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Physical Activity Levels in Middle and High School Physical Education: A Review

Stuart Fairclough and Gareth Stratton

Forty studies reporting physical activity during middle and high school physical education (PE) classes were reviewed. Students engaged in moderate-to-vigorous physical activity (MVPA) for 27% to 47% of class time. Intervention strategies were successful in increasing MVPA. During nonintervention classes the highest levels of MVPA occurred in invasion games and fitness activities. Movement activities stimulated the lowest levels. Boys and girls spent 40% of class time in MVPA. Differences in MVPA during PE were also methodology dependent. PE classes can complement other school-based opportunities to contribute to young people's daily physical activity.

Physical activity is an important aspect of any health promotion program, and lack of it is a primary risk factor for many lifestyle-related diseases. Promoting health and physical activity is the responsibility of a number of agencies and institutions, and schools are central to most policies (8,12,20,58,86). Moreover, school responses to the physical activity and health needs of society have traditionally been reflected through physical education (PE) in most countries across the world (33,40).

Corbin's pyramid for health-related physical activity and stairway to fitness outline the significant contribution that PE can make in the promotion of lifelong physical activity (13,14). Welk (89) has also proposed a model to promote physical activity in youth. This has much to offer PE in that it considers physical activity promotion through enabling, predisposing, reinforcing, and demographic factors. Combining the goals of these models sets the scene for youth physical activity promotion, with PE as a key contributor to this process. In the U.S. these goals have been translated into quantifiable targets in national physical activity policy (i.e., Healthy People 2010 recommendations; 86). These targets, first, advocate the need for daily PE (objective 22-9) and second, recommend that children be active for 50% of class time (objective 22-10). Other countries have not set a national standard for PE-related physical activity. Instead, physical activity goals are usually implicit in the content of PE curricula. Rather than contain explicit curriculum-based physical activity targets, the PE curriculum in England (19) is noted as being

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an important vehicle in promoting health-related physical activity within broader national physical activity recommendations for young people (8).

Studies investigating the health-related effects of PE have focused on factors such as motivation (60), fitness (48), and long-term physical activity (85). They have also quantified the amount of physical activity that participants achieve during PE class time (81). Comparing PE activity levels across studies is problematic because of the contextual diversity that exists in different types of schools. This is certainly the case when elementary, middle, and high school PE is considered. Elementary school PE is usually taught by classroom teachers, who do not have specialist PE knowledge. Moreover, elementary curricula tend to focus on the development of core movement skills through simple activity forms (62,64). Conversely, middle and high school is the first time that most students are taught by specialist physical educators. As students progress through these grades, they usually have opportunities to experience and develop across a greater breadth of activities (29,30,57).

A decline in young people's habitual physical activity levels, however, also coincides with middle and high school (7,9). There is evidence that this reduction occurs as a result of a combination of biological, social, psychological, and environmental factors (68). Moreover, during these grade levels (and in high school in particular), the frequency and duration of PE classes are often curtailed to the benefit of other curricular areas (76,86). Notwithstanding this, it has been demonstrated that on those days when middle school students attend PE class, they also engage more frequently in moderate and, especially, vigorous physical activity than on non-PE days (49). Furthermore, the contribution of PE classes increased with age (49). There is also evidence that when school-based physical activity opportunities are restricted, such as on non-PE days, children do not compensate with greater activity after school (18). In addition, total daily activity has been shown to be greater on PE days than on non-PE days (18,56). Another study demonstrated that mean heart rate was greater during PE than any other period of the day (36). Thus, PE classes might be important as regularly occurring windows of opportunity for physical activity engagement at moderate and vigorous intensities. This might be especially significant among those children who are least active and for whom PE might be their only regular opportunity for activity at these intensities (65). Accordingly, physical educators should aim to provide optimal opportunities for physical activity engagement by working towards the Healthy People 2010 target of 50% of class time.

