#### The Four S's of Healthy Childhood Movement: Sweat, Step, Sit, and Sleep

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## Movement is a continuum

behaviour

light physical activity

moderate-to-vigorous physical activity

## Movement across the 24-hour day





#### Sedentary behaviour

Light physical activity

Moderate-to-vigorous physical activity

# How do you make a cosmopolitan?



#### The eatwell plate



Use the eatwell plate to help you get the balance right. It shows how much of what you eat should come from each food group.



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Anicle

#### SMMR Statistical Methods in Medical Research

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#### Compositional data analysis for physical activity, sedentary time and sleep research

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The health effects of daily activity behaviours (physical activity, sedentary time and sleep) are widely studied. While previous research has begely examined activity behaviours in isolation, recent studies have adjusted for multiple behaviours. However, the inclusion of all activity behaviours in traditional multivariate analyses has not been possible due to the perfect multicollinearity of 24-h time budget data. The ensuing lack of adjustment for known effects on the outcome undermines the validity of study findings. We describe a statistical approach that erables the inclusion of all daily activity behaviours, based on the principles of compositional data analysis. Using data from the International Study of Childhood Obesity, Lifectyle and the Environment, we demonstrate the application of compositional multiple linear regression to estimate adjouity from childhan's daily activity behaviours expressed as isometric log-ratio coordinates. We present a novel method for predicting charge in a continuous outcome based on relative charget within a composition, and for calculating associated confidence intervals to allow for statistical inference. The compositional data analysis presented overcomes the lack of adjustment that has plagued traditional statistical methods in the field, and provides robust and reliable insights into the health effects of daily activity behaviours.

#### Keywords

Compositional data analysis, physical activity, sadantary belaviour, sleep, multicollinearity

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International Journal of Obesity https://doi.org/10.1058/541366-018-0053 a ARTICLE

#### **Pediatrics**

#### Compositional associations of time spent in sleep, sedentary behavior and physical activity with obesity measures in children

#### Robert Talarico<sup>1</sup> - Jan Janssen<sup>1,2</sup>

Received: 3 October 2017 / Revised: 16 January 2018 / Accented: 31 January 2018 © Macmilian Publishers Limited, part of Springer Nature 2018

#### Abstract

Background/objectives: The 24 h day is made up of four movement behaviors: sleep, sedentary behavior (SB), light intensity physical activity (LIPA), and moderate-to-visorous physical activity (MVPA). Previous studies examining associations between movement behaviors and obesity have used flawed statistical methods that did not account for the co-dependent and compositional nature of movement behaviors. Our objective was to use compositional data analysis methods to investigate the relationships between movement behaviors and obesity measures among children.

Subjects/methods: Participants were 434 children aged 10-13 years. They were an accelerometer for 7 days to determine time spent in SB, LIPA, and MVPA. Sleep duration was determined from the accelerometer and a log. The obesity measures were the body mass index, waist circumference, and fat mass index. Compositional data analysis was used to estimate whether the composition of movement behaviors was associated with obesity measures, and the extent to which changing time in movement behaviors within the movement behavior composition was associated with changes in obesity measur Results: The composition of movement behaviors across the 24h day was associated with all three obesity measures (p < 0.001). Relative to other movement behaviors, time spent in MVPA was negatively associated with obesity measures (p < 0.01), time spent in LIPA was positively associated with obasity measures (p < 0.05), while time spent in SB and skeep were not associated with obesity measures. The estimates suggested that an 18 min/day increase in MVPA, 21 min/da decrease in LIPA, 87 min/day decrease in SB, or 67 min/day increase in sleep relative to the remaining behaviors would be associated with a 0.1 unit decrease in BMI 2-score. Conclusions: The composition of movement behaviors across the day is associated with obesity measures. The findings

suggest that changing the movement behavior composition by increasing MVPA and decreasing LIPA would be the most effective approach for improving obesity measures.

#### Introduction

Moderate-to-vigorous physical activity (MVPA), light intensity physical activity (LIPA), sedentary behavior (SB), and sleep are mutually exclusive time-use components that together comprise the entire 24 h day. Research examining

Electronic supplementary material The online version of this article (https://doi.org/10.1038/s41285-015-0081-a) contains supplementary material, which is available to authorized users. 100 Ian Janosen

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these movement behaviors in isolation has indicated that they are related to obesity and many other health indicators. within children [1-3]. In recent years there has been an interest in studying the effects of combinations of movement behaviors [4]. The approach typically used in previous multiple movement behavior studies was to include two or more movement behaviors as independent variables in a traditional regression model to determine their independent associations with an obesity measure [4]. For instance studies using linear and logistic regression have reported that television viewing, a common type of sodestary behavior, is associated with obesity after adjusting for MVPA and sloep [5, 6]. Unforminately, as highlighted in commentaries and sta-

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tistical methods papers [7-10], using traditional regression approaches to examine the independent associations between movement behaviors with obesity and other health outcomes is a flawed statistical approach that has

Associations between sleep duration, sedentary time, physical activity, and health indicators among Canadian children and youth using compositional analyses1

ABTICLE

Valerie Carson, Mark S. Tremblay, Jean-Philippe Chaput, and Sebastien F.M. Chastin

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# Change in waist circumference by displacing movement behaviours



