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Objectively-measured physical activity in children is influenced by social indicators rather than biological lifecourse factors: Evidence from a Brazilian cohort

Alan G Knuth [a,*,1], Inácio Crochemore M Silva [b,1], Vincent T van Hees [d,1], Kelly Cordeira [b,1], Alícia Matijasevich [b,e,1], Aluísio J D Barros [b,1], Iná Santos [b,1], Ulf Ekelund [c,d,1], Pedro Curi Hallal [b,c,1]

[a] Federal University of Rio Grande (FURG), Postgraduate Program in Public Health, Brazil
[b] Federal University of Pelotas (UFPel), Postgraduate Program in Epidemiology, Brazil
[c] Department of Sport Medicine, Norwegian School of Sport Sciences, Oslo, Norway
[d] Medical Research Council (MRC), Epidemiology Unit, Institute of Metabolic Science, University of Cambridge, Cambridge, UK
[e] Department of Preventive Medicine, University of São Paulo, São Paulo, Brazil

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ABSTRACT

The aim of this study was to examine the longitudinal influences of early life social and biological indicators on objectively measured physical activity. All newborns in 2004 in the city of Pelotas, Southern Brazil were enrolled in a birth cohort study. At the age of 6 years, a follow-up visit included objective assessment of overall physical activity (summarized in milli-g, 1 mg = 0.001 g) by tri-axial wrist worn accelerometry. The associations between early life exposures, such as type of delivery, parity, birth weight, preterm delivery, maternal physical activity, socioeconomic position, and overall physical activity were examined. Valid accelerometry data were obtained from 2604 children (78.2% of the eligible individuals). Girls were less active than boys (β = −8.65 mg; 95% CI −10.0; −7.30). Higher socioeconomic position was related to lower activity levels (β = −9.69 mg. 95% CI −12.45; −6.93) and a similar association was found with maternal schooling. No associations were found with birthweight, type of delivery or preterm delivery. This study provides evidence for the role of some social factors in explaining children's physical activity behaviors, and minimizes the influence of some early life biological factors at determining physical activity levels.

1. Introduction

Accurate measurement of physical activity is a challenge in all age groups, but particularly in childhood. Self-report instruments based on the perception that mothers or guardians have about children's physical activity levels (proxy reports) and those based on self-reports from the child are subjective measure. Given the sporadic nature of the movement at this age group (Rowlands, 2007), assessing physical activity is particularly demanding at this age, and proper measurement is a starting point for the epidemiological evidence on physical activity levels of children around the world.

Practical issues, such as the costs associated with the use of criterion standards, i.e. doubly labeled water, which estimates physical activity based on energy expenditure, make it difficult to use such instruments in large scale studies, leading researchers to rely on secondary or subjective measures of physical activity (Sirard and Pate, 2001). From the secondary measures available, accelerometry is the most widely used method as it is possible to use in large scale studies including those with children. Some of the important issues of accelerometry at this age group (Rowlands, 2007) are related to: (a) the epoch (the signal from an accelerometer summarized over a given time interval), that must be short; (b) the duration of measurement, that shall include weekends; (c) the time of use, that shall include night and day avoiding replacements of the device; and (d) the position of use, hip or wrist. In order to determine the overall physical activity and the context in which it takes place, a combination of accelerometry and a subjective instrument is desired.

There are two important gaps in the knowledge about physical activity in children: the limited prospective data available and the lack of in-depth analyses of the influence of some social variables on physical activity behaviors. Studies on physical activity in the context of the Developmental Origins of Health and Disease (DOHaD) hypothesis are

Abbreviations: PA, physical activity; DOHaD, Developmental Origins of Health and Disease; ALSPAC, Avon Longitudinal Study of Parents and Children.

* Corresponding author.
E-mail address: alan_knuth@yahoo.com.br (A.G. Knuth).

[1] The authors contributed equally to this work.

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even rarer (Ridgway et al., 2011; Hallal et al., 2006). One study combining data from European and Brazilian cohorts concluded that none of the birth variables was associated with physical activity at 11–12 year-olds (Mattocks et al., 2008). Another study showed social and ecological exposures tend to influence physical activity levels among adolescents (Hearst et al., 2012). Among low- and middle-income countries, insights about the social determinants of health are essential, given the socioeconomic inequalities (Paim et al., 2011). Therefore, the Brazilian context or similar places add knowledge in terms of a mix, comprehending social and cultural expression of the behaviors. The Brazilian case is of particular interest, given the country has a longstanding history of high socioeconomic inequalities, especially in terms of income inequality.

The aims of this study were to (a) describe objectively-measured physical activity among children aged 6 years participating in a birth cohort in a middle-income setting; (b) explore associations of some biological and social variables, collected early and contemporary in life, with current physical activity levels.

