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Sara Sofia Pereira Santos

Physical Activity Level in Children and Adolescents with Type 1 Diabetes: a cross-sectional study

Nível de Atividade Física em Crianças e Adolescentes com Diabetes Tipo 1: um estudo transversal

MARÇO, 2022

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DESIGNAÇÃO DA ÁREA DO PROJECTO

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TÍTULO DISSERTAÇÃO/~~MONOGRAFIA~~ (riscar o que não interessa)

Physical Activity Level in Children and Adolescents with Type 1 Diabetes Mellitus: a cross-sectional study

ORIENTADOR

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Faculdade de Medicina da Universidade do Porto, 18/03/2022

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DEDICATÓRIA

À Professora Dr.ª Cíntia Castro-Correia, que me orientou durante estes meses na elaboração desta dissertação, por todo o tempo que dispensou para me ajudar, pelos comentários e sugestões.

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Physical Activity Level in Children and Adolescents with Type 1 Diabetes: a cross-sectional study

Short title: Physical Activity Level in T1DM Youth

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ABSTRACT

Background: Type 1 Diabetes Mellitus (T1DM) carries a high risk for the development of several chronic systemic complications, being of vital importance its adequate management, balancing physical activity (PA) practice, diet, and insulin regimen. Nonetheless, some factors may be a barrier to regular PA in diabetic patients, as fear of hypoglycemia. Additionally, PA direct impact in T1DM is still poorly understood.

Objectives: Therefore, we aimed to compare physical activity level (PAL) between children and adolescents with T1DM and healthy controls, as well to report other factors which may affect PA in youth.

Materials and Methods: A total of 86 participants (T1DM=61, control=25) were included. Data was collected through a questionnaire, applied to patients that recurred to CHUSJ between December 2021 and January 2022.

Results: No significant differences were found regarding PAL when comparing T1DM youth with healthy peers (1.470 vs. 1.469 METs/min*, p=0.964).* In T1DM group, a positive correlation was found between PAL and HbA1c (r=0.254, *p=0.048*).

Conclusions: Our findings suggest that diabetes-associated barriers do not play a significant role limiting PA routines in diabetic youth, since reported PAL was similar in both groups. This study emphasized the necessity of overcoming questions related to PA in T1DM patients, in an attempt to attain from physical activity the maximum benefit.

Keywords: Child; Exercise; Type 1 Diabetes

INTRODUCTION

Type 1 Diabetes Mellitus (T1DM) has seen, in the last years, an increase in its incidence, exceeding one million cases in patients aged 0 to 19 years worldwide [1, 2]. Data relative to Portuguese population shows an identical tendency, pointing environmental factors as the main cause for this increase [3]. Diabetes plays a negative influence in the patients' survival and quality of life [4]. This disease conducts to organ system degeneration, entailing a high risk of development of cardiovascular disease, retinopathy, neuropathy, and nephropathy, being the leading cause of chronic kidney disease [4, 5]. Hence, it is of vital importance its adequate management, balancing insulin regimen, carbohydrates intake and physical activity patterns [6].

Regular physical activity (PA) is known to be beneficial, particularly in children and adolescents with T1DM, helping to improve cardiovascular function, lipidic and glycemic profiles [7, 8], whilst it increases insulin sensitivity and lowers insulin requirements [9]. Additionally, recent evidence points out that regular PA contributes to extend partial remission time in children with T1DM, when comparing physically active and non-active groups. Moreover, it was found in the latter group lower HbA1c levels and lower daily insulin requirements, which may lead to a better control of long-term effects of the disease [10].

However, some factors may be a hindrance to regular exercise habits in this group of patients, namely the fear of hypoglycemia (FoH), the most common acute complication of T1DM [11]. There are few reports addressing the relation between T1DM and fear of hypoglycemia, although the existing data suggests that the latter has a negative impact towards the implementation of physical activity routines [12].

Despite the largely benefits associated with regular PA, the direct impact of this therapy in patients with T1DM is still poorly understood [13], with evidence showing a non-significant decrease in HbA1c with PA. More recent studies (2020) tend to confirm this tendency, as reported by Jamiolkowska-Sztabkowska in a 2-year prospective study of children with T1DM [10].

Therefore, the aim of this study was to compare the physical activity level between children and adolescents with T1DM and healthy controls, as well to report factors that may affect exercise levels in youth. We hypothesized that the presence of T1DM might influence physical activity habits of young patients, aiming additionally to evaluate the impact of PAL on BMI percentiles and HbA1c levels.

MATERIALS AND METHODS

STUDY DESIGN

A cross-sectional study was performed in Centro Hospitalar Universitário São João (CHUSJ), between December 2021 and January 2022. Data were collected through the application of a questionnaire, adapted from RAPIL II questionnaire, validated for Portuguese population [14]. The HbA1c level considered for diabetic patients was the last value measured, extracted from clinical records. The questionnaire was given to eligible patients that, during the period mentioned above, recurred to pediatric consultations in CHUSJ.

The questionnaire applied, aside from its validation for the study population, was standardized, with the same questions being applied to all participants irrespectively of their sex, age group or metabolic control of the disease, minimizing information bias.