In order to address students' long-term health, increases in PE activity levels should be focused on the promotion of lifelong physical activity. This can be achieved by physical educators encouraging out-of-school activity. Out-of-school activity might enable students to become independent participants in extra-curricular and community-wide initiatives (51). Whereas this latter goal is difficult to assess, low levels of physical activity (7,9), a high prevalence of obesity and overweight (84), and a reduction in the number of young people wanting to play organized sport (76) combine to suggest that PE is not satisfactorily meeting the lifelong physical activity promotion goal. On the other hand, relatively little is known about physical activity levels in PE. What is required is a detailed review of the contribution that PE lessons make to young people's physical activity profile.

This article aims to systematically review the literature on middle and high school students' physically activity levels during PE. This review is timely given current educational and health-related objectives.

Methods

Review Methodology

Data from 40 studies were located after an extensive online search of the Sport Discus, Medline, and Web of Science databases. Manual searches of reference list citations and bibliographies were also conducted. Investigations that reported physical activity during middle and high school PE lessons published in peer-reviewed sources were included in the review. Studies published as abstracts were not included. The majority of investigations measured physical activity using a single methodology, although four studies combined two measures of physical activity assessment.

Physical Activity Measurement

The methods of physical activity monitoring used in the reviewed studies were heart rate (HR) monitoring, systematic observation, and accelerometry. Most investigations expressed physical activity as the percentage of class time that students engaged in health-enhancing moderate-to-vigorous intensity physical activity (MVPA). Thresholds or cutpoints have been proposed for each method to establish the duration and frequency of MVPA episodes. For example, HR reserve (HRR) thresholds, cutpoints for the number of accelerometer counts, and systematic observation movement categories (such as walking) are commonly used. It was possible to estimate MVPA values for studies that originally reported data in this way or if lesson durations were included. In HR studies in which MVPA thresholds other than ≥ 50% HRR were used (81), the equivalent percentage of HRR for the reported threshold value was calculated based on students' sex and ages (81). If this surrogate HRR threshold was ≥ 50% HRR, then MVPA was estimated. Where reported HR thresholds were equivalent to < 50% HRR, MVPA was not estimated. Conversely, some absolute threshold values equated to ≥ 50% HRR. For these data, the estimated MVPA values reported in the review underestimated the true values but were as accurate as possible given the information reported in the original studies.

Although each of the methods has demonstrated sound validity and reliability among pediatric populations, they also have limitations (88,90). HR monitoring assesses the physiological load on the cardiorespiratory system but is suspect in contexts in which emotional stress might be prevalent. Systematic observation records physical activity behaviors and contextual information but does not directly measure physiological strain or movement. In contrast, accelerometers objectively measure the acceleration of the whole body during activity. Accelerometer counts are not directly affected by emotional stress, but they are limited in that they do not differentiate among activities in which limbs might be in motion but the hip is stationary. Furthermore, accelerometers cannot distinguish among gradients when the running velocity remains unchanged (88). Because each method measures a different dimension of physical activity (71), comparing levels of MVPA obtained using different instruments is problematic. Moreover, agreement among instruments when used in parallel is moderate to poor (88), especially during activity of varying intensities and durations, which is typical of that found in PE lessons. For these reasons this review considered data from each method separately.

Results

This article aims to present a detailed overview of how much MVPA students engage in during middle and high school PE. The results are presented in relation to different methods of physical activity assessment, the effect of interventions, types of activity, gender, and other contributory factors. Last of all, data relating to student engagement in vigorous intensity physical activity are presented.

Physical Activity Based on Method of Assessment

Thirty studies used HR monitoring as the method of physical activity measurement. Systematic observation was used in 10 papers, whereas physical activity assessed by accelerometry was reported in four studies. A combination of methods was used in four investigations. When data from all studies were combined, mean MVPA values measured by HR and observation were 40.4 ± 13.8% and 27.7 ± 14.9%, respectively. Accelerometer-assessed MVPA was reported for 46.8 ± 13.9% of class time.

