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Original Article

Depression and Eating Disorders in Children with Type 1 Diabetes

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Abstract ***Objective*: This study investigates depression and eating disorders in children with type 1 diabetes mellitus (DM) and aims to determine the associated factors. ***Methods:*** This cross-sectional study was conducted with 149 children with type 1 DM aged 10-17 years. The Children's Depression Inventory and Diabetes Eating Problem Survey-Revised were administered, anthropometric measurements were taken, and certain biochemical results were evaluated. ***Results:*** The mean age of the children was 13.42±2.31 years. The children who did not use carbohydrate counting had higher depression scores and lower eating disorder scores than those who did and depression and eating disorder scores were lower in children who used insulin pumps than in those who did not. A one unit increase in the children's HbA1c levels caused a three unit increase in eating disorder scores and 1.3 times greater risk of depression. ***Conclusions:*** Nutritional, biochemical and psychiatric evaluation, and monitoring are recommended when providing diabetes control among children.

Key words Children; Depression; Eating disorder; HbA1c; Type 1 diabetes mellitus

Introduction

Type 1 diabetes mellitus (DM) is characterised by a deficiency in insulin production in the body. The causes of type 1 DM are unknown and there are no valid data concerning the prevention of this serious disease.[1] The incidence of type 1 DM in children is increasing in Europe every day. It is predicted that the number of new cases will double in children younger than 5 years and will increase by 70% in children younger than 15 years by 2020.[2]

Providing glycaemic control by means of exogenous administration of insulin is the prevalent treatment of this disease.[1] As a result, certain factors, such as insulin dependence, especially at a young age, the maintenance/protection of body weight,[3] fear of hypoglycaemia,[4] and certain eating patterns to prevent hypoglycaemia lead to an increased risk of anxiety, depression,[5-7] and disordered eating behaviour in individuals.[8] Furthermore, according to a recent meta-analysis, disordered eating behaviour is more common in adolescents with type 1 DM compared with peers and is associated with poorer glycaemic control.[9]

The prevalence of depressive symptoms in children and adolescents has been found to be 30.0%,[10] and associated with elevated glycated haemoglobin (HbA1c) levels[10-12] and poorer metabolic control.[13] Furthermore, an increased incidence of depression in children with eating disorders

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has been reported.[5]

Some methods, such as the use of insulin pumps[14,15] and carbohydrate counting,[16] can be used to provide metabolic control. Studies have shown that carbohydrate counting and medical therapy together could reduce HbA1c and hypoglycaemia[17,18] and improve quality of life.[18] Likewise, insulin pump therapy has been found to have an effect on reducing HbA1c levels 3-6 months after starting treatment.[19]

Although both carbohydrate counting and insulin pump therapy are associated with a reduction in HbA1C, there are limited data examining the psychosocial effects of the use of these methods and studies on the effect of carbohydrate counting on depression are contradictory.[20] Consequently, in this study we aimed to assess disordered eating and depression scores according to carbohydrate counting and insulin pump usage, as well as to detect the prevalence of disordered eating behaviour and depression in our study group and determine associated factors.

Methods

Sample and Procedure

The sample of the study consisted of 149 children (81 male, 68 female) with type 1 DM, aged 10-17 years, who were admitted to the Department of Paediatric Endocrinology of a university hospital in Ankara, Turkey between February and May 2016. The participants were selected on the basis that they did not have another chronic disease (cardiovascular disease, polycystic ovary syndrome, thyroid dysfunction, asthma, etc.) and received no hormone treatment or medication.

Data Collection

Data were collected using a questionnaire prepared by the researchers. The questionnaire was divided into six sections:

i. Demographic information (14 questions)
ii. Health information (carbohydrate counting, use of insulin pump, etc.) (5 questions)
iii. Children's depression inventory (27 items)
iv. Diabetes eating problem survey-revised (DEPS-R) (16 items)
v. Anthropometric measurements (5 items)
vi. Biochemical results (3 data)

Ethical approval for the study was obtained from the Istanbul Medipol University Non-Interventional Clinical Studies Ethics Board (number: 10840098-604.01.01-E. 2296). Oral and written informed consent was obtained from the children's parents before they were included. The participants were informed that their information would be kept confidential and used only for scientific purposes. Each participant signed a voluntary participation form and completed the questionnaires. All procedures were in line with the Helsinki Declaration. The questionnaire, which took approximately 25 minutes to complete, was administered to the volunteering children's parents by the researchers.

