Journal of Physical Education and Sport ® (JPES), Vol 19 (Supplement issue 3), Art 138, pp 957 - 961., 2019
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Physical activity and sedentary time during physical education lessons between different physical activity groups of a sample of Finnish 11-year-old students

SALIN, K[1]., HUHTINIEMI, M[2]., WATT, A[3]., HAKONEN, H[4]., MONONEN, K[5],. JAAKKOLA, T[6].
[1,2,,6]FACULTY OF SPORT & HEALTH SCIENCES, UNIVERSITY OF JYVÄSKYLÄ, JYVÄSKYLÄ, FINLAND;
[3]COLLEGE OF ARTS & EDUCATION, VICTORIA UNIVERSITY, MELBOURNE, AUSTRALIA
[4]LIKES RESEARCH CENTRE FOR PHYSICAL ACTIVITY AND HEALTH, JYVÄSKYLÄ, FINLAND
[5] RESEARCH INSTITUTE FOR OLYMPIC SPORTS, JYVÄSKYLÄ, FINLAND

Published online:May 31, 2019
(Accepted for publication April 18, 2019)
DOI:10.7752/jpes.2019.s3138

Abstract
Problem statement: Insufficient PA is rising concern in modern society. Physical education as a compulsory subject allows all students to engage physical activity. However, the activity levels may vary during the physical education lesson depending on the motivation of students.
Purpose: The purpose of this study was to determine the amount of time spent in light physical activity, moderate to vigorous physical activity and sedentary activity by a sample of Finnish fifth grade students during physical education lessons.
Approach: A cohort of 407 Finnish students' (177 boys, 232 girls) participated to study. To determine activity, participants wore GTX3 Actigraphs for seven consecutive days. Participants' activity scores were grouped in quartiles based on their weekly average moderate to vigorous physical activity. Different activity group and gender comparisons were undertaken using MANOVA.
Results: Contrasts regarding activity quartiles revealed that in the least active group quartile (Q1) boys had more sedentary time and less MVPA time than in the more active group quartiles (Q3&Q4). Among girls, Q1 girls had less moderate to vigorous physical activity than girls grouped in Q3-Q4, and had more sedentary time than all other quartile groups.
Conclusions: Results demonstrated that during PE lessons differences in activity between children with different moderate to vigorous physical activity levels exist. Physical education teachers should consider developing lesson strategies to address the differences identified in ST and MVPA. Programs that foster consistency in student engagement at the moderate to vigorous physical activity level may also support a decrease in levels of sedentary time across the physical education lesson.
Keywords: physical education, physical activity, children, accelerometer

Introduction

Recent reports highlight the public health concern related to insufficient physical activity (PA) and the harmful effects of excessive or uninterrupted sedentary behaviour especially screen time (Liu, Wu & Yao, 2016). In addition to reduced PA, another concern is polarization of PA (Lundvall & Meckhbach, 2010), which is demonstrated by cohorts of the childhood population being physically active, whereas other cohorts are living highly sedentarily(3). Since there is strong evidence of progressive decline in PA as individuals gets older(4-6) it is essential to engage people in physical activity during the early childhood period. School physical education (PE) lessons have proved to be effective way to increase PA during school day and serve an important role in adopting a physically active lifestyle(7-8). The purpose of this study was to investigate the different PA levels of 11-12 years old Finnish children across a day inclusive of PE lessons.

PA guidelines for children aged 5-17 years outline that at least 60 minutes of moderate to vigorous physical activity (MVPA) every day is required to gain health benefits(9). Based on sample data collected from children across 12 countries the mean time for MVPA was close to the recommended guidelines(10). However, quartile distributions of MVPA levels have previously been shown to clearly differentiate activity groups(11), particularly during leisure-time (after school & weekends)(12). In addition to low levels of MVPA, less active children usually engage in higher levels of sedentary time (ST)(11). However, high amounts of ST are also commonly reported among highly active children(13).