Interventions to Increase Physical Activity During PE

All intervention studies that purposely aimed to increase the amount of student activity during lessons were successful. In descriptive studies in which activity was measured under nonintervention conditions, students engaged in MVPA for 37.9 ± 14.6% (HR), 26.6 ± 15.2% (observation), and 46.8 ± 13.9% (accelerometry) of class time. In contrast, when PE was taught under intervention conditions, students were more active (percent of class time = 47.9 ± 10.6 for HR and 31.9 ± 18.7 for observation; see Table 1a). Some interventions focused on training-like exercise programs to improve student activity levels. Seliger et al. (74) incorporated "intensified exercises" into regular PE classes. Though MVPA was not reported, significant improvements in cardiorespiratory load were observed, which were illustrated by a 20% increase in students' mean HR (74). More recently, Baquet and colleagues (4) implemented high intensity running and jumping protocols in PE and noted an increase in MVPA from 40% to 65.7% between control and intervention classes.

Some interventions placed equal emphasis on improving activity and motor development through more subtle integration of fitness activities into PE classes. For example, Quinn & Strand (63) reported student engagement in MVPA for 49.6% of football class time, and Scantling et al. (72) observed a threefold increase in MVPA during badminton lessons. Other pedagogical interventions have focused on the planning and teaching processes by integrating MVPA with other planned learning objectives (27). Moreover, an alternative pedagogy-based intervention was based on the effect of different types of supervision and feedback on MVPA (73). It was noted how "active" forms of supervision corresponded with episodes of increased MVPA more often than did "passive" supervision (see Table 1b). A large-scale multicenter intervention to enhance students' MVPA was underpinned by physical educators receiving in-service training designed to revise and adapt existing instructional strategies (50). Significant improvements were observed in intervention schools from 48% of class time in MVPA at baseline to 53.5% and 53.1% after the first and second years, respectively (50).

Physical Education Activity Type and Physical Activity

Table 1a Summary of Interventions Designed to Increase MVPA: HR Studies

Study and gender	*N*	*n*				Percent class time in MVPA		
		Int	Con	Age	Intervention design	Int	Con	*p*
Bacquet et al. (4)[a]					Intensified running & jumping protocol vs. regular gymnastics or badminton over 10 lessons			< .001
males	203			13.1		64.3	39.1	
females	142			12.8		67.1	40.9	
Fairclough & Stratton (26)[a] (females)		12	14	11–12	MVPA as an additional lesson objective over a 5-lesson gymnastics unit	40.8	28.9	.008
Klausen et al. (44)[b]				12–13	Additional PE classes that were not intensified	18.0	15.0	n/a
males	17							
females	18							
Quinn & Strand (63) (males)[c]	60			12–13	Integrated fitness, skills, and play over a 4-lesson football unit	49.6	34.2	< .05
Scantling et al. (72)[d] (females)	43			15–16	Integrated fitness, skills, and play over a 4-lesson badminton unit	41.3	8.6	< .001
Strand & Anderson (77)[c] (males)	60			12–13	Integrated fitness, skills, and play over a 4-lesson football unit	42.1	39.0	ns

[a]MVPA derived from 50% HRR threshold. [b]MVPA derived from 150 beats/min threshold. [c]MVPA derived from 156 beats/min threshold. [d]MVPA derived from 130 beats/min threshold.

Table 1b Summary of Interventions Designed to Increase MVPA: Observation Studies

Study and gender	*N*	*n*				Percent class time in MVPA___		*p*
		Int	Con	Age		Int	Con	
Fairclough & Stratton (26)[a] (females)		20[b]	20[b]	11–12	MVPA as an additional lesson objective over a gymnastics unit.	18.5	13.5	.047
McKenzie et al. (50)[a] (males and females)	7396[b]			11–14	Two year PE program comprising curricular materials, staff development, and on-going teacher support.	53.3	46.7	.02
Schuldheisz & van der Mars (73)[a] (males)	8			11–12	Active vs. passive student supervision during the health-related fitness component[c] of two basketball lessons.	69.2% of HRF	48.7% of HRF	n/a
Simons-Morton et al. (75)[d] (males and females)	510[e]			11–14	Curricula emphasizing health-related PE and teacher encouragement of maximum physical activity during lessons.	24.0	16.1	ns

Note. HRF = health-related fitness.
[a]SOFIT observation instrument used (53). [b]*n* based on SOFIT observation protocol of four students per lesson. [c]Health-related fitness component was of 9–11 min duration per lesson. [d]CPAF observation instrument used (59). [e]*N* based on observation of five students per lesson.

