Landscape and Urban Planning 134 (2015) 83–92

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Research paper

Objectively measured differences in physical activity in five types of schoolyard area

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HIGHLIGHTS

- We investigate how schoolchildren use different schoolyard areas during recess.
- We examine schoolyard behavior using GPS, accelerometer and GIS.
- Grass and playground areas had the highest proportion of moderate to vigorous activity.
- Solid surface areas had the highest proportion of time spent sedentary.
- Girls accumulated more sedentary time in all area types compared to boys.

ARTICLE INFO

Article history:
Received 23 December 2013
Received in revised form 2 October 2014
Accepted 6 October 2014
Available online 5 November 2014

Keywords:
Behavior
Schoolyards
Accelerometer
Gis
GPS
Youth

ABSTRACT

Physical activity (PA) in childhood is related to a multitude of short- and long-term health consequences. School recess can contribute with up to 40% of the recommended 60 min of daily moderate-to-vigorous physical activity (MVPA). This paper aims to investigate how schoolchildren use different schoolyard areas during recess and whether these areas are associated with different levels of PA. Time spent by 316 students (grade 5–8) in five types of schoolyard area was measured during at least two days and four separate recess period per person (in total 1784 recess periods), using global positioning system (GPS) and the level of activity was measured using accelerometers. Total time spent and proportions of time spent sedentary and in MVPA were calculated per area type. Significant differences in PA levels were found. Grass and playground areas had the highest proportion of time in MVPA and solid surface areas had the highest proportion of time spent sedentary. Boys and children spent a higher proportion of time in MVPA. Girls accumulated more sedentary time in all area types compared to boys. This finding emphasizes the importance of investigating various settings and features in schoolyards in promoting PA. Grass and playground areas may play an important role in promoting PA in schoolyards, while a high proportion of time in solid surface areas is spent sedentary. In future, more detailed studies of the exact schoolyard setting using a combination of GPS, accelerometer and direct observation would be beneficial.

1. Introduction

Physical activity (PA) in childhood is related to a multitude of short- and long-term health consequences by its preventive effect on physical conditions, such as obesity (Harrison & Jones, 2012; Mark & Janssen, 2009), markers of cardio metabolic risk factors (Holman, Carson, & Janssen, 2011), low bone mass and increased blood pressure and cholesterol (Janssen & Leblanc, 2010). PA has also proved to be crucial to the cognitive performance (Sibley & Etnier, 2003) and mental well-being of the child, by preventing the development of depression (Janssen & Leblanc, 2010) and

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http://dx.doi.org/10.1016/j.landurbplan.2014.10.005
0169-2046/

strengthen the self-esteem (Ekelund et al., 2004). A systematic review indicates that the more time children and youth engage in PA of at least moderate intensity, the greater the health benefits they achieve (Janssen & Leblanc, 2010).

The importance of promoting PA in childhood is confirmed by the fact that the PA level early in life seems to follow into adulthood (Pate, Baranowski, Dowda, & Trost, 1996; Telama et al., 2005).

Despite the current public health recommendation to participate in 60 min or more of moderate-to-vigorous physical activity (MVPA) each day, a study from the United States shows that 42% of the children aged 6–11 years old, and only 8% of the adolescent aged 12–19 years old, meet the recommendations (Troiano et al., 2008). A report from the Danish national board of health indicates that 58% of the boys and 55% of the girls aged 11–15 years old are physically active at least 60 min a day (Sundhedsstyrelsen, 2006). Additionally, the pattern of children's sedentary behavior is a concern. Several studies indicate that children and adolescents spent a considerable proportion of their day sedentary, with sustained sequences of 20–30 min or more (Abbott, Straker, & Erik Mathiassen, 2013; Harrington, Dowd, Bourke, & Donnelly, 2011). School time in particular has shown to be associated with more uninterrupted sedentary periods than non-school time (Abbott et al., 2013). A study by Biddle, Pearson, Ross, and Braithwaite (2010) found that sedentary behavior patterns established during childhood or adolescence often are followed into adulthood, and that this so-called tracking seems to be stronger for sedentary behavior than for PA. In adults, sedentary time has shown to be an independent risk factor for obesity and diabetes (Katzmarzyk, 2010). Sedentary time may as well have detrimental effect on children's health if the findings observed in adults are true for children (Healy et al., 2008).

