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Physical Activity Intensity Distribution during Physical Education among Swedish Upper Secondary School Students

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Abstract

Background: Physical education (PE) has been identified as a potentially powerful domain to promote physical activity (PA) among school-aged youth. In Sweden, there is a lack of studies investigating PA intensity distribution during PE among upper secondary school student. *Aim:* The aim of this study was to investigate PA intensity distribution during PE among Swedish upper secondary school students. *Methods:* PA was measured during 41 PE lessons among 121 (n = 75 boys) Swedish upper secondary school students (ages 16-18 years) using hip-mounted objective activity monitors from ActiGraph™ (GT3X+ accelerometers). *Results:* The participants spent a median of 23% of the PE lessons time being sedentary, 17% in light PA (LPA), and 59% in moderate-to-vigorous PA (MVPA). There were no differences between boys and girls for neither sedentary (p = .185), LPA (p = .377), or MVPA (p = .839). Sedentary (p = .001) and LPA (p < .0001) were lower and MVPA (p < .0001) higher during fitness-related activities when compared to invasion games. *Conclusion:* A median of 59% of the PEL time was spent in MVPA which is relatively high in an international comparison. No differences were observed between boys and girls. Fitness-related activities contributed to higher MVPA when compared to invasion games.

Keywords: accelerometers; adolescents; fitness; moderate-to-vigorous physical activity; sedentary; youth, physical education

Introduction

A profound body of evidence has established a relationship between physical activity (PA), particularly at moderate and vigorous intensity, and a wide-range of health benefits among school-aged youth (Janssen & Leblanc, 2010; Poitras et al., 2016). Based on these evidence, available PA recommendations suggests that school-aged youth should accumulate 60 minutes or more per day of moderate-to-vigorous PA (MVPA) (Janssen & Leblanc, 2010). Currently, self-reported data suggest that approximately 20% of contemporary school-aged youth meet this recommendation (Hallal et al., 2012; Sallis et al., 2016) and, in Sweden, data collected with objective activity monitors suggest that 32% and 14% of Swedish upper secondary school students (year 2), boys and girls respectively, meet the PA recommendations (Nyberg, 2017).

In light of such evidence, the school physical education (PE) has been identified as a potentially powerful domain to promote MVPA among school-aged youth (Sallis et al., 2012). PE has thus been acknowledged to play a crucial role in public health efforts (Sallis et al., 2012) and, recently, provision of MVPA during PE lessons (PEL) was stressed by the World Health Organization (2013) with the intention of creating health promoting environments. In the United States and United Kingdom, the Centre for Disease Control and Prevention (U.S. Department of Health and Human Services et al., 2010) and the British Association for Physical Education (afPE) (2008) respectively proposed that school-aged youth should participate in MVPA for at least 50% of PEL time. According to two recently published systematic reviews and meta-analyses (Hollis et al., 2017; Hollis et al., 2016), the proportion of MVPA during PELs was 45% in elementary school (Hollis et al., 2016) and 41% in secondary school (Hollis et al., 2017). The meta-analysis for secondary school students further yields that the proportion of MVPA during PELs was lower (36%) among older (approximately aged 12–18 years) as compared to younger students (Hollis et al., 2017).

In Sweden, two studies have investigated the proportion of MVPA during PELs (Fröberg, Raustorp, Pagels, Larsson, & Boldemann, 2017; Raustorp, Boldemann, Johansson, & Martensson, 2010). One small-scale study including 10 year-olds found that 50% of PEL time was spent in MVPA (Raustorp et al., 2010). More recently, a larger study including 39 PELs revealed that 8, 11 and 14 year-olds spent approximately 25% of the PEL time in MVPA (Fröberg et al., 2017). The latter study

further demonstrated that the proportion of MVPA varied across PEL scope and context/content with the highest proportions of MVPA being observed for fitness-related activities (Fröberg et al., 2017). To the best of our knowledge, these are the only two Swedish studies addressing proportions of PA during PELs. Thus, there is currently lack of studies investigating proportions of PA during PELs among older school-aged youth.