Anthropometric Measurements

Anthropometric measurements, including weight (kg), height (cm), and waist circumference (cm) were measured by well-trained investigators, using standard measurement protocols. Height was measured with a stadiometer to the nearest 0.1 cm. Waist circumference was measured at the mid-point, above the iliac crest, and below the lowest rib margin at minimum respiration, using a flexible tape to the nearest 0.1 cm.[21,22] The children were weighed using a body composition analyser (TBF-300A, Body Composition Analyzer) to the nearest 0.1 kg. Body fat mass (kg) and body fat percentage (%) were also obtained using this analyser.[23] Weight and height were used to calculate the body mass index (BMI), calculated as weight (kg) divided by height squared (m^2). BMI for age Z-scores (BMI *z*-score) were calculated using WHO AnthroPlus software.[24]

Biochemical Results

The fasting blood glucose, fasting insulin, and HbA1c parameters of the children, which are routinely analysed by the biochemistry service of hospital, were evaluated.

Instruments

Children's Depression Inventory

The Children's Depression Inventory (CDI) is used to detect depressive symptoms in children. This scale was developed by Kovacs[25] and validated for Turkey in a study conducted by Öy.[26] It consists of 27 items and the child is asked to choose the most appropriate of three statements describing their symptoms over the previous 2 weeks. Each statement was scored from 0 to 2 depending on the severity of the depressive symptom. The scores were added to give a final score (0-54). Higher scores indicate an increase in the severity of depression. Scores of 19 or above identify potentially clinically depressed children. The validity and

reliability value of the scale is 0.80.[26] In this study, Cronbach's alpha was found to be 0.898, which was considered acceptable.

Diabetes Eating Problem Survey-Revised

The Diabetes Eating Problem Survey-Revised (DEPS-R) is a DM-specific self-report scale for eating disorders. The original instrument consists of 28 items and is used to determine DM-specific eating disorders in adults.[27] It has recently been revised to create an instrument for the paediatric population, comprising a brief 16-item version, used by Markowitz et al in 2010. The DEPS-R can be completed in less than 10 min and has demonstrated good psychometric properties. Items are scored on a Likert scale from 0 (never) to 5 (always) and the score range is 0-80. A higher score indicates more disturbed eating behaviour and greater pathology. The validity and reliability value of the scale is 0.860.[28] The DEPS-R was used to evaluate eating disorders in the children with type 1 DM in this study, with an acceptable Cronbach's alpha of 0.850.

Statistical Analyses

The Statistical Package for the Social Sciences (version 15.0) software was used for all analyses. Quantitative data were analysed using visual (histogram and probability plots) and analytical methods (Kolmogorov-Smirnov and Shapiro-Wilk tests) to determine whether the data were normally distributed. The mean and standard deviation values of age, anthropometric measurements, body composition, biochemical findings, and CDI and DEPS-R scores of the children were obtained using *t*-tests for parametric data and the Mann-Whitney U test for nonparametric data. Correlations were calculated using the Spearman or Pearson test. Independent effects of the different factors on the eating disorder score were evaluated using a multivariate linear regression model. The goodness of fit of the multiple logistic regression models was assessed using the Hosmer-Lemeshow test. Odds ratios and 95% confidence intervals were presented. A p-value of less than 0.05 was considered to be statistically significant.

Results

General Characteristics

The mean age of the children was 13.42±2.31 years and they were diagnosed with DM at a mean age of 8.52±2.96 years; 30.2% of the children had DM in their family history. In terms of treatment, 65.1% of the children had been using carbohydrate counting for an average of 26.87±25.62 months and 16.1% of the children had been using an insulin pump for an average of 18.38±20.74 months.

Evaluation of Health and Biochemical Status

The means of fasting blood glucose and HbA1c of participants were 191.09±87.36 mg/dL and 9.03±2.00%, respectively (Table 1). Fasting blood glucose (mg/dL), serum insulin, and HbA1c (%) levels were statistically similar in both genders. There was no statistically significant difference in the use of carbohydrate counting and insulin pump duration according to gender (p>0.05) (Table 1).

