Short Communication

Accelerometer data treatment for adolescents: Fitting a piece of the puzzle

Melody Smith [a,*], Steve Taylor [b], Leon Iusitini [c], Tom Stewart [d], Fa'asisila Savila [c], El-Shadan Tautolo [c], Lindsay Plank [e], Shabnam Jalili-Moghaddam [f], Janis Paterson [c], Elaine Rush [c]

[a] School of Nursing, The University of Auckland, Auckland, New Zealand
[b] Department of Biostatistics and Epidemiology, Auckland University of Technology, Auckland, New Zealand
[c] Centre for Pacific Health and Development Research, Auckland University of Technology, Auckland, New Zealand
[d] Human Potential Centre, Auckland University of Technology, Auckland, New Zealand
[e] School of Medicine, the University of Auckland, Auckland, New Zealand
[f] Child Health Research Centre, Auckland University of Technology, Auckland, New Zealand

ARTICLE INFO

ABSTRACT

This study aimed to assess the differences in participant retention and associations between physical activity and key variables when a range of accelerometer data inclusion criteria are employed. Data were drawn from 204 adolescents of Pacific Island heritage (survey, body composition, 7-day accelerometry) and their parents (date of birth, socioeconomic status) between October 2014 and February 2016 in Auckland, New Zealand. Data wear time criteria for inclusion were as follows: A) ≥ 10 h/weekday or ≥ 8 h weekend day, ≥ 5 days (at least one weekend day); B) ≥ 10 h/weekday or ≥ 8 h weekend day, ≥ 4 days; C) ≥ 7 h/day, ≥ 3 days; D) ≥ 10 h/day, ≥ 1 day. Overall, 49%, 62%, 88%, and 96% of participants met the criteria, respectively. Adjusted odds of meeting each criterion were examined using a multivariable logistic regression model. Almost 50% of participants were excluded by the most stringent inclusion criteria. Increased body fat percentage and proportion of time in moderate-to-vigorous activity were associated with decreased odds of meeting Criterions A and B. This research contributes to a growing understanding of the impact of differing accelerometer reduction approaches to sample retention and bias in adolescent physical activity research.

1. Introduction

Physical activity (PA) is fundamental to optimal health and development across the life course (World Health Organization, 2010). Objectively assessing the duration, intensity, and frequency of PA is essential for measuring the links between PA and health. Understanding these relationships can guide intervention development and evaluationand inform health promotion messages. Accelerometry is the method of choice to gain an unbiased, objective understanding of PA (Kelly et al., 2016). This technology facilitates the sensitive collection of movement data accumulated over specified epochs, enabling the calculation of time spent in differing activity intensities (e.g., moderate-to-vigorous PA, MVPA).

Many questions still remain regarding accelerometer data treatment (e.g., minimum wear time for data inclusion) (Cain et al., 2013). Toftager et al. (2013)investigated the impact of differing accelerometer data treatment criteria on sample inclusion and bias in 1348 Danish adolescents aged 11–14 years. Adopting more stringent criteria resulted in significant reductions in participant inclusion. Moreover, participants

with larger body sizes and older adolescents were more likely to be excluded when more stringent criteria were employed. Reasons for accelerometer non-wear are multifactorial and can include individual factors such as response to peer influence (removal of unit because it is 'uncool') and social desirability bias (wearing units only when participating in PA) as well as researcher/measurement factors (e.g., researcher directives to remove individual participation in contact sports or water activities) (Kirby et al., 2012; Belton et al., 2013; Sirard and Slater, 2009). Accelerometer data treatment decisions can introduce unwanted bias and substantial loss of significant information, with impacts possibly greatest for those of importance in health research. This issue warrants further investigation to determine the most appropriate approach for a given population.

Pacific peoples are the fourth largest population group in New Zealand, comprising 7% of the total population. In 2014/2015, three times more Pacific children were classified obese (30%) than the general population (Ministry of Health, 2015). Yet, Pacific youth are generally under-represented in PA and health research. The need to include youth from a range of sociodemographic groups in health research is recognised as important but challenging (e.g., due to logistical barriers such as transport or conflicting priorities, and implicit attitudinal barriers such as mistrust or differentiation) (Brannon et al., 2013). Study

aims were (1) to quantify participant inclusion using a range of wear time criteria for accelerometer data reductionand (2) to calculate the odds of meeting wear time criteria across key variables, with a sample of New Zealand adolescents of Pacific Island heritage.

2. Methods

Data were drawn from the Pacific Islands Families cohort study of Pacific youth in Auckland, New Zealand (Rush et al., 2016). From October 2014 to February 2016, a subsample of the full cohort underwent body composition and metabolic risk assessment. Participants were stratified by sex and body weight decile at 11 years then purposively invited to participate (to facilitate representation across sex and weight). Informed consent was obtained from the individual and their parent. Participants were asked to fast the night before they were collected from their home and transported to Auckland Hospital where body composition was measured. Participants were fitted with an accelerometer on an elasticated belt and asked to wear the belt for waking hours over the next seven days except when bathing, swimming, sleeping, and playing contact sports. On the eighth day, the accelerometer was collected and koha (voucher) provided.

