The Physical Educator Vol. 79 • pp. 713–734 • 2022
https://doi.org/10.18666/TPE-2022-V79-I6-11202

PHYSICAL ACTIVITY

The Relationship Between Physical Education and Daily Physical Activity Among Children and Youth: A Narrative Overview

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Abstract

From a health promotion perspective, schools are ideal settings for the promotion of physical activity since virtually all children and youth can be reached. Physical education is mandatory in many countries and offers unique opportunities for the promotion of physical activity among children and youth. However, since physical education represents a rather small proportion of the total waking hours among children and youth, it is important to determine the influence of physical education on daily physical activity among children and youth. While studies indicate that children and youth are physically active during physical education and that interventions might increase physical activity even further, the individual contribution of physical education to daily physical activity appears promising but not conclusive.

Research has established a clear relationship between physical activity (PA), particularly at moderate and vigorous intensity, and health benefits among school-aged children and adolescents (Piercy et al., 2018). On the basis of this evidence, PA guidelines have specified that children and youth should engage in at least 60 min of daily

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moderate-to-vigorous PA (MVPA; Piercy et al., 2018). Despite these recommendations, recent estimates have suggested that only about 20% of children and youth worldwide achieve this level of daily PA (Guthold et al., 2020). Sufficient daily PA is critical given that childhood and adolescence are developmental life stages during which the foundations for future health behaviors might be established (Sallis et al., 2012).

Schools are ideal settings for the promotion of PA and health since almost all children and youth can be reached. Many interventions occur in the school setting, and promising interventions often include implementation of PA into the school curriculum (Messing et al., 2019).

In several countries, physical education (PE) is mandatory. Although the educational objectives of PE vary across countries and regions, the promotion of PA and health appear to be common denominators (Pühse et al., 2011).

Several studies have investigated the percentage of PA during PE classes among children and youth. For example, two systematic reviews and meta-analyses have demonstrated that the proportion of accelerometer-measured MVPA during PE was 45% in elementary school and 41% in secondary school. Most of the reviewed studies were conducted in the United States and Australia (Hollis et al., 2017; Hollis et al., 2016).

In addition to these studies, a systematic review has reported that improvement in class organization, management, and instruction increased time spent in MVPA by approximately 10% (Lonsdale et al., 2013). However, PE arguably represents a rather small proportion of total waking hours among children and youth.

PA represents a complex framework and can be expressed in terms of intensity, duration, frequency, and type (e.g., aerobic and muscle-strengthening activities). It can also be performed in at least four domains throughout the day: transportation (e.g., walking and cycling), school (e.g., PE and recess), leisure time (e.g., active play and organized sport and exercise), and the household environment (e.g., self-care undertakings). Theoretically, some children and youth engage in most of their PA during PE, whereas others participate in organized sport and exercise and therefore may engage in most of their PA outside of school time.

Daily PA levels are challenging to measure. Studies relying upon self-reported data (i.e., recall questionnaires) can be prone to recall bias and social desirability. However, the introduction of objective methods, such as heart rate monitors and activity monitors (e.g., pedometers and accelerometers), has improved the measurement of PA during the last few decades (Rachele et al., 2012).

The theory of expanded, extended, and enhanced opportunities suggests that children and youth might be more physically active when presented with more opportunities (Beets et al., 2016). One of the components, extended (or extension), might be achieved through allocation of additional time for PE. In contrast, the compensation hypothesis (often referred to as the ActivityStat) suggests the possibility that increased PA in one domain is compensated by an equal decrease in another domain for preservation of an overall set-point (Gomersall et al., 2013).

In light of the compensation hypothesis, this paper provides a focus on studies that have investigated differences in PA among children and youth during days with PE as compared with non-PE days.

Physical Education and Daily Physical Activity

Table 1 presents examples of observational and experimental studies that had more than 100 participants and that investigated the relationship between PE and daily PA among children and youth. As shown, studies included children and youth in different age groups and from different countries. The studies used a variety of PA measurements, including recall (1–7 days), pedometry (4–7 days), and accelerometry (1–7 days).

