Preventive Medicine Reports 4 (2016) 429–434

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: http://ees.elsevier.com/pmedr

Permanent play facility provision is associated with children's time spent sedentary and in light physical activity during school hours: A cross-sectional study

Knut Eirik Dalene [a,*], Sigmund A. Anderssen [a], Ulf Ekelund [a], Anne-Karine Halvorsen Thorén [b], Bjørge H. Hansen [a], Elin Kolle [a]

[a] Department of Sports Medicine, The Norwegian School of Sport Sciences, P.O. Box 4014, Ullevål Stadion, N-0806 Oslo, Norway
[b] Department of Landscape Architecture and Spatial Planning, The Norwegian University of Life Sciences, P.O. Box 5003 NMBU, N-1432 Ås, Norway

ARTICLE INFO

Article history:
Received 15 April 2016
Received in revised form 9 August 2016
Accepted 12 August 2016
Available online 13 August 2016

Keywords:
Physical activity
Child
Adolescent
School
Recess

ABSTRACT

Objective: To study the associations between: 1) number of permanent outdoor play facilities per pupil and 2) the size of the outdoor play area per pupil with sedentary time and physical activity (PA) during school hours in six-, nine-, and 15-year olds. We conducted a cross-sectional study of nationally representative samples of Norwegian six- (n = 1071), nine- (n = 1421) and 15-year-olds (n = 1106) in 2011 (the Physical Activity Among Norwegian Children Study). The participation rates were 56.4%, 73.1% and 57.8% for six-, nine- and 15-year olds, respectively. We assessed PA objectively for seven consecutive days using accelerometers, the size of a school's outdoor play area (SOPA) using an online map service and the permanent play facility (PPF) provision using a standardized form during school site visits. We successfully measured SOPA and PPF in 99 schools, from which 3040 participants provided valid accelerometer data. We used generalized least-squares random-effects models with robust variance estimation to assess associations. Our results indicate that better provision of permanent play facilities may reduce sedentary time and increase time spent in light PA among six-year-olds. Permanent play facility provision was not associated with sedentary time or PA among nine- and 15-year-olds. Associations found between outdoor play area size, physical activity and sedentary time were negligible. Future research should investigate what types of permanent play facilities may be associated with physical activity in both children and adolescents.

1. Introduction

Since almost all children spend a large proportion of their awake time in school, this arena provides a unique setting for physical activity (PA) promotion. During and adjacent to the school day, children may have several opportunities to be physically active, e.g. through active travel, physical education (PE) and recess. Intervention studies aimed at promoting PA in all these settings have shown promising results (Lonsdale et al., 2013; Larouche et al., 2014; Ickes et al., 2013). However, because it is already compulsory in most schools and does not compete with academic interests (Ickes et al., 2013), recess might be a particularly attractive arena for PA promotion. Children also seem to be more physically active in school free play than during PE lessons (Sleap and Warburton, 1996), and more physically active outdoors compared with indoors (Gray et al., 2015). Unstructured free play during recess has been shown to contribute 5–40% of recommended daily PA (Ridgers et al., 2006), indicating that some schools might have a large PA promoting potential through simple, low-cost strategies.

Designing outdoor play areas that stimulate as many pupils as possible to be physically active is, however, a multifaceted process. For example, studies indicate that girls and boys use different areas of their school's outdoor play area (SOPA) when being physically active (Fjørtoft et al., 2009; Anthamatten et al., 2014), that PA levels are higher in areas with a naturalistic feel (Fjørtoft, 2004) and that colorful playground markings can increase recess PA (Blaes et al., 2013). Both the size of SOPA and the availability of permanent play facilities (PPF) are basic components of a schoolyard design, and studies indicate that both factors may be important to stimulate PA (D'Haese et al., 2013; Escalante et al., 2012; Nielsen et al., 2010). However, previous research is limited by the use of subjective measures of PA and small sample sizes (Haug et al., 2010; Ridgers et al., 2010b). Furthermore, studies investigating the association between the size and PPF content of SOPA with time spent sedentary among children and adolescents are limited. Even though debated, studies have indicated that sedentary time

Abbreviations: PA, Physical activity; PE, Physical education; CPM, Counts per minute; LPA, Light physical activity; MVPA, Moderate-to-vigorous physical activity; SES, Socioeconomic status; CI, Confidence interval; BMI, Body mass index; SOPA, School's outdoor play area(s); PPFs, Permanent play facilities.

* Corresponding author.
E-mail addresses: k.e.dalene@nih.no (K.E. Dalene), sigmund.anderssen@nih.no (S.A. Anderssen), ulf.ekelund@nih.no (U. Ekelund), kine.thoren@nmbu.no (A.-K.H. Thorén), b.h.hansen@nih.no (B.H. Hansen), elin.kolle@nih.no (E. Kolle).

http://dx.doi.org/10.1016/j.pmedr.2016.08.011

might pose a negative effect on cardiovascular risk factors already at a young age (Healy and Owen, 2010). Therefore, further research is necessary to identify the importance of the size and PPF content of SOPA for both PA and sedentary time.

Therefore, the aim of this study was to assess the associations between: 1) number of permanent play facilities and 2) the size of the outdoor play area with objectively measured sedentary time and physical activity during school hours in a representative sample of pupils from Norwegian schools.

