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Fear of Hypoglycemia and Longer Disease Duration Associated with Physical Activity Avoidance in Children and Adolescents with Type 1 Diabetes Mellitus

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What is already known on this topic?

Children and adolescents with type 1 diabetes mellitus have lower levels of physical activity (PA) than their peers.

What this study adds?

This study highlights the times in school life and leisure time when PA is avoided. Moreover, the socioeconomic determinants of this avoidance are discussed. Unraveling the inequalities embedded in this behavior may help with intervention efforts.

Abstract

Objective: To determine physical activity (PA) avoidance and its associated factors among children with type 1 diabetes in four situations: leisure time (LT) PA out of school, LT PA at school during breaks, attendance at physical education (PE) classes and activity during PE classes.

Methods: Cross-sectional study. The cohort consisted of 137 children, aged 9-18 years, with type 1 diabetes registered at a tertiary center between August 2019 and February 2020, 92 of whom attended for face-to-face interview. Responses were rated on a 5-point-Likert scale for PA in the four situations. Never/rarely/occasionally responses were defined as avoidance. Chi-square, parametric/non-parametric comparison and multivariate logistic regression analysis were used to detect and confirm variables associated with each avoidance situation.

Results: Among the children 46.7% avoided PA during LT out of school and 52.2% during breaks, 15.2% avoided PE classes and 25.0% avoided active play during PE classes. Older children (14-18 year-olds) avoided PE classes [odds ratio (OR) = 6.49, 95% confidence interval (CI) = 1.10-38.13] and PA during breaks [OR = 2.85, 95% CI = 1.05-7.72] and girls avoided PA out of school (OR = 3.18, 95% CI = 1.18-8.06) and during breaks (OR = 4.12, 95% CI = 1.49-11.40). Those who had a sibling (OR = 4.50, 95% CI = 1.04-19.40) or had a poorly-educated mother (OR = 3.63, 95% CI = 1.15-11.46) avoided PA during breaks and those from low-income households avoided PE classes (OR = 14.93, 95% CI = 2.23-99.67). As the duration of disease prolonged, avoiding PA during LT out of school increased (4-9 years; OR = 4.21, 95% CI = 1.14-15.52 and ≥10 years; OR = 5.94, 95% CI = 1.20-29.36).

Conclusion: Adolescence, gender, and socioeconomic inequalities deserve greater focus for better PA behavior among young people with type 1 diabetes. As the disease duration prolongs, revising and strengthening intervention to encourage PA may be needed.

Keywords: Type 1 diabetes, physical activity, child, adolescent, socioeconomic inequalities

Introduction

Regular physical activity (PA) is known to improve the quality of life and health of those with type 1 diabetes and to reduce their risk of complications related to the disease. However, children and adolescents with type 1 diabetes have lower levels of PA than their peers without diabetes (1,2,3). Reasons given for PA avoidance include concerns

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about hypoglycemia, syllabus, weather conditions, loss of diabetes control and low fitness levels. Other causes of low PA levels in children or adolescents with type 1 diabetes stem from their families, school personnel or even physicians discouraging them from PA (4,5,6). School-age children with type 1 diabetes who lack adequate knowledge about exercise management also have trouble participating in PA at school (7). Furthermore, children with type 1 diabetes who are aware of the physiological and psychosocial benefits of regular PA may have difficulty in taking action and thus need support (8). In particular, family support plays a key role in reducing barriers preventing children with diabetes from having an active lifestyle (5). Socioeconomic inequalities have been reported to negatively affect the knowledge of healthy children about PA or their PA-related behaviors (9). However, to our knowledge, these inequalities for PA behavior have not been investigated among type 1 diabetes children. Unraveling the relationship between socioeconomic characteristics and PA may contribute to efforts aimed at increasing PA levels during the on-going management this disease in affected children and adolescents.

The aim of this study was to investigate PA avoidance behavior among children with type 1 diabetes in four situations: Leisure time (LT) PA out of school; LT PA in school during breaks; attendance in physical education (PE) classes; and activity during PE classes.

Methods

Study Population

This cross-sectional study was executed between August 2019 and February 2020 among children with type 1 diabetes aged 9-18 years, who were registered at Ege University Pediatric Endocrinology and Diabetes Outpatient Clinic, İzmir, Turkey. Of the 137 children registered, those who were diagnosed with type 1 diabetes for at least six months and those who did not have any other chronic illnesses were included in the study. For data collection, a 31-item study specific questionnaire, which is more explained in the variables title with its subheadings in the 5th and 6th page, was administered through face-to-face interviews in the diabetes education room; interviews lasted approximately 15 minutes. The interviews were carried out after routine visits to the Outpatient Clinic. The information about 11 parameters concerning their disease was retrieved from their medical records. Before the study was conducted, ethical approval was obtained from Ege University Ethical Committee (decision no: 19-7T/75, date: 7/31/2019), and before the interviews were conducted, signed, informed consent was given by the children and their parents. Data collection ceased in March 2020 when the Coronavirus disease-2019 pandemic reached Turkey.