Most studies reported the type of PE activity being taught, which was valuable because the information added vital context to the data. To make comparisons among activity types more meaningful, they were grouped according to their common characteristics (i.e., basketball and soccer were classed as team invasion games, dance and gymnastics were categorized as movement activities, etc). MVPA during fitness-oriented activities and team invasion games was generally greater than during other types of activities (Figure 1).Percent of class time in MVPA during these activities averaged 48 and 46, respectively, which approached the Healthy People 2010 target of 50% (87). These high activity levels were apparent across studies that used HR monitoring (10,11,39,42,78,80,82,83), observation (51), and accelerometry (2,28,41). In contrast, students took part in MVPA for only a third of net-game and movement-activity class time. Activity engagement in these activities, however, was studied less frequently (4,6,24,28,38,45, 46,72,83). MVPA during track-and-field lessons varied depending on the lesson focus. During throwing and jumping lessons, students were active for between 7.2% and 25.5% of class time (3,16,17) compared with 27.6% during running activities (24).

Gender and Physical Activity

Twenty-one studies reported boys' and girls' activity levels separately. Twenty-one studies reported boys' and girls' activity levels separately. The data indicated that boys engaged in MVPA for between 16% and 61% of class time, compared with 16% and 57% for girls (Table 2a–c). These values also varied by the type of activity that the students were involved in. In studies that directly compared gender differences in MVPA, findings were equivocal (boys, 40.7%; girls, 40.5%). Some investigations highlighted that boys were most active (24,25,27,28,36,50), whereas

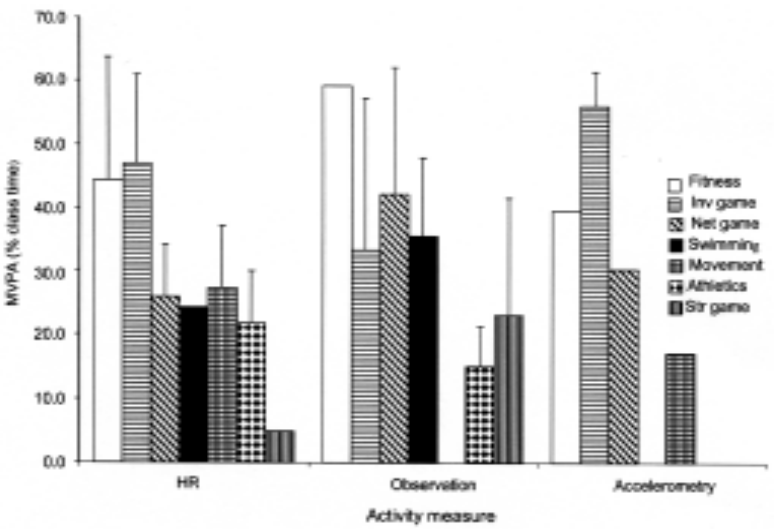

Figure 1 — Mean percentage of PE class time (± *SD*) spent in MVPA during different PE activities measured by HR, observation, and accelerometry.