In the context it should be emphasized that the Swedish PE program feature several knowledge requirements which does not require students to reach and maintain high proportion of PA during lessons. For example, the students are expected to develop skills and knowledge related to health and well-being (Swedish National Agency for Education, 2011). These low intensity and sometimes "passive" requirements constrain PE teachers to optimize their PELs in terms of intensity distribution. Therefore, it is still interesting to investigate proportions of PA during PELs as PE might have implications for public health efforts (Sallis et al., 2012). Consequently, the aim of this study was to investigate proportions of PA during PELs among a sample of Swedish upper secondary school students, ages 16-18 years.

Participants and methods

Participants

A convenience sample of 324 upper secondary school students (n = 11 classes, year 1 and 2, ages 16-18 years) attending one inner-city school in a large Swedish municipality were invited to participate in the study. During the recruitment procedure, it was clarified that participation was voluntary, and that anyone could withdraw their participation at any moment without providing any further explanation or justification. In total, 132 students accepted the invitation (41% of the original sample) and they provided informed, written and signed consent prior to their involvement in the study.

Measures

SEDENTARY AND PHYSICAL ACTIVITY

Sedentary (i.e., sitting/standing still in an upright position), light PA (i.e., the intensity between sedentary and MVPA) (LPA), and MVPA

during PELs were measured with small, light-weight, hip-mounted (by means of an elastic band) ActiGraph™ (Pensacola, Florida, US) GT3X+ accelerometers. Accelerometers from ActiGraph™ have been proven valid and reliable (de Vries et al., 2009) and the GT3X+ accelerometer measures accelerations as a result of bodily movement in the vertical, horizontal, and perpendicular axis. Prior to data collection, the participants were provided with the opportunity to familiarize themselves with the accelerometers by wearing them during a workshop session. They were also provided with the opportunity to ask any question related to the data collection procedure.

Collected accelerometer-data was downloaded and processed with ActiLife software (ActiGraph™ LCC, Pensacola, FL, U.S.) and integrated into 15 seconds epoch to acquire detailed data for sedentary, LPA, and MVPA. The ActiLife time-filters (start/stop time) and observation protocols were used to 'cut out' the PEL monitoring time. The following cut-points for the vertical axis were used to estimate minutes of PEL time spent in sedentary and PA: sedentary: ≤100 counts per minute (CPM); LPA: 101-2295 CPM; and MVPA: ≥2296 CPM (Evenson, Catellier, Gill, Ondrak, & McMurray, 2008). These cut-point has previously been recommended for school-aged youth as it provide the best classification accuracy (Trost, Loprinzi, Moore, & Pfeiffer, 2011). Also, these cut-points are quite similar to those commonly used among adults (aged >18 years) (Troiano et al., 2008). Proportions (%) of PEL time spent in each activity category was calculated by dividing minutes of sedentary, LPA, and MVPA by total monitoring time (e.g., 25 min of MVPA / 50 min monitoring time = 50% of MVPA).

SEX, AGE AND ANTHROPOMETRICS

The participants self-reported sex, age, and body height (cm) and body weight (kg) by questionnaire prior to the first week of data collection. Data for body height and body weight were used calculate body mass index (BMI) using the following formula: body weight (kg) / [height (m)]^2

DATA COLLECTION PROCEDURE

Data collection was carried out during three consecutive weeks in May, 2018, and one author (J.G.) was present during all measured PELs to a) verify that all accelerometers were worn appropriately at the start of each

PEL; and b) document PEL start/stop time and scope and content/context by observation protocol.

PHYSICAL EDUCATION LESSON SCOPE AND CONTEXT/CONTENT

During the three weeks of data collection, a total of 51 PELs were scheduled and, of these, 41 co-ed lessons (i.e., both boys and girls attended the observed lessons) were included in the analyses (80% of all available lessons). The reason for exclusions was that some PELs involved water-based activities such as swimming (the accelerometer is not water-proof) while other were cancelled due to other school events. The averaged scheduled PEL time was 55 minutes and the averaged monitoring time (i.e., actual lesson length) was 48.4 minutes. All lessons were delivered by certified PE teachers.