SAMPLE SIZE

For sample size calculation, a $p<0.05$ was considered to be significant, and a 80% power was defined [15]. A cross-sectional study by Wu et al., that used METs/min as a measure for PAL, was considered as reference for standard deviation of PA levels [16]; considering PAL categories [17], the value of 0.25 was set as a statistically significant difference. Therefore, a sample size of 42 was determined for each group of comparison.

PARTICIPANTS

The inclusion criteria for both groups were the following: (1) patients aged between 6 and 18 years-old; (2) absence of severe disease or condition limiting the participant's mobility or ability to perform physical activity (including respiratory or endocrine-metabolic conditions); (3) absence of mental disease or any other condition compromising the child or adolescent's autonomy. Regarding the T1DM patients' group, the diagnosis of type 1 Diabetes Mellitus was a mandatory requirement, whereas in the control group, Diabetes diagnosis was excluded.

Questionnaires with missing data were excluded from the analysis, as well as questionnaires with invalid or incongruent data (e.g., reporting fifteen hours of sleep and eight hours of screen time per day). The absence of consent or participation refusal, either from the patient or from their legal tutor, was also considered an exclusion criterion.

QUESTIONNAIRE AND ASSESSMENT OF PHYSICAL ACTIVITY LEVEL

The questionnaire was constructed to retrieve different types of information: general personal and socioeconomical information, screen time, sleep time and physical activity performed during a typical week (**Supplemental Material, attachment A**). Physical activity level was estimated as mean daily METs/min.

For total daily MET calculation, a typical weekday was contemplated. Beyond PA and sleep time reported in the questionnaire, one hour for eating, one hour for grooming, and five hours of school classes per day were considered; the remaining time of the day corresponded to sedentary activities (as reading or watching television) and, for simplification purposes, it was considered having an energy expenditure equivalent to 1.3 METs/min. Detailed information about the formula used is described in **Supplemental Material, attachment B**.

These estimations used as reference the MET values present in the Youth Compendium of Physical Activities of 2018 [18]; for missing MET values in the latter compendium, corresponding values listed on the Compendium of Energy Expenditures for Youth of 2008 [19] were used. **Supplemental Material, attachment C** listed the activities and respective MET values used.

For interpretation purposes, PAL can be subdivided in four categories: sedentary (PAL ≥ 1.0 and < 1.4), low active (PAL ≥ 1.4 and < 1.6), active (PAL ≥ 1.6 and < 1.9) and very active (PAL ≥ 1.9 and < 2.5), according to the Institute of Medicine [17].

Weight status, evaluated as BMI (Body Mass Index) percentiles was determined through weight and height, according to preestablished growth curves, adjusted for age and sex, used in the Portuguese clinical practice [20]. Overweight was defined as a BMI equal or greater than the 85^{th} percentile, but inferior to the 95^{th} percentile. Obesity was defined as a BMI equal or greater than the 95^{th} percentile. Underweight was considered when BMI was under the 5^{th} percentile.

STATISTICAL ANALYSIS

Data collected through the questionnaire was introduced in a Microsoft Excel spreadsheet and transposed to GraphPad Prism 8.0.2, where all statistical procedures were performed.

Continuous variables were tested for normal distribution by the D'Agostino-Pearson omnibus normality test. Since the studied parameters did not follow a Gaussian distribution, descriptive statistics were calculated as median with interquartile range (IQR). For continuous variables, Mann Whitney U test was used to compare data between the two groups; for categoric variables, a Fisher Exact Test was performed. In T1DM group, Spearman coefficient was calculated to evaluate the possible correlation between PAL and HbA1c levels, BMI percentile and screen time. Lastly, in the same group, HbA1c levels were grouped by parental education level and a comparison was performed using Kruskal-Wallis test.

Statistical significance was set at $p<0.05$.

ETHICAL APPROVAL

The application of the questionnaire was previously authorized by the Ethics Committee of CHUSJ (no. 302/21). Written information about the study was given to children's parents and/or legal guardians, who signed an informed consent.

RESULTS

A total of 86 participants were included in this study, between 6 and 18 years old, distributed among the two groups of analysis: diabetic (n=61) and control (n=25). Diabetic group had 52,5% males, and an age median of 14y (IQR: 11–16); control group had 48% males, and an age median of 11y (IQR: 8–14.5). No group differences were found regarding sex (*p=0.813*); however, concerning age, children in control group tended to be significantly younger comparatively to T1DM group (*p=0,021*). Regarding residency type, access to an outdoor space, and proximity to a park or bike lane, no considerable differences were found as well (*p=0.153*, *p=0.083*, *p>0.999*, respectively).

PAL has shown to be similar in T1DM and control groups (1.470 METs/min vs. 1.469 METs/min*, p=0.964*). **Figure 1** provides an overview of PAL by categories in both groups. On the subject of BMI percentiles, an analysis concerning weight status categories (underweight, normal weight, overweight and obese) has shown similar groups' composition. Alternatively, analyzing concrete BMI percentiles revealed analogous results when comparing diabetic youth and healthy peers (72^{nd} percentile (IQR: 50^{th}–$84{,}5^{th}$) vs. 79^{th} percentile (57^{th}–92^{nd}), *p=0.263*). Detailed characteristics of the sample are summarized on **Table 1**.