A number of the studies reviewed in this paper reported a positive relationship between PE and daily PA among children and youth (Table 1). For example, studies relying on recall showed that those who participate in PE at least once per week have increased likelihood of reaching the PA recommendations, or belonging to the highest category of MVPA, compared with those who do not participate, or do so less frequently. Some studies with activity monitors reported increased likelihood of reaching the PA recommendations, more daily steps, and minutes of MVPA or vigorous PA during days with PE as compared to non-PE days. Of these, Silva et al. (2018) analyzed accelerometer data from a multinational sample of approximately 5,900 children aged 9 to 11 years and found that boys who

Table 1
Examples of Studies (Observational and Experimental) That Have Investigated the Relationship Between Physical Education and Daily Physical Activity Among Children and Youth.

Reference	Study sample, design, and selected results
Observational studies	
Alderman et al. (2012)	279 children (boys and girls) aged 12 (mean) years from the United States. PA measurement: 5 days pedometry. The result showed that the least (1,575 steps), moderately (2,650 steps), and most highly active (5,950 steps) children took more steps during days with PE as compared with non-PE days. A higher proportion of boys and girls met the daily steps recommendations on days with PE compared with non-PE days (boys: 37% and girls: 61% on days with PE vs. boys: 13% and girls: 27% on non-PE days).
Aljuhani & Sandercock (2019)	111 children and youth (males) aged 12 to 14 years from Saudi Arabia. PA measurement: 7 days accelerometry. The children engaged in more MVPA (13 min) during days with PE as compared with non-PE days. The results showed that the inactive and unfit children and youth engaged in more MVPA during days with PE as compared with non-PE days. No difference among active and fit children and youth. A higher proportion of children and youth reached the PA recommendations during days with PE as compared with non-PE days.
Brusseau et al. (2011)	363 children (boys and girls) aged 8 to 11 years from the United States. PA measurement: 7 days pedometry. The results showed that the children took more steps (1,170 steps) during days with PE as compared with non-PE days.
Calahorro-Cañada et al. (2017)	150 children and youth (males and females) aged 8 to 19 years from Spain. PA measurement: 5 days accelerometry. The results showed that the unfit (7 min) and fit (8 min) children and youth engaged in more MVPA during days with PE as compared with non-PE days.

Table 1 (cont.)

Reference	Study sample, design, and selected results
Comte et al. (2015)	508 youth (males and females) aged 17 (mean) years from Canada. PA measurement: 7 days accelerometry. The results showed no difference in PA between youth who participated in PE and those who did not. The youth who participated in PE had 69% increased likelihood of reaching the PA recommendations compared with those who did not participate.
Dencker et al. (2006)	229 children (boys and girls) aged 8 to 11 years from 4 schools with differences in PA during school day in Sweden. Time allocated to PE was as follows: School 1: 45 min every day and Schools 2–4: 45 min, 2 times/week (collected within an intervention but presented as cross-sectional). PA measurement: 4 days accelerometry. No difference between children from the 4 schools for daily PA.
Frémeaux et al. (2011)	206 children (boys and girls) aged 9 to 10 years from 3 schools with differences in PA during school day in England. Time allocated to PE: School 1: 9.2 hr/week; School 2: 2.4 hr/week; and School 3: 1.7 hr/week. PA measurement: 7 days accelerometry at 4 occasions over 12 months. The results showed that in-school PA was 64% higher among children from School 1, but those from Schools 2 and 3 compensated the less in-school PA with more out-of-school PA. No difference between the children from the three schools for whole-week PA.
Gordon-Larsen et al. (2000)	17,766 children and youth (males and females) aged 11 to 21 years from the United States. PA measurement: 7 days recall. The results showed that the children and youth who participated in PE 1 to 4 times/week had 44% increased likelihood of belonging in highest category of MVPA as compared with those who did not participate. Participation in PE 5 times/week was associated with 121% increased likelihood of belonging in highest category of MVPA.

Table 1 (cont.)

