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Family Functioning in Adolescents with Type 1 Diabetes: Comparisons with Healthy Peers and Associations with Metabolic Control

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Abstract

Objectives: Families play a pivotal role in the care of adolescents with chronic illnesses, such as type 1 diabetes (T1D). This study's aim was to evaluate family functioning in families of adolescents with T1D and to assess its relationship with metabolic control. **Methods:** Fifty-eight adolescents and young adults diagnosed with T1D, aged 14–21 years, and 116 healthy adolescents (controls) matched for age, gender and socioeconomic status were included in this study. The participants' mean age was 15.9 years (±1.6 years). The demographics and family functioning were reported by the participants. The McMaster Family Assessment Device (FAD) measured family functioning across six dimensions. **Results:** In problem-solving and behavioral involvement, T1D adolescents self-reported similar scores to healthy controls. On the contrary, in the domains of communication ($p = 0.048$), family roles ($p = 0.045$), affective responsiveness ($p = 0.048$), affective involvement ($p = 0.043$) and general functioning ($p = 0.044$), the T1D group scored lower than the controls, indicating better family functioning. Furthermore, within the T1D group, better metabolic control, assessed by glycated hemoglobin (HbA1c), was associated with a trend toward improved affective responsiveness, although this did not reach statistical significance ($p = 0.091$). **Conclusions:** Our findings highlight the importance of family functioning among adolescents with T1D and point toward distinct family processes that can be addressed in the context of routine care to enhance wellbeing and facilitate T1D management.

Keywords: adolescents; type 1 diabetes; family functioning; metabolic control

Academic Editors: Daniela Foti and Marina Basina

Received: 19 January 2026
Revised: 14 April 2026
Accepted: 30 April 2026
Published: 8 May 2026

1. Introduction

Type 1 diabetes (T1D) is an autoimmune hyperglycemic disorder characterized by progressive destruction and insulinopenia, and it remains the most common form of youth-onset diabetes in many populations, especially those of European ancestry. Although T1D typically presents after the age of 6 months, most cases are diagnosed in childhood and adolescence. However, it may also present at any age, later in life [1]. T1D is a demanding

and at times challenging chronic disorder that is typically managed with the administration of insulin, through multiple daily injections, insulin pumps or hybrid systems in parallel with continuous glucose monitoring (CGM) and carbohydrate intake counting during meals, in the context of a healthy diet and exercise, with 60 min of moderate to rigorous exercise recommended every day [2]. Moreover, CGM is necessary to optimize control during and after exercise [2].

Everyday T1D management involves a demanding daily regimen that includes multiple insulin administrations, blood glucose monitoring, a healthy diet, and exercise. These requirements can exceed the typical developmental and psychological capacities of children, although many adolescents are capable of coping with the demands of disease management. Thus, effective disease control demands family support and supervision by caregivers, which can place a considerable burden on all family members and alters the family dynamics [3]. These everyday complexities of T1D management can easily become a serious cause of stress in the family unit, especially for the parents. Family stress can reciprocally influence the course of the disease and further impact the everyday lives of young patients. With this said, a systematic review that involved studies of families with underaged (<18years) children with diabetes highlighted the negative correlation between family stress and offspring glycemic control [4]. Furthermore, Whittemore and colleagues' model of adaptation highlights the interplay of individual and family characteristics (such as sociodemographic) and family processes related to T1D glycemic control [5].

Family functioning, defined as processes that are relevant to the family environment captured in certain dynamic dimensions of family life [6], has been related to the risk, course, and prognosis of variable mental health and medical conditions, such as T1D [7]. Among pediatric patients with diabetes, family functioning has been shown to be a major factor, accounting for 34% of the variance in metabolic control [8]. Accordingly, the aforementioned systematic review revealed a strong positive correlation between adaptive family functioning and improved glycemic control, while family conflict was associated with poor glycemic control [4].

Consequently, there is an urgent need to frame family functioning research on a robust theoretical basis. The McMaster Model of Family Functioning (MMFF27) provides this framework and is broadly used to conceptualize family systems based on over 20 years of research and clinical work with families [6]. According to the McMaster model, family functioning determines the structural and interactive family features. The McMaster family assessment device (FAD) measures different aspects of family functioning: problem-solving, communication, family roles, affective responsiveness, affective involvement, and behavior control [9].