In all, 11.9% of the participants skipped insulin pump usage. More than half of the children (68.4%) thought that their daily life was inhibited because of DM. Some of the children had difficulty using the insulin pump (39.0%), following up blood glucose (28.0%), adhering to the recommended nutrition programme (27.1%), and exercising regularly (5.9%). In terms of adherence to the recommended nutrition programme, the children could not eat meals when they wanted (51.7%), or as they wished (33.9%), and they

Table 1 Evalution of general characteristics and biochemical findings of the children by gender

Variables	Boys (n:81) $\overline{\chi}$±SD (Min-Max)	Girls (n:68) $\overline{\chi}$±SD (Min-Max)	t	p
Age (years)	13.56±2.17 (10-17)	13.26±2.47 (10-17)	0.795	0.428
Age diagnosed with diabetes (year)	8.72±3.03 (2-15)	8.28±2.88 (1.5-16)	0.892	0.374
Carbohydrate counting duration (month)	26.56±26.81 (1-120)	27.19±24.61 (1-120)	-0.119	0.905
Insulin pump usage duration (month)	22.40±16.88 (2-48)	14.72±23.94 (2-66)	0.840	0.411
zBMI (SDS)	0.31±1.05 (-2.22-2.68)	0.52±0.98 (-1.38-2.80)	-1.223	0.223
Biochemical Findings				
Fasting blood glucose (mg/dL)	193.25±94.35 (57-474)	188.43±78.57 (73-392)	0.332	0.741
Serum insulin (μIU/mL)	2.93±1.80 (1.02-6.10)	2.97±2.11 (0.20-7.27)	-0.500	0.961
HbA1c (%)	9.07±1.97 (5.5-15.0)	8.98±2.04 (5.80-15.40)	0.282	0.778

failed to use carbohydrate counting (10.2%), or to wait for a while after using the insulin pump (4.2%).

The eating disorder and depression scores of the children are given in Table 2. There was no statistically significant difference between the eating disorder scores of boys and girls (11.19±6.75 and 11.76±6.97, respectively) (p>0.05). However, there was a statistically significant difference between the eating disorder scores of the children using (18.94±11.84) or not (26.34±10.27) carbohydrate counting and using (16.16±13.76) or not (22.56±11.19) an insulin pump (p<0.05) (Table 2).

In all, 11.4% of the children had a depression score <19. There was no statistically significant difference between the depression scores of boys and girls (21.49±11.49 and 21.57±12.30, respectively) (p>0.05). The children who did not use carbohydrate counting (13.63±7.14) had higher depression scores than who did (10.28±6.40) (p<0.05). Similarly, depression scores were lower in those using insulin pumps than not (8.58±5.59 and 12.00±6.93, respectively) (p<0.05) (Table 2).

The results of the multiple linear regression analysis between demographic characteristics, DM treatment methods, diagnostic criteria, and associated factors for DM of the participants and eating disorder scores are shown in Table 3. The HbA1c levels and waist circumference of the children had significant effects on their eating disorder scores. HbA1c levels had the greatest effect: a one unit increase in the children's HbA1c levels caused a three unit increase in the eating disorder score.

The effects of some risk factors on the depression status of the children are given in Table 4. A one unit increase in the children's HbA1c levels increased the risk of depression 1.3 times (p<0.05). The age at which the children were diagnosed with DM (year) and body fat mass (kg) did not

Table 2 Eating disorder and depression scores of the children according to use carbohydrate counting and insulin pump

	Scores					
	Eating disorder			**Depression**		
	$\overline{\chi}$±SD (Min-Max)	**t**	**p**	**$\overline{\chi}$±SD (Min-Max)**	**Z**	**p**
Gender						
Boys (n:81)	11.19±6.75 (4-58)	-0.041	0.967	21.49±11.49 (2-36)	0.795	0.553
Girls (n:68)	11.76±6.97 (0-37)			21.57±12.30 (4-52)		
Using Carbohydrate Counting						
Yes (n:97)	18.94±11.84 (4-53)	-3.799	**0.000***	10.28±6.40 (1-36)	1.645	**0.009***
No (n:52)	26.34±10.27 (7-58)			13.63±7.14 (0-37)		
Using Insulin Pump						
Yes (n:24)	16.16±13.76 (4-52)	-2.466	**0.015***	8.58±5.59 (2-27)	1.620	**0.001***
No (n:125)	22.56±11.19 (4-58)			12.00±6.93 (0-37)		

*p<0.05

Table 3 Effects of some properties on DEPS-R scores

Variables	**B**	**SE**	**Beta**	**t**	**p**	**95 % CI**	
Age (year)	-0.049	0.432	-0.010	-0.113	0.910	-0.903	0.806
Gender	1.388	1.542	0.060	0.900	0.370	-1.661	4.437
Age diagnosed with diabetes (year)	-0.104	0.297	-0.027	-0.351	0.726	-0.691	0.483
Using carbohydrate counting	0.613	1.885	0.025	0.325	0.746	-3.115	4.341
Using insulin pump	3.853	2.207	0.121	1.746	0.083	-0.510	8.217
HbA1c (%)	3.103	0.448	0.534	6.923	**0.000***	2.217	3.989
Waist circumference (cm)	0.345	0.108	0.286	3.178	**0.002***	0.130	0.559
Body fat mass (kg)	0.029	0.107	0.021	0.270	0.788	-0.182	0.240