Reference	Study sample, design, and selected results
Hobin et al. (2010)	2,379 children and youth (males and females) aged 10 to 14 years from Canada. PA measurement: 7 days recall. The results showed that the youth who participated in PE ≥ 2 times/week had 86% and 112% increased likelihood of belonging in the moderately and active category compared with those who participated in PE < 2 times/week.
Loprinzi et al. (2017)	459 children and youth (males and females) aged 12 to 15 years from the United States. PA measurement: 7 days recall. The results showed that the youth who had PE every day reached the PA recommendations during more days compared with those who did not have PE every day.
Mayorga-Vega et al. (2018)	158 youth (males and females) aged 13 to 16 years from Spain. PA measurement: 7 days accelerometry. The youth engaged in more MVPA (17 min) during days with PE as compared with non-PE days. The results showed that a higher proportion of the youth reached the PA recommendations and daily 10,000 steps during days with PE as compared with non-PE days.
Meyer et al. (2013)	676 children (boys and girls) aged 7 and 11 years from Switzerland. PA measurement: 4 to 7 days accelerometry. The results showed that the children engaged in more MVPA (16 min) during days with PE as compared with non-PE days. A higher proportion of the children reached 90 min of daily MVPA during days with PE as compared with non-PE days.
Myers et al. (1996)	995 children and youth (males and females) aged 9 to 15 years from the United States. PA measurement: 1 day recall. The results showed that the children and youth (white) who participated in PE during the previous day had more PA.
Mooses et al. (2017)	504 children (boys and girls) aged 7 to 9 and 10 to 12 years from Estonia. PA measurement: 7 days accelerometry. The results showed that the children engaged in more MVPA (13 min) during days with PE as compared with non-PE days.

Table 1 (cont.)

Reference	Study sample, design, and selected results
Morgan et al. (2007)	485 children (boys and girls) aged 9 years (mean) from the United States. PA measurement: 4 days pedometry. The results showed that the least (1,715 steps), moderately (1,145 steps), and most highly active (2,470 steps) children took more steps during days with PE as compared with non-PE days.
Pate et al. (2007)	5,432 adolescents (females) aged 14, 15, and 18 years from the United States. PA measurement: 3 days recall. The results showed that the adolescents who participated in PE had 33% to 60% more vigorous physical activity blocks and 12% to 32% more MVPA blocks compared with those who did not participate.
Sigmund et al. (2014)	338 children (boys and girls) aged 9 to 11 years from Czech Republic. PA measurement: 2 days accelerometry. The children (normal-weight and overweight/obese girls and normal-weight boys) engaged in more MVPA during days with PE as compared with non-PE days. The results showed that a higher proportion of children (overweight/obese girls and normal-weight boys) reached the PA recommendations during days with PE as compared with non-PE days.
Silva et al. (2018)	5,874 children (boys and girls) aged 9 to 11 years from Australia, Brazil, Canada, China, Colombia, Finland, India, Kenya, Portugal, South Africa, the United Kingdom, and the United States. PA measurement: 7 days accelerometry. The results generally showed that the children who participated in PE had more PA (both boys and girls). Boys (total sample) who participated in PE 1 to 2 days/week and 3 days or more/week had 56% and 62% increased likelihood of reaching the PA recommendations compared with those who did not participate. No associations among girls (total sample).

Table 1 (cont.)

Reference	Study sample, design, and selected results
Silva et al. (2019)	12,220 children and youth (males and females) aged 11 to 19 years from Brazil. PA measurement: 7 days recall. The children and youth who participated in PE 3 days or more/week engaged in more PA compared with those who did not participate. The results showed that a higher proportion of the children and youth who participated in PE 3 days or more/week reached the PA recommendations compared with those who did not participate.
Tassitano et al. (2010)	4,210 youth (males and females) aged 14 to 19 years from Brazil. PA measurement: 7 days recall. The results showed that the youth who participated in PE 2 days/week had 27% increased likelihood of reaching the PA recommendations compared with those who did not participate.
Uddin et al. (2020)	206,417 children and youth (males and females) aged 11 to 17 years from 65 countries. PA measurement: 7 days recall. The results showed that the children and youth who participated in PE 1 to 2 days/week and 3 days or more/week had 26% and 105% increased likelihood of reaching the PA recommendations compared with those who did not participate.
Viciana et al. (2017)	123 children and youth (males and females) aged 12 to 15 years from Chile. PA measurement: 7 days accelerometry. The children and youth engaged in more MVPA during days with PE as compared with non-PE days. The results showed that a higher proportion of the children and youth reached the PA recommendations during days with PE (24%) as compared with non-PE days (15%).
Wilkin et al. (2006)	159 children (boys and girls) aged 7 to 10 years from 3 schools with differences in PA during school day in England. Time allocated to PE: School 1: 9.0 hr/week; School 2: 2.2 hr/week; and School 3: 1.8 hr/week. PA measurement: 7 days accelerometry. In-school PA was higher among children from School 1, but those from Schools 2 and 3 compensated the less in-school PA with more out-of-school PA. The results showed no difference between the children from the three schools for whole-week PA.

