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Student Physical Activity Levels During a Season of Sport Education

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The purpose of this study was to determine the extent to which sport education can provide students with sufficient opportunities for developing moderate-to-vigorous physical activity (MVPA). Nineteen seventh-grade boys (average age = 12.9 yrs.) participated in a 22-lesson season of floor hockey. For all students (both higher and lower skilled), students averaged a total of 31.6 min of MVPA during the season, or 63.2% of lesson time. Further, there was no significant difference according to skill level (33.4 min [Higher] vs. 30.4 min [Lower]), nor were there any significant differences in MVPA levels across the phases of the season.

A traditional goal of physical education that has received renewed emphasis is that of providing physical activity to children, particularly given increasing evidence that physical activity is associated with short and long-term health benefits in youth (11, 18). Indeed the National Association of Sport and Physical Education (9) lists two of its national standards as "exhibits a physically active lifestyle," and "achieves and maintains a health-enhancing level of physical fitness." Furthermore, objective 22.10 of the Healthy People 2010 report recommends a minimum of 50% of lesson time in physical education be spent in moderate-to-vigorous physical activity (MVPA) (20).

Despite these objectives, physical education has demonstrated a frequent inability to meet the challenge of providing sufficient MVPA in classes. Studies by Simons-Morton et al. (13,14) indicate that, on average, less than 10% of physical education class time is spent in MVPA. In a review of children's heart rates during physical education lessons, Stratton (15) also confirmed that a majority of lessons failed to achieve the 50% criteria.

While physical education classes may not be providing sufficient activity levels, there is a strong relationship between participation in sports and physical activity. In a study of 183 12-to 14-year olds, Katzmarzyk and Malina (8) found participation in organized sports to account for between 16 and 20% of daily total energy expenditure and between 55 and 65% of physical activity energy expenditure. Utilizing data from the 1990 Youth Risk Behavior Survey (YRBS) Pate and colleagues (10) found that over 60% of United States high school students meeting guidelines for participation in physical activity reported participation in

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organized sports. These findings support the notion that a physical education curriculum based around sport might provide one avenue for promoting physical activity in students.

In spite of the initial allure of games, Siedentop (12) has suggested that most sport within physical education rarely reproduces those features of sport that lead to its attractiveness, resulting in student claims of irrelevancy and boredom. Ennis (3) too, has critiqued sport-based public school physical education as often exhibiting discriminatory and abusive practices, noting "more than apologies are necessary."

Siedentop (12) describes typical physical education sports units as rarely lasting longer than three weeks, where team selection is changed daily and is usually ad hoc, and where very little (if any) of a sport's culture and ritual is transmitted through the experience. In contrast, he lists six key features of sport, including (a) that sport is done by seasons, (b) players are members of teams and remain in that team for the entire season, (c) seasons are defined by formal competition, (d) there is a culminating event to each season, (e) there is extensive record keeping, and (f) there is a festive atmosphere in which the season (and particularly the culminating event) take place.

As a result of this analysis, Siedentop developed "sport education," a curriculum and instruction model to provide students with authentic sport experiences. Within sport education seasons, students become affiliated with teams for the entire length of the unit (usually at least 20 lessons), and take greater responsibility for the organization and management of the sporting experience within physical education. A typical sport education season also involves students not only in skill learning and game play, but adopting leadership positions and taking responsibility for the conduct of the unit. Student roles include coaches, captains, referees, scorers, statisticians and members of the sports organizing board. One vignette of a sport education unit is provided:

A class of 45 students is divided into nine teams. Each of these teams selects its own captain, coach and manager. They also chose a name, and may have team pictures taken or adopt a uniform color. The first part of the season involves a training camp, where the teacher provides a number of skills drills in which the group participates as a whole. A small segment of time at the end of each lesson is allocated for team coaches to run practices with their teams. Each team is assigned a "home space."

After a series of lessons in which the basic skills are learned and practiced, a pre-season competition is held. During this phase of the season, students practice becoming referees, learn how to keep score and take statistics, and are involved in many of the managerial tasks such as setting up the field, running the time clock, and having all the equipment ready for play.

As the season progresses, refining and practicing skills takes less of the class time, and formal competition becomes the focus. It is a team competition, so the major goal is the win the competition by compiling points for winning matches, but also for good sportsmanship, being organized, and completing any set managerial duties. At the completion of the finals series, a variety of awards are presented; final ranking, referee awards, fair play awards and participation awards.