R^2 = 0.451, (*p<0.05), β: Coefficient of regression, SE: Standart error of mean

correlate with depression risk. However, a one unit increase in the weight of the children increased depression prevalence risk 1.04 times. This result was found to be borderline significant (p=0.056) (Table 4).

Table 4 Effects of some risk factors on depression status of the children

Variables	OR	95 % CI		p
Age diagnosed with diabetes (year)	1.066	0.891	1.276	0.486
Weight (kg)	1.045	0.999	1.094	0.056
Body fat mass (kg)	0.994	0.929	1.065	0.874
HbA1c (%)	1.300	1.005	1.681	**0.045***

*p<0.05

The correlation of the DEPS-R and depression scores with HbA1c (%) levels is shown in Figure 1. Positive correlations were found between DEPS-R scores and HbA1c (%) (r=0.605, p=0.000) (Figure 1A), depression scores and HbA1c (%) (r=0.597, p=0.000) (Figure 1B), and DEPS-R scores and depression scores (r=0.714, p=0.000) (Figure 1C).

Discussion

Diabetic individuals are an important risk group in terms of psychological problems, such as depression, anxiety, and eating disorders.[11,29] In this study, we aimed to investigate depression and eating disorder scores in children with type

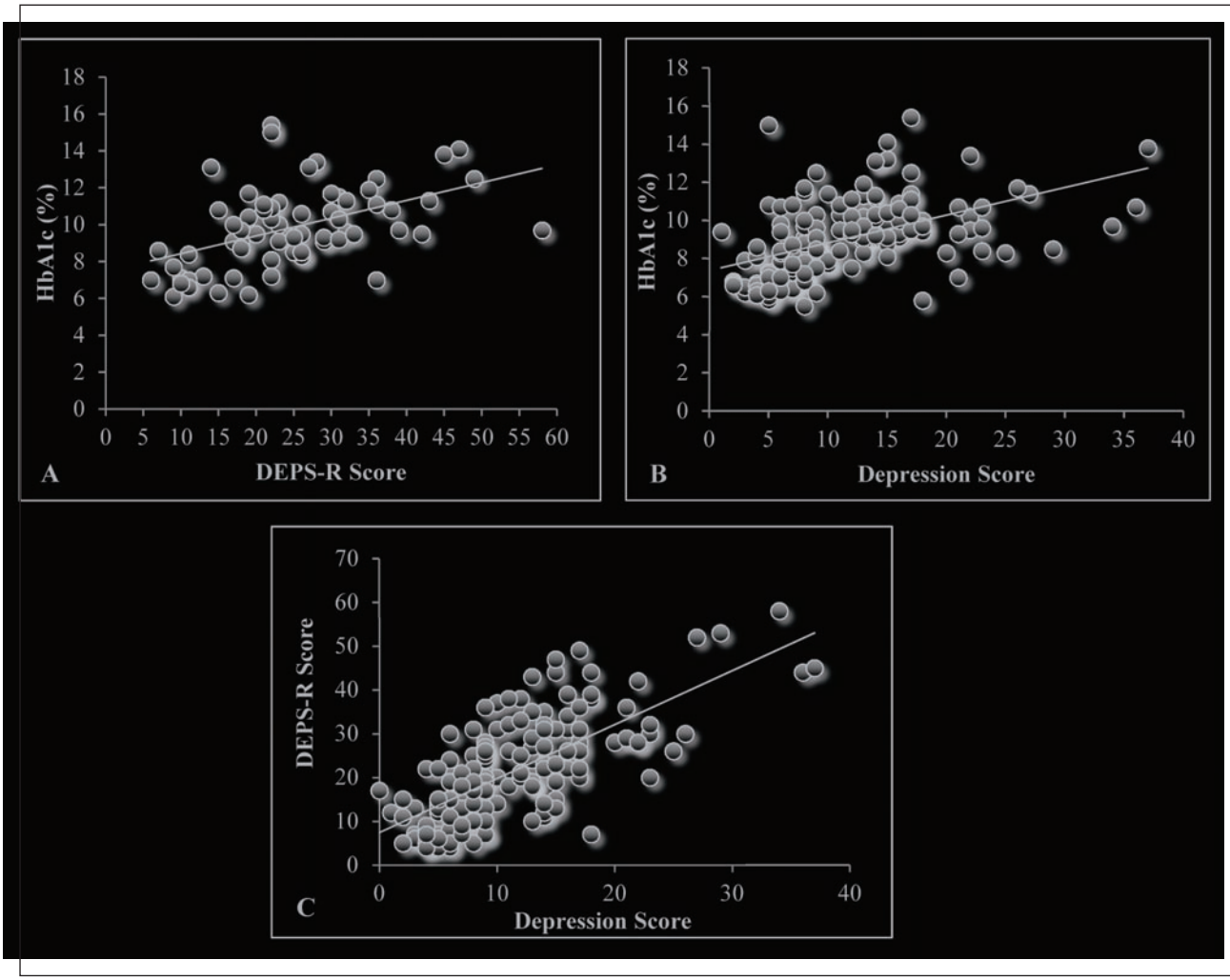

Figure 1 (A) Correlation between DEPS-R scores and HbA1c (%) levels of the the children (r:0.605, p:0.000); (B) Correlation between depression scores and HbA1c (%) levels of the children (r:0.597, p:0.000); (C) Correlation between DEPS-R and depression scores (r:0.714 p:0.000).

1 DM and the effect of associated factors on depression and eating disorders. As a result of the study, we obtained the following results. First, 1 in 10 children had depression (depression score >19) according to the CDI. There is a close significant relationship between the physiological and physical health of individuals with type 1 DM.[5,13] Moreover, children and adults with type 1 DM have at least double the risk of depression compared with the general population.[5,13] Our results support the existing evidence. Moreover, in this study, the majority of the children were found to be inhibited in their daily lives because of DM and had difficulties concerning DM treatment.

The second finding is that the depression scores showed no variation for gender or age (Table 2). However, women with type 1 DM have been found to be more depressed than men with type 1 DM.[11,29] Mood has also been found to be an important reason for diagnosis with DM among women in adulthood.[30] Furthermore, age is thought to be important for the depression status of patients with DM. The risk of psychological difficulties is known to increase with age in diabetic children,[31] especially during adolescence.[32] However, our results fail to support the current evidence. The possible reasons for this may be the age of diagnosis in our sample and the nascent gender awareness of these children.