Table 1 (cont.)

Reference	Study sample, design, and selected results
Experimental studies	
Bugge et al. (2012)	696 children and youth (males and females) aged 6 to 7 years at baseline, 612 aged 10 years at 3-years postintervention, and 441 aged 13 years at 4-years follow-up in Denmark. Intervention school: PE 180 min/week, teacher training, and indoor and outdoor PE and playing facilities were upgraded. Control school: PE 90 min/week. PA measurement: 4 days accelerometry. The results showed no difference between the children and youth from intervention and control schools for PA at 3-years postintervention and at 4-years follow-up.
Caballero et al. (2003)	1,409 children (boys and girls) aged 8 years at baseline (3 school year follow-up) in the United States. Intervention: PE (i.e., 30 min of PE 3 times/week, PA breaks in classroom, and guided play during recess), classroom curriculum, food service, and family involvement. Control: Continued according to previous practice (duration/frequency of PE unclear). PA measurement: 1 day accelerometry and 1 day recall. No difference between the children from the intervention school and the children from the control school for daily PA (accelerometry). The results showed that the children from the intervention school engaged in more daily PA (recall) than did those from control school.
Hasselstrøm et al. (2008)	379 children (boys and girls) aged 6 years at baseline and 10 years at 3-years follow-up in Denmark. Intervention: PE 180 min/week, teacher training, and indoor and outdoor PE and playing facilities were upgraded. Control: PE 90 min/week. PA measurement: 4 days accelerometry. The results showed no difference in PA between children from the intervention school and children from the control school at 3-years follow-up.

Table 1 (cont.)

Reference	Study sample, design, and selected results
Hobin et al. (2017)	Substudy 1: 35,877 youth (males and females) aged 16 years (mean) from Canada. Substudy 2: 671 youth (males and females) aged 14 to 15 years (mean) from Canada. Both substudies: Natural experimental study, quasi-experimental. Intervention: province-wide PE policy mandating PE (required youth to complete ≥ 55 hr of MVPA, e.g., ≥ 30 min of daily MVPA on ≥ 5 days/week, during a 5-month semester to achieve the course credit). Control: Substudy 1: PA measurement: 7 days recall over 4 years (pre–post); Substudy 2: PA measurement: 7 days accelerometry annually over 4 years. Substudy 1: The results showed no difference between the youth from the intervention school and the youth from the control school for the proportion reaching ≥ 30 or ≥ 60 min of daily MVPA. Substudy 2: The results showed no difference between the youth from the intervention school and the youth from the control school for MVPA.
Kriemler et al. (2010)	502 children (boys and girls) aged 7 and 11 years at baseline (1 school year follow-up) in Switzerland. Intervention: increased PE (2 times/week of 45 min taught by PE teacher and 3 times/week of 45 min taught by classroom teacher, short PA breaks (5 min) and 10 min of daily PA homework. Control: 3 times/week of 45 min taught by classroom teacher. PA measurement: 5 days accelerometry. The results showed no difference between the children from the intervention schools and the children from the control schools for total PA, but children from the intervention schools engaged in more daily MVPA than those from control schools.

Table 1 (cont.)

