing this finding to females' higher rates of depression and psychological issues with findings from earlier research [10-13].

Furthermore, susceptibility of females to poor glycemic control during adolescence may be attributed to the high fat content of their bodies with subsequent increase in adipocytokines as leptin and adiponectin which decreases insulin sensitivity [16].

In our study, the participant age was found to be significantly different between both groups controlled and uncontrolled. However in the multivariate logistic regression analysis, age and educational level were not found to be significant predictors for glycemic control.

Patients with poor control had significantly higher mean of age than the group with good control. Furthermore, stratification of patients according to the age showed that glycemic control decreases with advancement of the age; this result is supported by several studies [6,17,18].

According to **Vanelli *et al.* [19]** who studied children and adolescents with diabetes, regardless of insulin regimen, older age was linked to a higher mean HgA1c and a lower likelihood of achieving HgA1c in the target range. The reason for this is that adolescents typically have poorer glycemic control than younger kids or adults with diabetes [20], Puberty brings about significant changes in physiology, such as the acceleration and slowing of somatic growth, the emergence of secondary sexual traits, and the beginning of reproductive capacity [20-21].

Additionally, exposure to stressful circumstances related to puberty may result in poor glycemic control by stimulating the autonomic nervous system and causing hyperglycemia [22]. The rapid biological changes of puberty, in addition to the difficulty of adjusting to a way of life that necessitates self-management of dietary practices, exercise behaviors, and insulin adjustment, have been linked to poor control in adolescents [23].

In line with findings by **Mohammad *et al.* [6]** who discovered that higher level of education of the mother and father was associated with higher rate of good glycemic control than lower levels of education, the results of this study show that higher level of education of the mother and father were associated with higher rate of good glycemic control than lower levels of education.

One of the major findings of our study is the significant association between the children and adolescents social class and their glycemic control, which agrees with study conducted by **Taha *et al.* [7]** in Sudan, found that there was a significant relationship between socioeconomic status and glycemic control.

In a multicenter study by **Gesuita *et al.* [11]** in Italy to find the role of socioeconomic status and clinical factors on HbA1c in children and adolescents with type 1 diabetes, found that a lower social class was associated with poor metabolic control which agrees with our results.

In contrast to our study, **Mohammad *et al.* [6]** in a study conducted in Assiut university-Upper Egypt found no significant relation between the

socioeconomic status and the glycemic control. Also **Eliadarous** [24] was not able to detect any correlation between the parents' incomes and glycemic control of diabetic children in Sudan.

Poor glycemic control in children from low socioeconomic backgrounds may be caused by a number of factors, including high rates of parental illiteracy. Beyond the direct impact on good health care, illiteracy may also have an impact on the father's ability to earn enough money to support the family, including health care, and obstruct good financial support for children with diabetes. But this subpar glycemic control lowers the children's quality of life and raises their risk of diabetic complications [25].

In the current study, BMI was not found to be a significant factor for glycemic control. The correlation between BMI and metabolic control was controversial in several studies [26, 27]. In our study, this could be explained by the presence of other confounding factors in the group of low BMI as the short duration of the disease and younger age of the patients and the cross sectional design of the study.

In our study the irregular treatment was associated with increased risk of uncontrolled DM which agrees with different studies [11, 12]. Also, we found that poor level of knowledge was associated with increased risk of uncontrolled type 1 DM. in line with this, **Beck *et al.*** [28] who found a significant relationship between diabetes knowledge and glycemic control. In contrast, **Santos *et al.*** [29], saw no such relationship.

In our study there was no significant effect of frequency of blood glucose monitoring on glycemic control. In contrast to other studies [6, 30] found that the glycemic control was significantly higher in patients with daily glucose checking than those with weekly or monthly glucose checking.

The frequent glucose testing will allow patients to identify, prevent, or manage episodes of hypo- and hyperglycemia and avoid missing the marked day-to-day excursions in plasma glucose from high to low values that characterize T1DM in children.

The cross sectional design of this study may have contributed to the lack of a statistical significance (P value was 0.092), and hence, we hypothesize that there would be a significant correlation in a future prospective study with a larger sample size. We anticipate that poor compliance for frequent testing of blood glucose is influenced by no insurance coverage of blood glucose test strips in Egypt. Other causes for infrequent testing may be behavioral including negligence of testing blood glucose.

