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Physical activity and sedentary behavior levels in children and adolescents with type 1 diabetes using insulin pump or injection therapy – The importance of parental activity profile

Isabelle Michaud [a,b,c], Mélanie Henderson [c], Laurent Legault [d], Marie-Eve Mathieu [a,c,*]

[a] Department of Kinesiology, University of Montreal, Montreal, QC, Canada, H3C 3J7
[b] Data Analysis Resource Center, Statistics Canada, Ottawa, ON, Canada, K1A 0T6
[c] Department of Pediatrics, University of Montreal and CHU Sainte-Justine, Montreal, QC, Canada, H3T 1C5
[d] The Montreal Children's Hospital, McGill University Health Center, Montreal, QC, Canada, H3H 1P3

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ABSTRACT

In children and adolescents, treatments for type 1 diabetes (T1D) have recently evolved with the introduction of the insulin pump. However, little is known about how a pump is associated with physical activity (PA) patterns. The goal of the study was to examine the activity profile of Canadian children and adolescents with T1D according to their insulin treatment (pump vs. injections), as well as barriers to exercise and parental lifestyle habits. A self-administered questionnaire was completed by 188 subjects with T1D aged 6 to 17 and their parents at the endocrinology clinic of Sainte-Justine's University Hospital Center (Montreal, Canada). Sixty percent of patients used an insulin pump. There were no significant differences in any components of the PA profile, sedentary habits, and exercise barriers between subjects using injections and those using a pump. Fear of hypoglycemia was the main PA barrier in both treatment groups. A more diverse PA practice by parents was associated with more moderate-to-vigorous PA and less screen time in adolescents. In conclusion, type of treatment was not associated with more activity in pediatric patients with T1D and a varied parental PA profile was the main factor of interest for healthier habits in adolescents with T1D.

1. Introduction

Canadian guidelines suggest that children and adolescents engage in at least 60 min of moderate-to-vigorous physical activity (MVPA) and less than 2 h of screen time per day. Physical activity (PA) can substantially lower HbA1c levels, morbidity, and mortality in patients with T1D (Bernardini et al., 2004; Canadian Diabetes Association Clinical Practice Guidelines Expert Committee, 2013; Herbst, Bachran, Kapellen, & Holl, 2006; MacMillan, Kirk, Mutrie, Matthews, et al., 2014; Valerio et al., 2007). Regularly active adults have a lower risk of cardiovascular diseases (Franco et al., 2005; Kodama et al., 2013; Li & Siedrist, 2012), higher socialization and quality of life (Fox, 1999), are less prone to cognitive decline (Sofi et al., 2010) and have higher cognitive function (Martins et al., 2011). In children, regularly active individuals do better in school (Davis & Cooper, 2011). Despite the fact that they tend to be less active than the general population, children with T1D could benefit greatly from regular PA (Fintini et al., 2012; Sundberg, Forsander, Fasth, & Ekelund, 2012; Trigona et al., 2010; Valerio et al., 2007).

Barriers to an active lifestyle are key to better understanding low PA levels in patients with T1D. Fear of hypoglycemia has been identified as a barrier to PA in teenagers (Younk, Tate, & Davis, 2009), while working schedules, loss of metabolic control, and poor physical condition, in addition to fear of hypoglycemia, have been closely linked to low levels of exercise in adults with T1D (Brazeau, Rabasa-Lhoret, Strychar, & Mircescu, 2008). Also, in children with or without T1D, parental encouragement and support to practice PA are key factors to children's participation in PA (Quirk, Blake, Dee, & Glazebrook, 2015; Yao & Rhodes, 2015). However, the scientific literature is mixed as to know if the parental PA behavior itself has an influence on children's PA levels (Gustafson & Rhodes, 2012).

The use of an insulin pump for the treatment of T1D has increased in the past 15 years, particularly in pediatric patients (Johnson, Cooper, Jones, & Davis, 2013). Compared to injections treatment, use of a pump improves glycemic control and reduces severe hypoglycemia in pediatric patients with T1D, and these improvements seem to be maintained on a long period of time (Johnson et al., 2013). In adults, a higher quality of life's score and an increased mental health perception have been reported for patients using a pump compared to those using injections (Hoogma et al., 2006). However, in adolescents

* Corresponding author at: Department of Kinesiology, University of Montreal, P.O. Box 6128, Downtown Station, Montreal, Quebec, Canada, H3C 3J7. Tel.: +1 514 343 6737; fax: +1 514 343 2181.
E-mail address: me.mathieu@umontreal.ca (M-E. Mathieu).

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and young adults, Boland, Grey, Oesterle, Fredrickson, and Tamborlane (1999) reported no such difference between the two types of treatment.

With potential advantages of pump therapy on pediatric patients with T1D, it is of interest to see if patients using a pump have a different lifestyle (sedentary behaviors and PA patterns) from those using injections. To date, few studies compared the activity profile of pediatric patients with T1D using a pump with patients using injections (MacMillan, Kirk, Mutrie, & Robertson, 2014; Øverby et al., 2009). They revealed that the type of insulin treatment was not associated with either sedentary or PA levels. Supporting studies are now important to confirm these findings. In addition, an in-depth assessment of the specific components of PA practice and barriers to exercise is needed. The goal of the current study was thus to investigate the sedentary and PA levels of Canadian pediatric patients with T1D according to their insulin treatment (pump vs. injections), including activity components such as intensity, duration, frequency and variety of exercises, exercise barriers and parental PA behavior. The hypothesis of the current work is that pump users will present an equivalent or improved activity profile when compared to injection users.