Talarico and Janssen, Int J Obes, 2018

#### Adherence to movement recommendations and BMI



Janssen et al., Appl Physiol Nutr Metab, 2017

### 24-hour movement guidelines for school-aged children and youth



#### SWEAT

#### MODERATE TO VIGOROUS PHYSICAL ACTIVITY

An accumulation of at least 60 minutes per day of moderate to vigorous physical activity involving a variety of aerobic activities. Vigorous physical activities, and muscle and bone strengthening activities should each be incorporated at least 3 days per week;

#### STEP

#### LIGHT PHYSICAL ACTIVITY

Several hours of a variety of structured and unstructured light physical activities;

#### **SLEEP**

#### SLEEP

Uninterrupted 9 to 11 hours of sleep per night for those aged 5–13 years and 8 to 10 hours per night for those aged 14–17 years, with consistent bed and wake-up times;

#### SIT

#### SEDENTARY BEHAVIOUR

No more than 2 hours per day of recreational screen time; Limited sitting for extended periods.

Canadian 24-Hour Movement Guidelines for the Early Years (0-4 years) For healthy growth and development, infants, toddlers, and preschoolers should achieve the recommended balance of physical activity, high-quality sedentary behaviour, and sufficient sleep.	Move	SLEEP SIT	
A healthy 24 hours includes:	SLEEP	SIT	
INFANTS (LESS THAN 1 YEAR)			
Being physically active several times in a variety of ways, particularly through interactive floor-based play—more is better. For those not yet mobile, this includes at least 30 minutes of tummy time spread throughout the day while awake.	14 to 17 hours (for those aged 0-3 months) or 12 to 16 hours (for those aged 4-11 months) of good-quality sleep, including naps.	Not being restrained for more than 1 hour at a time (e.g., in a stroller or high chair). Screen time is not recommended. When sedentary, engaging in pursuits such as reading and storytelling with a caregiver is encouraged.	
TODDLERS (1-2 YEARS)			
At least 180 minutes spent in a variety of physical activities at any intensity, including energetic play, spread throughout the day—more is better.	11 to 14 hours of good-quality sleep, including naps, with consistent bedtimes and wake-up times.	Not being restrained for more than 1 hour at a time [e.g., in a stroller or high chair] or sitting for extended periods. For those younger than 2 years, sedentary screen time is not recommended. For those aged 2 years, sedentary screen time should be no more than 1 hour—less is better. When sedentary, engaging in pursuits such as reading and storytelling with a caregiver is encouraged.	
PRESCHOOLERS (3–4 YEARS)			
At least 180 minutes spent in a variety of physical activities spread throughout the day, of which at least 60 minutes is energetic play—more is better.	10 to 13 hours of good-quality sleep, which may include a nap, with consistent bedtimes and wake-up times.	than 1 hour at a time (e.g.,	

## **Sleep duration recommendations**









### We can intervene on sleep!

#### GENERAL TIPS FOR HAVING HEALTHY SLEEP HYGIENE<sup>142</sup>



Go to bed and wake up at the same time every day (even on the weekends!)



Don't go to bed feeling hungry, but also don't eat a heavy meal right before bed

 1		

**Avoid caffeine consumption** (e.g., coffee, soft drinks, chocolate) starting in the late afternoon



**Develop a relaxing routine** before bedtime - ideas include bathing, music, and reading



**Expose yourself to bright** light in the morning - sunlight helps the biological clock to reset itself each day



**Reserve your bedroom for** sleeping only - keep cell phones, computers, televisions and video games out of your bedroom



Make sure your bedroom is conducive to sleep - it should be dark, quiet, comfortable, and cool

**Sleep on a comfortable** 

mattress and pillow



**Exercise regularly** during the day



Don't have pets in your bedroom



## Sedentary behaviour recommendations

#### <u>Infants and toddlers</u> 0 minutes/day



#### <u>Preschoolers</u> ≤ 1 hour/day



#### <u>School-aged kids</u> ≤ 2 hours/day



#### Infants, toddlers, and preschoolers should not be restrained for >1 hour at a time



# Sedentary behaviour evidence is heavily based on T.V. time



# Large reductions in sedentary behaviour will displace many movement behaviours



Sleep

Sedentary behaviour

Light physical activity

Moderate-to-vigorous physical activity

Talarico and Janssen, Int J Obes, 2018





# Displacing 1 hour/day of sedentary video games influences life satisfaction



I Janssen, J Adolesc Health 2016;59:517-22

# Physical activity recommendations

### *Infants* Interactive floor based play and ≥ 30 minutes/day of tummy time



# Physical activity recommendations

#### <u>Toddlers and preschoolers</u> ≥ 180 minutes/day of activity of any intensity including energetic play (≥ 60 minutes/day for preschoolers)



# Physical activity recommendations

#### School-aged children and youth ≥ 60 minutes/day of moderate-to-vigorous activity



### It takes ~3 hours of activity time to accumulate 1 hour of moderate-to-vigorous physical activity



#### Half of moderate-to-vigorous activity comes from other sources



#### Adherence to 24-Hour movement guidelines in preschool-aged children



#### Adherence to 24-hour movement guidelines in preschool-aged children



Chaput et al., BMC Public Health, 2017

#### Adherence to 24-hour movement guidelines in school-aged children and youth



Roberts et al., Health Reports, 2017

#### Adherence to 24-hour movement guidelines in school-aged children and youth



Roberts et al., Health Reports, 2017

### 2016 ParticipACTION report card grades



Sleep

# **Concluding remarks**



# **Concluding remarks**