In T1DM group, HbA1c levels were studied as a measure of Diabetes' metabolic control, and a median of 8.1% (IQR: 7.25–9.0) was found. Three different categories of parental education level were considered: primary education level (with both parents completing less than 12 school years), secondary education level (at least one of the parents completed 12 school years), and higher education level (at least one of the parents had a bachelor's degree). No substantial differences were found between HbA1c levels in the three groups (*p=0.817*), as shown by **Figure 2**; however, the most extreme values (14.0 and 14.4 g/dL) were found in the group of parents with lower education level.

Regarding in the diabetic patients' group, a weak positive correlation was found between HbA1c levels and PAL (r=0.254, *p=0.048*), having higher PAL values being associated with superior HbA1c levels (**Figure 3**). Possible correlations were tested between screen time and BMI, PAL and BMI and PAL and screen time, with no noteworthy results to report (**Table 2**).

When distinguishing diabetic patients using continuous subcutaneous insulin infusion (CSII, n=58) from those who use multiple daily insulin injections (MDI, n=3), PAL was not significantly different (PAL median: 1.470 vs. 1.600, respectively, p=0.101); a substantial difference was found between the HbA1c in these subgroups (8.05% in CSII vs. 14.4% in MDI,

p<0.001). When analyzing T1DM group for continuous glucose monitoring (CGM), no differences were found regarding PAL (1.470 in CGM group vs. 1.486, p=0.658); however, HbA1c was considerably lower in group with CGM (7.6% vs. 9.2%, p<0.001).

Finally, data from both groups was merged to evaluate the influence of residency type, presence of outdoor space and proximity to a park or bike lane in exercise practice. Considering these factors, none proved to have a noticeable influence in exercise, as shown in **Table 3**.

DISCUSSION

The present study was designed to evaluate physical activity level (PAL), having as main goal to compare data between diabetic youth and healthy peers. Prespecified hypothesis expected to find lower PAL values in diabetic patients, taking into consideration factors as fear of hypoglycemia (FoH) and loss of control over diabetes as a barrier to PA performance [21, 22]. Nonetheless, our results showed equivalent PA levels among both groups of study, suggesting the factors aforementioned have a reduced weight in hinder exercise practice. Our findings meet conclusions drawn by Salem et al. in a randomized control trial, which showed no considerable differences between the occurrence of hypoglycemia in patients attending exercise programs versus sedentary peers [23].

A sub-analysis was then performed to search for differences in PAL inside T1DM group, differentiating patients using CSII from those using MDI, as well as to understand if the adoption of CGM had influence in PAL. No substantial differences were found in the groups above-mentioned; concerning CSII and MDI, the similarity between results can be explained by the low number of patients in our sample using MDI (only 3 from a total of 61). However,

when looking at HbA1c levels in the same subgroups, major differences were observed, favoring CSII over MDI, as well as the adoption of CGM as a positive strategy towards an optimal metabolic control. As stated by Battelino [24], CGM yields instant feedback on glucose levels and its trend to change, permitting adjustments in carbohydrates intake, physical activity, and insulin dosing, and, consequently, a greater balance of HbA1c levels.

Regarding data from T1DM group, correlations were explored to find possible associations between PAL, BMI percentiles, HbA1c levels and screen time. Despite the significant result, the relation between PAL and HbA1c explains only 6,5% (r^2=0,065) of the variation in HbA1c levels. Data in literature is controversial about the association between PA and HbA1c levels. As remarked by Kennedy et al. [13], despite the largely benefits concomitant with regular PA, the direct impact of this therapy in patients with T1DM is still poorly understood. This systematic review and metanalysis showed a decrease in HbA1c with PA, but not statistically significant. Recent studies have observed the same tendency, as reported by Jamiolkowska-Sztabkowska in a 2-year observation [10].

Despite it was expected HbA1c levels to decrease with higher PAL values, some reasons can be pointed out to substantiate the tendency found in the present study. These causes include an increased calorie intake to avoid hypoglycemia [25] and a reduction in insulin dosage when performing exercise [13]. Furthermore, HbA1c levels, although an extensively used indicator of metabolic control in diabetic patients and a marker for the development of long-term complications, lack to evaluate the frequency and the magnitude of glucose daily variation [24]. It is also noteworthy to mention a possible reporting bias, since children and adolescents may have reported higher PA levels as a compensation for an HbA1c level above the target defined.

Different factors play a role on T1DM children's metabolic control: not only factors related with the disease management, for example the use of CSII and CGM adoption, as referred above, but also environmental factors, among which are mindful parenting, household income, parents' age, and their education level. As reported in MILES study, parenting style has been shown to influence glycemic control and quality of life [26]; low income and low education level have also been associated with higher HbA1c levels in diabetic children [27]. In our study, we failed to ascertain potential differences in HbA1c levels when categorizing parents by their education level. Nevertheless, two outliers were found in the group with lower educational stage, suggesting that extreme cases of metabolic dysregulation may be linked to a lower parental education level.