2. Methods

2.1. Participants

The study was performed at the diabetes clinic of Sainte-Justine's University Hospital Center, Montreal, Canada (~850 patients). A self-administered questionnaire was completed by 188 subjects with T1D and one of their parents (or legal guardian) prior to a regular visit with their physician. Face-to-face recruitment was performed directly at the clinic by University of Montreal's students in exercise science program. Data were obtained between March and November 2013. Data were collected across various seasons. To be included in the study, participants had to meet the following criteria: age between 6 and 17, duration of diabetes greater than one year, and no other chronic diseases. The project was approved by the ethics committee of the Sainte-Justine's University Hospital Center. All participants signed an informed consent form. Of the 205 patient–parent pairs that agreed to take part in the study, which represent 23% of the clientele, 188 completed all the relevant questions and were included in the study. Among the 17 excluded pairs, 8 had their diagnosis of diabetes less than one year before the questionnaire was filled out, 8 did not meet the age criteria, and 1 was administered the wrong questionnaire.

2.2. Variables of interest

2.2.1. Subject questionnaire

Age, sex, height, and weight were obtained using a self-reported questionnaire filled in by the child/adolescent with the help of an accompanying adult and the assistance of the research staff ($n = 6$). Age- and sex-specific body mass index (BMI) percentiles were calculated according to the US Centers for Disease Control and Prevention growth charts (Centers for Diseases Control and Prevention, 2014; Lau, 2007). The number of years since the patient's diabetes diagnosis, the method of insulin administration, if yes or no the patient experienced hypoglycemia/hyperglycemia during its practice of PA in the past, and exercise barriers (barriers to PA in T1D score – BAPAD1) (Dubé, Valois, Prud'homme, Weisnagel, & Lavoie, 2006) were also obtained via questionnaires. The validity and reliability of the 11-item's BAPAD1 test have been verified in adults (Brazeau et al., 2012). For this study on children and adolescents, 9 items were kept since 2 items were not applicable to this age group ("The fear of suffering of a heart attack" and "the fear of being tired") and "the school schedule" was added. The BAPAD1 score was obtained by calculating the average of the individual scores obtained for each type of barrier in which answers to exercise barriers were rated from 1 (extremely improbable) to 7 (extremely probable). For the purposes of the present analysis, scores from 1 to 4 were categorized as "barrier not present" while scores from 5 to 7 as "barrier present".

The activity profile was obtained using the questionnaire from cycle 2 of the Canadian Health Measures Survey (Statistics Canada, 2009–2011). In this questionnaire, children (<12 years old) reported how many hours per day they usually spent doing sedentary activities such as using a computer, playing video games, or watching TV/videos. The response categories were "none", "<1 h/day", "1-2 h/day", "3-4 h/day", "5-6 h/day", and "≥7 h/day", and for the data analysis, the three first categories were set as "≤2 h/day" and the other categories as ">2 h/day", which is the closest possible threshold within these categories to the cut-off according to the Canadian guidelines for screen time (<2 h/day) (Canadian Society of Exercise Physiology, 2012).

Adolescents (≥12 years) reported how many hours per week they usually spent undertaking sedentary activities. The response categories were "none", "<1 h/week", "1-2 h/week", "3-5 h/week", "6-10 h/week", "11-14 h/week", "15-20 h/week", and ">20 h/week", and for data analysis, the first six categories were set as "≤2 h/day" and the other categories as ">2 h/day". Children reported the number of days per week they engaged in at least 60 min of MVPA (in the previous 7 days and during a usual week). Adolescents reported the number of times and how many minutes at each occasion, in the past 3 months, they practiced each of the 21 listed PA (e.g. walking, biking, jogging, fishing, playing golf).

Next, the average minutes per day spent in various PA was derived. Using the World Health Organization norms on metabolic equivalent task (MET) (World Health Organisation, 2015) and the Ainsworth's Compendium of PA for children (Ridley, Ainsworth, & Olds, 2008), activity was categorized as low (≤3 METs), moderate (<3 METs ≤6), or vigorous (>6 METs) intensity. This allowed us to calculate the amount of time spent daily in each PA intensity and to identify adolescents who followed the recommendations of ≥60 min of MVPA daily (World Health Organisation, 2011). An estimation of the daily energy expenditure ($kcal \cdot day^{-1}$) was also calculated using the specific METs values ($kcal \cdot kg^{-1} \cdot h^{-1}$), the time spent daily doing each activity ($min \cdot day^{-1}$), and the participant's weight (kg) (McArdle, Katch, & Katch, 2010).

2.2.2. Adult questionnaire

The accompanying parents (or legal guardians) answered questions regarding their own PA habits (118 mothers, 65 fathers and 5 missing values). In that questionnaire, they identified the PA that they practiced in the last 3 months among a list of 21 different activities (no minimal duration was required) (Statistics Canada, 2009–2011). Each PA was categorized as low/moderate (METs ≤6) or vigorous (>6 METs) intensity (Ainsworth et al., 2000; World Health Organisation, 2015). This allowed us to identify parents that were practicing at least one vigorous PA. The parent's PA variety was also calculated and the PA variety was dichotomized for regression analysis as <3 vs. ≥3 for the outcome "minutes of MVPA" and <2 vs. ≥2 for the outcome "total screen time". Finally, parents also reported if they were participating in a PA with their child or not.

2.3. Statistical analysis

Pearson's chi-square and non-parametric Mann–Whitney-Wilcoxon tests were used for comparisons of distributions between subgroups. Cohen's effect sizes were computed to allow comparisons of means using Cohen's d value based on pooled standard deviation and proportions between groups using Cohen's h value (Cohen, 2013). Following Cohen's standard, effect sizes <0.5 were considered small, ≥0.5 and <0.8 were considered medium, and ≥0.8 were considered large. Percentages, medians, and quartiles (Q1 and Q3) are presented.