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Original Article

Contribution of high and moderate-intensity physical education classes to the daily physical activity level in children

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Abstract:
Introduction. Children's engagement in vigorous-intensity physical activity is more effective in improving fitness than moderate-intensity physical activity. However, there is limited information about the effect of vigorous-intensity physical education classes on daily physical activity levels. **Objective** .Compare the contribution of high and moderate-intensity physical education classes by assessing 5 daily physical activity level classifications[sedentary time (ST) and time of light (LPA), moderate (MPA), vigorous (VPA), and moderate-vigorous physical activity (MVPA)] in 9–10-year-old students. **Materials and methods.** A total of 66 students were recruited with a mean age of 9.48 ± 0.5 years. The participants were assigned to 2 groups: high-intensity activity and moderate-intensity activity. The physical activity level was assessed by accelerometry (Actigraph wGT3X-BT). The Wilcox on signed-rank test was used for the pre and post-intervention statistical analysis. **Results**. No significant differences were observed in ST (1993.0 min; 1980.5 min, p = 0.429), LPA (800.5 min; 817.3 min, p = 0.191), MPA (67.7 min; 65.4 min, p = 0.299), VPA (18.7 min; 16.5 min, p = 0.098), and MVPA (86.4 min; 82.0 min, p = 0.267) for the high-intensity activity group. For the moderate-intensity activity group, no significant differences were observed neither for ST (1893.5 min; 1959.7 min, p = 0.170) nor for LPA (873.4 min; 845.4 min, p = 0.545). Compared to the high-intensity activity group, the moderate-intensity activity group exhibited a significant reduction in MPA (91.0 min; 63.2 min, p = 0.000), VPA (22.0 min; 11.6 min, p = 0.011), and MPVA (113.0 min; 74.8 min, p = 0.001). **Conclusion**. High-intensity physical activity did not significantly contribute to an increase in physical activity levels among different intensities (LPA, MPA, VPA, MVPA) but did not decrease them either. Nevertheless, moderate-intensity physical activity decreased the levels of MPA, VPA, and MVPA per day.
Keywords: High-intensity exercise, physical education, pedagogy, youth

Introduction

Since the end of the XIX century, physical education (PE) had been linked to public health. Throughout time, this link has been highlighted by researchers (Dudley, Cairney, Wainwright, Kriellaars, & Mitchell, 2017). The role of PE in health has been described by Sallis et al. (2012), who gave PE a key role in this field, which was reinforced by the fact that PE is an educational process that is directly associated with physical activity (PA) (Aibar & Chanal, 2015). The importance of PE for health is most likely attributed to the multiple physiological and psychosocial benefits of PA, which is clearly confirmed by prior studies (Kumar, Robinson & Till, 2015; Budzynski-Seymour et al., 2020). In addition, there is strong evidence showing that prolonged sedentary behaviour is independently associated with many adverse health conditions, including world's major non-communicable diseases (NCDs) (Kohl et al., 2012).A reduction in the opportunities for being physically active has led to an increase in health problems ranging from cardio metabolic diseases to mental health disorders. All of this is seen in increasingly younger ages, which is in part attributable to a systematic decline in PA at schools (Fleming et al., 2014). There is evidence suggesting that, a crowded school curriculum with an intense focus on academic achievement, lack of school leadership support, funding and resources, and poor quality of teaching are barriers to PA promotion at schools (Hills et al., 2015).

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According to Bailey (2006), PE promotes the learning and development of technical, social, and reflex motor skills, personal knowledge, and PA habits (Crum, 2017). In this sense, PE helps to preserve habits gained in early ages throughout adulthood, promotes a healthy lifestyle, and increases daily PA levels (Hills et al., 2015; Mischenko et al., 2020); therefore, it is a crucial factor in the prevention of diseases associated with physical inactivity (Bendíková&Dobay, 2017).Owing to the increasing levels of physical inactivity (Kohl et al., 2012), the World Health Organization (2020) and the Centers for Disease Control (CDC) (2010) established PA recommendations for different age groups, in which the recommendation for children and adolescents is 60 min or more of moderate-to-vigorous intensity PA (MVPA) daily; as part of 60 min, at least 3 days a week, they should perform vigorous activity such as running or playing soccer. However national data from the United States collected using accelerometers and self-report survey data from Australia have shown that less than half of children meet this recommendation (Hollis et al., 2015).