Considering PAL cutoffs defined by the Institute of Medicine [17], 29,5% of patients in the T1DM group and 28% in the control group were sedentary (PAL < 1.4 METs/min) (**Figure 1**). In addition, when attending BMI percentiles, 26,6% of patients in T1DM group and 36% in the control group were overweighted or obese. These findings, albeit aside from the primary aim of this study, emphasize the high prevalence of obesity in youth, entailing an increased risk of chronic diseases and increased mortality [28, 29]. In diabetic patients, risks linked to obesity have been found to be increased and high BMI percentiles may lead to an earlier age of diagnosis [30].

Besides, we aimed to assess, from a global perspective, if residency-associated conditions, as living in an apartment opposed to a house, would influence PAL. A recent systematic review by Hesketh et al. [31] summarized factors potentially affecting PA in young children. Reported results presented both barriers and facilitators for PA practice regarding the presence of an outside space and community resources, as parks and playgrounds. Our results met this

tendency, since none of the environmental conditions assessed had a considerable role in exercise practice.

In parallel with the high proportion of sedentarism, a considerable percentage of participants in this study stated living in the proximity to a park or bike lane, as well as having a garden or outdoor space available, contributing to rebut the hypothesis that favorable environmental conditions would be linked to a more active routine in youth. Nevertheless, some studies have already shown that home-park distance may not be the main factor determining the visitation of parks, since children do not always go to the nearest park [32, 33]. A recent study by Rivera revealed concordant data [34], highlighting park features that encourage a park frequentation and, consequently, enhance its attractiveness for exercise practice, e.g., the existence of multisport courts. Beyond the aforesaid conditions, the availability of walkable areas has also been proved to influence positively PA practice, which may be an important point of intervention to incite a shift in PA routines among children and adolescents towards a less sedentary lifestyle.

Additionally, considering HbA1c target level (<7%) defined by the International Society for Pediatric and Adolescent Diabetes (ISPAD) [35], only about 13% of the diabetic patients studied accomplished the HbA1c goal; whether a more tolerant aim is considered (7.5%), the referred percentage rises only to 29,5%. It represents less than one third of diabetic youth; thus, further strategies need to be addressed for a better metabolic control towards HbA1c intended levels.

This study was conducted in accordance with STROBE guidelines for cross-sectional studies. However, our analysis was limited by the small sample size and, consequently, the asymmetric distribution of the variables. Notwithstanding, except for age, both T1DM and

control groups were similar in sex, residency-associated conditions, and parental educational level, increasing their comparability. Moreover, either BMI percentiles and PAL calculations were performed regarding each patient's age group and sex, minimizing bias attributable to these characteristics.

Aforementioned, other factors with potential influence in PAL and HbA1c, as fear of hypoglycemia, frequency of hypoglycemic events and diet composition were not evaluated in our analysis. Furthermore, it would be interesting to heighten the difference between PAL in diabetic patients using CSII from PAL in patients using MDI as diabetes management regimen, taking into consideration the insufficient group size in the present study. CSII is considered to be more flexible and precise [36], and can subside exercise-induced dysglycemia, when compared with MDI [37, 38], which can hypothetically result in a tendency to higher exercise levels in these patients, along with a lower incidence of hypoglycemia.

Diet evaluation would likewise be a key point to analyze concomitantly with PAL. Firstly, it could confirm a potential propensity to a pre-exercise carbohydrates load, and its influence on HbA1c and weight. Secondly, a stratification of youths regarding their energy intake could provide a more precise analysis of PAL and its correlation with HbA1c levels, since high-fat and low-carbohydrate diets have been associated with worse glycemic control, independently of PAL and BMI [39].

To conclude, our findings suggest that diabetes-associated barriers, such as FoH, do not play a significant role in limiting PA routines in diabetic youth, since reported PAL was similar in T1DM and control groups. Furthermore, this study emphasized the necessity of overcoming questions related to physical activity in T1DM patients, in an attempt to attain from PA the utmost benefit, namely the reduction of long-term complications of the disease.

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LIST OF ABBREVIATIONS

PAL – Physical Activity Level

PA – Physical Activity

T1DM – Type 1 Diabetes Mellitus

HbA1c – Hemoglobin A1c

CSII – Continuous Subcutaneous Insulin Infusion

MDI – Multiple Diary Injections

CGM – Continuous Glucose Monitoring

FoH – Fear of Hypoglycemia

BMI – Body Mass Index

EL – Education Level

IQR – Interquartile Range

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Author contributions

All the authors have accepted responsibility for the entire content of this submitted manuscript and approved submission.

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Competing interests

The funding organization(s) played no role in the study design; in the collection, analysis, and interpretation of data; in the writing of the report; or in the decision to submit the report for publication.