Table 2a Percent of Class Time Spent in MVPA by Gender: HR Studies

Study and gender	N M	N F	Age	PE activities	Percent class time in MVPA	*p*
Baquet et al. (4)[a]	203	142	13.1 (M) 12.8 (F)	Intensified running & jumping, badminton, gymnastics	51.7 (M) 54 (F)	NS
Crowhurst et al. (15)[b]		9	14–16	Invasion games	35.3	n/a
Fairclough (23)[a]		20	13.0	Range of PE activities	38.5	n/a
Fairclough (24)[a]	33	35	13.1	Team games, individual games, track & field, gymnastics, dance	45.9 (M) 33.9 (F)	< .05
Fairclough (25)[a]	40	33	13.1 (M) 13.0 (F)	Range of PE activities	42.5 (M) 30.1 (F)	n/a
Fairclough & Stratton (26)[a]		26	11–12	Gymnastics	34.9	n/a
Fairclough & Stratton (27)[a]	62	60	11–14	Team games, individual activities, individual games, movement activities	39.4 (M) 29.1 (F)	< .01
Fairclough & Stratton (28)[a]	33	22	13.0	Invasion games, running/fitness, net games, movement activities	42.1 (M) 36.7 (F)	n/a
Fromel et al. (35)[c]		138	16.6	Dance	47.3	n/a
Quinn & Strand (63)[d]	60		12–13	Football	41.9	n/a
Scantling et al. (72)[e]		43	15–16	Badminton	25.0	n/a
Strand & Anderson (77)[f]	60		12–13	Football	40.6	
Strand & Reeder (78)[g]	55		12–13	Invasion games, volleyball, wrestling, swimming	35.3	n/a
Strand & Reeder (79)[h]	121		12–13	Team games	17.7	n/a
Stratton (80)[i]	21	21	12–13	Handball	55.2 (M) 58.3 (F)	NS
Stratton (82)[i]	22	22	12–13	Handball	24.1 (M) 30.7 (F)	< .01
Yelling et al. (91)[a]		18	11.8	Netball	56.5	n/a
Yelling et al. (92)[a]		6	11.9	Netball	55.6	n/a

Note. Data from descriptive and intervention studies combined where appropriate. M = male; F = female.
[a]MVPA derived from 50% HRR threshold. [b]MVPA derived from 50% peak VO_2 threshold. [c]MVPA derived from 70% HR max threshold. [d]MVPA derived from 156 beats/min threshold. [e]MVPA derived from 130 beats/min threshold. [f]MVPA derived from 60% HRR threshold. [g]MVPA derived from 150 beats/min threshold. [h]MVPA derived from 60% HR max threshold. [i]MVPA derived from 140 beats/min threshold.

Table 2b Percent of Class Time Spent in MVPA by Gender: Observation Studies

Studies	*N*	Age	PE activities	Percent class time in MVPA	*p*
Fairclough & Stratton (26)[a]	40[b] (F)	11–12	Gymnastics	16.0	n/a
McKenzie et al. (50)[a]	7396 (combined)[b]	11–14	Range of PE activities	58.2 (M) 46.4 (F)	n/a
Stratton (80)[c]	7 (M) and 7 (F)	12–13	Handball	16.0 (M) 17.2 (F)	ns

Note. Data from descriptive and intervention studies combined where appropriate. M = male; F = female.
[a]SOFIT observation instrument used (53). [b]*N* based on SOFIT observation protocol of four students per lesson. [c]CARS observation instrument used (61).

Table 2c Percent of Class Time Spent in MVPA by Gender: Accelerometer Studies

Studies	*N*	Age	PE activities	Percent class time in MVPA	*p*
Arnett & Lutz (2)[a]	60 (F)	13–14	Invasion games	56.1	n/a
Fairclough (23)[b]	20 (F)	13.0	Range of PE activities	34.7	n/a
Fairclough & Stratton (28)[b]	33 (M) 22 (F)	13.0 (M) 13.0 (F)	Invasion games, running/fitness, net games, movement activities	42.0 (M) 28.0 (F)	n/a
Hastie & Trost (41)[c]	19 (M)	12.9	Hockey	61.3	n/a

Note. Data from descriptive and intervention studies combined where appropriate. M = male; F = female.
[a]Tritrac-R3D accelerometer used. MVPA derived from moderate intensity threshold cutpoint of 1,772 vector magnitude counts (22). [b]Tritrac-R3D accelerometer used. MVPA derived from moderate intensity threshold cutpoint of 1,000 vector magnitude counts (67). [c]CSA accelerometer used. MVPA derived from cutpoints calculated using the energy expenditure prediction equation of Freedson et al. (34).

the opposite was true in others (4,80,82).