Regarding the PE class, in 2010, CDC has proposed that MVPA should account for50% of the PE class time. The importance of vigorous physical activity (VPA) is based on its contribution to cardiorespiratory fitness, cardiovascular health, and cognitive function during childhood and adolescence; VPA shows greater effect compared to moderate physical activity (MPA)(Cao et al., 2019; Martínez-López et al., 2018; Reyes-Amigo & Labisa-Palmeira, 2020). Nonetheless, few studies have explored the PE contribution to the activity time in students; it has been confirmed that VPA in PE class accounts for the fifth part of total PE class time (Fairclough & Stratton, 2006). This reaffirms the study of Hollis et al., (2015), who showed that MVPA levels during elementary school PE lessons did not meet the United States CDC and the United Kingdom's Association of Physical Education recommendation (50% of lesson time); though, MVPA levels were higher than those estimated in a previous review (34.2%).Therefore, it is suggested that interventions to increase MVPA during PE lessons are needed (Hills et al., 2015).

In addition, there is scarce evidence exploring the direct PE contribution to daily PA. Regarding this issue, the work of Morgan, Beighle, & Pangrazi, (2007) shows that there is no negative compensatory effect; in contrast, it increases the total daily activity. Kerr et al. (2016) in their work showed that high-intensity PE classes also increased the total daily activity compared to the days of moderate-intensity PE classes. Thus, even though the PE role in health is well-established, there is still a knowledge gap in the contribution of high-intensity PE classes to PA levels in children and adolescents.

This study aims to compare the contribution of high and moderate-intensity PE classes by daily assessing 5 PA level classifications (i.e., sedentary time, LPA, MPA, VPA, and MVPA) in 9–10-year-old students.

Materials and methods

Participants

A total of 66 students from a public school in Valparaiso, Chile voluntarily participated in the study (23 boys, 43 girls), 9–10 years old (9.48 ± 0.5 years), with a Tanner maturity stage of1–2 (self-reported and paediatric examination) (Matsudo & Matsudo, 1994).

The inclusion criteria were being a regular student at the school where the investigation took place and having a prepuberal maturity state. Exclusion criteria were as follows: participation in an extracurricular physical activity program, having a diagnosed chronic disease (except obesity), orthopaedic limitation, assistance class of less than 95%, and/or presenting symptoms during the intervention (e.g., discomfort and thoracic pain).

The final sample included N = 48 subjects (32 girls, 16 boys) because 11 students were part of an extracurricular program, and 7 had a diagnosed chronic disease.

Participants were randomly assigned into two groups: high-intensity activity (HIA) and moderate-intensity activity (MIA). As a randomization result, the groups were formed as follows: 7 boys and 18 girls in HIA (n = 25), and 9 boys and 14 girls in MIA (n = 23).

The sample size was calculated using variance analysis as a reference and 0.95 as an anticipated statistical power, with an alpha error of 0.05 and of 0.5 to detect the effect size. The calculated sample of 54 participants (G-power 3.1. 3 software, Germany).

The study was approved by the Playa Ancha University Bioethics committee (001/2017), and Helsinki Declaration norms were followed. Parents and students signed informed consent and assent, respectively.