TABLES AND FIGURES

Table 1. *Characteristics of T1DM and Control Groups.*

Characteristics	T1DM (n=61)	Control (n=25)	Differences
Age, median (IQR)	14 (11–16)	11 (8–15)	***p=0.021***
Gender, n (%)			
Male	32 (52,5%)	12 (48%)	*p=0.813*
Female	29 (47,5%)	13 (52%)	
Weight status, n (%)			
Underweight	1 (1,6%)	0 (0%)	*p=0,678*
Normal weight	45 (73,8%)	16 (64%)	
Overweight	10 (16,4%)	6 (24%)	
Obese	5 (8,2%)	3 (12%)	
Daily screen time median (IQR), min	120 (90 – 240)	120 (60 – 120)	***p=0.021***
PAL median (IQR), METs/min	1,470 (1,391-1,574)	1,469 (1,383-1,576)	*p=0.964*
HbA1c median (IQR), %	8.1 (7.25 – 9.0)	–	–
Residency, n (%)			
Apartment	36 (59,0%)	10 (40%)	*p=0.153*
House	25 (41,0%)	15 (60%)	
Garden / outdoor space, n (%)	36 (59,0%)	20 (80%)	*p=0.083*
Proximity to a park / bike lane, n (%)	45 (73,8%)	19 (76%)	*p>0.999*
Parental Education, n (%)			
Primary Education Level (< 12 years)	14 (23,0%)	3 (12%)	*p=0.511*
Secondary Education Level (12 years)	21 (34,4%)	10 (40%)	
Higher Education Level (>12 years)	26 (42,6%)	12 (48%)	

Abbreviations: PAL – Physical Activity Level; IQR – interquartile range.

Significant p values (p<0.05) are bold.

Table 2. *Correlation and respective Spearman correlation coefficients between variables in T1DM group.*

Correlation	**Spearman r correlation coefficient**	***p value***
PAL and HbA1c levels	0.254	***0.048***
Screen time and BMI percentile	0.095	*0.467*
PAL and BMI percentiles	0.010	*0.938*
PAL and screen time	0.041	0.756

Abbreviations: PAL – Physical Activity Level; BMI – Body Mass Index.

Significant p values (p<0.05) are bold.

Table 3. *Influence of residency type and surroundings in PAL median.*

Characteristics	**PAL median**	**Difference**
Apartment	1.491	*p=0.130*
House	1.466	
Presence of outdoor space	1.470	*p=0.860*
Absence of outdoor space	1.473	
Proximity to a park / bike lane	1.480	*p=0.064*
Absence of park / bike lane	1.439	

Abbreviations: PAL – Physical Activity Level.

Significant p values (p<0.05) are bold. Data from the totality of the sample is represented.