Other Influences on PE Physical Activity

Whereas the effects of intervention design, activity type, and gender have predominantly been studied in middle and high school PE settings, other variables have not received as much attention. Studies comparing the MVPA of students of differing abilities have generally shown the most highly skilled students to engage in MVPA for around 5% more class time than their less skilled peers (2,27,41,46; see Table 3). One study that used an absolute HR threshold to represent MVPA, however, reported that average- and low-ability students were slightly more active than the higher ability group (2% of class time; 82). Another aspect of PE classes that has seldom been investigated is the relationship between motivation and the amount of MVPA that students participate in. This is important because physical activity levels might by linked to effort and perceived competence, which are predictive of intrinsic motivation (32).One study measured levels of activity, enjoyment, and perceived competence during lessons and categorized the students by physical activity level (25). The high-MVPA group reported significantly less enjoyment of lessons than the low-MVPA group. Moreover, this trend was observed with perceived competence, although the difference was not statistically significant (25).

There is limited evidence of the extent of the impact of adiposity on PE activity levels. In a review of correlates of youth physical activity, the association between body mass index and habitual physical activity was found to be equivocal (70). The evidence to support any such relationship in the context of PE is relatively scarce. One study of 13-year-old girls reported a moderate inverse relationship between body fat and accelerometer counts/min ($r = –.65$, $p < .01$), and a weak, nonsignificant association between body fat and MVPA assessed by HR (23). Similarly, another study showed no significant differences in HR-derived MVPA among girls of varying body fatness (91). Cardiorespiratory fitness status is another biological factor that might influence students' PE activity levels (81). In the one study designed to investigate this relationship, however, cardiorespiratory fitness accounted for less than 6% of the variance in girls' MVPA as derived from HRR thresholds and accelerometer counts (23).

Vigorous-Intensity Physical Activity

Vigorous-intensity physical activity (VPA) might stimulate improvements in cardiorespiratory fitness (55). Students were engaged in VPA for about 21% of class time in HR studies (4,24,80,82,91,92) compared with 10.8% when observation was the method of assessment (3,16,17,26,43,50,51,80). Seventeen percent of class time was spent in VPA in the single accelerometer study to report activity at this intensity (41). Boys were involved in VPA for around 2–3% more class time than were girls. This difference was consistent for HR (20.8% vs. 18.0%) and observation studies (10.2% vs. 7.7%).

Discussion

Forty studies describing students' physical activity during middle and high school PE classes were reviewed. During regular PE taught under nonintervention conditions, students engaged in MVPA for between 27% and 47% of class time depending on measurement instrument. These values highlight the pedagogical nature of PE activity, which is underpinned by educational principles and differing instructional

Table 3 Percent of Class Time Spent in MVPA by Students of Differing Abilities

Studies	*N*			Age	Category selection criteria	Percent class time in MVPA			*F*
	High	Ave.	Low			High	Ave.	Low	
HR studies									
Fairclough & Stratton (27)[a] (males and females)	44	39	39	11–14	PE teachers selected based on evaluation of general PE abilities	38.3	31	33.1	ns
Li & Dunham (46)[b] (males and females)	24	24	24	11–16	PE teachers selected based on knowledge of students	22.3	20.3	17.9	ns
Stratton (82)[c] (males and females)	15	17	10	12–13	PE teachers selected based on evaluation of students' abilities in games	24.8	27.7	29.9	ns
Accelerometry studies	High	Int.	Low			High	Int.	Low	
Arnett & Lutz (2)[d] (females)	19	22	19	13–14	Investigators and teachers selected based on years of PE participation, investigator observation, students' perceived sport competence.	62.1*	54.9	51.4	< .0001
Hastie & Trost (41)[e] (males)	9	—	10	12.9	Investigators selected based on students' performances on a hockey-skills test.	62.2	—	60.0	ns

Note. Ave. = average; int. = intermediate.

[a]MVPA derived from 50% HRR threshold. [b]MVPA derived from 144 beats/min threshold. [c]MVPA derived from 140 beats/min threshold. [d]Tritrac-R3D accelerometer used—MVPA derived from moderate intensity threshold cutpoint of 1,772 vector magnitude counts (22). [e]CSA accelerometer used—MVPA derived from cutpoints calculated using the energy expenditure prediction equation of Freedson et al. (34).