The third result is that an increase in the children's HbA1c levels resulted in an increase in the risk of depression (Table 4). In addition, a positive correlation was found between depression scores and HbA1c levels (Figure 1B). Mental health comorbidities cause adverse effects on disease management in adolescents with chronic diseases.[33] Depression has been associated with increased HbA1c.[34] Psychological (mood) problems are considered to worsen metabolic control through the neuroendocrine pathway, which is associated with stress and inflammation in these patients.[35] Anxiety increased nearly two-fold in individuals with poor glycaemic control in a cross-sectional study.[33] Moreover, HbA1c levels are the central mediator of long-term metabolic outcomes and depression[6] and worsening of glycaemic control may cause an increased risk of psychological problems.[36] These findings are consistent with our study.

We also found that the children using carbohydrate counting had lower depression scores than those who were not (Table 2). The diabetic diet and certain dietary restrictions may complicate living with DM and dietary advice can often be rejected. Carbohydrate counting increases flexibility in food choice and is considered a tool that makes the lives of those with DM more manageable.[37] However, the positive effects of carbohydrate counting on HbA1c and psychological status are still debatable.[20]

The children using insulin pumps (continuous subcutaneous insulin administration) showed lower depression scores than those who did not (Table 2). The psychological and metabolic effects of the use of insulin pumps are contradictory and there is insufficient evidence concerning diabetic children and adolescents. Treatment with insulin pumps has previously been shown to cause negative results in children and adolescents due to the self-administration of insulin, lower overall parental involvement, and greater self-consciousness about the disease.[38] However, in recent years, research on children who use insulin pumps has found positive psychological outcomes,[39] similar to our findings. Using an insulin pump rather than undergoing multiple doses of insulin administration yields positive developments in terms of self-efficacy, depression, and the quality of life of adolescents with type 1 DM. In addition, it is easier to cope with DM using an insulin pump than multiple doses of insulin administration.[40] Using an insulin pump results in fewer physical complaints and restrictions than the injection method,[41] but it also results in more self-reported fear and stress when problem solving and leads to people being less social.[39] However, these results may be due to the use of less objective and more open-ended scales.[42] Moreover, with the development of technology, the emergence of new pumps will give rise to differences between the old and new literature.