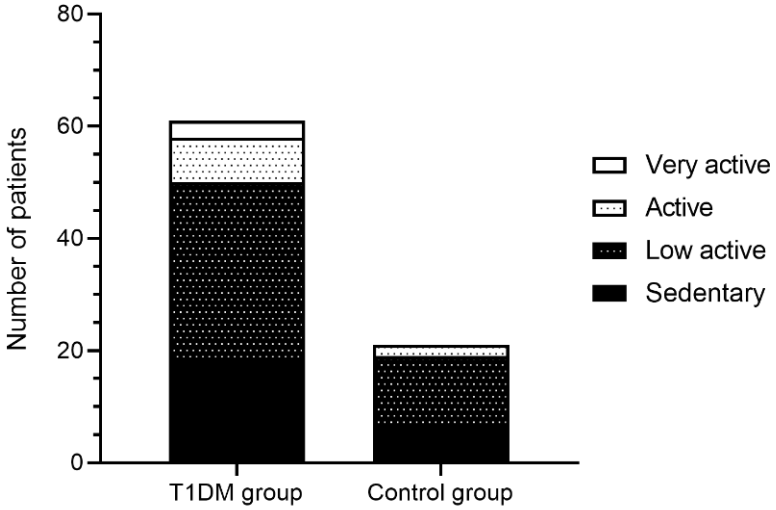

Figure 1. *PAL categories in T1DM and control groups.*

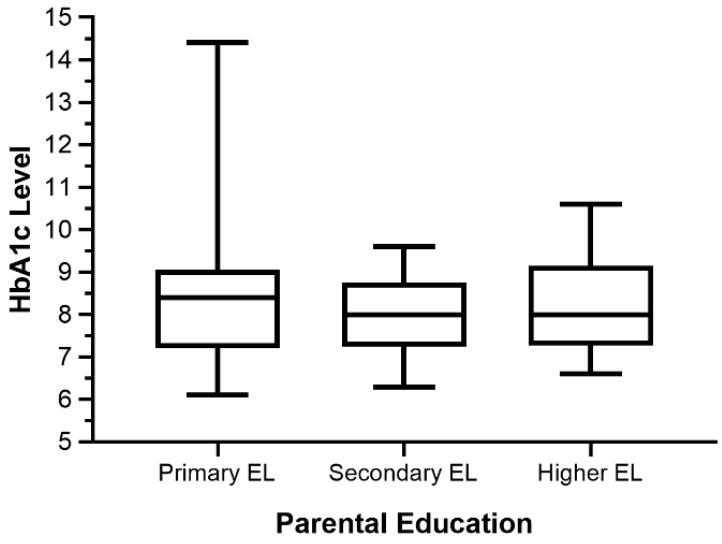

Figure 2. *HbA1c level in T1DM group by parental education level.*

Abbreviations: EL – education level

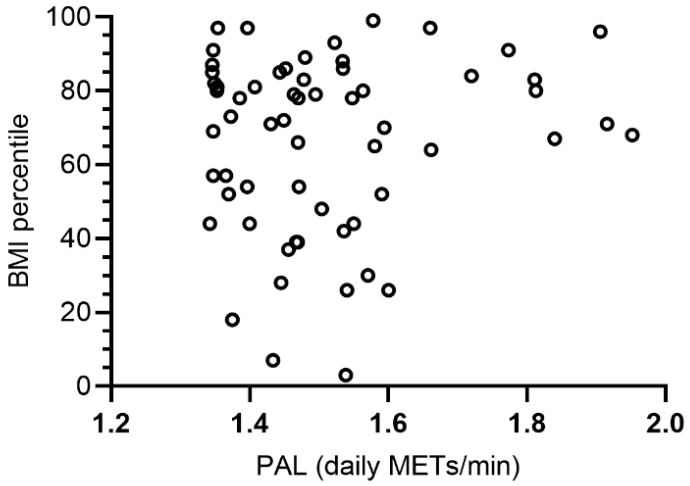

Figure 3. *Correlation between PAL and BMI percentile in T1DM group.*

SUPPLEMENTAL MATERIAL

Attachment A – Questionnaire:

QUESTIONÁRIO PARA AVALIAÇÃO DA ATIVIDADE FÍSICA

Este questionário faz parte de um estudo que tem como objetivo avaliar a realização de atividade física em crianças acompanhadas no CHUSJ, assim como os principais fatores que possam condicionar a prática de exercício. Asseguramos que os dados obtidos não serão divulgados ou utilizados com qualquer outro propósito que não o estudo acima mencionado. Agradecemos desde já a sua colaboração.

Investigador principal: Sara Sofia Santos; contacto: up201606279@med.up.pt.

1. IDENTIFICAÇÃO

Idade: _____ anos

Sexo: ☐ Rapaz ☐ Rapariga Peso atual: _____kg Altura: _____m

Ano escolar: _____

2. HABITAÇÃO

Em que tipo de habitação a criança vive? ☐ Apartamento ☐ Moradia ☐ Outro: _____

A habitação em questão tem algum **jardim** ou **espaço exterior**? ☐ Sim ☐ Não

Vives próximo(a) de um parque ou ciclovia? ☐ Sim ☐ Não

3. AGREGADO FAMILIAR DA CRIANÇA

Idade do pai: _____ anos Escolaridade do pai: _____

Idade da mãe: _____ anos Escolaridade da mãe: _____

A criança tem irmãos? ☐ Sim ☐ Não Se sim, quantos? _____

Para além da criança, com quantas pessoas ela vive em casa? _____

Por favor, indique quais destas pessoas vivem em casa com a criança:

☐ Pai ☐ Mãe ☐ Irmão(ãos) ☐ Avós ☐ Tios ☐ Outras pessoas

4. DESLOCAÇÃO CASA – ESCOLA

Qual é a forma de deslocação preferencial da criança **entre casa e escola**?

☐ A pé ☐ De carro / transporte motorizado ☐ Transportes públicos ☐ Bicicleta

Se ela anda **a pé** (seja só parte ou a totalidade do percurso), quanto tempo demora no percurso casa-escola / escola-casa? (some o tempo que gasta nos percursos a pé **durante um dia**) _____h_____min

A criança realiza algum outro percurso **a pé** diariamente, para além do trajeto entre casa e escola?

☐ Sim ☐ Não Se sim, quanto tempo demora nesse percurso? _____h_____min

5. AULAS DE EDUCAÇÃO FÍSICA

Quantas vezes a criança tem aulas de Educação Física por semana?

- Aulas de **45 minutos**: ☐ Nenhuma vez ☐ 1 vez ☐ 2 vezes ☐ 3 vezes
- Aulas de **90 minutos**: ☐ Nenhuma vez ☐ 1 vez ☐ 2 vezes ☐ 3 vezes

6. MODALIDADES DE DESPORTO

Para além das aulas de educação física, pratica alguma modalidade de desporto? ☐ Sim ☐ Não

Se sim, que modalidade(s) pratica?

☐ Futebol	☐ Basquetebol	☐ Andebol	☐ Voleibol
☐ Atletismo	☐ Ginástica	☐ Dança	☐ Natação
☐ Artes marciais	☐ Ciclismo	☐ BTT	☐ Ténis
☐ Equitação	☐ Remo / canoagem	☐ Vela	☐ Surf
☐ Hóquei	☐ Patinagem	☐ Skate	☐ Outra(s)

Se respondeu "Outra(s)", qual(is)? _____

Aproximadamente, durante quanto **tempo por semana** a criança costuma praticar as atividades físicas assinaladas na pergunta anterior? Se mais do que uma, especifique a que atividade corresponde o tempo.

1. _____h_____min Modalidade: _____
2. _____h_____min Modalidade: _____
3. _____h_____min Modalidade: _____

Pratica outro tipo de atividade física (como ginásio, caminhadas, passadeira, etc.)? ☐ Sim ☐ Não

Se sim, qual? _____ Quanto tempo **por semana**? _____h_____min

7. TEMPO DE ECRÃ

Com qual(is) tipo(s) de dispositivos com ecrã a criança costuma entreter-se durante o dia?