Previous studies reported that PA levels vary during PE lessons depending on the context of the lesson(14-15) and content of the lesson(16-17), class sizes(17), autonomy of the students(18), or student

Corresponding Author: SALIN, K, E-mail: kasper.salin@jyu.fi

demographics(19-20). While the recommendation (e.g. in USA) for MVPA is at least 50% of the lesson time, in most studies it has been found that these guidelines are not met. For example, in Sweden, USA, Estonia 25%, 27% and 29% of the lesson time were spent in MVPA(16-18), and only 3% of the students achieved the recommendation for 50% in MVPA(17). In previous studies, light physical activity (LPA) percentages during PE lessons (in Australia and Sweden) have been 33.1-35.8% and ST percentage (in Estonia, Australia and Sweden) 29.3%-39.3% of the lessons(16,22,23).

Based on the recent literature, it is known that activity levels vary depending on content and context of PE. However, how much time and in which intensity levels active and inactive children engage during PE lessons is still unclear. The purpose of this study is to measure PA and ST during PE lessons between different activity groups and genders in a sample of 11-year-old children. Specifically, the amount of time and percentage of time spent in various activity levels (i.e. ST, LPA, MPA, vigorous physical activity [VIG]) during PE lessons will be determined. In addition, the contribution of participating in PE to the daily total ST, LPA, and MVPA and association of length of PE lessons and total PA will be evaluated.

Methods

This study used data from the research project "Associations between monitoring and feedback system for physical functional capacity and Finnish students' physical performance, physical activity engagement and motivation in PE. The study targeted children's PA and sedentary behaviours.

Participants and setting

In total, 592 children (309 girls, 283 boys) aged 11-12 (M = 11.3, SD = 0.3) participated in the study. Data were collected from students in 37 different classes across 17 socio-demographically representative Finnish schools in September 2017. Participants' stature was measured to the nearest 0.1 cm using portable measuring equipment. Body mass was measured to the nearest 0.1 kg using calibrated scales for children in light clothing who were barefooted. For each participant, BMI was calculated and z-scores were assigned to each child(24). Mean BMI was 18.8 (SD 3.06) (girls 18.8 [2.98], boys 18.9 [3.17)]. Children were categorized as underweight, healthy weight, overweight and obese(24) (table 1).

Instruments

Children were fitted with a GT3X-BT Actigraph accelerometer (Pensacola, FL) by trained researchers in the beginning of the research period. Participants were asked to wear the accelerometer for seven consecutive days (with exception of sleep-time and water-based activities) on their right hip with an elastic belt. The epoch length was set at 15 seconds and data was processed using Actilife Lifestyle monitoring System, version 6.12.1. Non-wear time was defined as 30 min of consecutive zeros. Analyses were restricted to 407 participants (68.8% of 592 participants) who provided at least three days (two week days plus one weekend day) of valid accelerometer data (mean 6.22, range 3-7) and had at least 30 minutes of wear-time during the PE lesson. Three-day measurement has proven to be a reliable method when investigating PA and ST(25). A valid day was defined as recording at least 500 min of measured wear time between 07:00 and 23:00. In previous studies, it has been shown that at least 360 minutes should have measured for a valid day(26). To avoid possible bias in PA levels and ST, children who provided three valid days of accelerometer data were compared with those who provided four or more days. No differences between MVPA levels were found.

Procedure

Standard cut-points were used to define the mean daily percentage of time spent at various intensities: sedentary (0-100cpm), light (101-2295cpm) and moderate to vigorous (>2295cpm)(27). LPA and moderate to vigorous were divided to two categories to allow closer examination (LPA1 101-1197, LPA2 1198-2295: moderate physical activity (MPA) 2296-4011 and VIG 4012-19999). The relative time in which children participated in LPA, MVPA or ST was calculated as percentages [(certain activity level time / total wear time)×100].

PA levels and ST were also assessed during the PE lessons. In Finland, students in each grade have two hours (45 minutes) of obligatory PE, but there might also be an additional PE lesson in fifth grade (45 min) due to curriculum reform implemented in 2016(28). Official school timetables for each participant were obtained from the school. In addition, and for data consistency reasons, participants were asked to fill out diaries indicating the beginning and the end of the school day. PE lessons were tracked from the accelerometer data, based on the school timetable of the students. PA was compared between boys and girls with independent *t*-tests. In addition, different PA groups were classified in accordance with quartile distributions, based on the weekly total MVPA separately for boys and girls. For boys, quartiles for MVPA were as follows Q1: 0-48.5 minutes, Q2 48.6-61.6 minutes, Q3:61.7-78.8 minutes and Q4:78.9-151 minutes. For girls, quartiles for MVPA were as follow: 0-39.7 minutes, Q2:39.8-52.5 minutes, Q3:52.6-65.6 minutes, and Q4:65.7-128 minutes.

