Association Between 24 h Movement Behaviours and Cardiovascular Risk Factors in Adolescents Living with Type 1 Diabetes: A Compositional Data Analysis

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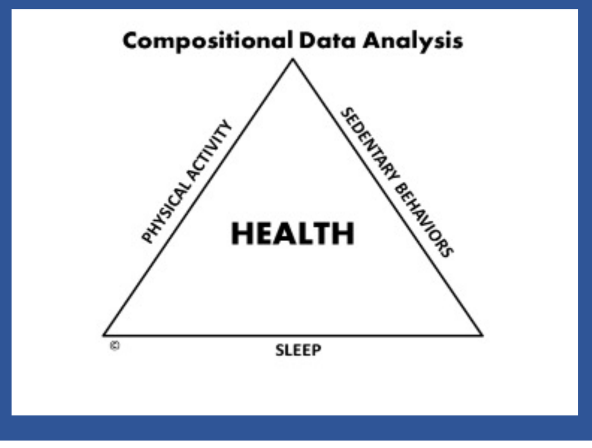

Introduction

Cardiovascular disease (CVD) is the most prevalent cause of premature death and disability in individuals living with type 1 diabetes (T1D). Sedentary lifestyle, lack of physical activity, and poor treatment compliance are considered to be the main causative factors in dyslipidemia, hyperglycemia, hypertension, insulin resistance, obesity, and ultimately increased CVD risk in individuals living with T1D.

Previous research has showed that movement behaviours, such as physical activity, sedentary behaviour (SB), and sleep are independently associated with cardiovascular risk factors in children and adolescents. However, time spent in sleep, SB, and physical activity constitutes mutually exclusive components of the complete day (24 h), thus increasing time spent in one behaviour can only occur at the displacement of time available for other behaviours within that day.

Compositional Data Analysis (CoDA) considers each behaviour that is a part of a finite sum (24 h) and allows studying the effect of each behaviour relative to each other rather than in isolation. It has recently been used in studies of associations between movement behaviours that individuals engage in on a daily basis and CVD risk factors in the general population.

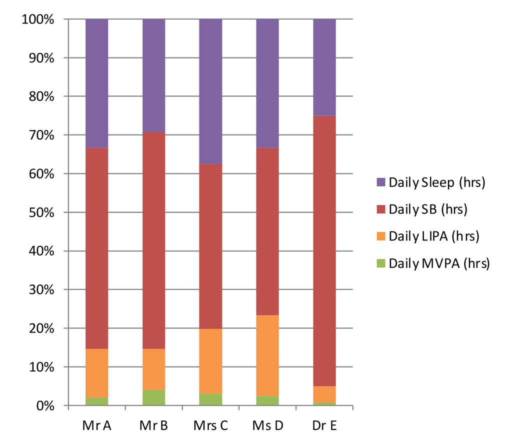

Figure 1. 24 h movement behaviour as a composition

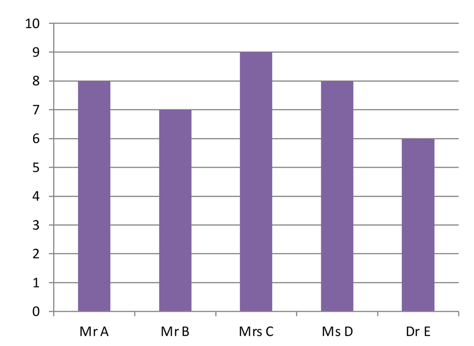

Figure 2. Hemoglobin A1c level

However, to our knowledge, no study has used CoDA to examine the association between the full 24-h movement behaviour composition and CVD risk factors in adolescents living with T1D. Therefore, the purpose of this study was to investigate associations between time spent in any 24-h movement-related behaviours, relative to the other behaviours, and the CVD risk factors in adolescents living with T1D.

Methods and Materials

Participants

- 33 adolescents (69.7% F, Age (± SD) = 13.8 ± 2.9 yr) living with T1D & 16 peers living without T1D (57.9% F, Age (± SD) = 13.2 ± 3.5 yr)

Cardiovascular risk factors

- Body composition, lipid profiles, and blood pressure

Accelerometry assessment of composition of the day

- Sleep, SB, light intensity physical activity (LIPA) & moderate to vigorous physical activity (MVPA)

Potential confounding variables

- Age, sex, and pubertal stage

Statistical analysis

- All statistical analyses were performed using the SPSS 20 and Rstudio software.
- Differences of time spent in each behaviour between T1D and peers without T1D groups were tested using MANOVA and a CoDA approach based on isometric log-ratio transformed data.
- The total 24-h (1440 min) day was partitioned in proportions of time spent in four behaviours (MVPA, LIPA, SB, sleep), then each participant's daily time-use composition was transformed into a set of three isometric log-ratio (*ilr*) coordinates, which map the compositions in real space (unconstrained by time). The following is an example *ilr* transformation of sleep.