Measure

Physical Activity Levels

Triaxial Accelerometry (ACL) was used to assess PA level in the participants through a validated device (Actigraph wGT3X-BT) and software (ActiLife 6). Accelerometers were worn one day prior to the day when the data were started to be recorded; thus, it was configured to be active when it is set through the software. The device was placed on the right anterior axillary line of the iliac crest using an elastic belt, which is the nearest centre of mass point (Calahorro et al., 2015). In this study, accelerometers were worn for 4 days (i.e., 3 school days and 1 weekend day); once the data were downloaded, the recording was included if i) there were at least 3 days recorded (2 school days and 1 weekend day)and if there were ii) at least 8 h of recording per day (Andersen, Bugge, Dencker, Eiberg, & Naaman, 2011). The data that did not meet the abovementioned criteria were not analysed. Students could only remove the device during water activities or sports, showering, and sleeping. Given the intermittent nature of children PA, a short EPOCH of 5–15 seconds was used (Dorsey, Herrin, Krumholz, & Irwin, 2009) with a 100 Hz frequency. Based on the counts per minute, daily PA classifications were sedentary, light, moderate, vigorous, and moderate-vigorous. The cut point was determined by the Evenson equation for the ActiGraph wGT3X-BT model, validated for school children (Evenson, Catellier, Gill, Ondrak, & McMurray, 2008; Trost, Loprinzi, Moore, & Pfeiffer, 2011).

Intervention

A pilot test was performed 2 weeks prior to beginning this study; it was performed at a different school and included 32 students of the same age (9–10 years old). This pilot test showed that students were able to repeatedly perform HIA and MIA for the assigned period of time. Both groups (MIA and HIA) performed 17 sessions, 2 times a week; each session was45 min long and was guided by a PE teacher.

The main part of the HIA class consisted of four activities: 2 relay activities and 2 small-side games of cooperative and opposition activities. Each activity had a 6-minactive time and 2 min of recovery (24 min total). The intensity was 75–95% HR max (maximum heart rate). MIA was similar to standard PE classes with 4 continuous games as the main part of the class, with the time active and recovery ratio of 6 and 2 min, respectively (24 min total) and intensity of60–74% HR max. Both activities (MIA and HIA) were performed at a place exclusively dedicated to PE classes. Intensity was controlled using a heart rate monitor (M400 POLAR, Finland). The intervention (Table 1) is based on what has been described by other authors (Hellin et al., 2019; Bendiksen et al., 2014; Reyes-Amigo; Soto-Sanchez & Palmeira 2018) regarding the activities and its performing time duration.

Table 1. Intervention description

Groups	Content	Description	Time
HIA	Warm-up	Chasing game (tag) and joint mobility	5 min
	Activities	2 relay activities / 2 C-O activities	24 min
	Intensity	75–90% HR max	
	Cool-down	Flexibility	5 min
MIA	Warm-up	Chasing game (tag) and joint mobility	5 min
	Activities	4 continuous or cooperative activities	24 min
	Intensity	60–74% HR max	
	Cool-down	Flexibility	5 min

HIA, high intensity activity group; MIA, moderate-intensity activity group; RPE: rate of perceived exertion; min: minutes; s: seconds; C-O: cooperative (collaboration)–opposition

Statistical analysis

Analyses were performed using IBM SPSS v. 20.0. A Chi-square test was used to analyse differences between groups according to gender and sexual maturity stage. Each variable data distribution was tested using the Shapiro–Wilk test. The Wilcoxon signed-rank test was used to analyse variable statistical differences before and after the intervention because some variables exhibited data asymmetry before and after the intervention. In addition, using the U de Mann–Whitney test, HIA and MIA groups were analysed before the intervention to determine whether there was any statistical difference between both groups. The value of $P < 0.05$ was used as a significance level.

Results

A total of 48 participants completed the intervention, and no adverse effects were reported. Both groups achieved an attendance of 94%, i.e., 16 out of 17 sessions. Table 1 shows the characteristics prior to the intervention; no difference was observed. The chi-square test showed no difference either in the boys/girls ratio (chi-square = 0.414, $p < 0.05$) or in the maturity stage (chi-square = 0.882, $p < 0.05$).

Variables	HIA n (25) Mean	SD	MIA n (23) Mean	SD	P
Age (years)	9.48	0.50	9.52	0.51	0.775
Height (cm)	138.16	6.22	138.60	6.11	0.802
Weight (kg)	37.89	6.99	41.21	10.04	0.235

Table 2. HIA and MIA pre-intervention characteristics

The sum of different PA times for3 days is shown next. When comparing HIA and MIA groups before the intervention, there was a statistical difference in MPA time (HIA 67.7 min, CI 95% [58.1–77.3] vs. MIA 91.0 min [75.9–106.2]; p: 0.045); the time expend by the MIA group was greater. No other statistical difference was observed before the intervention (Table 3).