The school is recognized as an important setting for promoting PA and reducing sedentary time due the major role it plays in children's and adolescent's life (Mota et al., 2008; Naylor & McKay, 2009). Within the school, two main contexts exist in which children have the opportunity to be physically active; the physical education (PE) lessons and recess. A review by Biddle and Asare (2011) found that recess PA improves cognitive performance; academic achievement; classroom behavior, attention and concentration. Several other studies have also demonstrated the importance of recess in the promotion of PA (McKenzie, Crespo, Baquero, & Elder, 2010; Ridgers, Fairclough, & Stratton, 2010; Ridgers, Saint-Maurice, Welk, Siahpush, & Huberty, 2011). A study by Ridgers, Stratton, and Fairclough (2006) found that activity during recess can contribute with up to 40% of the daily recommendation of 60 min of MVPA. Gender differences in recess PA are well documented, with boys typically engaging in more PA and girls spending more time sedentary (Bailey et al., 2012; Hilland, Ridgers, Stratton, & Fairclough, 2011; Ridgers, Salmon, Parrish, Stanley, & Okely, 2012; Ridgers, Stratton, & Fairclough, 2005). In addition, PA during recess was found to decrease with age (Fjortoft, Kristoffersen, & Sageie, 2009; Fjortoft, Lofman, & Halvorsen Thoren, 2010). Apart from these demographic factors, various other determinants have shown to influence PA during recess including biological (Ekelund et al., 2004; Hilland et al., 2011) and physical environmental factors (Nielsen, Bugge, Hermansen, Svensson, & Andersen, 2012; Taylor et al., 2011). Time spent outdoors also has a potential influence on children's PA. Previous studies have found that objectively measured PA was 2–3 fold higher outdoors than indoors (Cooper et al., 2010; Ferreira et al., 2007). From a health promotion perspective, it is interesting particularly to look at the physical environment factors, as many of these can be changed relatively easy by changing the design and contents of a schoolyard.

Several studies have described the impact of schoolyard characteristics on PA and found various factors to be conducive to PA such as playground area per student (Fairclough, Beighle, Erwin, & Ridgers, 2012), playgrounds colors (Ridgers, Stratton, Fairclough, & Twisk, 2007; Stratton & Mullan, 2005) and the amount of removable and permanent equipment available (Haug, Torsheim, Sallis, & Samdal, 2010; Nielsen, Taylor, Williams, & Mann, 2010; Zask, van Beurden, Barnett, Brooks, & Dietrich, 2001).

The majority of these studies have used observations or self-reported measurements when studying the association between schoolyard characteristics and children's movement patterns (Hilland et al., 2011; Ridgers et al., 2010; Taylor et al., 2011). Only few studies used objective measures (Global positioning systems (GPS) in combination with heart rate monitor), in assessing the movement patterns and PA levels of children aged 6 and 14 years old in one recess (Fjortoft et al., 2009, 2010). More research is needed to identify environmental indicators for PA in children at different gender and age groups according to one of these studies (Fjortoft et al., 2009).

The aim of this study was to investigate the use of different schoolyard areas and determine if these settings were related to differences in PA and sedentary behavior in schoolchildren (students) attending grade 5–8 using GPS and accelerometer. The objective will be addressed through the following specific research questions:

- How much time do students spend in the different schoolyard areas?
- What is the proportion of time spent in MVPA and sedentary out of the time spent in each schoolyard area?
- Are there gender or age differences in use and activity level in the different schoolyard areas?

2. Material and methods

2.1. Population

This study used baseline data from the When Cities Move Children (WCMC) study. WCMC is a longitudinal natural experiment conducted in and around the Haraldsgade district in Copenhagen, the capital of Denmark. The aim of the WCMC study is to document and assess the impact of urban renewal in the Haraldsgade district on children's PA and urban movement. Four schools in the district were invited to participate in the WCMC study (Klinker, Schipperijn, Kerr, Ersboll, & Troelsen, 2014b).

The district in which the four schools are located is characterized by being very multi-ethnic with 30 different nationalities represented. Children comprise 20% of the roughly 9300 people living in the district, and about 70% of these children are categorized by Statistics Denmark as immigrants or descendants of immigrants (Klinker et al., 2014a).

On behalf of the parents, the school boards of the four schools granted permission to include all their students in grade 5–8 (aged 10 to 15 years old) in the study. The parents received a passive informed consent form which the students could return if they did not want to participate, and they could withdraw during any stage of the study. The data were collected between April 2010 and September 2011. At the time of the study, 623 students attended the four schools in grade 5–8, from which 523 participated in the study (an 84% response rate).

2.2. Instruments

PA was recorded as an activity-count every 2 s using the ActiGraph accelerometer model GT3X. The ActiGraph accelerometer is a small lightweight activity monitor designed to detect movements in vertical, horizontal and transverse axes. But since the validated cut-off points for different activity levels for this age group are