In light of the fact that the family dynamics play a major and complex role in children's adjustment, in variable ways related to the patient's prognosis, it is important to narrow down specific *processes* involved in family functioning that can be targeted to ultimately improve health outcomes and familial relationships [10]. More precisely, a variety of family processes may either facilitate or hinder the development of skills and disease management, given that families constitute complex and dynamic systems in which interpersonal processes are continually evolving, particularly during adolescence [11,12]. It is possible that certain domains of family functioning impact self-management or the adolescents' adherence to their treatment regimen, while others play a minimal role. Additionally, family functioning processes may at certain developmental periods constitute risks or protective factors in regimen adherence. This is especially salient during adolescence, since adherence declines across this developmental period [12,13], increasing adolescents' risk for poor metabolic control and long-term complications [14].

The purpose of the present study was to evaluate family functioning in adolescents with T1D and a healthy control group. This study's main aims were:

(a) To describe and compare family functioning across adolescents with and without T1D;
(b) To investigate possible associations between certain domains of family functioning and sociodemographic variables;
(c) To access the relationship between family functioning and metabolic control among T1D adolescents.

2. Materials and Methods

2.1. Measures

Participants with T1D. For the purpose of this study, 58 adolescents and young adults diagnosed with T1D aged 14–21 years who were regularly followed at the Diabetes and Metabolism Clinic of the Second Department of Pediatrics, National and Kapodistrian University of Athens, "P. & A. Kyriakou" Children's Hospital, were recruited. Participants were recruited prospectively from 2013 to 2019. *Controls.* This study included 116 adolescent students matched for age, gender and socioeconomic level, who were recruited from school-level grades 9–12 on a 1:2 ratio, with the single exclusion criterion of suffering from any acute or chronic disease. They were also indirectly matched for socioeconomic status, as both patients and the controls attended the same private/public high school.

Ethics. Ethical approval was received from the Ethics Review Board of both the "P. & A. Kyriakou" Children's Hospital in Athens, Greece, and the Hellenic Ministry of Education and Religious Affairs. Informed consent for study participation was obtained from all parents/legal guardians of eligible participants prior to their participation in the study.

Demographics. The personal demographic data of all participants were collected, including their place of residence, parental educational level and socioeconomic status.

Somatometric data. The controls self-reported their somatometric parameters (weight, height, BMI). For adolescents with T1D, the somatometric parameters (weight, height, BMI), blood pressure and heart rate were measured and recorded by a nurse or a medical doctor on the day of participation in the study, during their appointment at the Diabetes Unit.

Diabetes history. All participants in the T1D group (n = 58) self-completed a detailed personal medical questionnaire, including T1D duration, age of diabetes onset, and type of insulin therapy.

Glycemic control. The mean annual HbA1c (mean value of four measurements in the past 12 months) was retrieved from participants' medical records as an index of glycemic control. According to the current international guidelines, the target HbA1c for youth with T1D should be <7%, while HbA1c < 6.5% are recommended for the early stage 3 phase (honeymoon period) and for patients using diabetes technology (i.e., CGMs and insulin pumps/hybrid pump systems) [15]. However, only 45% of our patients used insulin pumps, and CGMs were not available in Greece at the time of data collection. Thus, the target HbA1c level of 7% was used for the definition of optimal glycemic control for the whole T1D population.

Family functioning. The Family Assessment Device (FAD) was used [9]. The FAD measures the structural, organizational, and transactional characteristics of families. The FAD is a 60-item measure based on the McMaster Model that assesses family functioning on six different dimensions: *problem-solving* assesses the ability of the family to handle problems and implement problem-solving (e.g., "*We resolve most everyday problems around the house*"); *communication* assesses the exchange of clear and direct verbal information (e.g., "*When someone is upset the others know why*"); *family roles* evaluates the allocation of responsibilities for family tasks between family members (e.g., "*We discuss who is to do household jobs*"); *affective responsiveness* assesses the ability of family members to emotionally respond to one

another (e.g., *"We don't show our love for each other"*); *affective involvement* evaluates to what degree family members are interested in and care about each other (e.g., *"If someone is in trouble, the others become involved too"*); and finally, *behavior control* captures the manner and degree used to express and maintain standards of behavior in the family (e.g., *"We don't hold any rules or standards"*). The General Functioning Scale of the McMaster Family Assessment Device (FAD), which includes 12 items, differentiates healthy from unhealthy family functioning (e.g., *"Making decisions is a problem for our family"*).