Table 3. Pre-intervention daily PA levels

PA Levels	HIA	MIA	P
ST	1993.0 (1933.3–2052.7)	1893.5 [1818.1–1968.8]	0.076
LPA	800.5 (774.1–865.8	873.4 [873.8–939.9]	0.135
MPA	67.7 (58.1–77.3)	91.0 [75.9–106.2]	0.045
VPA	18.7 (11.6–25.8)	22.0 [11.8–32.1]	0.885
MVPA	86.4 (71.1–101.8)	113.0 [90.1–135.9]	0.122

PA, Physical activity; ST, Sedentary time; LPA, Time of light; MPA, Moderate physical activity; VPA, Vigorous physical activity; MVPA, Moderate-vigorous physical activity

The obtained results showed no statistical difference before and after the intervention in the HIA group for the sedentary time variable (before 1993.0 min, CI 95% [1933.3–2052.7]; after 1980.5 min, CI 95% [1895.5–2065.5] p = 0.429); sedentary activities accounted for 69.2% and 68.7% of the time before and after the intervention, respectively. Similarly, the MIA group also showed no statistical difference in sedentary time (before: 1893.5 min, CI 95% [1818.1–1968.8]; after 1959.7 min, CI 95% [1876.9–2042.5] p = 0.170) with 65.7% and 68% of time spent in sedentary activities before and after the intervention, respectively. In terms of LPA, neither HIA nor MIA group showed statistical differences before and after the intervention (HIA: before: 800.5 min, CI 95% [774.1–865.8]; after 817.3 min, CI 95% [740.6–894,8] p = 0.19. (MIA before: 873.4 min, CI 95% [873.8–939.9]; after: 845.4 min, IC del 95% [768.0–923.0] p = 0.545). Forthe MPA variable, the HIA group showed no statistical difference before and after the intervention (before 67.7 min, CI 95% [58.1–77.3]; after 65.4 min, CI 95% [58.1–77.3] p = 0.299). In contrast, the MIA group showed statistical difference in this variable before and after the intervention (before 91.0 min, CI 95% [75.9–106.2]; after 63.2 min, CI 95% [51.3–75.0] p = 0.000), with a significant MPA reduction after the intervention, from 3.1% to 2.1% of the time for such activities. For the time spent in VPA, the HIA group showed no statistical difference before and after the intervention (before: 18.7 min, CI 95% [11.6–25.8]; after: 16.5 min, CI 95% [9,7–23,3] p = 0.098). In contrast, the MIA group showed a significant reduction of the same variable, from 0.7% to 0.4% of time spent in VPA (before: 22.0 min, CI 95% [11.8-32.1]; after: 11.6 min, CI 95% [4.3–18.9] p = 0.011). Finally, for MVPA (the sum of MPA and VPA), the HIA group showed no statistical difference before and after the intervention (before: 86.4 min, CI 95% [71.1–101.8]; after: 82.0 min, CI 95% [64.7–99.3] p = 0.267). Meanwhile, the MIA group also showed a significant reduction in the time spent in MVPA, from 3.9% to 2.5%, before and after the intervention, respectively (before: 113.0 min, CI 95% [90.1–135,9]; after 74.8 min, CI 95% [57.8–91.8] p = 0.001). All data previously mentioned is shown in Tables 4 and 5.

Table 4. HIA group: pre and post-intervention PA levels

PA Levels	Pre	%	Post	%	P
ST	1993.0 (1933.3–2052.7)	69.2	1980.5 (1895.5–2065.5)	68.7	0.429
LPA	800.5 (774.1–865.8)	27.7	817.3 (740.6–894.8	28.3	0.191
MPA	67.7 (58.1–77.3)	2.3	65.4 (58.1–77.3)	2.2	0.299
VPA	18.7 (11.6–25.8)	0.6	16.5 (9.7–23.3)	0.5	0.098
MVPA	86.4 (71.1–101.8)	3	82.0 (64.7–99.3)	2.8	0.267