☐ Telemóvel ☐ Computador ☐ Televisão ☐ Tablet ☐ Consolas ☐ Outro: _____

Aproximadamente, durante quanto **tempo por dia**, num **dia da semana**, costuma entreter-se com os dispositivos mencionados anteriormente? _____h_____min

E durante um **dia do fim de semana**? _____h_____min

8. HORAS DE SONO

A que horas a criança se costuma deitar e levantar? (responda de acordo com o horário mais frequente)

- Dias da semana: hora de deitar _____h_____min; hora de levantar _____h_____min
- Fim de semana: hora de deitar _____h_____min; hora de levantar _____h_____min

9. ATIVIDADES DOMÉSTICAS

Com que frequência a criança costuma realizar atividades domésticas (fazer as camas, limpar o pó, varrer o chão, cozinhar, arrumar a casa, etc.)?

☐ Nunca ☐ Raramente ☐ Por vezes ☐ Muitas vezes ☐ Quase sempre ☐ Sempre

A preencher pelo médico:

Doente diabético: ☐ Sim ☐ Não

Data de preenchimento do questionário: _____/_____/_____

Nº do questionário:_____

Attachment B – Formula used for METs calculation:

a. Duration of each activity per week (min) x MET value = Volume of each activity per week

   ∑ (all activities) = Volume of physical activity per week

b. **Sleep** = Sleep minutes in a typical weekday x $METvalue_{sleeping}$ = Sleep min x 0,9

c. **Schooltime** (considering 5h per day) = 300 min x $METvalue_{schoolwork}$ = 300 x 1,5 = 450

d. **Eating** (considering 1h) = 60 min x $METvalue_{eating}$ = 60 x 1,5 = 90

e. **Grooming** (considering 1h) = 60 min x $METvalue_{grooming}$ = 60 x 2 = 120

f. **Sedentary activity** = (24h – Sleep-time – (5h + 1h + 1h)) x $METvalue_{sedentary\text{-}activity}$ = 1440 min – Sleep min – 420 min) x 1,3

Final formula:

$$\frac{\sum(allactivities)}{7} + \text{Sleep} + \text{Schooltime} + \text{Eating} + \text{Grooming} + \text{Sedentary activity}$$

Unit: METs/min (daily mean)

Attachment C – Activities and corresponding MET values considered for PAL estimate:

Activity Code	Specific Activity	MET by age group (years)			
		6 – 9	10 – 12	13 – 15	16 – 18
Activities listed on the Youth Compendium of Physical Activities (2018) (18)					
65100X	Basketball	6,7	7,0	7,2	7,5
30100X	Calisthenics	4,3	4,4	4,4	4,5
25120X	Cycling	4,7	5,3	5,8	6,4
40100X	Dance	3,6	4,1	4,5	4,8
30220X	Gymnastics	2,7	2,7	2,7	2,7
65240X	Handball	5,4	5,6	5,7	5,8
65320X	Rollerblading	5,2	5,2	5,3	5,4
60380X	Running	7,8	8,5	9,1	9,8
65480X	Soccer	7,7	8,1	8,4	8,7
75180X	Swimming	9,5	9,1	8,9	8,6
65520X	Tennis	6,1	6,3	6,5	6,7
65560X	Volleyball	5,0	5,1	5,2	5,3
80320X	Walking	3,6	3,9	4,2	4,4
Activities listed on the Compendium of Energy Expenditures for Youth (2008) (19)					
331000	Archery	3,5	3,5	3,5	3,5
341660	Athletics	6,7	6,7	6,7	6,7
342012	Badminton	4,5	4,5	4,5	4,5
342262	Hockey	8,0	8,0	8,0	8,0
321292	Horseback Riding	4,0	4,0	4,0	4,0
341322	Martial Arts	10,0	10,0	10,0	10,0
341243	Mountain Biking	7,8	7,8	7,8	7,8
342402	Paddle Tennis	6,0	6,0	6,0	6,0
341272	Riding a Skateboard	5,0	5,0	5,0	5,0
341092	Rowing / Canoeing	7,0	7,0	7,0	7,0
321942	Sailing / Boating	3,0	3,0	3,0	3,0
641602	Surfing	5,0	5,0	5,0	5,0