Variables

Dependent variables: taking part in PA was questioned for: i) LT PA out of school (at home or outside); ii) LT PA at school during breaks; iii) attendance at PE classes (in some cases type 1 diabetes children are excused PE classes and do not attend); and iv) actual activity during PE classes. The children responded on a 5-point-Likert scale (never/rarely/occasionally/often/always). Responses including never/rarely/occasionally were classified as being PA avoidance. Each situation was analyzed separately for associations with independent variables. Those reporting PA avoidance were asked why they did this using an open-ended question.

Sociodemographic characteristics: Data was collected concerning the children and young peoples' age (9-13 or 14-18 years), sex, school type (private or public), the number of siblings, and parental education level using the Unesco International Standard Classification of Education (ISCED) 2011 (10). The ISCED groups were merged for analysis and grouped as low (ISCED ≤2: below lower secondary education), middle (ISCED = 3: upper secondary education) and high (ISCED ≥6: equal to or above bachelor degree). Perceived family income was graded on a 5-point-Likert scale and dichotomized as very high/high/middle and low/very low.

Characteristics of type 1 diabetes: Participants' weight (kg) and height (m), the time since diagnosis of type 1 diabetes, mean percentage (%) glycated hemoglobin (HbA1c) levels (excluding the first three months of diagnosis) in the previous year, hospital inpatient admissions in the previous year (number and reasons) and the number of outpatient admissions were retrieved from medical records. Optimal time in range was taken as ≥75% (11). Yearly outpatient control visits between 0 and 3 times were evaluated as "below optimal" and ≥4 or more visits were considered "optimal". The annual average HbA1c value was grouped as ≤7.5 (optimal), 7.5-9 (suboptimal), and ≥9 (high risk) (12). Body mass index-for-age Z-score cut-points were derived from Turkish standards by Neyzi et al. (13) and grouped as: underweight (< -2SD) normal (≤ + 2 and ≥-2) and obese (> + 2 SD). Diabetes duration was grouped as: 0-3 years, 4-9 years and ≥10 years.

Barriers to PA: The barriers defined in The Barriers to Physical Activity in Type 1 Diabetes (BAPAD1) scale for adults were used (2). The BAPAD1 scale has not been validated in pediatric and adolescent patients but has been used in young populations, previously (5). In the present

study two questions concerning fear of suffering a heart attack and having a low fitness level were not asked and the item regarding work schedule was changed to "school schedule". A total score was not derived, as the scale was not validated. Instead, each barrier was analyzed individually for any association with the dependent variables, a similar use of the scale as in the study of Jabbour et al. (5). Children were asked about these 10 possible barriers to PA on a scale ranging from 1 to 7 (1: extremely unlikely, to 7: extremely likely).

Knowledge of type 1 diabetes, nutrition and PA: This part included 10-items about type 1 diabetes (4 items), nutrition (3 items) and PA (3 items; see Appendix 1). The questions were developed in the light of literature. In order to prepare the question in regard to this part, "Patients' knowledge about the disease" in the form of introductory features developed by Karakurt et al. (14) was used and the questions were adapted to children with type 1 diabetes. In addition, the Diabetes Diagnosis and Treatment Guidelines of the Diabetes Foundation of Turkey were reviewed and the items that individuals with type 1 diabetes should know were reached and the questions were finalized in accordance with the guideline (15). Correct answers for these open-ended questions achieved a score of 1 and wrong answers/do not know options were scored zero.

Statistical Analysis

Statistical analyses were performed using Statistical Package for the Social Sciences, version 23 (IBM Inc., Armonk, NY, USA). For categorical variables, their relationships with avoidance behavior in four situations were evaluated with chi-square tests. Whether continuous variables (barriers to PA and knowledge of diabetes, nutrition and PA) were normally distributed was tested using the Kolmogorov-Smirnov test. As none of the barriers to PA were normally distributed, log transformation to make data conform to normality was performed. For normally distributed data sets (inappropriateness of the syllabus and fear of hypoglycemia), the Student's t-test was performed. For comparison of non-parametric data sets, Mann-Whitney U test was used. A p value less than 0.05 was considered statistically significant. For logistic regression analysis, variables associated with PA avoidance behavior in bivariate analysis were included in the model.

