Evaluating the effectiveness of a nationwide school policy on physical activity levels in Danish school-aged children: A natural experiment

Statistical analysis plan (SAP)

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Background

In 2014, the Danish Government introduced a new school policy requiring an average of 45 minutes physical activity (PA) daily during the school day. The overall objective of this natural experiment is to examine the effectiveness of this national school policy on objectively-measured PA levels among Danish school-aged children aged 6 – 17 years between 2009 – 2018 (1). PA was measured by accelerometry during a 7-day period in children from 31 schools in 2017-2018 (post-policy) and compared to data from four historical school-based studies conducted between 2009-2012 (pre-policy) (2-5). All invited schools in the post-policy

population were represented in the pre-policy study populations, and calendar periods of data collection and age groups were matched according to the four historical studies.

Aims:

- *The primary aim* is to examine the effectiveness of the 2014 school policy on school time PA, which is defined by any bodily movement above sitting and standing.
- *The secondary aims* are to examine the effectiveness of the 2014 school policy on
    - School time moderate to vigorous PA (MVPA) and total PA (mean counts per minute (CPM))
    - Overall (school- and leisure time) PA, MVPA and mean CPM

Data processing and statistical analyses

Accelerometry

PA was assessed by waist-mounted accelerometry. The device was mounted with an elastic belt. In the four pre-policy studies ActiGraph monitors (AM7164, GT1M, and GT3X) were used. In the post-policy study, Axivity AX3 accelerometers were used. The Axivity AX3 instrument stores raw acceleration, whereas the main output of Actigraph monitors is counts per time unit. A newly developed aggregation method enables the generation of Actigraph counts from raw acceleration with very high agreement (6), which enables harmonization of PA data across different instruments. Data were processed using 10-seconds epochs.

Since timetables were not available in all pre-policy studies, aggregated acceleration data by age group and study were used to create PA intensity trajectories for each weekday represented. In these, a clear pattern appeared during the school hours due to the constant shift between class and recess. The trajectories made it possible to identify a group level *morning wake time*, *evening to bedtime* and *start and end of school day*. Subsequently, these time points were used to define: i) school time and ii) total time (from morning till bedtime). The time point identification was done by two researchers separately and then compared to ensure data quality. Moreover, the time points were compared to timetables available in the post-policy population.

PA levels will be examined from 2009-2018. During the same period, it is anticipated that the length of the school day has expanded due to the 2014 school policy, which will influence the total school time participants have available to accumulate PA. As a supplement, a standardized 8.10am-1pm school time variable was conducted, which controls the effect of school length. Both the standardized school time variable and the school time variable based on the above-mentioned trajectories will be used to examine the primary aim.

i) School- and ii) total PA will be examined using following PA outcomes:

- *Time spent with PA above 753 CPM* is the primary outcome of this study. The school policy does not specify the intensity of the 45 minutes of daily PA required. Thus, a new cut-off point is generated with the assumption that PA is any bodily movement above sitting and standing. In the post-policy population, participants wore an Axivity accelerometer around the waist and thigh (only waist is used in the present study). A new method using the thigh-worn accelerometer is with high accuracy able to objectively classify different activity types (7). Thus, the >753 cut point was determined by using the thigh accelerometer classification to extract the activity counts measured at the hip for sitting and walking activities, and subsequently a ROC analysis was carried out to estimate the threshold that distinguish walking from sitting with the highest possible sensitivity (0,908) and specificity (0,899) (data not published).

- *Time spent with MVPA* using the Evenson cut-point (>2296 CPM) is a secondary outcome (8)

- *Mean CPM* as a general measure of total volume of PA is a secondary outcome

Statistical analyses

All analyses will be conducted in StataBE 17 (StataCorp).

All outcomes are continuous. Thus, a linear mixed-effect model approach will be used to examine any changes in PA levels over time. Time will be treated as a categorical variable in which each year (2009, 2010, 2012 and 2017/18) represents a category. A newly published Danish report based on objective data from the post-policy population reports differences in PA levels among boys and girls and different age-groups during school time (9), and analyses will therefore be adjusted for age and gender. Moreover, analyses will be adjusted for seasonal variations (10). Project, school-identifier and individual identifier will be modelled as random effects due to the assumption that observations within these clusters are not independent, and individual identifiers are nested in schools, which are nested in projects. We assume that the effect of the school policy might be different in the younger school children compared to the older ones. Thus, an interaction term or stratification will be utilized to account for this.

Initially, pre-policy trends (t: 2009, 2010 and 2012) will be inspected. t denotes time (t=2009, 2010, 2012, 2017/18) and b(t) denotes reference-category contrasts describing the effect of time t with t=2009 as reference category. Firstly, we will test pre-policy linearity in b(t) (H0: b(2010)=b(2012)/3). If linearity exists, we will test for a constant pre-policy level in b(t) (H0: b(2010)=b(2012)=0). If the pre-policy trend is either

linear (positive or negative) or constant, we will analyze post-policy data using mixed-effect linear regression testing either i) whether linearity (positive or negative) continues post-policy (H0: b(2010) = b(2012)/3 = b(2017/18)/8.5) or ii) no difference between pre- and post-policy, if the pre-policy trend is constant (H0: b(2010)=b(2012)=b(2017/18)=0). This will be examined using post-estimation testing of linear combinations of coefficients. If no linear trend exists in pre-policy data, a bootstrap method will be implemented testing whether b(2017/18) significantly exceed any pre-policy estimates in b(2009), b(2010) or b(2012). If using the bootstrap method, we will make no assumptions regarding pre-policy trends in b(t).

Data will be checked for all statistical assumptions concerning the mixed-effect model; normality and homoscedasticity of residuals and linearity between dependent and independent variables.

Analyses are completed in February and March 2022.

Codebook:

Variable name	Variable Label	Variables types	Legal values	Value labels
id_project	Individual and project identifier	Categorical/nominal		
gender	Boy or girl	Categorical/dichotomous	0, 1	0: Girl, 1: Boy
age	Age at examination	Continuous	6-18	
school_level	School level at examination	Categorical/dichotomous	1, 2	1: 0th-5th grade, 2: 6th-9th grade
grade	Academic school year	Categorical/ordinal	1-9	1: grade 1, 2: grade 2 etc.
school_at_examination	School at examination	Categorical/nominal	1-57	1: school 1, 2: school 2 etc.
year	The year of data collection	Categorical/nominal	2009, 2010, 2012, 2017/18	2009, 2010, 2012, 2017/18
season	The season of data collection	Categorical/dichotomous	1, 2	1: spring/summer, 2: fall/winter
project2	Project over time - FASER matched with historical projects	Categorical/nominal	1-4	1: CHAMPS, 2: EYHS, 3: NBBB, 4: SPACE
Intervention	Pre- or post-intervention	Categorical/dichotomous	0, 1	0: Pre-intervention, 1: Post-intervention
category	The day is divided in 4 categories (events)	Categorical/nominal	1- 5	1: school time (timetable), 2: school time (standard 8.10-13), 3: Leisure time, 4: Total (full day)
Duration	Duration of events in minutes (categories above)	Continuous		
Weekday	Day of the week	Categorical/nominal	1-5	1: mon, 2: tue, 3: wed, 4: thur 5: fri

DayNumber	Day of recording	Categorical/nominal	1-8	1: First measurement day, 2: Second… etc.
non-wear	Minutes of non-wear	Continuous		
Cpm	Average counts per minutes	Continuous		
mvpa_min	Minutes of moderat to vigorous physical activity (>2296 counts)	Continuous		
movement_min	Minutes of movement (>753 counts)	Continuous		

Literature:

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