Data analysis

Lesson activity averages and standard deviations were computed for all continuous variables in the overall sample. Multivariate analysis of variance (MANOVA) was used to assess differences between quartiles in different activity levels. Class group was included in the analyses to control for the possible effect that this could have on children's activity during PE lessons. The numbers of participants meeting the PA guidelines were compared between groups using chi-square tests. All analyses were completed using IBM SPSS Statistics 24.0.

Results

Boys in Q1 had significantly greater body mass than their Q3 and Q4 peers (p<.001-.010, *d=0.92-0.93),* and a significantly higher proportion of Q1 boys were categorized more overweight/obese than those in Q4 (p=.002). Q1 girls had higher BMI than Q4 (p=.040, d=0.31). Significantly more Q2-Q4 boys and girls achieved the recommended PA levels than Q1 boys and girls during weekdays (p<.001-.003). Daily average MVPA time was 59.2 (SD 22.5) (61.1 [22.1] during weekdays; 54.5 [34.3] during weekends). Boys (64.1 [SD 23.6]) had more MVPA than girls (55.2 [SD 20.7]) (p<.001, d=040). During weekend days, significantly more Q3-Q4 boys and girls achieved the recommended PA levels than Q1 and Q2 boys and girls (p<.001-.013). During both weekdays and weekend days, significantly more Q4 boys and girls achieved PA recommendations than Q3 boys and girls (p<.001). Boys in Q1 had significantly more ST time than Q2-Q4 groups during weekdays (p<.001, d=0.92-1.52) and weekends (p<.001, d=0.81-1.36). Among girls, during the weekdays the Q1 cohort had more ST (p.<001-.022, d=0.71-1.30) than Q2 and Q4, and on weekends Q1 and Q2 had more ST than Q4 (p<.001-.012, d=0.89-0.79).

ST, LPA and MVPA during PE lessons

The mean PE lesson time was 91.2 minutes (SD 13.7) and 94.2% of the lessons were longer than 60 minutes. From the total wear time during PE lessons children spent 37.3% in sedentary activity, 39.3% in LPA (26.7% in LPA1 and 12.6% in LPA2) and 23.3% in MVPA (14.3 in MPA and 9.0% in VIG). Significant differences were only found between boys and girls in VIG activity minutes (boys 8.9 vs. girls 7.4, p=.034, d=0.20). Children who had shorter PE lessons (60 minutes or less), had significantly more ST time during lessons (50.2% vs. 36.4%, p<.001) and less LPA (33.3% vs. 40.3%, p=.002) and MVPA (16.3% vs. 23.4%, p=.020). Results also revealed that students participating in the same lesson were demonstrating substantial differences in ST and MVPA. The highest difference for a class group in student ST was 63% (range 25-88%) and 48% for MVPA (range 28-76%). The lowest difference for a class group in ST was 7% (8-15%) and 10% for MVPA (%). Only 6.4% of the students achieved the level 50% of MVPA level during the PE lesson.

In ST there were significant differences between the Q1 boy's group and both Q3 and Q4 boys (p=.050-<.017, d=0.64-0.65), with Q1 boys having the highest amount of ST. Q1 boys had less MPA and MVPA than boys in groups Q3 (p=.004, d=0.72, <.001, d=0.82) and Q4 (p<.001, d=0.80-0.98), and less VIG (p=.005, d=0.89) than Q4 boys. Also, Q2 had less VIG than Q4 (p=.010, d=0.25). Q1 girls had less MVPA (p=.001, d=0.54, <.001, d=0.50) and VIG (p=.002, d=0.70, <.001, d=0.67) than Q3 and Q4 girls (table 2). When the least active and most active groups were compared (i.e. Q1 boys vs Q1 girls, Q4 boys and Q4 girls) no significant differences between boys and girls were revealed in MVPA or VIG. PE lessons contributed 39.9% of daily average MVPA for Q1 boys and 46.0% for Q1 girls. For Q4 similar MVPA percentages of 28.7% for boys and 29.7 for girls were determined. PE lessons contributed 18.2% for Q1 boys and 18.7% for Q1 girls of total LPA. Similarly, percentage of total LPA during PE lessons for Q4 boys was 15.0% and for Q4 girls, 14.8%. For Q1 girls LPA during PE lessons contributed significantly more LPA of the daily accumulation than for Q4 girls (p=.004).