The FAD requires individuals to rate their level of agreement/disagreement for specific family behaviors (e.g., "*We try to think of different ways to solve problems*" and *"We don't talk to each other when we are angry*"), using a 4-point Likert scale ranging from 1 (strongly agree) to 4 (strongly disagree). Higher scores are indicative of poorer family functioning.

Scoring: The FAD is scored by adding the responses for each item (1–4) and totaling them for each scale, then dividing them by the number of items in each scale (between 6 and 12, the higher the overall score, *the worse* the level of family function. Clinical cutoffs: general family functioning—2.00; communication, affective responsiveness, problem-solving—2.20; roles—2.30; behavior control—1.90; and affective involvement—2.10 [9].

The FAD has been implemented in a variety of settings, translated into more than 20 languages, and used in countries including the Netherlands, Mexico, Spain, South Africa, and England, indicating its wide cultural applicability [16,17]. In this study, we used all six dimensions of the FAD and the subscales showed that good internal consistency α ranged from 0.81 to 0.89.

2.2. Statistical Analyses

Quantitative variables were expressed as mean values (standard deviation) and as the median (interquartile range), while categorical variables were expressed as absolute and relative frequencies. For the comparison of proportions, chi-square and Fisher's exact tests were used. Student's *t*-test was used for the comparison of participants' age and parental age between the two groups. The odds ratios with their 95% confidence intervals were computed from the results of the conditional logistic regression analyses. The FAD scale was compared across glycemic control groups via multivariate models. Bonferroni correction was used for correcting type I error due to multiple comparisons and partial eta square effect sizes were reported. Cohen provided benchmarks to define effects: small (partial eta square = 0.01); medium (partial eta square = 0.06); and large (partial eta square = 0.14) [18]. All reported *p* values are two-tailed. Statistical significance was set at $p < 0.05$ and analyses were conducted using SPSS statistical software (version 17.0).

3. Results

For the purpose of this study, 174 adolescents were included. The mean age of the participants was 15.9 years (±1.6 years). Of the participants, 58 suffered from T1D (29 boys and 29 girls, mean age 16.3 years (±2.0 years). T1D patients had a mean (±SD) diabetes duration of 6.7 years (±3.5) and in the last 12 months, they had mean HbA1c of 8.0 ± 1.3%.

T1D adolescents were matched with 116 healthy adolescents, of whom 58 were boys and 58 were girls, with a mean age of 15.8. (±1.4 years). The matching was implemented in a ratio of 1:2 with regard to their school, class and gender. As shown in Table 1, which presents the demographic characteristics of all participants (n = 174) separately for each group, no significant differences were shown between the two groups regarding gender, age, nationality and religion. The T1D group and the control group were similar in age (16.3 ± 2 years and 15.8 ± 1.4 years, respectively) ($p = 0.100$). No significant differences were observed in the proportion of cases and controls by calendar year (2013–2019); $p > 0.05$ (Table S1 in Supplementary Material).

Table 1. Individual sociodemographic characteristics among adolescents with T1D and healthy controls.

		Group				*p*
		Healthy Controls		Adolescents with T1D		
		N	%	N	%	
All		116	100	58	100	
Gender	Boys	58	50.0	29	50.0	1.000 ++
	Girls	58	50.0	29	50.0	
Age mean (SD)		15.8 (1.4)		16.3 (2)		0.100 +
Nationality	Other	10	8.9	3	5.7	0.552 ‡
	Greek	102	91.1	50	94.3	
Religion	Christian Orthodox	98	86.7	47	85.5	0.822 ‡
	Other	15	13.3	8	14.5	

+ Student's *t*-test, ++ Pearson's chi-square test, and ‡ Fisher's exact test.

3.1. Comparing Demographics Across the Two Groups of Participants

Regarding the demographic characteristics of participants' families, T1D adolescents had significantly older parents, compared to their healthy peers (fathers' age: controls 48.4 years versus T1D group 51.3 years, $p = 0.026$; mothers' age: controls 43.8 years versus T1D group 45 years, $p = 0.029$). No further differences were shown in familial demographic characteristics across the two groups. The family structure did not differ (married parents: controls 79.6% versus T1D group 86.5%, $p = 0.28$). Moreover, the educational or vocational characteristics of parents did not differ across the two groups, nor did their nationality or immigration status differ. Moreover, sibling characteristics (age of siblings, gender of siblings and number of siblings) were compared across groups and no differences were shown. In sum, no differences were found between the two groups except in the age of their parents.