Results

Of the 137 children registered at the center, 116 (84.7%) met the inclusion criteria. Of these 116, 92 (79%) children were interviewed. Table 1 shows the scores obtained from all participants, and from those who did and did not avoid PA in the four situations under consideration for a range of variables as barriers to PA and for knowledge

Table 1. Sociodemographic and diabetes relevant variables and their association with leisure time physical activity at home/outside and at school during breaks

Sociodemographic variables		Total n (%)*	Leisure time physical activity			
			At home or outside		At school during breaks	
			Avoids n (%)	x^2 p	Avoids n (%)	x^2 p
Age (years)	9-13	36 (39.1)	12 (33.3)	4.27 **0.04**	12 (33.3)	8.41 **0.004**
	14-18	56 (60.9)	31 (55.3)		36 (64.3)	
Gender	Girls	57 (61.9)	33 (57.9)	7.49 **0.01**	38 (66.7)	12.6 **<0.001**
	Boys	35 (38.1)	10 (28.6)		10 (28.5)	
Type of school	Public	68 (73.9)	30 (44.1)	0.72 0.39	36 (52.9)	0.06 0.80
	Private	24 (26.1)	13 (54.2)		12 (50.0)	
Siblings	None	77 (83.7)	34 (45.9)	5.14 **0.02**	45 (58.4)	7.43 **0.006**
	≥1	15 (16.3)	9 (50.0)		3 (20.0)	
Education level of mother	Low	43 (46.7)	24 (55.8)	3.10 0.21	28 (65.1)	7.38 **0.02**
	Middle	21 (22.8)	7 (33.3)		11 (52.4)	
	High	28 (30.5)	12 (42.9)		9 (32.1)	
Education level of father	Low	38 (41.3)	19 (50.0)	0.52 0.76	24 (63.2)	3.38 0.18
	Middle	20 (21.7)	8 (40.0)		8 (40.0)	
	High	34 (37.0)	16 (47.1)		16 (47.1)	
Income	Very high, high, middle	85 (92.4)	40 (47.1)	0.04 0.83	44 (51.8)	0.07 0.78
	Low, very low	7 (7.6)	3 (42.9)		4 (57.1)	

Table 1. Continued

Sociodemographic variables		Total n (%)*	Leisure time physical activity			
			At home or outside		At school during breaks	
			Avoids n (%)	x^2 p	Avoids n (%)	x^2 p
Variables relevant to diabetes						
Time after diagnosis (years)	0-3	18 (19.6)	4 (22.3)	7.06 **0.03**	10 (55.6)	3.92 0.14
	4-7	54 (58.7)	26 (48.1)		24 (44.4)	
	≥10	20 (21.7)	13 (65.0)		14 (70.0)	
BMI for age	Healthy weight	56 (60.9)	24 (42.9)	0.81 0.36	32 (57.1)	1.41 0.23
	Unhealthy weight	36 (39.1)	19 (52.8)		16 (44.4)	
Hospitalization in the previous year	≥1	74 (80.4)	10 (55.6)	0.69 0.40	10 (55.6)	0.10 0.74
	None	18 (19.6)	33 (44.6)		38 (51.3)	
Attending appointments in the previous year	≤3	25 (27.2)	9 (37.5)	1.11 0.29	9 (37.5)	2.80 0.09
	≥4	67 (72.8)	34 (50.0)		39 (57.4)	
HbA1c (last year average, %)	Optimal	28 (30.5)	9 (32.1)	4.22 0.12	15 (53.6)	2.57 0.27
	Suboptimal	39 (42.3)	19 (48.7)		17 (43.5)	
	High risk	25 (27.2)	15 (60.0)		16 (64.0)	
Total		92 (100)	43 (46.7)		48 (52.2)	

HbA1c: glycated hemoglobin

of their disease. Sociodemographic and type 1 diabetes characteristics and the association with PA avoidance in the four situations is presented in Table 2. The mean overall age of the participants was 14.08 ± 2.63 years and mean duration since diagnosis was 6.55 ± 3.84 years. Among the causes of hospitalization in the previous year, the most common was hyperglycemia/ketoacidosis (33.3%). None of the children were hospitalized for hypoglycemia. Of the four PA avoidance situations, the most frequent one was during breaks at school (52.2%). In the open-ended question for this, the most frequent reason (91.7%) declared was "being a grown up". Avoiding PA out of school ranked second (46.7%) and among the open-ended responses, 60.5% cited "being a grown-up" while 34.9% reported "spending time for studying". Regarding PE classes, 15.2% did not attend and 25.0% avoided PE activity during the PE class. Among the causes of avoidance, "spending time for studying" was again cited by many with 78.6% of the non-attending group and 69.6% of those who avoided PE activity at PE class using this reason. A smaller proportion cited blood sugar irregularities as the reason for avoiding PE classes completely (7.1%) while 8.7% used this reason to avoid PE activity at PE class. Variables associated with avoidance of PA at Table 1 and Table 2 in at least one of the situations included being older [14-18 years, $p = 0.04$ (at home or outside)], $p = 0.004$ (at school during breaks) and $p = 0.03$ (attendance to PE), being female [$p = 0.01$ (at home or outside) and $p < 0.001$ (at school during breaks)], having a sibling [$p = 0.02$ (at home or outside) and $p = 0.06$)], having a less well educated mother [$p = 0.02$ (at school during breaks)] and being from a low-income household [$p = 0.01$ (attendance to PE) and $p = 0.04$ (active plays during PE)]. Diabetes related determinants did not have an effect, with the exception of disease duration [$p = 0.03$ (at home or outside)].