2. Materials and methods

All live births in 2004 in the city of Pelotas (South of Brazil) from mothers residing in the urban area of the municipality were eligible to participate in a cohort study ($n = 4231$ children). Mothers were interviewed within 24 h after delivery and infants were weighed and measured. Participants were seen at the ages of 3 months ($N = 3985$), 1 ($N = 3907$), 2 ($N = 3869$) and 4 years ($N = 3799$) prior to the follow up visit at 6 years.[8] Data on child sex, birth weight, gestational age, and type of delivery, as well as parity (birth order) and self-reported leisure-time physical activity of the mothers before and during pregnancy were collected in the perinatal study. Mothers were classified as active in pregnancy if reporting any physical activity practice in all three trimesters of gestation. When children were 4 years old, self-reported leisure-time physical activity of mothers and the mothers' perceptions about physical activity of children compared to their peers were assessed. Maternal education was collected through completed years of schooling at the 6 (mean: 6.8) year follow-up, and socioeconomic position at birth was assessed through an asset index, later divided into four groups, from 1 (the wealthiest) to 4 (the poorest).

At the 6 year follow-up (Santos et al., 2014), children and their parents were invited to the research clinic of the Epidemiologic Research Center, Federal University of Pelotas for a comprehensive assessment of health. This fieldwork lasted for 10 months, from October 2010 to August 2011. A detailed description can be found at Santos et al. (2014).

At the research clinic, children and their parents received instructions regarding the use of the accelerometer, which was used from 4 to 7 days according to the following protocol: children who were assessed on Mondays, Tuesdays or Wednesdays were asked to wear the accelerometer until the following Monday. Those who were seen on Thursdays, Fridays or Saturdays used the accelerometer until the following Wednesday. The methodological approach was based on the number of accelerometers, availability of research assistants to collect the monitors and to guarantee at least weekend day of measurement. The monitors were placed on the non-dominant wrist of the children and the following instructions were given: a) use the monitor at all times of the day, even while sleeping and bathing, b) contact the research team if you have any questions, and c) schedule a date and time for the return of the device. A research team member collected the device at the scheduled time at the children's place.

Overall physical activity was measured by the GENEActiv accelerometer model to collect acceleration data ($1\ g = 9.8\ m \cdot s^{-2}$, here the data are expressed in mg - 1 mg = 0.001 g) in three axes. These devices are waterproof and lightweight (16 grams), and were set-up with a frequency of 85.7 Hz. The commercial GENEActiv software was used to initialize and download data from each accelerometer monitor. The accelerometer data in binary format was analyzed with R-package GGIR (http:/cran.r-project.org) (van Hees et al., 2013), providing the main summary measure with the average magnitude of wrist acceleration over the measurement period (normalizing for missing data, i.e. monitor non-wear). The signal processing scheme (1) verifies the sensor calibration error using local gravity as a reference, (2) detects sustained abnormally high values and non-wear periods, (3) calculates the vector magnitude of body acceleration using the Euclidian Norm minus one (ENMO: $\sqrt{x^2 + y^2 + z^2} - 1$ g) with resulting negative values rounded up to zero, and (4) imputes invalid data segments by the average of similar time points on different days of the measurement (van Hees et al., 2013). Further, the first 10 h and the last 20 h of data in each raw accelerometer file were excluded as these were potential periods when the accelerometers would not be attached to the participants (between initialization and attachment, and between collection of the monitors and download, respectively). Files were considered appropriate for analyses if valid data were present for every 15-minute period in a 24-hour cycle (even when scattered over multiple days) and with calibration error (deviation from 1 g during no movement) lower than 0.02 g (after calibration). For the current analysis, only participants who provided at least two days of measurement were considered.

Statistical analyses were performed using Stata 12.0. Analyses on the influence of early life exposures on physical activity at 6 years were run using one-way analysis of variance in the unadjusted analysis and linear regression in the adjusted analysis. A hierarchical conceptual model was used to include variables in a linear regression model. Initially, birth-related variables were included followed by socioeconomic position, maternal physical activity during pregnancy and finally variables collected when children were aged 4 and 6 years, respectively. A cut-off point of 0.05 was used for statistical significance, but all variables with a P value ≤ 0.2 were kept in the model in order to minimize residual confounding. In the analysis between current maternal schooling and physical activity, there was no adjustment for early life socioeconomic position due to the collinearity between the two variables.

Mothers provided their written consent for study participation, this includes the mothers and children information. The study protocol was approved by the Federal University of Pelotas Medical School Ethics Committee.

3. Results

Descriptive data are presented in Table 1. In 2004, more boys than girls were born (51.9% vs 48.1%, respectively) and the normal delivery was more prevalent (55.5%) than caesarean. Low birthweight and preterm delivery were 10.0% and 14.5% of the sample, respectively. Mothers became less active during pregnancy, and 63.6% of them perceived their children as active at 4 years old. In the last follow-up visit, around half of the mothers reported complete Elementary school.

Analytical sample was considered according the availability of valid accelerometer data and its characteristics, also presented in Table 1, are similar to the original cohort participants. The research team delivered accelerometers to 3331 cohort members and obtained valid data from 2604 children (78.2%). Reasons for incomplete data included failure to comply with the analytical requirements presented in the methods section and because 514 (15.4%) of the data were obtained with the GENEA accelerometer device. The GENEA accelerometer is a non-commercial model that was used in the beginning of the fieldwork but showed limited applicability at large cohort studies. The GENEA accelerometer was replaced by the current commercial version GENEActiv.

The average number of days of accelerometer wear was 4.7 days (SD = 0.99). In Table 2, accelerometry data obtained using GENEActiv are presented in detail.