3.2. Comparing Family Functioning Across the Two Groups of Participants

Table 2 shows the scores obtained in different domains of family functioning across the two groups of participants. Boxplots of FAD domain scores by group are presented in Figure S1 of the Supplementary Material. Affective responsiveness and family roles had higher values in both groups, followed by affective involvement.

Table 3 shows the results of the univariate and multiple conditional logistic regression with the dependent variable being the presence of T1D. Both in the univariate model and the multiple conditional logistic regression (after adjusting for parental age, parental education and parental marital status), it was shown that four components of FAD and general family functioning were significantly associated with the presence of T1D. Namely, in communication, family roles, affective responsiveness, and affective involvement, the T1D group had lower scores than the healthy controls, indicating *better* family functioning. General family functioning was also significantly associated with the presence of T1D. On the contrary, in the areas of problem-solving and behavioral involvement, T1D adolescents reported similar scores compared to healthy adolescent controls.

Table 2. Family functioning dimensions among participants with or without diabetes.

	Groups					
	Healthy Controls			Adolescents with T1D		
FAD Component	**Range**	**Mean (SD)**	**Median (IQR)**	**Range**	**Mean (SD)**	**Median (IQR)**
Problem-solving	1–3.3	2.0 (0.4)	2 (1.7–2.2)	1.2–3.2	2 (0.4)	2 (1.8–2.2)
Communication	1.1–3.1	2.1 (0.4)	2.1 (1.9–2.3)	1–3	2 (0.4)	2 (1.7–2.3)
Family roles	1.4–3.2	2.3 (0.3)	2.4 (2.1–2.6)	1–3.6	2.2 (0.4)	2.2 (1.9–2.5)
Affective responsiveness	1.2–3.7	2.4 (0.5)	2.3 (2–2.7)	1–3.5	2.2 (0.6)	2.3 (1.8–2.5)
Affective involvement	1.1–4	2.2 (0.5)	2.1 (1.9–2.4)	1.1–3.3	2 (0.5)	2.1 (1.7–2.3)
Behavioral involvement	1.1–3.2	2.1 (0.4)	2.1 (1.8–2.3)	1.3–3	2.1 (0.4)	2 (1.8–2.4)
General family functioning	1.1–3.1	2.0 (0.4)	1.9 (1.8–2.3)	1–2.8	1.9 (0.4)	1.8 (1.6–2.1)

Table 3. Univariate and multiple conditional logistic regression with dependent variable of the presence of T1D.

FAD Component	OR (95% CI) [+]	*p*	OR (95% CI) [++]	*p*
Problem-solving	1.31 (0.57–3.01)	0.528	2.12 (0.59–7.68)	0.251
Communication	0.47 (0.20–0.99)	0.046	0.49 (0.21–0.99)	0.048
Family roles	0.41 (0.17–0.99)	0.048	0.42 (0.19–0.98)	0.045
Affective responsiveness	0.53 (0.27–0.99)	0.047	0.53 (0.25–0.99)	0.048
Affective involvement	0.45 (0.21–0.97)	0.041	0.44 (0.22–0.93)	0.043
Behavioral involvement	0.80 (0.45–2.85)	0.800	2.34 (0.73–7.52)	0.155
General family functioning	0.49 (0.22–0.97)	0.047	0.50 (0.27–0.96)	0.044

[+] Unadjusted odds ratio (95% confidence interval) and [++] odds ratio (95% confidence interval) adjusted for parental age, parental education and parental marital status.

3.3. Comparing Family Functioning Across Glycemic Control Groups

Participants with T1D were further analyzed in relation to their metabolic control, measured with glycated hemoglobin (HbA1c), and dichotomized as optimal glycemic control (HbA1c < 7.0%) versus poor glycemic control (HbA1c > 8.5%) (Table 4), where no significant differences were found. However, marginally non-significantly higher scores, yet with a large effect size (i.e., partial eta square ≥ 0.14), were found to affect responsiveness in patients with poor glycemic control in comparison with those with optimal control ($p = 0.091$).