Comparisons of the scores for items which were considered barriers to PA and concerning knowledge of their diabetes for those who did and did not avoid PA for each of the four situations are presented in Table 3. School schedule had the highest score (3.04 ± 2.37) among all the barriers, followed by fear of hypoglycemia (2.72 ± 2.02). The score for fear of hypoglycemia was higher among those both avoiding PE classes and avoiding PA in PE classes. Loss of control of diabetes was reported to be the biggest reasons by those who avoided LT PA both outside school and during school during breaks. Fear of being tired was higher among those who avoided LT PA out of school or at school during breaks and those who avoided activity during PE class. Fear of hurting oneself was higher among those who avoided LT PA at school during breaks and those who avoided attendance at PE classes. In terms of knowledge about diabetes the three highest scores (0.96 ± 0.21) concerned signs and management of low blood sugar and number of meals a day that should be consumed. Notably, the lowest score concerned PA and asked about the minimum minutes per week of PA (0.54 ± 0.50).

The results of the logistic regression analysis of PA avoidance in the four situations among young people with

type 1 diabetes are presented in Table 4. The older group (14-18 years) avoided PE classes [odds ratio (OR) = 6.49, 95% confidence interval (CI) = 1.10-38.13] and PA during breaks (OR = 2.85, 95% CI = 1.05-7.72) and girls avoided PA out of school (OR = 3.18, 95% CI = 1.18-8.06) and during breaks (OR = 4.12, 95% CI = 1.48-11.40). Children having a sibling (OR = 4.50, 95% CI = 1.04-19.40) and those having poorly educated mothers (OR = 3.63, 95% CI = 1.15-11.46) avoided PA during breaks and children from low-income households avoided PE classes (OR = 14.93, 95% CI = 2.23-99.67). As the duration since diagnosis got longer, participants were more likely to avoid PA during LT and out of school (duration 4-9 years; OR = 4.21, 95% CI = 1.14-15.52 versus duration ≥10 years; OR = 5.94, 95% CI = 1.20-29.36).

Discussion

The present study found that in children and adolescents with type 1 diabetes, older patients (14-18 years), girls, those with siblings, and those with less well educated mothers or from low-income households were more likely to avoid PA in one or more of the situations investigated. A general finding was that as the disease duration increased, PA avoidance became more likely.

Table 2. Sociodemographic and diabetes relevant variables and their association with attendance to PE classes and taking part in active plays during PE classes

Sociodemographic variables		Total n (%)*	Physical education classes at school			
			Attendance to		Active plays during	
			Avoids n (%)	x^2 p	Avoids n (%)	x^2 p
Age (years)	9-13	36 (39.1)	2 (5.5)	4.27 **0.03**	6 (16.7)	2.19 0.13
	14-18	56 (60.9)	12 (21.4)		17 (30.4)	
Gender	Girls	57 (61.9)	10 (17.5)	0.62 0.42	17 (29.8)	1.86 0.17
	Boys	35 (38.1)	4 (11.4)		6 (17.1)	
Type of school	Public	68 (73.9)	8 (11.8)	2.40 0.12	16 (23.5)	0.30 0.58
	Private	24 (26.1)	6 (25.0)		7 (29.2)	
Siblings	None	77 (83.7)	12 (15.6)	0.05 0.82	19 (24.7)	0.02 0.87
	≥1	15 (16.3)	2 (13.3)		4 (26.7)	
Education level of mother	Low	43 (46.7)	8 (18.6)	0.83 0.65	11 (25.6)	0.34 0.84
	Middle	21 (22.8)	3 (14.3)		6 (28.6)	
	High	28 (30.5)	3 (10.7)		6 (21.4)	
Education level of father	Low	38 (41.3)	6 (15.8)	0.58 0.74	10 (26.3)	0.34 0.84
	Middle	20 (21.7)	2 (10.0)		4 (20.0)	
	High	34 (37.0)	6 (17.7)		9 (26.5)	
Income	Very high, high, middle	85 (92.4)	10 (11.7)	10.32 **0.01**	19 (22.4)	4.17 **0.04**
	Low, very low	7 (7.6)	4 (57.1)		4 (57.1)	
Variables relevant to diabetes						
Time after diagnosis (years)	0-3	18 (19.6)	1 (5.6)	2.79 0.24	5 (27.8)	1.75 0.41
	4-7	54 (58.7)	8 (14.8)		11 (20.3)	
	≥10	20 (21.7)	5 (25.0)		7 (35.0)	
BMI for age	Healthy weight	56 (60.9)	7 (12.5)	1.12 0.56	14 (25.0)	0.78 0.67
	Unhealthy weight	36 (39.1)	7 (19.4)		1 (0.03)	
Hospitalization in the previous year	≥1	74 (80.4)	4 (22.2)	0.85 0.35	6 (33.3)	0.82 0.36
	None	18 (19.6)	10 (13.6)		17 (23.0)	
Attending appointments in the previous year	≤3	25 (27.2)	3 (12.5)	0.18 0.66	5 (20.8)	0.30 0.58
	≥4	67 (72.8)	11 (16.2)		18 (26.5)	
HbA1c (last year average, %)	Optimal	28 (30.5)	5 (17.8)	0.33 0.84	7 (25.0)	0.02 0.98
	Suboptimal	39 (42.3)	5 (12.8)		10 (25.6)	
	High risk	25 (27.2)	4 (16.0)		6 (24.0)	
Total		92 (100)	14 (15.2)		23 (25.0)	