This study also shows a positive correlation between depression scores and eating disorder scores in children (Figure 1C). In particular, 75.0% of girls with depression have an eating disorder and girls with high depression scores have higher eating disorder scores. Furthermore, the risk of depression symptoms are greater in girls with eating disorders and 69.2% of girls with eating disorders have symptoms of depression.[5] This relationship is expected because depression and eating disorders are involved in the aetiology of one another.

Eating disorders adversely affect health and physiological functions and cause repetitive negative episodes in eating behaviour.[43] Eating disorders are more common in individuals with type 1 DM than in the general population. These conditions significantly affect the physical and emotional health and nutritional status of individuals with DM and are associated with impaired metabolic control and a higher risk of medical complications, including higher mortality rates. Brief self-report screening measures are available for the detection of eating disorders.[44] Restricting

and skipping insulin doses are more common behaviours related to weight loss in patients with type 1 DM.[43] In this study, 11.9% of children and adolescents skipped their insulin (data not shown). Restricting or skipping insulin doses increases the risk of eating disorders ten-fold,[45] so it is thought to be beneficial to follow patients in this respect.

This study found no difference in terms of eating scores between genders (Table 1). However, the prevalence of eating disorders among adolescents with type 1 DM is 8-30% and is more common in girls than boys**.** Increases in body weight, body dissatisfaction, and a history of dieting and depression contribute to eating disorders in female patients with both type 1 and type 2 DM.[46] Body dissatisfaction especially occurs more commonly among girls with type 1 DM and it is important to pay attention to the potential of developing eating disorders in the age range of 13-14 years. Puberty is an important period in the development of eating disorders,[47] so it will be important to consider this issue in future studies.

In this study, eating disorder scores were lower in children with type 1 DM using insulin pumps and carbohydrate counting (Table 2). In addition, the use of an insulin pump and carbohydrate counting are not risk factors for disordered eating behaviour (Table 3). Using an insulin pump provides normalisation of eating behaviour rather than giving more importance to food intake through carbohydrate counting. Eating disorder scores decreased over time and the use of an insulin pump was associated with a reduction in eating disorder behaviour in a study conducted among children with type 1 DM aged 10-17 years who used an insulin pump for 6 months.[43] Our results support this. However, the results for the effect of carbohydrate counting on disordered eating behaviour risk are inconsistent. In addition to rigid controls, carbohydrate counting may contribute to the development of eating disorders[48] and the risk of eating disorders may be lower in patients using carbohydrate counting.[45]

We also identified a positive correlation between eating disorder scores and HbA1c levels (Figure 1A). Parallel with this result, a one unit increase in HbA1c levels resulted in a three unit increase in eating disorder scores (Table 3). The presence of DM and eating disorders together causes poor glycaemic control and an increased risk of complications over the long term. Retinopathy has been shown to develop in 86.0% women with high-level eating disorders and only 24.0% of women with normal eating behaviour after 5 years.[49] In another study, consciously skipping insulin to lose weight caused deterioration in all psychological variables and higher BMI. More impaired metabolic control was observed in patients missing insulin than not.[50] A comorbidity of eating disorders is low glycaemic control, which may increase the risk of eating disorders in children with type 1 DM. However, the comorbidity of eating disorders over the long term cannot be determined in this study. In this context, longitudinal and large sample size studies would be useful.

In conclusion, our study shows that children with type 1 DM are at risk of depression. The depression and eating disorder scores were higher in children who did not use carbohydrate counting and insulin pumps. In particular, depression and eating disorders can be seen more often in children with type 1 DM, whose metabolic outcomes are more impaired than those of other children. For this reason, nutritional, biochemical and psychiatric evaluation, and monitoring are important for providing DM control in children. A DM management team, including a physician, dietician, nurse, and mental health professional, is recommended for DM management.

Limitations

Undertaking a similar study with a large sample of patients of all ages, as well as comparison with a control group, would be useful. Further research should examine the early indicators of eating disturbances in pre-teen and early male and female teenagers, as well as the longer-term impact on adults as they progress beyond adolescence and into early adulthood. We expect that innovations leading to the replacement of traditional insulin injection, blood monitoring, carbohydrate counting, and dietary compliance will have a major impact on the development of eating disturbances in children with type 1 DM.

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Declaration of Interest

The authors declare that they have no conflict of interests.

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