Ethical approval was provided by the Central Health and Disability Ethics Committee (14/CEN/108; 28 July 2014).

Factors hypothesised as being related to compliance with accelerometer wear instructions (and thus examined in the current study) are outlined below:

2.1. PA and sedentariness

2.1.1. Accelerometry

Activity was assessed using ActiGraph wGT3X+ activity monitors (ActiGraph, Pensacola, FL). These small (4.6 cm × 3.3 cm × 1.5 cm) lightweight (19 g) units reliably measure motion across three axes using an electromechanical accelerometer (Lee et al., 2015). Units were initialised using a sampling frequency of 30 Hz. After collection, raw data were aggregated into 30 s epochs using the low-frequency extension filter (Cain, 2013). Data were screened after every use to identify any obvious accelerometer malfunctions so these units could be removed from circulation. Epochs with more than 16,000 counts per minute were removed (Cain, 2013). Non-wear time was classified as 60 min or more of consecutive zero counts (Oliver et al., 2011). Re-wears (i.e., asking participants to wear the units for additional days if incomplete data were collected) were not logistically or economically feasible. Four combinations of criteria for inclusion in analyses were investigated: (A) at least 5 days (with at least one being a weekend day), with at least 10 h of valid data for weekdays and at least 8 h of valid data for weekend days (Cain, 2013); (B) at least 4 days, with at least 10 h of valid data for weekdays, or at least 8 h of valid data on weekend days; (C) at least 3 days with at least 7 h of valid data on each day (producing acceptable reliability in 5595 children aged 11 years ($R = 0.7$)) (Mattocks et al., 2008); and (D) at least one day with at least 10 h of valid data (Tudor-Locke et al., 2010). Data were processed using ActiLife v6.11.9 (ActiGraph, Pensacola, FL). Proportion of time in MVPA was derived using the thresholds of Evenson et al. (2008).

2.1.2. Self-reported sedentary behaviours

Time spent in sedentary behaviours (e.g., watching TV) was assessed for weekdays and weekend days using items from the IPEN-A survey (International Physical Activity and the Environment Network (IPEN), 2013). Average time spent in sedentary behaviours on a usual day was calculated ((typical weekday minutes*5 + typical weekend day minutes*2) / 7).

2.2. Social and demographic factors

2.2.1. Age and sex

Date of birth (used to calculate age) and sex were collected from primary caregivers at baseline data collection (six weeks postpartum).

2.2.2. Household socioeconomic status

At the 14-year wave, primary caregivers were asked about their level of socioeconomic deprivation as measured by the New Zealand Index of socioeconomic Deprivation for Individuals (NZiDep) (Salmond et al., 2006). This deprivations-based measure of socioeconomic status asks about eight types of deprivation (e.g., "put up with feeling cold to save heating costs") with yes/no responses. The number of yes responses was summed and categorised into five bands.

2.2.3. Response to peer influence

Three items assessed the degree to which youth misbehaved to comply with peer pressure in the last year (e.g., "In the last year, how often have you done badly at something (e.g., schoolwork) just to please your friends?") (McDonough et al., 2015). A 5-point Likert scale response option was used, ranging from "never/almost never" to "always/almost always", and values summed to generate a scale of response to peer influence (1 = not influenced; 15 = heavily influenced).

2.3. Body composition

Total body fatness and abdominal fatness were measured using whole-body dual energy X-ray absorptiometry (DXA; model iDXA, software v.15; GE-Lunar, Madison, WI).

2.4. Data analysis

Descriptive statistics for the proportion of participants included were calculated for each criterion. Odds of meeting each of the four criteria were examined using a multivariable logistic regression model, adjusting for each sociodemographic and physical variable listed above. There were missing values in the peer pressure variable, which were accounted for by pooling the results from 50 complete datasets generated using multiple imputation.

3. Results

Of the 255 participants invited to participate, 205 agreed to be involved in the study. Reasons for non-participation were as follows: could not be contacted by phone, had moved out of Auckland, or refused. Of those included, one participant lost their accelerometer and another refused to wear the belt, yielding a final sample of 203. Table 1 outlines the characteristics of participants included in analyses. The proportion of participants included using criteria A-D were 49%, 62%, 88%, and 96%, respectively. Table 2 shows the odds of meeting each criteria by key variables. Participants with higher body fatness were less likely to meet each inclusion criteria A and B, as were participants with greater MVPA. No other evidence of associations was found.

4. Discussion

Accelerometer data treatment and reduction is notoriously challenging, and no best practice currently exists. This study aimed to inform data treatment approaches in adolescents of Pacific Island heritage.

Findings showed a substantial and increasing decline in the number of participants included when more stringent inclusion criteria were employed. Over half of the study participants were excluded using the IPEN-A criterion. This was much higher than the only other study to consider participant inclusion issues in adolescent PA research, where 15% of Danish adolescents were excluded using this criterion (Toftager