REPORTING GUIDELINES

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1: "*a cross-sectional study*"
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2: "*PA direct impact in T1DM is still poorly understood.*"
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 3: "*some factors may be a hindrance to regular exercise habits in this group of patients, namely the fear of hypoglycemia (…) There are few reports addressing the relation between T1DM and fear of hypoglycemia"*
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 4: "*We hypothesized that the presence of T1DM might influence physical activity habits of young patients*"
Methods			
Study design	4	Present key elements of study design early in the paper	Page 4: "*A cross-sectional study was performed*"
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 4: "*was performed in Centro Hospitalar Universitário São João (CHUSJ), between December 2021 and January 2022 (…) recurred to pediatric*

			consultations in CHUSJ"
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Page 5: "*inclusion criteria for both groups were the following: (…)*"
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Pages 5 and 6: "*Physical activity level was estimated as mean daily METs/min. (…) Weight status, evaluated as BMI (Body Mass Index) percentiles was determined through weight and height…"*
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 4: "*Data were collected through the application of a questionnaire (…) The HbA1c level considered for diabetic patients was the last value measured, extracted from clinical records*"
Bias	9	Describe any efforts to address potential sources of bias	Page 4: "*its validation for the study population, (…) minimizing information bias*"
Study size	10	Explain how the study size was arrived at	Page 5: "*a sample size of 42 was determined for each group of comparison*"
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 6: "*For total daily MET calculation, a typical weekday was contemplated (…) Detailed information about the formula used is described in Supplemental*

			Material, attachment B"
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 7: "*Continuous variables were tested for normal distribution by the D'Agostino-Pearson omnibus normality test (…) Mann Whitney U test was used…"*
		(*b*) Describe any methods used to examine subgroups and interactions	Page 7: "*Spearman coefficient was calculated to evaluate the possible correlation (…) HbA1c levels were grouped by parental education level and a comparison was performed using Kruskal-Wallis test.*"
		(*c*) Explain how missing data were addressed	Page 5: "*Questionnaires with missing data were excluded from the analysis*"
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	*Not applicable.*
		(*e*) Describe any sensitivity analyses	*No sensitivity analysis was performed.*
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analyzed	Page 7: "*A total of 86 participants were included (…): diabetic (n=61) and control (n=25)*"
		(b) Give reasons for non-participation at each stage	*Not applicable (no participants were excluded after data collection process).*

		(c) Consider use of a flow diagram	*Not applicable (no flow diagram was used to represent the composition of both groups).*
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 7: "Diabetic group had 52,5% males…" and Table 1 (page 20)
		(b) Indicate number of participants with missing data for each variable of interest	*Not applicable (only completely fulfilled questionnaires were included in the analysis).*
Outcome data	15*	Report numbers of outcome events or summary measures	Page 8: "*PAL has shown to be similar in T1DM and control groups (1.470 METs/min vs. 1.469 METs/min, p=0.964).*"
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 8: *"a weak positive correlation was found between HbA1c levels and PAL (r=0.254, p=0.048)*" *No regression models were performed since residuals distribution did not follow a normal pattern.*
		(*b*) Report category boundaries when continuous variables were categorized	Page 6: "*PAL can be subdivided in four categories: (…)*"
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	*Not applicable (no relative risk was calculated regarding the studied variables).*
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 8: "*When distinguishing diabetic patients using continuous subcutaneous insulin infusion (CSII, n=58)*

			from those who use multiple daily insulin injections (MDI, n=3"
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 9: "*Prespecified hypothesis expected to find lower PAL values in diabetic patients (…) our results showed equivalent PA levels among both groups of study*"
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 10: "*possible reporting bias, since children and adolescents may have reported higher PA levels as a compensation for an HbA1c level above the target defined*" Page 12: "*our analysis was limited by the small sample size and, consequently, the asymmetric distribution of the variables*"
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 13: "*our findings suggest that diabetes-associated barriers, such as FoH, do not play a significant role in limiting PA routines in diabetic youth, since reported PAL was similar*"
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 12: "*which may be an important point of intervention to incite a shift in PA routines among children and*

			adolescents towards a less sedentary lifestyle." (…) "*further strategies need to be addressed for a better metabolic control towards HbA1c intended levels*" Page 13: "*this study emphasized the necessity of overcoming questions related to physical activity in T1DM patients, in an attempt to attain from PA the utmost benefit*"
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 19: "*Research funding: None declared.*"

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

SUBMISSION GUIDELINES

The following pages contain Information for Authors provided by the ***Journal of Pediatric Endocrinology and Metabolism*** *(ISSN: 0334-018X) regarding articles submission.*

1. Scope and general policies of the Journal

The *Journal of Pediatric Endocrinology and Metabolism* (*JPEM*) is a peer-reviewed journal which publishes cutting-edge articles on clinical investigations in pediatric endocrinology and basic research. *JPEM* is the only international journal dedicated exclusively to endocrinology in the neonatal, pediatric and adolescent age groups. *JPEM* is a high-quality journal dedicated to pediatric endocrinology in its broadest sense, which fills a gap at a time of rapid expansion in the field of endocrinology.

JPEM is issued monthly, and it is published in print and electronically. *JPEM* publishes only English-language articles in the following categories:

- Research Articles – Reports of original research.
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- Opinion Papers and Editorials
- Point/Counterpoint Papers
- Short Communications
- Case Reports
- Letters to the Editor and Replies
- Guidelines and Recommendations

Submissions in the following fields are welcomed:

- Pediatric Endocrinology
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- Inherited Metabolic Diseases
- Vitamin D Deficiency
- Neonates/Neonatal Screening
- Hormonal Disorders and Therapy
- Thyroid/Thyroid Disorders
- Bone Metabolism and Growth Impairment
- Cancer Diagnostics
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2. Ethical conduct of research

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