PE: physical education, HbA1c: glycated hemoglobin

Table 3. The comparison of the scores on items for barriers for physical activity and knowledge for diabetes between groups avoiding and those not avoiding physical activity at four situations

		Leisure time physical activity						Physical education classes at school					
	Total (mean ± SD)	At home or outside (mean ± SD)			At school during breaks (mean ± SD)			Attendance to (mean ± SD)			Active plays during (mean ± SD)		
Barriers for physical activity		Avoids	Does not avoid		Avoids	Does not avoid		Avoids	Does not avoid		Avoids	Does not avoid	
School schedule	3.04 ± 2.37	3.40 ± 2.47	2.73 ± 2.26	p = 0.16	3.43 ± 2.46	2.61 ± 2.22	p = 0.21	3.64 ± 2.23	2.93 ± 2.39	p = 0.41	3.96 ± 2.40	2.74 ± 2.30	p = 0.86
Fear of hypoglycemia	2.72 ± 2.02	2.90 ± 1.87	2.55 ± 2.16	p = 0.24	2.98 ± 2.19	2.43 ± 1.81	p = 0.06	1.92 ± 1.20	2.85 ± 2.11	p = 0.01	2.26 ± 1.63	2.87 ± 2.13	p = 0.047
Weather conditions	2.66 ± 2.11	2.23 ± 3.04	1.86 ± 2.25	p = 0.07[u]	2.62 ± 2.03	2.70 ± 2.20	p = 0.93[u]	3.35 ± 2.09	2.53 ± 2.09	p = 0.07[u]	3.47 ± 2.35	2.39 ± 1.96	p = **0.03**[u]
Risk of hyperglycemia	2.25 ± 1.88	2.32 ± 2.18	1.70 ± 2.03	p = 0.2[u]	2.29 ± 1.95	2.20 ± 1.81	p = 0.90[u]	1.78 ± 1.47	2.33 ± 1.93	p = 0.30[u]	2.08 ± 1.78	2.30 ± 1.91	p = 0.55[u]
Location of a gym	2.20 ± 2.09	2.09 ± 2.28	1.93 2.22	p = 0.87[u]	2.43 ± 2.31	1.93 ± 1.79	p = 0.40[u]	1.85 ± 1.87	2.25 ± 2.12	p = 0.45[u]	2.13 ± 2.15	2.21 ± 2.07	p = 0.68[u]
Loss of control for diabetes	2.09 ± 1.89	2.27 ± 1.79	1.91 1.97	p = **0.04**[u]	2.43 ± 2.04	1.70 ± 1.65	p = **0.02**[u]	2.07 ± 1.43	2.08 ± 1.96	p = 0.53[u]	2.26 ± 1.94	2.03 ± 1.89	p = 0.47[u]
Fear of being tired	2.04 ± 1.93	2.30 ± 1.81	2.00 ± 1.85	p = **0.03**[u]	2.43 ± 2.13	1.61 ± 1.60	p = **0.02**[u]	2.50 ± 2.40	1.96 ± 1.84	p = 0.57[u]	2.74 ± 2.28	1.81 ± 1.75	p = **0.02**[u]
Fact that you have diabetes	2.02 ± 1.72	1.74 ± 2.26	1.25 ± 2.01	p = 0.66[u]	1.91 ± 1.59	2.13 ± 1.85	p = 0.91[u]	1.85 ± 1.29	2.05 ± 0.78	p = 0.91[u]	1.95 ± 1.58	2.04 ± 1.76	p = 0.86[u]
Actual physical health, excluding your diabetes	1.82 ± 1.83	1.65 ± 1.95	1.60 ± 2.02	p = 0.73[u]	1.89 ± 1.99	1.72 ± 1.66	p = 0.73[u]	2.07 ± 2.01	1.76 ± 1.80	p = 0.51[u]	2.13 ± 2.13	1.71 ± 1.72	p = 0.50[u]
Fear of hurting yourself	1.52 ± 1.37	1.67 ± 1.38	1.49 ± 1.25	p = 0.12[u]	1.97 ± 1.78	1.02 ± 0.15	p = **0.001**[u]	2.14 ± 1.87	1.94 ± 1.24	p = **0.04**[u]	1.95 ± 1.89	1.37 ± 1.25	p = 0.12[u]
Knowledge for diabetes													
Name of hormone causing diabetes	0.63 ± 49	0.70 ± 0.46	0.57 ± 0.50	p = **0.02**	0.73 ± 0.45	0.52 ± 0.51	p = 0.09	0.64 ± 0.50	0.63 ± 0.49	p = 0.83	0.61 ± 0.50	0.64 ± 0.48	p = 0.64
Organ responsible for diabetes	0.82 ± 0.39	0.88 ± 0.32	0.76 ± 0.43	p = **0.001**	0.90 ± 0.31	0.73 ± 0.45	p = 0.19	0.71 ± 0.47	0.83 ± 0.38	p = 0.07	0.78 ± 0.42	0.83 ± 0.38	p = 0.37
One sign of low blood sugar	0.96 ± 0.21	0.95 ± 0.21	0.96 ± 0.20	p = 0.89[u]	0.96 ± 0.20	0.95 ± 0.21	p = 0.93[u]	1.00 ± 0.00	0.95 ± 0.22	p = 0.39[u]	1.00 ± 0.00	0.94 ± 0.24	p = 0.24[u]
What to do when blood sugar decreases	0.96 ± 0.21	0.98 ± 0.15	0.94 ± 0.24	p = 0.37[u]	0.96 ± 0.20	0.95 ± 0.21	p = 0.93[u]	0.93 ± 0.27	0.96 ± 0.19	p = 0.58[u]	0.96 ± 0.21	0.96 ± 0.21	p = 1.00[u]
How many meals a day	0.96 ± 0.21	0.98 ± 0.15	0.94 ± 0.24	p = 0.38[u]	1.00 ± 0.00	0.91 ± 0.29	p = **0.03**[u]	0.93 ± 0.27	0.96 ± 0.19	p = 0.58[u]	0.96 ± 0.21	0.96 ± 0.21	p = 1.00[u]