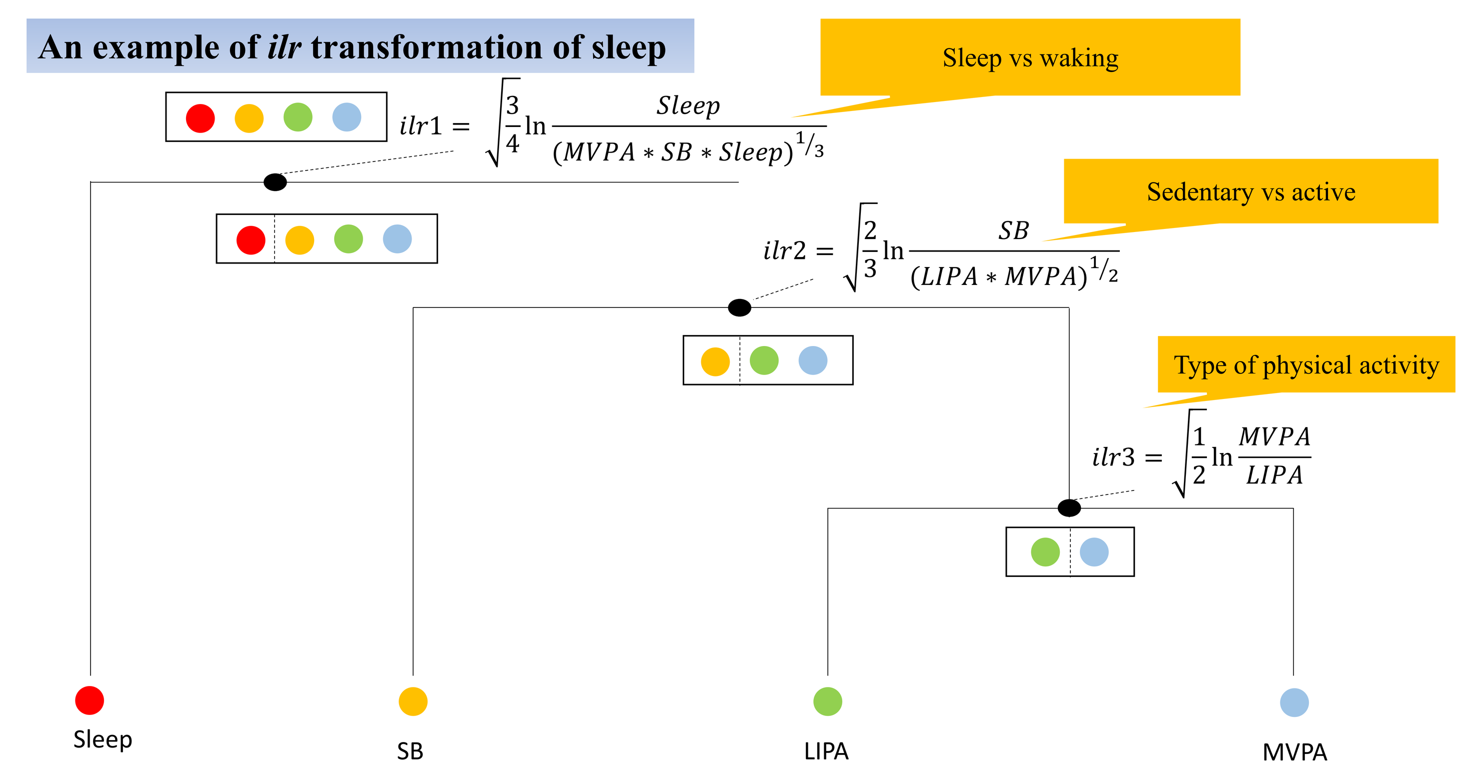

Figure 3. *ilr* transformation of sleep

- The associations between CVD risk factors (dependent variables) and the set of three *ilr* coordinates for each behaviour (explanatory variables) were explored using multiple linear regression models (i.e., adjusted for age, sex, and pubertal stage)