2. Materials and methods

2.1. Participants

The participants in this cross-sectional study, the Physical Activity Among Norwegian Children Study, were nationally representative samples of six-, nine- and 15-year-olds. Statistics Norway randomly selected the cohort using cluster sampling, with school as the primary unit. When a school agreed to participate, we invited all pupils in first, fourth or tenth grade to participate. In total, 5757 pupils from 107 schools were invited. We obtained written informed consent from 3598 participants and their primary guardians, yielding participation rates of 56.4%, 73.1% and 57.8% for six-, nine- and 15-year-olds, respectively. The Regional Committee for Medical Research Ethics and the Norwegian Social Science Data Services reviewed and approved the study. We conducted the study according to the Helsinki declaration.

2.2. Anthropometrics

We measured weight and height to the nearest 0.1 kg (Seca 877, SECA GmbH, Hamburg, Germany) and 0.1 cm (wall-mounted measuring tape), respectively, while the participants wore light clothing and no shoes. Body mass index (BMI) was calculated as kg/m^2.

2.3. Physical activity

We measured PA using ActiGraph accelerometers (models GT1M and GT3X+; ActiGraph, LLC, Pensacola, Florida, USA). Children's free-living PA measured with ActiGraph accelerometers has previously been shown to correlate moderately well with activity energy expenditure measured by doubly labeled water ($r = 0.66$, $p < 0.001$) (Ekelund et al., 2001). The participants were fitted with the accelerometers on their right hip during school visits, and instructed to wear the monitor during all waking hours for seven consecutive days, except during showering and bathing. Using the Actilife software (ActiGraph, LLC, Pensacola, Florida, USA), we initialized the accelerometers to sample vertical accelerations (30 Hz), and to start recording at 06:00 on the day after the monitors were attached in order to eliminate reactivity-bias (Dossegger et al., 2014). We used KineSoft (KineSoft Software, Rothesay, New Brunswick, Canada) to analyze the accelerometer files.

An epoch length of 10 s was used, which has been deemed suitable for children (McClain et al., 2008). We defined non-wear as intervals ≥20 consecutive minutes with no activity recordings, and wear time by subtracting non-wear from school hours. In Norway, school normally starts between 8:00 and 9:00 and ends between 13:00 and 14:45, depending on school and grade. To ensure that we only included school hours, we defined schooldays as 9:00–13:00 for six- and nine-year-olds and 9:00–14:00 for 15-year-olds. These periods include morning-, lunch- and afternoon recess for all grades. We excluded all schooldays with ≥60 min of non-wear and included participants if they had accumulated ≥2 valid schooldays of accelerometer data. We collected all data from March to December in 2011 (no measures in July due to summer holidays). Measurements were evenly distributed across the school year, with the exception of August and December during which only 82 and 95 pupils were measured, respectively.

We used counts·min^{-1} (CPM) as a measure of overall school PA. We calculated CPM by dividing the total number of school day counts by the total number of school day wear minutes. To investigate time spent sedentary, in PA of light intensity (LPA) and of moderate-to-vigorous intensity (MVPA), we used cut-points of <100 CPM (1–1.5 METs), 100–1999 CPM (1.6–2.9 METs) and ≥2000 CPM (≥3 METs), respectively (Andersen et al., 2006).

2.4. Play facilities/area size

During school visits, the research team registered the number of PPFs using a standardized form. Subsequently, we calculated the number of PPFs per pupil. To measure the size of SOPA we used a polygon measurement tool and updated electronic maps from the Norwegian Mapping Authority (finn.no, 2011). We calculated SOPA by subtracting areas of buildings, car parks and other areas with car traffic from the school's total outdoor area, and then calculated the SOPA per pupil. Others have used similar methods (Pagels et al., 2014; Ridgers et al., 2010a; Nilsen, 2014).

Through interviews with teachers, we received information on recess period organization potentially influencing the availability of space and play facilities (e.g. access to areas outside school property and sectioning of SOPA during recess).

2.5. Socioeconomic status

We used the highest education level of the participant's parents (data from Statistics Norway) as a proxy for socioeconomic status (SES) and computed four SES groups: low (primary school, lower secondary school, vocational high school), middle low (secondary school/high school), middle high (undergraduate degree) and high (graduate degree).

2.6. Sample size calculations

We based the sample size calculations on the ability to detect subgroup differences in CPM. With respect to this, 516 individuals in each age and sex group allowed us to detect subgroup differences of 7% using a two-tailed test ($1 - \beta = 0.90$; two-tailed $\alpha = 0.05$). Because of cluster sampling, we incorporated a design effect of 1.1, yielding a final target sample size of 567 individuals in each age and sex group.

2.7. Statistical analysis

We performed all statistical analyses using Stata 13.1 (StataCorp. 2013. Stata Statistical Software: TX: StataCorp LP.). We used independent samples *t*-test to investigate sex differences, and one-way ANOVA with Bonferroni corrections to assess differences between the three age groups. For our main analyses, we ran all the models separately for the different age groups. To account for cluster sampling, we used GLS-re models with robust variance estimation. Initially, we entered the interaction terms *sex * number of PPFs* and *sex * play area size*. The interaction terms were not statistically significant. Consequently, we did not stratify the main analyses by sex but rather included sex as a covariate.

We adjusted all analyses for accelerometer wear time (except analyses of CPM), measurement month, sex, and SES, and the dummy variables "access to areas outside school property", "sectioning of play areas", "recess at different time points for different classes" and "allowed to spend recess indoors". We also adjusted for number of PPFs in analyses with the size of SOPA as the independent variable.

3. Results

Of the 3598 participants, 3040 from 99 schools met the inclusion criteria. Because of construction work, we did not get valid measurements in three schools (n = 212). The remainder of the excluded