Research on sport education has shown that many students prefer this format of sport to others within physical education (2, 4, 6), and students of both sexes report working harder than in regular physical education lessons (16). Students

particularly enjoy being on the same team, and lower skilled students specifically perceive they are useful and can make a serious contribution to their teams (1, 7). It is also important to note that participation in this game play does not seem to compromise skill and tactical development. For example, in one sport education season, individuals showed significant improvement from the beginning phases of the season to the end (7).

Despite these initial positive findings, there is no research on whether sport education seasons can provide students with sufficient opportunities for developing MVPA. There are a number of reasons *why* sport education might be conducive to promoting physical activity. First, there is significant time allocation to game play during sport education seasons. Further, since, games involve only small-sided teams (4 or 5-a-side) there is less opportunity for students to experience inactivity through hiding in the outfield or becoming "competent bystanders" (17). Finally, in contrast to a typical beginning to physical education lessons where students assemble and wait for roll call, in sport education teams will often assemble in their own home areas and begin to warm up or practice immediately on arrival at the gym.

While these above mentioned factors might be conducive to the promotion of activity levels, sport education seasons also involve a number of students in non-active roles. These may include roles such as scorekeeping, statistician, or report writer. In all these cases, the benefits of increased MVPA that are gained through match play may be countered by the inactivity involved in these administrative roles.

Purpose of the Study

The purpose of this study was (a) to determine through objective monitoring, the amount of MVPA students participated in during the three phases of a Sport Education season, (b) to examine the effects of skill level on the amount of physical activity performed, and (c) to determine if there were changes in students' skill levels during the season. This third objective was included given the tension teachers often feel when trying to address the multiple goals of physical education (in this case, fitness versus skill development). It was hypothesized that students of all skill levels would exhibit sufficient levels of MVPA during each phase of the sport education season, and that participants would increase their skill level over the course of the 22-lesson unit.

Method

Participants and Setting

Nineteen seventh-grade boys (average age = 12.9 yrs ± .8) participated in a 22-lesson season of floor hockey. These students were all enrolled in a compulsory, daily co-educational physical education program in a public southern rural middle school. Lessons were 50 min in length.

As the final unit for the school year, students were able to select from hockey, tennis, softball or continuous cricket. In this case, only boys elected to participate in the hockey season. The students were not required to change clothes for this class and simply assembled in their home area on arrival at the gymnasium. In

accordance with the university's institutional review board for human subjects, informed consent was received from all participants and their guardians prior to the commencement of the study.

The teacher for this study was the primary author. While not a staff member, he had conducted many different Sport Education seasons as a visiting teacher at this school. In addition, all of the students in this hockey class had participated in previous seasons with this teacher in team handball and Frisbee seasons.

While the teacher was aware of the objectives of the study, and conducted skill practices with a high degree of "instructional intensity," he also made every attempt to remain true to the instructional objectives of sport education. That is, teams were able to practice independently of the teachers (i.e., without additional cues or activity hustles), and during matches, were led by their peer coaches. As a result, any atypical expression of the model was most likely in the early, teacher-directed phases of the season.

The season plan. The early lessons of the unit were designed to teach the skills of ball control and movement. A pre-season followed, in which teams either practiced under the direction of their captain or participated in scrimmages against other teams. The final phase of the season saw the introduction of formal competition (where results counted towards league standings), and the season culminated in play-offs and a championship game. Full details of the season are presented in Table 1.

During the formal competition phase, four games were played during any one lesson. Two games commenced at 9:00 and a second two at 9:18, each lasting 15 min. The 12 min before game time was allocated to team practice and pre-game organization (setting up goals, collecting whistles, etc.), while the final min of each lesson were allocated to the breakdown of goals, the completion of post-match forms (score sheets and referees' reports) and the return of sticks, balls and activity monitors.