PA, Physical activity; ST, Sedentary time; LPA, Time of light; MPA, Moderate physical activity; VPA, Vigorous physical activity; MVPA, Moderate-vigorous physical activity

Table 5. MIA group: pre and post-intervention PA levels

PA Levels	Pre	%	Post	%	P
ST	1893.5 [1818.1–1968.8]	65.7	1959.7 [1876.9–2042.5]	68.0	0.17
LPA	873.4 [873.8–939.9]	30.3	845.4 [768.0–923.0]	29.3	0.545
MPA	91.0 [75.9–106.2]	3.1	63.2 [51.3–75.0]	2.1	0.00
VPA	22.0 [11.8-32.1]	0.7	11.6 [4.3–18.9]	0.4	0.011
MVPA	113.0 [90.1–135.9]	3.9	74.8 [57.8–91.8]	2.5	0.001

PA, Physical activity; ST, Sedentary time; LPA, Time of light; MPA, Moderate physical activity; VPA, Vigorous physical activity; MVPA, Moderate-vigorous physical activity

Discussion

This study compared the contribution of high and moderate-intensity PE classes to daily PA by assessing 5 pre and post-intervention variables (ST, LPA, MPA, VPA, and MVPA) in 9–10-year-old students. According to the obtained results, HIA did not show any significant change in 5 PA classifications before and after the intervention. Therefore, performing HIA did not contribute to increasing PA levels after the intervention. Even though there was no increase, neither was there a decrease; thus, a compensatory effect caused by the class intensity can be ruled out. This contradicts what Kerr et al. (2016) have shown to be a significant contribution to daily PA. Kerr et al. (2016) studied prepuberal students (same as in this study), performed a comparable intervention, and observed increases in daily vigorous and highly vigorous (hard and very hard intensity = ≥ 9 METs) activities, which differed from our results. There are some methodological variations between the studies; however, they still explore similar variables. According to Morgan et al. (2007), PE classes do not have a compensatory effect on daily PA, which agrees with our results. In addition, there is evidence that strongly suggests that PE class participation increases PA levels and fitness (Gea-García et al., 2020).

Compared to the HIA group, the MIA group significantly decreased MPA, VPA, and MVPA levels. Therefore, our results showed that moderate-intensity classes did not contribute to increasing PA levels; rather, they resulted in a decrease in 3 most relevant categories (MPA, VPA, and MVPA). These results differ from those of Morgan et al., (2007), where they indicated that performing PE classes helped not just by accumulating more activity time (Alderman et al., 2012) but also by achieving impactful PA recommendations (Hills et al., 2015). Similarly, the negative compensatory effect showed by the MIA group agrees with the work of Moreno, Concha, & Kain (2012), where they found that the majority of PE class time was performed at light and moderate intensity and did not contribute to the PA level increase, which agrees with our study.

Our investigation proposed a frequency of 2 PE classes per week, while Silva, Chaput, & Tremblay (2019) studied the frequency of 3 times per week, which increased PA levels and reached the recommended values. Thus, the times per week that PE class is performed is essential for achieving the expected results, which can explain why the HIA group did not increase its PA level.

According to CDC (2010) and the Department of Health, Physical Activity, (2011), it is important to emphasize high-intensity activities during the PE class because it is a relevant factor in increasing PA levels (Hills et al., 2015); therefore, PE planning should seek (or aim for) those intensities (Hellin et al., 2019) more than light or moderate-intensities (Sturm, Kelso, Kobel, & Demetriou, 2020). Similar to this study, there is supporting evidence that shows how predominantly moderate-to-vigorous intensity PE classes, and not just moderate-intensity classes, may have a greater effect on children and adolescent PA level during and after PE classes (Fairclough & Stratton, 2005; Bailey, 2006). The HIA group did not show a significant increase either in PA levels, light activity time, or sedentary time, which suggested that there was no negative compensatory effect. This suggests that PE classes should be of high-intensity and performed more than twice a week to increase the PA level(Hollis et al., 2015).