Furthermore, we examined the possible associations between glycemic control and parental education by dividing the study's T1D population into groups based on parental education. No statistically significant difference was found in parental education between the groups with optimal (HbA1c < 7%) vs. poor glycemic control (HbA1c > 8.5%). Although in the group with optimal control, the prevalence of mothers with university education/postgraduate studies was almost double that of the mothers of poorly controlled patients (62.5% vs. 37.5%, $p = 0.887$), the difference did not reach statistical significance, probably due to the small number of participants in each subgroup. Similarly, in the subgroups' analyses of paternal education, in the group with optimal glycemic control, the prevalence of fathers with university education/postgraduate studies was three times that of the fathers of poorly controlled adolescents (75.0% vs. 25.0%, $p = 0.650$), but the difference did not reach statistical significance.

Table 4. Family functioning dimensions among T1D participants with optimal versus poor metabolic control.

	HbA1c				p [1]	Partial Eta Square
	<7.0% (n = 15)		>8.5% (n = 15)			
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)		
Problem-solving	2 (0.5)	2 (1.5–2.2)	2 (0.4)	2 (1.8–2.2)	0.555	0.02
Communication	1.7 (0.4)	1.6 (1.4–2.2)	2.2 (0.5)	2.2 (2–2.4)	0.104	0.13
Family roles	2 (0.5)	2 (1.8–2.3)	2.1 (0.5)	2.1 (1.8–2.5)	0.877	0.00
Affective responsiveness	2 (0.6)	2 (1.3–2.5)	2.5 (0.5)	2.5 (2.3–2.7)	0.091	0.14
Affective involvement	1.9 (0.6)	1.8 (1.3–2.3)	2.1 (0.4)	2.1 (1.9–2.3)	0.722	0.01
Behavioral involvement	2.1 (0.5)	2.1 (1.7–2.4)	2.2 (0.4)	2.2 (1.9–2.5)	0.401	0.04
General family functioning	1.7 (0.4)	1.7 (1.5–2)	2 (0.4)	2 (1.8–2.2)	0.115	0.12

[1] p-value for univariate tests after Bonferroni correction.

4. Discussion

The management of T1D in pediatric patients is a family matter that is interrelated with certain aspects of family functioning. To the best of our knowledge, there are only a few studies on this specific topic and population [4,8]. This study investigated possible disparities in family functioning between adolescents with T1D and healthy matched controls.

Interestingly, compared with their healthy peers, adolescents with T1D in the present study reported more effective communication, clearer role allocation, more appropriate emotional responsiveness and involvement, and better overall family functioning, while showing no differences in problem-solving and behavioral control. These noteworthy findings may reflect a systemic resilience advantage, possibly capturing a form of adaptive restructuring in response to the demands of a chronic illness such as T1D. In that view, Walsh et al.'s study defined resilience as the ability to withstand and rebound from adversity, strengthened and more resourceful, thus encompassing personal growth [19,20]. Moreover, T1D adolescents and their families, in their efforts to manage diabetes, often develop family-based competencies, which may be a benefit stemming from the *structure* and *discipline* that are inherent in consistently following daily routines. This study's participants with T1D were in mid-adolescence and their average T1D duration was over 6 years; thus, these families were already quite experienced in diabetes management. In line with this finding, the *diabetes resilience model* suggests that diabetes outcomes may be influenced by protective processes, which remain understudied [21]. Similarly, in a systemic approach, most recently, the *ecological resilience model* for adolescents with T1D found that family functioning was the strongest predictor of resilience among adolescents with T1D, supporting the theory that adaptive family processes are pivotal in achieving positive outcomes in this population [22]. Importantly, given the cross-sectional design of our study, the observed adaptive patterns across several domains cannot be definitively attributed to the effects of the illness itself. They may reflect adaptive processes in response to the demands of T1D, pre-existing family characteristics, or sample-related factors such as sustained engagement with healthcare services.