Discussion

This study examined the PA levels of children (aged 11-12) during the PE lesson and differences in PA between gender and physical activity groups. In addition, total ST and PA between different PA groups were compared. Also, the attainment of WHO PA guidelines were compared between different groups. This study showed that students with different total weekly MVPA levels also differ in PA levels assessed during PE lessons. The current data revealed that the range for ST and MVPA was very high during the same PE lesson and students with lower total MVPA had also lower MVPA time during PE lessons. On the other hand, the least active male students had more LPA than the more active male groups. The results of this study therefore, reinforce the importance of focusing on the least active children, since they are experiencing less high intensity PA than other groups. Getting the most active children to move more in PE may not have much influence on overall PA, overall health or their current connection with a physically active lifestyle, whereas supporting the least active to move in PE more may have greater potential to influence their total PA(30), health and even their attitude towards PA and engaging in a physically active lifestyle. The increase in overall PA of the least active children will also contribute to longer term developments in societal health and well-being.

MVPA, LPA and ST during PE lessons

In previous studies that have used objectively measured PA, percentage of MVPA in PE has been 34.7 (range 25.1-44.4)(29). In this study, percentage of MVPA was 23.3 which is lower than average in systematic review by Hollis[29], but a similar level as reported in a Swedish study (25%)(16). Lower levels of MVPA in this study may be influenced by the common practice of PE being taught in primary school settings in Finland by generalist teachers, who do not have a specialist background in PE, with only limited training in PE curriculum and pedagogy. Level of MVPA during PE lessons may also be influenced by other factors. For example, in a study from Australia it was reported that when students had a possibility to influence to the context of the PE lesson their PA levels are higher(18). In addition, classes that have less than 25 students have demonstrated higher levels of student MVPA(17). Type of PE content also influences activity levels. Fröberg, et al. reported that fitness, orienteering and games generate higher levels of MVPA than dance or gymnastics(17). While the

level of MVPA was low, there was a positive finding that there was no statistical difference in MVPA between boys and girls, which has usually seen in studies measuring MVPA during PE lessons(17,20).

In this study, students in PE lessons that lasted more than 60 minutes had more time in MVPA and less time in ST than children in PE lessons less than 60 minutes. This is in line with previous studies reporting that PE lessons with 90 minutes have higher contribution to the recommendation for MVPA(19). Hence, it would be more beneficial for students to participate in PE lessons longer than 60 minutes, since the organisational arrangements and class management may reduce the total time available for PA, especially from MVPA(14). The contribution of PE lessons to daily total PA varied between 28.7% and 46%. It has been shown previously that PE contributes significantly to daily total PA(30). Among the least active contribution was nearly 50% of total daily MVPA. At the same time, these groups were least active during PE lessons. Increasing MVPA time among these students in PE could potentially increase the total MVPA during their day. This aspect highlights the importance of focusing more on less active children.

While the MVPA levels found in this study was much lower than the recommended level (e.g. in the USA, 50% of total time)(21) for PE lessons, it should keep in mind that some PE activities are delivered at a lower intensity. Furthermore, PE also has other purposes than PA engagement, such as social, well-being and psychological objectives(28). While meeting the target level of MVPA (50%) during the PE lessons can be seen as an indicator of positive engagement within PE, it is only one aspect of the goals of a high-quality PE curriculum. In the future, greater focus could be directed to the PA equality of PE lessons. Instead of targeting high amounts of MVPA (i.e. 50%), which seems to be realistic only for the most active children, keeping children moving at an equivalent level of MVPA would constitute an important objective for PE lessons that may also contribute to broader societal health goals(31). This study provides important information for PE teachers and acknowledging the possibility of being differently active during PE lesson should be included in the planning process of the PE lessons. PE lessons could be planned so that there is no place for ST or at least trying to minimize these situations in the PE lessons. If it is not possible to limit the sedentary sessions during the lesson, it should be taken into account that same students do not stay sedentary for a long time.