Most PELs had multiple scope and context/content making them challenging to categorize. The measured PELs with multiple scopes and context/content were therefore categorized depending on which context/content was most prominent, i.e. represented the most lesson time. This approach led to the following main PEL categories: a) fitness-related activities (e.g., brisk walking, jogging, interval training, and obstacle courses) (n = 28); b) invasion games (e.g., ball games, such as floor-ball and basketball, and ultimate frisbee) (n = 11); c) bowling (n = 1); and d) movement to music (n = 1). Thus, the main focus during the three weeks of data collection was on fitness-related activities, and some of these, including brisk walking, jogging and interval training, were carried out by the participants themselves (individually or in small groups) in the gym hall, school-yard or in the school surrounding.

Statistical Analyses

Medians (range) were calculated for body height, body weight and BMI as well as for proportions (%) of PEL time spent in sedentary, LPA, and MVPA. Data for these variables were skewed after checking Shapiro-Wilk test ($p < .05$), histograms and normality probability plots. Therefore, the non-parametric Mann-Whitney U-test was used to analyze differences between boys and girls in terms of a) body height, body weight and BMI; and b) proportions (%) of lesson time spent in sedentary, LPA, and MVPA. Mann-Whitney U-test was also used to analyze differences between the two major PEL categories fitness-related activities and invasion games. These analyzes were conducted with IBM SPSS Statistics

for Windows, Version 24.0. (IBM Corp. in Armonk, NY). The α-level was set at $p \leq .05$ and Bonferroni corrected to prevent conducting Type I error as a result of multiple testing, leaving the α-level of significance at $p \leq .016$ (.05/3 = .016).

Results

Participants and physical education lesson characteristics

Of the 132 participants who accepted involvement in the study, 121 (*n* = 75 boys) provided data for at least one PEL, with 11 being excluded due to absence from school and accelerometer monitor malfunction. The participants' characteristics are summarized in Table 1. Differences between boys and girls were observed for body height ($p < .0001$) and weight ($p < .0001$) but not for BMI ($p = .479$).

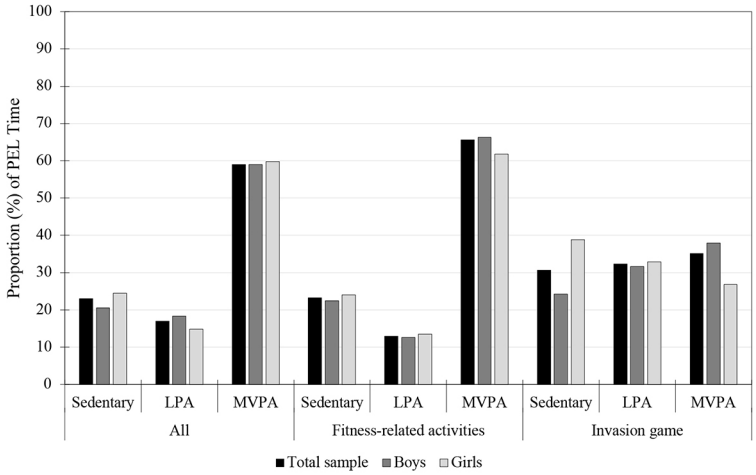

Figure 1. *Median proportion (%) of PEL time spent in sedentary, LPA, and MVPA across the total sample (black bars), and boys (dark grey) and girls (light grey) during all PELs, and fitness-related activities and invasion games, respectively.*

Sedentary and physical activity intensities

As summarized in Table 1 and further illustrated in Figure 1, the participants spent a median of 23% of the PEL time being sedentary, 17% in LPA, and 59% in MVPA. Moreover, the proportion of PA intensity var-

ied greatly between participants; sedentary ranged between 0% and 64%; LPA between 0% and 69 %; and MVPA between 5% and 98%. There were no differences between boys and girls for neither sedentary (p = .185), LPA (p = .377), nor MVPA (p = .839).