Reference	Study sample, design, and selected results
Møller et al. (2014)	1,188 children (boys and girls) aged 8 to 12 years from schools with differences in PA during school day in Denmark. Natural experimental study, quasi-experimental. Intervention: increased PE (sport schools with ≥ 4.5 hr/week) and a service training camp for PE teachers with focus on age-related training concept. Control (regular schools with 1.5 hr/week). PA measurement: 7 days accelerometry at 2 occasions over 12 months. In-school PA was higher among children from intervention schools, but those from control schools compensated the less in-school PA with more out-of-school PA. The results showed no difference between the children from the intervention schools and the children from the control schools for daily PA.
Sacchetti et al. (2013)	428 children (boys and girls) aged 8 to 9 (baseline) and 10 to 11 (follow-up) years at 2–school years follow-up in Italy. Intervention: 2 times/week of 50 min taught by PE teachers, and daily 30 min or more of PA carried out at the schoolyard and in the classroom. Control: 2 times/week of 50 min taught by classroom teachers. PA measurement: 7 days recall. The result showed that daily sedentary activities decreased among children from the intervention school compared with control schools.
Tarp et al. (2018)	495 children (boys and girls) aged 5 to 11 years (at baseline) from schools with differences in PA during school day in Denmark. Natural experimental study, quasi-experimental. Intervention: increased PE (sport schools with ≥ 4.5 hr/week). Control (regular schools with 1.5 hr/week). PA measurement: 7 days accelerometry. The results showed no difference between the children from the intervention schools and the children from the control schools for daily PA.

Note. MVPA = moderate-to-vigorous physical activity; PA = physical activity; PE = physical education.

participated in PE were more likely to meet the PA recommendations. This study also found that girls in high-income countries who participated in PE had an increased likelihood of spending more time in moderate physical activity and MVPA. Two other studies that used pedometers reported more daily steps during days with PE among both the least, moderately, and most highly active children and youth (Alderman et al., 2012; Morgan et al., 2007). Mayorga-Vega et al. (2018) measured PA by accelerometry among almost 160 Spanish youth aged 13 to 16 year and reported more MVPA during days with PE as compared with non-PE days. In another accelerometer-based study involving some 500 children and youth aged 7 to 12 from Estonia, Mooses et al. (2017) found that MVPA was approximately 13 min higher on days with PE as compared with non-PE days. A study from Saudi Arabia involving more than 100 boys aged 12 to 14 years also reported that the average time spent in MVPA was 13 min higher on days with PE compared with non-PE days (Aljuhani & Sandercock, 2019).

Sacchetti et al. (2013) investigated the effect of an intervention involving approximately 2 hr/week of PE delivered by PE teachers, in addition to daily 30 min or more of PA carried out at the schoolyard and in the classroom. The control group followed the standard program of approximately 2 hr/week of PE delivered by the classroom teacher. Sacchetti et al. reported that recalled daily sedentary activities decreased among children from the intervention school compared with control schools, suggesting that PA during non-PE times also increased because of the intervention.

Thus, these studies suggest a positive relationship between PE and daily PA among children and youth. Specifically, children and youth who participate in PE at least once per week have more PA compared with those who do not participate, or do so less frequently, and children and youth engage in more PA during days with PE as compared with non-PE days. There is also evidence to suggest that children and youth who are provided with increased time in PE engage in more daily PA.

In contrast to these findings, other studies reported no relationship between PE and daily PA among children and youth (Table 1). Frémeaux et al. (2011) analyzed whole-week accelerometer data among approximately 200 children aged 8 to 10 years. The children

attended three schools in Southwest England that had different socioeconomic conditions, sporting facilities, and time allocated to PE. One of the schools had an average of 9 hr/week of PE, whereas the other two schools had about 2 hr/week. The children who attended the school with more than 9 hr/week of PE engaged in 64% more PA during school days, yet children from the other two schools appeared to be more physically active outside of school time. For total PA between the two groups, no differences were observed among the children from the three schools. In the same research project, Wilkin et al. (2006) found that this fivefold increase in time allocated to PE explained less than 1% of the total weekly variation in PA. A study from Sweden investigated accelerometer data from about 250 Swedish children aged 8 to 11 years who were exposed to different times allocated to PE (Dencker et al., 2006). The children were recruited from one school with 45 min of PE every day and three schools with 45 min of PE twice per week. In their cross-sectional analyses, there was no difference in daily PA between children from the school with PE every day and children from the school with PE twice per week.