Results

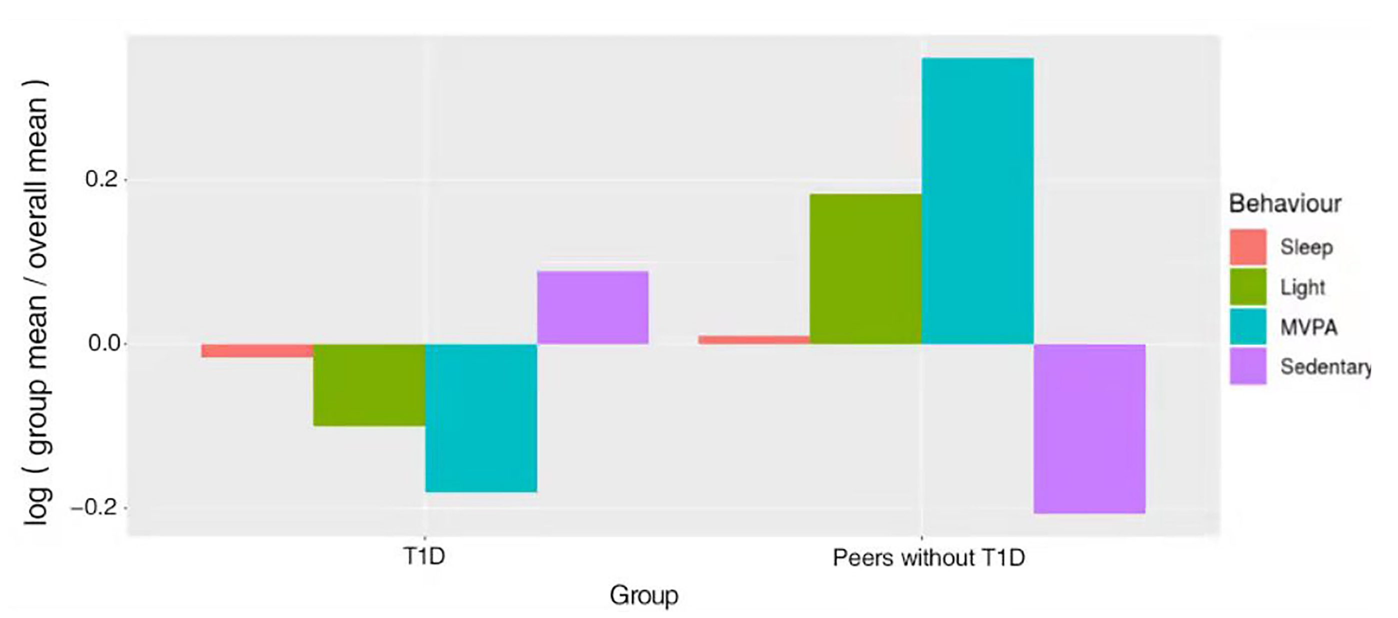

Figure 4. Compositional analysis of the group mean time spent in sleep, SB, LIPA and MVPA with respect to the overall mean time composition by group of T1D and Peers without T1D

Geometric mean bar plot indicating the time spent each behaviour (i.e., MVPA, LIPA, SB, and sleep), in terms of differences from the geometric mean value of the entire sample.
Each bar represents the ratio on a logarithmic scale (left axis) between the geometric mean of the specific group and the mean of the entire sample.

Cardiovascular risk factors	MVPA		Sleep	
	β	*p*	β	*p*
BMI z-score	0.03	0.9450	1.43	0.0433*
BMI	−0.47	0.6943	4.04	0.0270
Body fat (%)	−2.82	0.6160	13.73	0.0799
Triglycerides ($mmol \cdot L^{-1}$)	−0.32	0.0187*	0.42	0.104
HDL-C ($mmol \cdot L^{-1}$)	0.23	0.0752	−0.10	0.6733
LDL-C ($mmol \cdot L^{-1}$)	0.33	0.3380	1.29	0.0326*

Table 1. Compositional behaviour model for select cardiovascular risk factors in adolescents living with T1D for the proportion of the day spent in MVPA and sleep.
All models are adjusted for age, sex, and pubertal stages. Table shows the beta coefficients and p-values only for the first isometric log ratio coordinate that describes time spent in a specific behaviour, relative to time in the remaining behaviours; MVPA, moderate to vigorous physical activity, *Statistically significant difference ($p < 0.05$)

Future Work

- More studies with larger sample sizes are required to examine the relative contributions of multicomponent of movement behaviours and differential glycemic control treatment strategies.
- Future compositional data analyses should be performed on longitudinal and experimental data and may be stratified by sex.
- Future studies should consider adjusting for potential confounders such as diabetes-related information (e.g., duration of diabetes and insulin regimen), participants' diet quality and other health factors (e.g., obesity, chronic disease status).
- Consider the relationships between 24-h movement behaviours and neurobehavioural outcomes like depression and quality of life in individuals living with T1D

Conclusions

- Adolescents living with T1D showed less active and more sedentary when compared to their peers living without T1D
- Increased time spent in sleep and decreased time spent in LIPA is associated with higher BMI in adolescents living with T1D. Optimizing these behaviours may lead to better cardiovascular health outcomes in these individuals.
- This knowledge is important for future physical activity and future sleep guidelines aimed at optimizing cardiovascular health in pediatric populations with T1D should consider an integrated movement behaviour approach.

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