*> intermediate and low groups.

methods. These can combine to constrain the potential for physical activity during classes. The distribution of nonintervention MVPA levels ($SD = \pm 14.2\%$) suggests that students are very active in some classes, meeting and sometimes surpassing the 50% of class time target set by Healthy People 2010. Conversely, a number of classes stimulate only low levels of MVPA. Such variation in activity levels might be a reflection of the diverse subject goals that PE attempts to accommodate (e.g., health, motor skill, moral, social, creative development, etc; 69).

Physical activity levels increased as a result of intervention conditions. Some of the greatest improvements were achieved when regular lesson content was replaced by high-intensity activities and training-like protocols (4, 74). Though able to stimulate health and fitness benefits, such intervention designs did not appear to consider the wider educational focus of PE. Thus, intervention strategies based around the integration of fitness content alongside existing subject matter (63,72,77) or modified class content and teaching approaches (26,50,73,75) are more favorable given PE's educational remit and contrasting subject goals.

When MVPA levels were compared by activity type, consistent findings were observed across studies and measurement instruments. Team invasion games were effective in promoting high levels of MVPA. This might be because invasion-games lessons involve intermittent weight-bearing movement of varying intensities. Traditional PE curricula are often dominated by team games (57,76), which is positive from the perspective of activity engagement. They do not necessarily best prepare students for lifelong physical activity, however, because they generally bear little resemblance to adult physical activity choices (31,69). Other activities stimulate lower levels of movement. For example, net games and movement activities, respectively, emphasize motor skills and aesthetic appreciation and, as a consequence, do not stimulate high levels of MVPA. Regardless of activity type, simple modifications to teaching strategies and content can cause at least modest improvements in MVPA while allowing teachers to maintain planned core goals and educational themes (26,72).

Generally, boys' and girls' MVPA levels were similar because PE offers similar opportunities for boys and girls to be active. In studies that showed boys as more active than girls, data might have been skewed because of the type of activities that the respective sexes took part in (24,25,27,28,50). Girls' curricula often include a greater proportion of aesthetic and movement-based activities, whereas boys' tend to emphasize team games (31,57,76). Interestingly, in HR studies that used absolute MVPA thresholds, it was demonstrated that girls' HRs were higher than boys' (80,82). This paradox has been attributed to the fact that girls' HRs tend to be higher than boys' at the same intensity of work (5). Therefore, in PE lessons in which boys and girls engage in similar amounts of movement, girls might be expected to generate higher HRs (82). This physiological difference can be corrected when HRR is used to establish intensity thresholds because differences in boys' and girls' resting HR values are accounted for (81).

Another factor that might have an effect on MVPA during PE is students' ability levels. Motor abilities might affect the extent to which skills are effectively performed, which in turn could influence the potential level of activity attained in a given PE task or game (66,81). On this basis, higher skilled students would be expected to be more active than their less skilled peers. This was the case in most investigations that compared MVPA among ability groups (2,27,41,46), although, with the exception of one study (2), differences were not statistically significant.

The less skilled students were not necessarily the least active in all cases (27). This anomalous finding might have been a result of inaccurate initial categorization of students into ability groups. Alternatively, low-ability students might display more effort, which would result in greater activity levels, either because they are knowingly being monitored or because they associate effort with perceived ability (47). Another study reported that students of low and average ability engaged in moderate intensity activity more often than did the high-ability group (82). This trend, however, was reversed when the amount of time the groups spent in VPA was compared. It was suggested that VPA thresholds might differentiate more easily among activity groups (82) because moderate intensities might be more easily attainable for the full range of abilities in a class. Although ability-group differences were generally nonsignificant, they illustrated a need for teachers to use pedagogical strategies that allow all students equal opportunities for optimal activity engagement. Such strategies might relate to grouping and teaching by ability level, differentiating instruction, or individualized task setting with mixed-ability groups.