More effective *family communication* emerged as a key differentiating feature in adolescents with T1D compared with the healthy controls. Communication is defined here to reflect the exchange of clear and direct verbal information, such as sharing personal frustrations with family members, deviations from the daily regimen, or exploring dietary options. Daily T1D metabolic management requires continuous glucose monitoring and parental assistance, which can foster clear and effective communication, as shown in our study, in which adolescents with T1D performed better in this domain than their healthy

peers. This pattern may go against the typical conflictual parent–adolescent communication in this developmental period, when youth strive for independence, rely on peers for advice and tend to engage in less frequent communication with their parents [12,23]. In our study, when comparing across glycemic control groups, we found no differences in the communication domain among T1D adolescents. Previous research findings have shown the important role of family relations in glycemic control among adolescents with T1D [7,24,25]. Namely, poorer metabolic control and less efficient self-care have previously been associated with lower levels of family functioning [24]. Specifically, youth with more *expressive* and structured family environments have been shown to exhibit better adaptive skills following T1D diagnosis [26]. Accordingly, expressiveness can be targeted in intervention efforts, as shown in a randomized trial of Behavioral Family Systems Therapy for Diabetes. This intervention found that changes in family communication were differentially associated with glycemic control, regimen adherence, and family conflict, and the behavioral intervention was shown to improve family communication and problem-solving [27].

Family roles, the recurrent behavioral patterns through which family members fulfill family functions [6], were found to be another defining process differentiating youth with T1D from the healthy controls. Compared to their healthy peers, adolescents with T1D reported well-defined family roles. This comes as no surprise, since roles and tasks are more distinct in families with T1D, as dictated by their daily regimens and tasks, such as nutrition, blood testing and insulin dosing. On the contrary, in adolescence, roles become less rigid and more blurred in most families with healthy adolescents. During adolescence, increased family turmoil is the norm, as adolescents strive for independence [23] and parents grant more autonomy. On the other hand, for the families of children with T1D, it is expected for these shifts to be more evident, especially when shifting from parental management to adolescent self-management, as children grow into adolescents and assume more responsibility for diabetes management [12,28].

This ongoing shift or realignment of roles within families of children with T1D is mandatory in order to ultimately meet evolving diabetes management needs as children mature and gain independence, possibly accounting for the advanced skills reported by participants in the domain of family roles. Interestingly, a sense of autonomy and independence from the everyday involvement in T1D glycemic management, such as insulin pump therapy, has recently emerged as a core theme among adolescents with T1D [29].

Affective responsiveness was more developed among adolescents with T1D compared to their healthy peers, which may reflect an adaptive affective response to illness-related stress. Families of adolescents with T1D can develop greater emotional attunement as a means of adapting to the challenges of living with T1D. The need to monitor and to respond to potential complications may foster more frequent and meaningful emotional exchanges within the family context. Our study found no differences in affective domains when compared across glycemic control groups. Interestingly, better metabolic control was associated with a trend toward improved affective responsiveness. Although the association did not achieve statistical significance, the observed trend is clinically meaningful and aligns with previous findings indicating that poorer affective responsiveness is associated with worse glycemic control in adolescents with T1D [7]. Families that are able to respond appropriately to emotional needs may be able to reduce diabetes-related distress, and support adherence to treatment regimens. A cohesive family may work better as a team and effectively undertake disease care tasks [30]. On the other hand, according to research data, maladaptive family responses (anger, overcontrol) and family conflict are associated with poorer adherence [31]. For the purpose of psycho-educating families, adaptive affective responsiveness is expected to portray a range of affective family experiences that vary in

quality and quantity. The latter illustrates the level of responsiveness and is conceptualized along a continuum from under-responsiveness to over-responsiveness [6].

In the affective domain, affective involvement refers to the extent of attention and *worry* that family members attribute to family routines. This kind of involvement may facilitate or hinder tasks within the family, and in the case of families with T1D children, they can influence diabetes-relevant tasks. For instance, parents of adolescents with T1D often unwillingly sabotage self-management efforts by being overly controlling or questioning adherence, especially in adolescence with declining glycemic control [25]. We found better affective involvement among adolescents with T1D. This may be due to their need to engage family members in T1D management. Within this framework, a recent review on the consequences of T1D on families used content analysis and found corroboration for the notion that diabetes is a "family illness" [32]. As supported by the authors, T1D alters family life by introducing heightened emotions and novel routines via educational processes that arise post-diagnosis and permeate family life. In conjunction with these shifts in family dynamics, various pubertal and behavioral changes (e.g., in assuming responsibility for tasks involving T1D management) that normally occur during the pubertal period may adversely affect overall metabolic control [11]. More importantly, the pubertal transition activates neural social–emotional processing that spurs sensation-seeking [33]. At this time of turmoil, when adolescents are taking risks and seeking rewards, parents need to gradually "step back" and provide opportunities for autonomy building. The primary focus may not rest on the extent of parental involvement, but rather *how* their involvement is communicated. The solution may reside in parental supportive emotional guidance, rather than *controlling*, thus spurring less reactivity. This may in turn enhance self-management and self-efficacy. Therefore, the family needs to be trained to enable adaptive affective involvement in developmentally appropriate ways which are consistent with the stage of adolescence.