Limitations

This study has limitations mainly in the number of days measured, possible dietary intake interaction, and short-term of the sought outcome. Most studies use data from accelerometers from 7 consecutive days; in this study, only 4 days were collected (Andersen et al., 2011; Calahorro et al., 2015). Thus, future studies should collect data before, during, and after the intervention, and not just before and after it. In addition, seeking to control dietary intake interaction, this variable can be assessed in conjunction with different PA variables. Finally, future studies could use larger samples and evaluate longer-term outcomes and different ages (maturity stage).

Conclusions

The purpose of this study was to compare the contribution of high and moderate-intensity PE classes to 5 PA classifications in 9–10-year-old school students. It was demonstrated that the HIA group did neither significantly increase moderate to vigorous PA time nor decreased daily sedentary time. Nonetheless, the novelty of our results is that moderate-intensity classes did significantly decrease daily moderate, vigorous, and moderate to vigorous PA time; this phenomenon has not been reported in previous studies. Therefore, MIA classes do not benefit school children, specifically in terms of their PA levels. There needs to be a targeted focus on training teachers at schools on the benefits of PA throughout the school day and how they can assist in increasing physical activity opportunities for children. Based on the obtained results, PE teachers should be aware of the advantages and disadvantages that different activities, games, or exercise intensities have and always seek to increase daily PA level and fitness. Finally, according to the obtained results, the utility and contribution of this study is the practical application (relay races/small-side games) of daily high intensity activities as an adequate strategy for PE classes and PA level.

Conflicts of interest -There is not potential conflict of interest.

References

Aibar, A., & Chanal, J. (2015). Physical education: The effect of epoch lengths on children's physical activity in a structured context. *PLoS ONE*, *10*(4), 1–10. https://doi.org/10.1371/journal.pone.0121238

Alderman, B. L., Benham-Deal, T., Beighle, A., Erwin, H. E., & Olson, R. L. (2012). Physical education's contribution to daily physical activity among middle school youth. *Pediatric Exercise Science*, *24*(4), 634–648. https://doi.org/10.1123/pes.24.4.634

Andersen, L. B., Bugge, A., Dencker, M., Eiberg, S., & Naaman, B. E. L. (2011). The association between physical activity , physical fitness and development of metabolic disorders, *6*(June), 29–34. https://doi.org/10.3109/17477166.2011.606816

Bailey, R. (2006). Physical education and sport in schools: A review of benefits and outcomes. *Journal of School Health*, *76*(8), 397–401. https://doi.org/10.1111/j.1746-1561.2006.00132.x

Bendíková, E., & Dobay, B. (2017). Physical and sport education as a tool for development of a positive attitude toward health and physical activity in adulthood. *European Journal of Contemporary Education*, *6*(1), 14–21. https://doi.org/10.13187/ejced.2017.1.14

Bendiksen, M., Williams, C. A., Hornstrup, T., Clausen, H., Kloppenborg, J., Shumikhin, D., … Krustrup, P. (2014). Heart rate response and fitness effects of various types of physical education for 8- to 9-year-old schoolchildren. *European Journal of Sport Science*, *14*(8), 861–869. https://doi.org/10.1080/17461391.2014.884168

Budzynski-Seymour, E., Conway, R., Wade, M., Lucas, A., Jones, M., Mann, S., & Steele, J. (2020). Physical activity, mental and personal wellbeing, social isolation, and perceptions of academic attainment and employability in university students: Pooled analysis of the Scottish and British Active Students Surveys. *Journal of Physical Activity and Health*, *17*(6), 610–620. https://doi.org/10.3

Cao, M., Quan, M., & Zhuang, J. (2019). Effect of high-intensity interval training versus moderate-intensity continuous training on cardiorespiratory fitness in children and adolescents: A meta-analysis. *International Journal of Environmental Research and Public Health*, *16*(9). https://doi.org/10.3390/ijerph16091533

Calahorro, F., Torres-Luque, G., López-Fernández, I., Santos-Lozano, A., Garatachea, N., & Carnero, E. Á. (2015). Actividad física y acelerometría; orientaciones metodológicas, recomendaciones y patrones. *Nutricion Hospitalaria*, *31*(1), 115–125. https://doi.org/10.3305/nh.2015.31.1.7450

Center Disease Control. (2010). *Strategies to Improve the Quality of Physical Education*.