Table 1. *Participant characteristics and sedentary, LPA, and MVPA (MVPA) during PELs.*

	Total (n = 121)	Boys (n = 75)	Girls (n = 46)	P**
Participant Characteristics				
Age (years), Range	16-18	16-18	16-18	N/a
Body height (cm), Median (range)	176 (153-190)	179 (167-190)	167 (153-186)	< .0001
Body weight (kg), Median (range)	65 (48-96)	69 (53-96)	59 (48-83)	< .0001
BMI*, Median	21	21	21	.479
Sedentary, LPA, and MVPA during PELs				
Sedentary (%), Median (range)	23 (0-64)	21 (1-64)	24 (0-51)	.185
LPA (%), Median (range)	17 (0-69)	18 (0-69)	15 (1-38)	.377
MVPA (%), Median (range)	59 (5-98)	59 (5-98)	60 (19-98)	.839

Abbreviation: BMI, Body Mass Index; LPA, Light Physical Activity; MVPA, Moderate-to-Vigorous Physical Activity; PEL, Physical Education Lessons.
*Body weight (kg)/height (m)2
**Analyses performed with the non-parametric Mann-Whitney U-test with the α-level of significance: p ≤ .016

During fitness-related activities, the participants spent a median of 23% of the PEL time being sedentary, 13% in LPA, and 66% in MVPA. The corresponding values for invasion games were as follows: 31% sedentary, 32% in LPA, and 35% in MVPA. There were differences in sedentary (p = .001), LPA (p < .0001), and MVPA (p < .0001) between the two major PEL categories fitness-related activities and invasion games. Sedentary and LPA was lower and MVPA higher during fitness-related activities when compared to invasion games (Figure 1). There were no differences between boys and girls for sedentary, LPA and MVPA (all p > .05) during fitness-related activities. However, differences between boys and girls were found for sedentary (p = .016) and MVPA (p = .006) but not for LPA (p = .376) during invasion games.

Discussion

The main finding of this study was that the participants spent a median of 59% of the PEL time in MVPA. These figures are high in comparisons to previous meta-analyses of international studies within broader systematic reviews (Hollis et al., 2017; Hollis et al., 2016). For example, in their pooled analyses of objective data from 12-18-year-olds, Hollis and colleagues (2017) found that 36% of PEL time was spent in MVPA. However, it is noteworthy that the proportion of PEL spent in MVPA across the reviewed studies varied between 11% and 89% among elementary school students (Hollis et al., 2016) and between 13% and 68% among secondary school students (Hollis et al., 2017). These differences are likely attributed to PEL scope and context/content during each data collection period. As expected, a typical PEL might require school-aged youth to engage in a) instructions; b) demonstrations; and c) observations, more or less suggesting that maintaining high proportions of MVPA during PELs might be challenging during some types, or part of, lessons (Fröberg et al., 2017). Because the main scope and context/content during the PELs included in the present study was fitness-related activities, such as brisk walking, jogging and running, interval training, and obstacle courses (i.e., 68% of the analyzed PE lessons), this logically explain the relatively high proportions of MVPA as observed in this study.

The present study also showed that MVPA was higher during fitness-related activities when compared to invasion games. This is in line with previous research which also suggest that fitness-related activities generally provide the highest proportions of MVPA as, for example, reported in a previous review (Fairclough & Stratton, 2005) as well as in a recent study from Sweden (Fröberg et al., 2017). In the Swedish study, PELs with focus on fitness-related activities contributed to 37% and 33% of MVPA among boys and girls respectively (Fröberg et al., 2017). In the present study, the median share of MVPA was 66% during fitness-related activities and this might be explained by the type of activity in combination with measurement issues. For example, circuit training involving activities focusing on upper extremities likely contribute to less accelerations in the hip section as a result of bodily movement (the accelerometer was hip-mounted) as compared to, for example, brisk walking, jogging and running.

Moreover, at a group-level, the participants in the present study averagely met the 50% MVPA recommendations as suggested by the Centre

for Disease Control and Prevention (U.S. Department of Health and Human Services et al., 2010) and afPE (2008). Given that observed PE lessons lasted on average 48 minutes, one PEL generated approximately 30 minutes of MVPA which correspond to half of the current PA recommendations (i.e., 60 min or more per day of MVPA). Interestingly, the proportion of sedentary, LPA, and MVPA during PELs varied considerably among participants with, for example, MVPA ranging between 5% and 98%. Some PELs were, however, designed to allow for the students to take responsibility and carry out activities such as brisk walking or jogging in the school surroundings by themselves or in small groups and it is possible that some students did not adhere to the instructions provided by the PE teacher. This might explain why some low figures were observed for MVPA during those PELs.