In our study, 28.9% of hospital admission among the study participants was due to diabetic ketoacidosis, and 55% were due to hyperglycemia, in contrast to results by **Taha *et al.*** [7] **and Eliadarous *et al.*** [24] in Sudan in which 80% of studied participants were admitted to hospital for diabetic ketoacidosis.

Regarding occurrence of hypoglycemia, 75% of our study participants exposed to hypoglycemia in last 12 months with is higher than in a study by **Raju *et al.*** [31] involving nocturnal plasma glucose measurements every 15 minutes in T1DM, glucose levels were <70 mg/dL in 57% (12 of 21) of the patients. These findings can be explained by differences in health systems and follow up measures and early seeking medical advice in our population.

CONCLUSION

Our results revealed that proportion of uncontrolled DM among the studied patients was fairly high. Female sex, irregular treatment and lack of knowledge were the predictors for uncontrolled DM. Thus, planning of future interventions to help patients and the healthcare providers to achieve good glycemic control to prevent complications are warranted.

Conflict of interest: The authors declare no conflict of interest.
Sources of funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
Author contribution: Authors contributed equally in the study.

REFERENCES

1. **International Diabetes Federation (2015):** IDF Diabetes Atlas. 7th ed. Brussels, Belgium: International Diabetes Federation; pp. 1-140. Available at: https://www.diabetesatlas.org/upload/resources/previous/files/7/IDF%20Diabetes%20Atlas%207th.pdf
2. **American Diabetes Association (2018):** Children and adolescents: standards of medical care in diabetes – 2018. Diabetes Care, 41(1):126-36.
3. **Kamaleldeen E, Mohammad H, Mohamed E *et al.* (2018):** Microvascular complications in children and adolescents with type 1 diabetes mellitus in Assiut governorate, Egypt. Egyptian Pediatric Association Gazette, 66(4):85-90.
4. **Silverstein J, Klingensmith G, Copeland K *et al.* (2005):** Care of children and adolescents with type 1 diabetes: A statement of the American diabetes association. Diabetes Care, 28:186-212.
5. **Abd El-Tawab A (2012):** Family socio-economic status scale. Journal of Faculty of Education, Assiut University, 28(1):45-53.
6. **Mohammad H, Farghaly H, Metwalley K *et al.* (2012):** Predictors of glycemic control in children with Type 1 diabetes mellitus in Assiut-Egypt. Indian Journal of Endocrinology and Metabolism, 16(5):796-802.
7. **Taha Z, Eltoum Z, Washi S (2018):** Predictors of Glucose Control in Children and Adolescents with Type 1 Diabetes: Results of a Cross-Sectional Study in Khartoum, Sudan. Open access Macedonian Journal of Medical Sciences, 6(11):2035-39.
8. **Niba L, Aulinger B, Mbacham W *et al.* (2017):** Predictors of glucose control in children and adolescents with type 1 diabetes: results of a cross-sectional study in Cameroon. BMC Research Notes, 10(1):1-9.
9. **Majaliwa E, Munubhi E, Ramaiya K *et al.* (2007):** Survey on acute and chronic complications in children and adolescents with type 1 diabetes at Muhimbili

National Hospital in Dar es Salaam, Tanzania. Diabetes Care, 30(9):2187-92.