Two studies from Denmark and Canada showed similar results. In the Denmark study, Møller et al. (2014) investigated whether extra compulsory PE resulted in more accelerometer-measured PA in a large sample of children in 2009–2010. The study included 1,200 children aged 6 to 10 years and compared those from sports schools who had six PE classes per week with those from regular schools who had two PE classes per week. Although the children in sport schools engaged in more PA during school days as compared with those from regular schools, they were less physically active outside of school time, and no differences in daily PA were found between the children from the sports schools and the children from the regular schools. Hobin et al. (2017) investigated the effect of a province-wide PE policy on MVPA among Canadian youth. As part of the PE grading policy, the youth were required to engage in at least 30 min of daily MVPA on at least 5 days/week to achieve the course credits. Recall PA data were collected at pre- and postimplementation, and PA was measured from baseline to 4-years follow-up through the use of accelerometry in a subsample of the intervention (n = 447)

and control (n = 224) cohorts. No significant differences in PA were found between the intervention group and the control group.

Other studies that involved interventions also reported lack of effects on daily PA despite increasing time allocated to PE. The school-based intervention KISS involves two additional times per week of PE (90 min in total) taught by a PE teacher, short PA breaks (5 min), and 10 min of daily PA homework (Kriemler et al., 2010). Results showed no differences in total PA between the children from the intervention schools and the children from the control schools. However, children from the intervention schools engaged in more daily MVPA than those from control schools. Two studies from the Danish CoSCIS intervention showed, despite double the time allocated to PE, no significant difference in daily PA between the intervention group and the control group (Bugge et al., 2012; Hasselstrøm et al., 2008).

Collectively, the studies overviewed in this paper present somewhat mixed findings. For example, some studies suggest that PA is higher during days with PE compared with non-PE days, whereas other studies report no relationship between PE and daily PA. The latter studies include those that investigated differences in PA among children and youth who were exposed to different lengths of time allocated to PE. Although not systematic, this narrative overview suggests that the contribution of PE to daily PA appears promising but not conclusive.

A possible explanation that some studies report no relationship between PE and daily PA might be that children and youth compensate PA within and between days (Gomersall et al., 2013). Other explanations might be that the proportion of PA during PE is too low to affect daily PA and that PE might not have desirable effects on leisure-time PA.

However, some PE interventions reported effects on daily PA among children and youth despite not having increased time allocated to PE. Compared to peers in the control group, the children who participated in CATCH reported 12 min more of daily vigorous PA (McKenzie et al., 1996). The intervention involved PE curriculum and materials, in-service teacher trainings, and on-site teacher consultation service. Results from the TAAG showed a modest increase (1.6 min) of daily MVPA among girls (Webber et al., 2008). Studies

such as these suggest that there may be specific PE interventions that can increase daily PA among children and youth.

PE should be an important component of a comprehensive school-based intervention for the promotion of PA among children and youth. Pate et al. (2011) reviewed existing policies to increase PA among children and youth. They found support for policies directed toward increasing PE in school, in addition to improving school environmental support, promoting active transport, and launching mass media campaigns. Despite this, comprehensive school-based interventions present somewhat mixed results. One systematic review showed that multicomponent school-based PA interventions involving PE, PA during the school day, PA before and after school, and family engagement had limited effects on daily PA among children and youth (Russ et al., 2015). The same study indicated that school-based PA interventions including PE components were related to smaller changes in PA as compared with those without PE.

According to the research, children and youth engage in approximately 40% to 45% of MVPA during PE (Hollis et al., 2017; Hollis et al., 2016). Because of this, PE appears to be an effective domain for the promotion of PA, especially among otherwise physically inactive children and youth, since PE might be the only opportunity for them to engage in organized PA. However, promotion of PA should be regarded as just one component of quality PE. It is also important to provide meaningful learning experiences that meet other critical curriculum and educational objectives in PE. Children and youth who participate in PE should also acquire important knowledge, develop motor skills, and experience positive social interactions with peers and teachers, including learning to cooperate and demonstrating empathy and respect (Bailey et al., 2009).

Conclusion

PE has a unique opportunity to promote PA among children and youth. Although studies indicate that children and youth are physically active during PE and that interventions might increase daily PA, research needs to find effective ways to increase the percentage of children and youth who achieve the recommended daily PA level.

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