Crum, B. (2017). How to win the battle for survival as a school subject? Reflections on justification, objectives, methods and organization of PE in schools of the 21st century. *Retos: Nuevas Perspectivas de Educación Física, Deporte y Recreación*, *31*(2007), 238–244. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=122035684&lang=pt-br&site=ehost-live

Department of Health, Physical Activity, H. I. and P. (2011). *Start Active, Stay Active: A Report on Physical Activity for Health From the Four Home Countries' Chief Medical Officers*. Retrieved from http://eds.b.ebscohost.com/eds/pdfviewer/pdfviewer?vid=1&sid=bb7b61ea-7f96-4619-8491-5217b82c5917%40pdc-v-sessmgr06

Dorsey, K., Herrin, J., Krumholz, H., & Irwin, M. (2009). The utility of shorter epochs in direct motion monitoring. *Research Quarterly for Exercise and Sport*, *80*(3), 460–468. https://doi.org/10.1080/02701367.2009.10599584

Dudley, D., Cairney, J., Wainwright, N., Kriellaars, D., & Mitchell, D. (2017). Critical Considerations for Physical Literacy Policy in Public Health, Recreation, Sport, and Education Agencies. *Quest*, *69*(4), 436–452. https://doi.org/10.1080/00336297.2016.1268967

Evenson, K. R., Catellier, D. J., Gill, K., Ondrak, K. S., & McMurray, R. G. (2008). Calibration of two objective measures of physical activity for children. *Journal of Sports Sciences*, *26*(14), 1557–1565. https://doi.org/10.1080/02640410802334196

Fairclough, S. J., & Stratton, G. (2006). A review of physical activity levels during elementary school physical education. *Journal of Teaching in Physical Education*, *25*(2), 239–257.

Fairclough, S., & Stratton, G. (2005). "Physical education makes you fit and healthy". Physical education's contribution to young people's physical activity levels. *Health Education Research*, *20*(1), 14–23. https://doi.org/10.1093/her/cyg101

Fleming, T., Robinson, M., Thomson, B., & Graetz, N. (2014). Global, regional and national prevalence of overweight and obesity in children and adults 1980-2013: A systematic analysis. *Lancet*, *384*(9945), 766–781. https://doi.org/10.1016/S0140-6736(14)60460-8.Global

Gea-García, G. M., González-Gálvez, N., Espeso-García, A., Marcos-Pardo, P. J., González-Fernández, F. T., & Martínez-Aranda, L. M. (2020). Relationship Between the Practice of Physical Activity and Physical Fitness in Physical Education Students: The Integrated Regulation As a Mediating Variable. *Frontiers in Psychology*, *11*(July), 1–14. https://doi.org/10.3389/fpsyg.2020.01910

Hellin, M., Garcia-Jimenez, J. V., & Garcia-Pellicer, J. J. (2019). Intensity of physical education lessons in children according to the type of activity: Soccer, badminton, aerobics and motor skills. *Journal of Physical Education and Sport*, *19*(1), 603–610. https://doi.org/10.7752/jpes.2019.01088

Hills, A. P., Dengel, D. R., & Lubans, D. R. (2015). Supporting Public Health Priorities: Recommendations for Physical Education and Physical Activity Promotion in Schools. *Progress in Cardiovascular Diseases*, *57*(4), 368–374. https://doi.org/10.1016/j.pcad.2014.09.010

Hollis, J., Williams, A., Sutherland, R., Campbell, E., Nathan, N., Wolfenden, L., Morgan, P., Lubans, D., & Wiggers, J. (2015). A systematic review and meta-analysis of moderate-to-vigorous physical activity levels in elementary school physical education lessons. *Preventive Medicine*, *86*, 34–54.

https://doi.org/10.1016/j.ypmed.2015.11.018

Kerr, C., Smith, L., Charman, S., Harvey, S., Savory, L., Fairclough, S., & Govus, A. (2016). Physical education contributes to total physical activity levels and predominantly in higher intensity physical activity categories. *European Physical Education Review*, *24*(2), 152–164. https://doi.org/10.1177/1356336X16672127