10. **Ngwiri T, Were F, Predieri B *et al.* (2015):** Glycemic control in Kenyan children and adolescents with type 1 diabetes mellitus. International Journal of Endocrinology, 15:1-7.
11. **Gesuita R, Skrami E, Bonfanti R *et al.* (2017):** The role of socio-economic and clinical factors on HbA1c in children and adolescents with type 1 diabetes: an Italian multicentre survey. Pediatric Diabetes, 18(3):241-8.
12. **Clements S, Anger M, Bishop F *et al.* (2013):** Lower A1c among adolescents with lower perceived A1c goal: a cross-sectional survey. International Journal of Pediatric Endocrinology, 11(1):1-6.
13. **Neylon O, O'Connell M, Skinner T *et al.* (2013):** Demographic and personal factors associated with metabolic control and self-care in youth with type 1 diabetes: a systematic review. Diabetes/Metabolism Research and Reviews, 29(4):257-72.
14. **Setoodeh A, Mostafavi F, Rabbani A *et al.* (2011):** Female sex as a risk factor for glycemic control and complications in Iranian patients with type one diabetes mellitus. Iranian Journal of Pediatrics, 21(3):373-7.
15. **Danne T, Mortensen H, Hougaard P *et al.* (2001):** Persistent differences among centers over 3 years in glycemic control and hypoglycemia in a study of 3,805 children and adolescents with type 1 diabetes from the Hvidøre Study Group. Diabetes Care, 24(8):1342-7.
16. **De Block C, De Leeuw I, Van Gaal L (2005):** Impact of overweight on chronic microvascular complications in type 1 diabetic patients. Diabetes Care, 28(7):1649-55.
17. **Mounir G, Abolfotouh M (2005):** Psychosocial characteristics of diabetic students at sporting student hospital in Alexandria. J Egypt Public Health Assoc., 80:475-93.
18. **Urbach S, LaFranchi S, Lambert L *et al.* (2005):** Predictors of glucose control in children and adolescents with type 1 diabetes mellitus. Pediatric Diabetes, 6(2):69-74.
19. **Vanelli M, Cerutti F, Chiarelli F *et al.* (2005):** Nationwide cross-sectional survey of 3560 children and adolescents with diabetes in Italy. Journal of Endocrinological Investigation, 28(10):692-9.
20. **Mortensen H, Hougaard P, Hvidøre Study Group on Childhood Diabetes (1997):** Comparison of metabolic control in a cross-sectional study of 2,873 children and adolescents with IDDM from 18 countries. Diabetes Care, 20(5):714-20.
21. **Lane P, Snelling D, Hollman A *et al.* (2001):** Puberty permits increased expression of renal transforming growth factor-β1 in experimental diabetes. Pediatric Nephrology, 16(12):1033-9.
22. **Moussa M, Alsaeid M, Abdella N *et al.* (2005):** Social and psychological characteristics of Kuwaiti children and adolescents with type 1 diabetes. Social Science & Medicine, 60(8):1835-44.
23. **Cook J, Hoffman R, Stene M *et al.* (1993):** Effects of maturational stage on insulin sensitivity during puberty. The Journal of Clinical Endocrinology & Metabolism, 77(3):725-30
24. **Eliadarous H (2017):** Exploring the impact of diabetes in Sudan: Out-of-pocket expenditure and social consequences of diabetes on patients and their families. Dept of Public Health Sciences, pp. 1-59. http://hdl.handle.net/10616/45956
25. **DeWalt D, Hink A (2009):** Health literacy and child health outcomes: a systematic review of the literature. Pediatrics, 124(3):265-74.
26. **Cardwell C, Patterson C, Allen M *et al.* (2005):** Diabetes care provision and glycaemic control in Northern Ireland: a UK regional audit. Archives of Disease in Childhood, 90(5):468-73.
27. **Hanberger L, Samuelsson U, Lindblad B *et al.* (2008):** A1C in children and adolescents with diabetes in relation to certain clinical parameters: the Swedish Childhood Diabetes Registry Swediabkids. Diabetes Care, 31(5):927-9.
28. **Beck J, Zhang Y, Shay C *et al.* (2015):** Diabetes knowledge in young adults: Associations with hemoglobin A1C. Families, Systems, & Health, 33(1):28-35.
29. **Santos F, Bernardo V, Gabbay M *et al.* (2013):** The impact of knowledge about diabetes, resilience and depression on glycemic control: a cross-sectional study among adolescents and young adults with type 1 diabetes. Diabetology & Metabolic Syndrome, 5(1):1-5.
30. **Haller M, Stalvey M, Silverstein J (2004):** Predictors of control of diabetes: monitoring may be the key. The Journal of Pediatrics, 144(5):660-1.
31. **Raju B, Arbelaez A, Breckenridge S *et al.* (2006):** Nocturnal hypoglycemia in type 1 diabetes: an assessment of preventive bedtime treatments. The Journal of Clinical Endocrinology & Metabolism, 91(6):2087-92.