Table 1 Floor Hockey Season Plan

Lesson	Content	Teacher's role	Students' roles
1	Introduction Beginning skills	Class leader	Participant
2-7	Whole class skill instruction	Class leader	Participant
8-14	Pre-season scrimmages	Head coach	Coaches players
	Players learn and practice team skills and duty roles	Referee advisor	Learn duty role
15-19	Formal competition	Head coach Program manager	Coaches players Duty team roles
20-21	Play-offs	Program manager	Coaches players Duty team roles
22	Championship game Awards presentations	Program manager Master of ceremonies	Coaches players Duty team roles

Given this time allocation during the formal competition phase, all students participated in at least one game per day, and each team participated as the duty team on this occasion. A duty team provided two referees and two scorekeepers, one for each of the two games. Games were played across the length of the gym (approximate length = 90 feet). Playing crossways (the side wall and the bleachers were in-play) meant an almost enclosed playing area, allowing for continuous play. Indeed, the only time the ball was out of play was when it crossed the centerline on the basketball court.

Data Collection

Instrumentation. During each phase of the 22-lesson season, students wore a Computer Science and Applications Inc. (CSA) 7164 activity monitor for the duration of the class. The CSA 7164 is a uniaxial accelerometer designed to detect vertical acceleration ranging in magnitude from 0.05 to 2.00 G's with frequency response of 0.25 to 2.50 Hz. These parameters allow for the detection of normal human motion and will reject high frequency vibrations encountered in activities such as operation of a lawn mower. The filtered acceleration signal is digitized and the magnitude is summed over a user-specified time interval. At the end of each interval, the summed value or activity "count" is stored in memory and the integrator is reset. For the present study, a 1-min-sampling interval was used. The CSA 7164 has been shown to be a valid and reliable tool for assessing physical activity in children aged 10 to 14 (19). The same monitors were used throughout the study, and the students put them on as soon as they arrived at class. The boys then wore the monitor for the entire lesson (irrespective of their playing or nonplaying role) and returned it as they left the gym.

Data reduction. Minute-by-minute activity counts recorded for each student were uploaded to a QBASIC data reduction program for determination of time spent in moderate to vigorous (≥ 3 METs) (MVPA), and vigorous (≥ 6 METs) (VPA). The age-specific count ranges corresponding to the aforementioned intensity levels were derived from the energy expenditure prediction equation developed by Freedson and co-workers (5). METs = 2.757 + (0.0015 x counts.min^{-1}) – (0.08957 x age [yr]) – (0.000038 x counts.min^{-1} x age [yr]). This equation, which takes into account age-related differences in economy of motion and resting metabolic rate, accounted for 90% of the variance in observed MET levels and predicted energy expenditure during treadmill running and walking within $\pm$ 1 METS. MVPA and VPA scores for each phase of the season were calculated by averaging, within each subject, the min of MVPA and VPA recorded by the CSA in each lesson.

Skill classification. During the fifth lesson of this season, all students completed a six-station circuit of hockey skills that included shooting, dribbling, and ball control tests. While no formal validity scores are available for these tests, they were designed to replicate the skills of the game in action. All tests produced a quantitative score for either accuracy or time (recorded using a stop watch).

The teacher and his research assistant administered the tests. Three teams would either practice or scrimmage while two other teams completed a supervised test. Each team thereby rotated through the entire testing sequence during one lesson. Scores were recorded on a master sheet.

The data from each test were converted to z-scores, and the sum of these z-scores was the student's total score. Those students with positive total z-scores

($n = 9$) were labeled for analysis as "higher skilled" and those with negative total z-scores ($n = 10$) were labeled as "lower skilled." The students were then placed onto teams so that any teams sum z-score was near to or equal 0. This served to create five equal teams. It should be noted that these classifications were ones of high*er* and low*er* skilled. The test scores were not based on any particular normative criteria, and are not meant to state that the students were indeed high or low in skill.

Statistical analyses. A two-way repeated measures analysis of variance (ANOVA) was used to determine significant differences between the dependent variables (i.e., MVPA and VPA) across the phases of the season and skill level. Preplanned single degree of freedom contrasts were used to evaluate the statistical significance of group/phase differences in the dependent variables. Dependent t-tests with a Bonferroni correction for multiple comparisons were used to test differences in skill level before and after the 22-lesson season. Significance was set at an alpha level of 0.05.

Results

MVPA

Means (SD) for min of MVPA per lesson are presented in Table 2. Over the entire 22-lesson season, students averaged approximately 30 min of MVPA each lesson. This is equivalent to just over 60% of lesson time. This figure clearly exceeded the Healthy People 2010 goals of 50% lesson time. Of particular note is that across the whole season, 80% of the activity profiles sampled were above this criterion.