Table 3. Continued

	Total (mean ± SD)	Leisure time physical activity						Physical education classes at school					
		At home or outside (mean ± SD)			At school during breaks (mean ± SD)			Attendance to (mean ± SD)			Active plays during (mean ± SD)		
Most important food group in type 1 diabetes	0.71 ± 0.46	0.74 ± 0.44	0.67 ± 0.47	p = 0.14	0.77 ± 0.42	0.64 ± 0.49	p = 0.06	0.64 ± 0.49	0.72 ± 0.45	p = 0.33	0.74 ± 0.45	0.70 ± 0.46	p = 0.41
A food containing 15 grams of carbohydrates	0.72 ± 0.45	0.86 ± 0.35	0.59 ± 0.50	p = **0.05**[u]	0.77 ± 0.42	0.66 ± 0.48	p = 0.24[u]	0.88 ± 0.36	0.69 ± 0.46	p = 0.21[u]	0.78 ± 0.42	0.70 ± 0.46	p = 0.42[u]
Adjusting the insulin dose for exercise	0.84 ± 0.37	0.88 ± 0.32	0.80 ± 0.41	p = **0.02**	0.81 ± 0.39	0.86 ± 0.35	p = 0.54	0.79 ± 0.43	0.85 ± 0.36	p = 0.29	0.78 ± 0.42	0.86 ± 0.35	p = 0.12
PA-At least how many days per week	0.65 ± 0.48	0.67 ± 0.47	0.63 ± 0.49	p = 0.41	0.69 ± 0.47	0.61 ± 0.49	p = 0.66	0.57 ± 0.51	0.67 ± 0.47	p = 0.29	0.70 ± 0.47	0.64 ± 0.48	p = 0.28
Minimum physical activity minutes per week	0.54 ± 0.50	0.56 ± 0.50	0.53 ± 0.50	p = 0.61	0.54 ± 0.50	0.55 ± 0.50	p = **0.001**	0.50 ± 0.52	0.55 ± 0.50	p = 0.70	0.52 ± 0.51	0.55 ± 0.50	p = 0.70