Strengths and Limitations

The strength of this study was objectively measured data collected from more than 400 fifth grade students. Neither context nor content of the PE lessons were controlled within the research design. Only one PE lesson per student was included in the analysis. Future research will focus on following-up the activity levels of the same students during their subsequent PE lessons. In addition, data that are more comprehensive will be provided from the PE lessons related to the content of the lesson. This kind of information would be important for PE teachers when planning the lessons. What kind of content provides more ST and probably, why it is so? The influence of class size and the PE teacher's gender on children's MVPA and ST, and students' motives for PE participation and related PA engagement during PE lessons would be important variables to investigate.

Conclusion

This study showed that there are differences between the PA levels of students during PE lessons. Students whose daily PA level is at low level are also less active during their PE lessons. These less active students spend more time engaged in sedentary behaviour and are engaged in less MVPA during the lessons. In the future, more focus should be directed towards facilitating active movement within lessons at similar levels across the student cohort, not simply aiming to reach an objective of 50% in MVPA for all students during the lesson. Because there were fewer differences in LPA levels, this study reinforces that PE teachers should concentrate on creating opportunities for students to further engage in MVPA, but also, limit opportunities for ST. In this study, the least active male students also had also higher BMI. Therefore, there is a major concern related to these children's' health. Both PE teachers' and other school personnel (e.g. school health care personnel, principals) should acknowledge how to promote PA during and after school day.

Ethics statement

Ethical approval was obtained from the University of Jyväskylä ethics committee. Written parental consent and child assent to complete the study were obtained prior to participation.

Acknowledgements

This work was supported by the Ministry of Education and Culture (major, grant number 61/626/2016). The authors declare that there is no conflict of interest.

References

1.Liu M, Wu L, Yao S. Dose–response association of screen timebased sedentary behaviour in children and adolescents and depression: a meta-analysis of observational studies. *Bri J Sports Med.* 2016;50:1252-1258.

2.Lundvall S, Meckbach J. For whom and to what end? the challenges of the subject physical education and health seen through various perspectives. *Sport Sci Rev.* 2010;19(3-4):63-75.

3,Dumuid, D., Olds, T., Lewis, L.K., Martin-Hernandez, J.A., Katzmarzyk, B.T., Barreira, T. … Tremblay, M. (2017). Health-related quality of life and lifestyle behavior clusters in school-aged children from 12 countries. *Journal of Pediatrics,* 83,178-193.