*Clinical implications***.** In line with positive psychology's strengths-based approach, which emphasizes coping skills and positive qualities [34], resilience-related skills and perceptions represent important areas of intervention in the context of T1D management. These intervention domains encompass benefit finding, as well as emotion processing and emotion expression. The latter two were shown in this study, and have consistently been related to positive psychosocial and health outcomes [35]. Additional protective factors include active coping, hopefulness, social skills, and diabetes management self-efficacy [29,30]. Altogether, in combination with family functioning and disease management processes, individual and family strengths provide valuable means to promote positive diabetes-related outcomes [30].

More importantly, a family-centered approach requires routine integrated follow-up primary care visits. For instance, a child's behavioral reactivity towards their daily insulin administration regimen can spur parental distress, subsequently giving rise to stressful communication among family members and emotionally burdening the patient, possibly heightening adherence difficulties. Such behavioral patterns need to be recognized through structured parental monitoring and accordingly addressed with individualized behavioral interventions. In particular, the mechanisms through which worry is expressed can be revisited, allowing the family to develop alternative phrasings through which the parent can express specific concerns about current glycemic monitoring, rather than worry about the child, their skills, or the future. This shift in framing may help to reduce blame and tension.

*Limitations and strengths***.** This study's main limitation was the small sample size of T1D adolescents, which may have prevented the achievement of statistically significant differences between certain subgroups. However, the study population was representative of the Greek pediatric T1D population, as our Diabetes Unit belongs to the University

Department of a tertiary Children's Hospital, which is a referral center for central and Southern Greece and the islands. Another limitation of the present study was the absence of data from continuous glucose monitoring (CGM). Nonetheless, the quality of glycemic control was based on average HbA1c measurements during the past 12 months, which is adequately representative of the quality of diabetic control.

An additional limitation is the cross-sectional design that precludes any conclusions regarding causality or the directionality of the observed associations between T1D and family functioning. Finally, although groups were matched on key demographic variables, unmeasured factors such as parental engagement may have contributed to the observed differences.

One of the main strengths of the present study is that it included a healthy control sample, matched for age, gender and socioeconomic status on a 1:2 ratio, which was recruited from schools and was representative of the pediatric T1D population. Another positive attribute of the study was comparing family functioning between adolescents with optimal versus poor glycemic control, which provides greater insight and clinical applicability, highlighting specific family domains.

5. Conclusions

In conclusion, as reported by youth with T1D at the group level, families of adolescents with T1D can exhibit enhanced overall family functioning compared with healthy matched controls, particularly in the emotional and communicative domains. This is consistent with family resilience theory [19], suggesting a process of reorganization in response to the demands of a chronic condition such as T1D. Psychological support for youth with T1D should involve the entire family unit and target specific family processes.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/endocrines7020019/s1. Figure S1. Boxplot of FAD domain scores by group. Table S1. Individual socio-Demographic characteristics among adolescents with T1D and healthy controls.

Author Contributions: Conceptualization, B.K., A.T. and K.K.; methodology, B.K. and K.K.; software, C.T.; validation, E.C.T., I.-I.S., C.T. and K.K.; formal analysis, C.T.; investigation, B.K., S.K., A.P., V.C. and D.C.; resources, S.K., V.C. and D.C.; data curation, I.-I.S.; writing—original draft preparation, E.C.T. and B.K.; writing—review and editing, A.T. and K.K.; visualization, E.C.T.; supervision, A.T. and K.K.; project administration, A.P., A.T. and K.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of "P&A Kyriakou" Children's Hospital, number 10883, dated 8 March 2010.

Informed Consent Statement: Written informed consent has been obtained from the patients to publish this paper.

Data Availability Statement: Raw data are unavailable due to privacy or ethical restrictions.

Acknowledgments: We thank all participants of the study and their families. We especially thank Maria Kaza for her careful language editing of the manuscript.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

T1D	Type 1 diabetes
CGM	Continuous glucose monitoring
HbA1c	Glycated hemoglobin

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