[u]p value for Mann-Whitney U test statistics.
SD: standard deviation, PA: physical activity

The results showed that the risk of not attending PE classes and avoiding activity during breaks increased by 6.49 times and 2.85 times respectively, in the 14-18 age group. This may be due to behavioral changes associated with adolescence. El Achhab et al. (16) conducted a study of with 346 healthy adolescents and 58.8% displayed sedentary behavior. Sleeping less than seven hours, increased screen time and excessive use of smartphones, compared to younger children, were some of the reasons for the high rate of physical inactivity (16,17). In addition, because those in the ≥14-year-old group get prepared for high school and university entrance exams, they allocate less time to sports, leading to their being more inactive (18). The results of the present study appear to show that these trends of healthy adolescents are found amongst adolescent patients with type 1 diabetes, too. Given the frequent access to healthcare and health education in children with diabetes, there seems to be an opportunity to modify adolescent attitudes towards PA in these patients. Healthcare providers should increase the emphasis on PA to improve the quality of life and health of patients with type 1 diabetes and this message needs to be repeated regularly. Furthermore, the context and methods to promote PA during transition to adult services, which coincides with the adolescent period of the patients, should probably be modified in order to change the attitude and behavior of adolescent patients with type 1 diabetes towards PA.

Girls were more likely to avoid LT activities, both out of school (OR = 3.18) and at school during breaks (OR = 4.12) in comparison to boys. According to a study conducted with children/young people with type 1 diabetes in the 6-17 years age group, the proportion taking part in licensed sports (professional athletes who have sports licencing) was lower in girls (30.4%) than in boys (69.6%) (19). Girls also participated less than boys (62.8% vs. 37.2%) in PA during the week. These gender differences has been previously attributed to boys' interest in fitness and improved masculine body image, while girls' interest was in self-care activities. Other factors affecting this gender difference were school environment, family support and relations with neighbors. Society's expectations of girls may be very different from the expectations placed on boys (20,21,22). The similar findings for adolescent girls in the present study may not, therefore, be surprising. To eliminate these gender inequalities in young patients with type 1 diabetes, given the benefit of PA for these patients, should become a target for healthcare professionals dealing with this disease.

Having a sibling was identified as a risk factor for avoidance of PA in this study. It has been suggested that older siblings

Table 4. The results of the logistic regression analysis for avoiding physical activity at four settings among children with type 1 diabetes

		Avoiding leisure time physical activity		Avoiding physical education classes at school	
		At home or outside OR (95% CI)	At school during breaks OR (95% CI)	Avoids attendance to OR (95% CI)	Avoids active plays during OR (95% CI)
Age (Ref: 9-13 years old)	14-18 years old	1.44 (0.51-4.09)	2.85* (1.05-7.72)	6.49* (1.10-38.13)	
Gender *(Ref: Boys)*	Girls	3.18* (1.18-8.06)	4.12* (1.49-11.40)		
Siblings *(Ref: None)*	≥1 sibling	4.08 (0.99-16.74)	4.50* (1.04-19.40)		
Education level of mother *(Ref: High)*	Low Middle		3.63* (1.15-11.46) 2.16 (0.57-8.13)		
Income *(Ref: Very high, high, middle)*	Low, very low			14.93* (2.23-99.67)	4.63 (0.95-22.52)
Time after diagnosis *(Ref: ≤3 years)*	4-9 years ≥10 years	4.21* (1.14-15.52) 5.94* (1.20-29.36)			

OR: odds ratio, CI: confidence interval

may be involved with the care of the younger sibling, especially for older girls, and thus having less time for participating in PA (23,24). The findings in McMinn's study showed that European children showed a significant positive association between number of siblings and PA whereas an inverse relation existed for South Asian children (25). Thus, the meaning of being a child, and the expected roles and responsibilities may differ between populations; these responsibilities also apply to children with diabetes. However, in the present study, only 15 children were only-children and nearly all (14/15) came from middle/high income families. Being an only-child may be an indicator of better-off living conditions and opportunities. These children may benefit from interpersonal, social and environmental factors that affect their PA participation positively (24).

As the education level of the mother decreased, the avoidance of LT PA increased during breaks in the school day. These mothers may be less aware of the benefits of PA and less supportive or even discouraging about PA, regarding diabetes. Moreover, for these mothers, allocating more time for school lessons may also be prioritized and emphasized for the child. Doing PA can be interpreted as avoiding studying. Civil (19) reported that more than half of the participants whose mothers had a postgraduate degree, were licensed for sports activities. High educated mothers may be more aware of the benefits of PA, more encouraging and more confident about disease management during PA. Raising the awareness of less well educated mothers about the benefits of PA in diabetes may have a positive impact for their children.