To the best of our knowledge, there is no Swedish study investigating PA intensity distribution during PELs among upper secondary school students. However, the proportion of MVPA as observed in the present study are higher when compared to a previous study from Sweden involving youth aged 8, 11 and 14 years which concluded that approximately 25% of the PEL time was spent in MVPA (Fröberg et al., 2017). In this study, however, the proportion of MVPA varied considerably across lesson scope and context/content. For example, dance lessons, which were characterized by recurrent instructions and demonstrations, produced the lowest proportions of MVPA whereas the highest were observed for fitness-related activities (Fröberg et al., 2017).

Furthermore, although numerous studies to date suggest that boys generally are less sedentary and more physically active than girls when measured throughout the whole day (Cooper et al., 2015), our study showed that boys and girls were equally physically active during the PELs. These findings are in line with previous research (Fairclough & Stratton, 2005) and might suggest that PE is a suitable context to deliver PA to both boys and girls. However, we found differences between boys and girls during invasion games where boys spent more time in MVPA as compared to girls. Similar results have been reported among younger students in Sweden (Fröberg et al., 2017).

Strengths and limitations

Strength of this study include the usage of accelerometers to measure sedentary, LPA, and MVPA during PELs (80% of the totally available

lessons) among a fairly large sample of Swedish upper secondary school students. Another strength is that one author attended all PELs to verify that all accelerometers were worn appropriately, and to document start/stop time and lesson scope and content/context.

Limitations are the cross-sectional nature of data, the sampling strategy (i.e., convenience sample) which involved a school from only one socio-economic area, and that only 41% of the invited upper secondary school students accepted participation in the study. The latter might be ground for hypothesizing that acceptance to participation is a proxy marker for appreciating and raising the value of PE and, thus, the included students are perhaps those being most motivated and physically active during PELs. Another limitation is that the accelerometers cannot account for water-based activities which, unfortunately, led to some lesson being excluded.

Future research

Internationally, PE is generally acknowledged as a potentially powerful domain to promote MVPA among school-aged youth (Sallis et al., 2012); yet, in Sweden, there are few studies investigating the proportion of PA during PELs. Thus, additional studies measuring PA during PELs, across different ages and multiple scope and context/content, is of importance to inform to what extent Swedish PELs deliver MVPA among school-aged youth. Also, future studies should investigate proportions of PA during PELs among adolescents from different socio-economic groups.

Furthermore, in light of the ActivityStat hypothesis (Gomersall, Rowlands, English, Maher, & Olds, 2013), there is a possibility that students compensate their MVPA during PE with less PA in another domain to preserve an overall stable PA level. Although we lack data to investigate such possible compensatory change, some international studies with accelerometer-data for whole day PA suggests that students accumulate more MVPA during days with PE as compared with days without PE (Mayorga-Vega, Martinez-Baena, & Viciana, 2018; Meyer et al., 2013; Mooses et al., 2017). For example, Mayorga-Vega et al. (2018) measured PA among 13-16 year-olds and found less sedentary and more MVPA during days with PE as compared to non-PE days. Future studies should continue to investigate the contribution of PE to whole day PA.

Moreover, additional interventions to identify effective strategies to increase PA during PE is needed. In 2013, Lonsdale et al. conducted a systematic review and meta-analysis of interventions designed to increase MVPA during PE. The results showed that students in the intervention group on average accumulated 24% more of MVPA during PE time as compared to the control group. Although a small number of studies (n = 14) with moderate-to-high bias was included, these findings indicate that PE interventions might increase MVPA (Lonsdale et al., 2013).

Conclusion

In conclusion, a median of 59% of the PEL time was spent in MVPA which is relatively high in an international comparison. No differences were observed between boys and girls. Fitness-related activities contributed to higher MVPA when compared to invasion games.

Conflicts of interests

The authors declare no conflicts of interests.

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