Kohl, H. W., Craig, C. L., Lambert, E. V., Inoue, S., Alkandari, J. R., Leetongin, G., … Wells, J. C. (2012). The pandemic of physical inactivity: Global action for public health. *The Lancet*, *380*(9838), 294–305. https://doi.org/10.1016/S0140-6736(12)60898-8

Kumar, B., Robinson, R., & Till, S. (2015). Physical activity and health in adolescence. *Clinical Medicine*, *15*(3), 267–272. https://doi.org/10.7861/clinmedicine.15-3–267

Martínez-López, E., De la Torre-Cruz, M., Suárez-Manzano, S., & Ruiz-Ariza, A. (2018). 24 Sessions of Monitored Cooperative High-Intensity Interval Training Improves Attention-Concentration and Mathematical Calculation in Secondary School. *Journal of Physical Education and Sport*, *18*(3), 1572–1582. https://doi.org/10.7752/jpes.2018.03232

Mischenko, N., Kolokoltsev, M., Romanova, E., Alontsev, V., Ustselemov, S., Strashenko, V., & Andrianov, A. (2020). Program for improving strength abilities of 16–17-year-old students in the additional physical education system. *Journal of Physical Education and Sport*, *20*(5), 2796–2802. https://doi.org/10.7752/jpes.2020.s5380

Matsudo, S. M. M., & Matsudo, V. K. R. (1994). Self-assessment and physician assessment of sexual maturation in Brazilian boys and girls: Concordance and reproducibility. *American Journal of Human Biology*, *6*(4), 451–455. https://doi.org/10.1002/ajhb.1310060406

Moreno, L., Concha, F., & Kain, J. (2012). Movement intensity of children during physical education classes in public schools: results according to the type of professional that teaches the class. *Revista Chilena de Nutrición*, *39*(4), 123–128. https://doi.org/10.4067/S0717-7518201200040000

Morgan, C. F., Beighle, A., & Pangrazi, R. P. (2007). What are the contributory and compensatory relationships between physical education and physical activity in children? *Research Quarterly for Exercise and Sport*, *78*(5), 407–412. https://doi.org/10.1080/02701367.2007.10599440

Reyes-Amigo, T., & Labisa-Palmeira, A. (2020). Moderators of the effect of high-intensity and moderate-intensity games in schoolchildren on cardiorespiratory fitness and body composition. *Motricidade*, *16*(2), 156–169. https://doi.org/10.6063/motricidade.17253

Reyes-Amigo, T.; Soto-Sanchez, J. & Palmeira, A. (2018). Effect of high-intensity games on cardiorespiratory fitness and body composition in school children: Protocol of a randimized controlled trial. *Gymnasium*, *3*(1), 1–10.

Sallis, J. F., McKenzie, T. L., Beets, M. W., Beighle, A., Erwin, H., & Lee, S. (2012). Physical education's role in public health: Steps forward and backward over 20 years and HOPE for the future. *Research Quarterly for Exercise and Sport*, *83*(2), 125–135. https://doi.org/10.5641/027013612800745329

Silva, D. A. S., Chaput, J. P., & Tremblay, M. S. (2019). Participation frequency in physical education classes and physical activity and sitting time in Brazilian adolescents. *PLoS ONE*, *14*(3), 1–14. https://doi.org/10.1371/journal.pone.0213785

Sturm, D., Kelso, A., Kobel, S., & Demetriou, Y. (2020). Physical activity levels and sedentary time during school hours of 6th-grade girls in Germany. *Journal of Public Health (Germany)*, (2019). https://doi.org/10.1007/s10389-019-01190-1

Trost, S. G., Loprinzi, P. D., Moore, R., & Pfeiffer, K. A. (2011). Comparison of accelerometer cut points for predicting activity intensity in youth. *Medicine and Science in Sports and Exercise*, *43*(7), 1360–1368. https://doi.org/10.1249/MSS.0b013e318206476e

World Health Organization. (2020). *WHO guidelines on physical activity and sedentary behaviour: web annex: evidence profiles*. https://apps.who.int/iris/handle/10665/336657