Participants in the present study from low-income households were more likely to avoid both going to PE classes and if in a PE class, were less likely to actually take part. High socioeconomic status increased the likelihood of taking part in PA activities among healthy adolescents (26). The better the income, the more the family encourages children to participate in PA. However, in low-income households the child may be expected to study more and perform better at educational activities than recreational ones. This was a common reason given in the present study for children from poorer families to avoid school-based PA, possibly because of a perception of PA as lost studying time.

Exercise is important for glycemic control and better blood sugar profile in patients with type 1 diabetes, and there is a significant relationship between exercise and glycemic control (27). In contrast, Civil (19) reported no significant correlation between HbA1c values and the frequency of PA. In order to explain this contradiction, planning long-term and prospective studies can affect the outcome of the relationship.

Having a longer duration since diagnosis increased the trend towards PA avoidance. If the period since diagnosis was 4-9 years or ≥10 years, they were more likely to avoid LT PA activities at home/outside than children with a diagnosis within the last three years. Children with type 1 diabetes are reported to be shy of their peers or teachers, and may be anxious about being different from others (28). We did not investigate if the participants in this study hid their disease from their peers. However, this research could lead to investigate further researches on shyness of diabetes and PA behavior. This psychology may have discouraged PA outside of school or participating in LT activities. However, the participants reported fear of tiredness and losing control of their diabetes as the main reasons for not taking part in PA. Once again, the benefits of taking part in PA do not appear to have been emphasized enough by the healthcare providers that the study participants have contact with. This indicates an important need to strengthen pro-PA interventions, probably during the whole course of the disease.

Jabbour et al. (5) also reported fear of hypoglycemia, pressures of school schedule, and weather conditions as strong barriers for PA participation in children with type 1 diabetes. Further evidence suggests that fear of hypoglycemia will reduce the frequency of PA participation and, because of anxiety of patients about hypoglycemia, children are discouraged from participating in PA (4,19,29).

Interestingly, children who avoided PA in one of the situations scored better on knowledge of diabetes, including how to make insulin adjustments for exercise, than participants who took part in PA. This may show that better understanding of the disease and the possible effect of PA brought about more hesitancy or even fear of taking part in PA. This is parallel to the finding on fear of hypoglycemia. Finally, it was shown that children with poorer knowledge about the recommended minimum PA minutes per week tended to avoid PA. This appears to be more evidence that the message about the benefits of PA in type 1 diabetes are simply not as strong as the patient or family anxiety concerning hypoglycemia, loss of control and the perception of exercise as a waste of (studying) time or even just not suitable for adolescent girls in some societies.

Study Limitations

This was a cross sectional study, thus causal interpretations should be interpreted with care. The study was limited to the type 1 diabetes population of one pediatric clinic and to those who attended the clinic during data collection. The relatively small sample size and the possible selection bias may have influenced the final findings. Those who attend regularly could be those who were more worried about PA (may result in overestimated frequencies of avoidance) or who were more educated/aware of the benefits of PA (may result in underestimated frequencies for avoidance).

Conclusion

Adolescence, gender and socioeconomic inequalities deserve special management when seeking to improve levels of PA among children with type 1 diabetes. Many of the findings in this cohort with type 1 diabetes parallel the findings in their healthy peers. However, given the frequent opportunities to access healthcare and health education in this population, it appears that more emphasis is required on the benefits of PA in type 1 diabetes to overcome the negative effects of adolescence, patient and parental anxiety, and gender differences. In terms of the effect of socioeconomic inequality and poor parental education, these are wider societal problems that will require changes beyond the scope of individual healthcare services. The strong association between disease duration and poorer participation in PA indicate an urgent need to strengthen interventions designed to promote PA during the whole course of the disease, starting with parental education at diagnosis.

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Ethics

Ethics Committee Approval: The study was approved by the Ege University Ethical Committee (decision no: 19-7T/75, date: 7/31/2019).

Informed Consent: Before the interviews were conducted, signed, informed consent was given by the children and their parents.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: Büşra Donat Ergin, Işıl Ergin, Damla Gökşen, Design: Büşra Donat Ergin, Işıl Ergin, Damla Gökşen, Data Collection or Processing: Büşra Donat Ergin, Analysis or Interpretation: Büşra Donat Ergin, Işıl Ergin, Damla Gökşen, Literature Search: Büşra Donat Ergin, Writing: Büşra Donat Ergin, Işıl Ergin, Damla Gökşen.

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Click for Appendix 1. Knowledge on type 1 diabetes, nutrition, and PA

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