The link between the psychological effects of PE and activity levels has seldom been investigated. Based on the positive predictive relationship among intrinsic motivation, effort, and enjoyment (32), it might be expected that levels of motivation, MVPA, and enjoyment increase concomitantly. In the one study designed to specifically examine the association among these variables, however, students who took part in most MVPA reported the lowest levels of enjoyment (25). These findings concur with Goudas and Biddle's (37) observation that students did not enjoy PE when they were "pushed hard." Furthermore, it has been suggested that the physical demands of PE are a common reason for students disliking the subject (21). This negative association between intensity and enjoyment implies that promoting high levels of MVPA during PE is counterproductive to encouraging positive attitudes toward physical activity. It is emphasized, however, that this inverse relationship is based on only one study and might also have been related to other factors such as sensitivity of the measurement instrument or the type of activities in which the students took part. Clearly, more work is needed in this area to improve our understanding of the relationship among physical activity, motivation, and enjoyment in PE. This is important for the design and implementation of effective intervention strategies.

Biological factors such as body composition and fitness status are identified as enabling factors for youth physical activity (89). The importance of these variables to PE activity, however, is less clear, particularly because they have only been investigated in two small-scale inquiries. In a study involving adolescent girls, body fat was significantly correlated with MVPA measured by accelerometry (23). Such a relationship, however, was not apparent when HR monitoring was employed (23,91). These equivocal findings could be related to the type of PE activities in which participants were engaged when data was obtained. It is possible that among students with relatively higher body fatness, PE activities that require full body intermittent translocation for sustained periods (i.e., invasion games, running activities, circuit or station training, etc), are physically less manageable than those with a greater skill acquisition or creative emphasis. Moreover, the association between body fat and MVPA might be weaker when MVPA is assessed by HR rather than accelerometry because the absolute energy cost of movement for students with excess body fat is greater than for leaner peers. The augmented energy demand would result in an increased HR response, which could inflate the

amount of MVPA measured by HR monitoring relative to the amount of activity performed (1).

The association between cardiorespiratory fitness and MVPA in PE was extremely weak in the one study to assess this relationship (23). This finding is substantiated by the literature on habitual physical activity, which generally reports low correlation coefficients ($r \leq .2$) between peak VO_2 and various physical activity indices (55). The likely explanation is that most young people do not experience physical activity within or outside of PE classes that is of sufficient intensity and duration to increase peak VO_2 (1).

Conclusions and Recommendations

This review found that during regular PE classes, students spent between 27% and 47% of class time in MVPA. Interventions successfully increased MVPA from baseline and control group levels. Physical educators should aim to maximize physical activity opportunities during class time by drawing on the principles of those interventions that were underpinned by pedagogical and educational principles. The target for students to be active for 50% of class time (86) should be seen as a positive motivator for teachers when designing and delivering PE lessons. Differences in boys' and girls' activity levels were most likely related to the type of activities that are offered in their respective curricula. Discrepancies in MVPA among students of differing abilities support the suggestion that teachers generally teach the class as a whole without adequately planning for individual differences (54). This is an important principle of effective pedagogy, which might be better adhered to if lessons are planned with MVPA objectives in mind (87). By differentiating in this way, there is an increased likelihood of students having successful PE experiences, which are more likely to positively impact their perceived competence, intrinsic motivation, and persistence in physical activity. Teachers, however, should be sufficiently competent to be able to plan and teach PE in this way. Focused preservice and in-service training might be the most effective method of enabling teachers to engage mixed-ability learners in appropriate levels of MVPA (50,52). The diverse range of activities and pedagogical episodes inherent in PE lessons present barriers for student participation in VPA. Nonetheless, PE might be the only regular opportunity for the least active students to experience activity at this higher intensity (65). Delivery of activities that are more vigorous should be as enjoyable and purposeful as possible, with a clearly defined focus, so students can concentrate on participating rather than on their level of exertion.

It is recognized that curricular PE involves only a small proportion of students' waking hours. Furthermore, in many schools, the duration and frequency of PE lessons are restricted. Because of this, PE has a limited potential to significantly contribute to the daily physical activity levels of most young people. Therefore, it is unrealistic for PE to be seen as a panacea to combat the increases in physical inactivity and obesity. Instead, it should be perceived as a regularly occurring educational environment for structured physical activity that complements other opportunities within the school context. When seen in this light, PE, combined with other school-based physical activity opportunities, can make a valuable contribution to young peoples' daily physical activity.

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