4.Caspersen CJ, Pereira MA, Curran KM. Griffin, Changes in physical *activity patterns in the United States, by sex and cross-sectional age. Med Sci Sports Exerc.* 2003;32(9):1601-1609.
5.Corder K, Sharp SJ, Atkin AJ, et al.Change in objectively measured physical activity during the transition to adolescence. *Bri J Sports Med.* 2015;49(11):730-736.
6.Telama R, Yang X. Decline of physical activity from youth to young adulthood in Finland. *Med Sci Sports Exerc. 2000;32*(9):1617-1622.
7.Fairglouch S, Stratton G. Physical education makes you fit and healthy'. Physical education's contribution to young people's physical activity levels. *Health Educ Res.* 2004; 20(1):14-23.
8.Trudeau F, Laurencelle L, Trembley J, et al. Daily primary school physical education: effects on physical activity during adult life. *Med Sci Sports Exerc. 1999;31*(1):111-117.
9.WHO. *Global recommendations on physical activity for health.* Geneva: WHO. 2010. Retrieved from: http://whqlibdoc.who.int/publications/2010/9789241599979_eng.pdf
10.Sullivan SM, Broyles ST, Barreira TV, et al. Associations of neighborhood social environment attributes and physical activity among 9–11 year old children from 12 countries. *Health Place.* 2017;46:183-191.
11.Fairclough SJ, Boddy LM, Mackiintosh KA, et al. Weekday and weekend sedentary time and physical activity in differentially active children. *J Sci Med Sport.* 2015;18(4):444-449.
12.Belton S, O'Brien W, Issartel J, et al. Where does the time go? Patterns of physical activity in adolescent youth. *J Sci Med Sport.* 2016;19(11):921-925.
13.Jago R, Fox KR, Page AS, et al. Physical activity and sedentary behaviour typologies of 10-11 year olds. *Int J Behav Nutr Phys Act.* 2010;7:59.
14.Chow BC, McKenzie TL, Louie L. Physical activity and environmental influences during secondary school physical education. *J Teaching Phys Educ.* 2009;28,:21-37.
15.Harvey S, García-López LM. Objectively measured physical activity of different lesson contexts. *J Phys Educ Sport.* 2017;17(2):833-838.
16.Fröberg A, Raustrop A, Pagels P, et al. Levels of physical activity during physical education lessons in Sweden. *Acta Paediatr.* 2017;106(1):135-141.
17.Kirkham-King M, Brusseau TA, Hannon JC, et al. Elementary physical education: A focus on fitness activities and smaller class sizes are associated with higher levels of physical activity. *Prev Med Rep.* 2017;8:135-139.
18.How YM, Whipp P, Dimmock J, Jackson B. The effects of choice on autonomous motivation, perceived autonomy support, and physical activity levels in high school physical education. *J Teaching Phys Educ.* 2013;32(2):131-148.
19.Costa M, Oleveira T, Mota J, et al. Objectively measured physical activity levels in physical education classes and body mass index. *Retos: nuevas tendencias en educación física, deporte y recreación.* 2017;31:271
20.Smith NJ, Lounsbery MA, McKenzie TL. Physical activity in high school physical education: Impact of lesson context and class gender composition. *J Phys Act Health.* 2014;11:127-135.
21.Nettlefield, L., McKay, H. A., Warburton, D. E., McGuire, K. A., Bredin, S. S. D., & Naylor, P. J. (2011). The challenge of low physical activity during the school day: at recess, lunch and in physical education. *British Journal of Sports Medicine, 45*(10), 813-819.
22.Mooses, K., Pihu, M., Riso, E-M., Hannus, A., Kaasik, P., Kull, M. (2017). Physical education increases daily moderate to vigorous physical activity and reduces sedentary time. *Journal of School Health, 87*(8), 602-607.
23.Sanders T, Cliff DP, Lonsdale C. Measuring adolescent boys' physical activity: bout length and the influence of accelerometer epoch length. *Plos One.* 2014;9(3):e92040.
24.Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ.* 2007;320:1240.
25.Mattocks C, Ness A, Leary S, et al.Use of accelerometers in a large fiels-based sutdy of children: Protocols, design issues, and effects on precision. *J Phys Act Health.* 2008;5(Supp 1):S98-S111.
26.Cain, K. L., Salli JF, Conway TL., Ondrak, K. S., McMurray, R. G. (2008). Using accelerometers in youth physical activity studies: a review of methods. *Journal of Phys Act Health.* 2013;10:437-450.
27.Evenson, K. R,. Catellier DJ, Gill K., Ondrak., & McMurray, R. G. (2008). Calibration of two objective measures of physical activity for children. *J Sport Sci.* 2008;26(14):1557-1565.
28.Salin, K., Huhtiniemi, M. (2018). Physical Education in Finland - after Curriculum Reform 2016. In S. Popovic, B. Antala, D. Bjelica, & J. Gardasevic, *Physical Education in Secondary School - Researches - Best Practices - Situation.* Nikšić: FIEP. pp. 329-334.
29.Hollis, J. L., Suthreland, R., Williams, A. J., Campbell, E., Nathan, N., Wolfenden, L., … Wiggers, J. (2017). A systematic review and meta-analysis of moderate-to-vigorous physical activity levels in secondary school physical education lessons. *International Journal of Behavioral Nutrition & Physical Activity, 14*,
30.Pate, R. R., O'Neill, J. R., McIver, K. L. (2011). Physical activity and health: Does physical education matter? *Quest*, *63*(1), 19-35.
31.Webb L, Quennerstedt M, Öhman. Healthy bodies: construction of the body and health in physical education. *Sport Educ Soc.* 2008; 13(4), 353-372.