Table 2 Moderate to Vigorous Physical Activity Levels Throughout the Season of Sport Education ($N = 19$)

Group/phase	Mean (SD) (min)	% Lesson time
Overall season	30.6 (7.4)	61.3
High skill	31.1 (8.2)	62.2
Low skill	30.0 (6.6)	60.0
Skill practice	30.8 (8.2)	61.6
High skill	31.1 (7.0)	62.2
Low skill	30.5 (9.9)	61.0
Scrimmage	31.1 (4.7)	61.2
High skill	32.8 (4.4)	65.6
Low skill	29.4 (4.6)	58.8
Formal competition	29.9 (8.8)	60.8
High skill	29.3 (1.3)	58.6
Low skill	30.3 (4.5)	60.6

There were no significant differences between the MVPA levels of the higher- and lower-skilled students throughout the season [$F(1,17) = 0.21$, $p = 0.65$]. Higher- skilled students averaged 31.1 ± 8.2 min of MVPA throughout the season, while the lower-skilled students averaged 30.0 ± 6.6 min.

There were no significant differences in MVPA across the phases of skill learning, scrimmage and game play [$F(2,27) = 0.12$, $p = .89$]. No interaction was determined for skill by the phase of the season ($F(2,27) = 0.33$, $p = .72$).

VPA

Means (SD) for min of VPA per lesson are presented in Table 3. Over the course of the 22-lesson season, the students averaged 8.9 ± 6.5 min of VPA. Higher-skilled students (10.0 ± 7.1 min) tended to exhibit more VPA than their low-skilled counterparts (7.8 ± 5.9 min); however, this difference was not significant [$F(1,17) = 1.49$, $p = .24$]. Significant differences were found across the phase of the season, [$F(2,27) = 3.39$, $p = 0.048$]. VPA levels were significantly higher during the competition phase (12.2 ± 8.3 min) than the scrimmage phase (6.5 ± 3.6 min) [$F(1,27) = 6.4$, $p = .017$]. There was no interaction between skill level and the phase of the season [$F(2,27) = .39$, p = .68).

Skill Performance

Dependent t-tests revealed large and statistically significant improvements for both lower and higher skill performers in all skill components over the course of the season. At the completion of the season, the students were able to move with the ball more quickly and with more control. They also were also able to shoot the ball more accurately. Complete data for the skill tests at the beginning and end of the season are shown in Table 4.

Table 3 Vigorous Physical Activity Levels Throughout the Season of Sport Education (N = 19)

Group/phase	Mean (SD)	% Lesson Time
Overall season	8.9 (6.5)	17.4
High skill	10.0 (7.1)	20.0
Low skill	7.8 (5.9)	15.6
Skill practice	8.0 (6.0)	16.0
High skill	8.1 (5.9)	16.2
Low skill	7.9 (6.5)	15.8
Scrimmage	6.5 (3.6)	13.0
High skill	7.6 (4.1)	15.2
Low skill	5.3 (2.9)	10.6
Formal competition	12.2 (8.3)	24.4
High skill	14.3 (10.4)	28.6
Low skill	10.2 (6.8)	20.4

Table 4 Skill Test Performance From Early to Later Stages of the Season

Test item	Lesson 5	Lesson 22	*t*	*p*
Speed dribble (sec)	17.9 (4.4)	11.5 (1.6)	–.742	0.004
Agility dribble (sec)	16.3 (5.2)	12.2 (4.0)	–.472	0.011
Shooting accuracy (max = 15)	10.2 (3.0)	14.1 (1.4)	.517	0.004
Rapid fire shooting (max = 10)	7.8 (2.1)	9.7 (0.6)	.432	0.025
Dribble & shoot (max = 5)	3.5 (1.2)	4.7 (0.5)	.443	0.021
Flicking the ball (max = 25)	19.6 (4.1)	23.9 (1.3)	.430	0.025

Note: SD in parentheses. Reported probability scores include Bonferroni adjustments for Type 1 error.

Discussion

The results of this study show that a physical education setting operating under the sport education format can indeed produce sufficient levels of moderate-vigorous activity. Furthermore, students of lower skill level are not discriminated against in terms of achieving health-related physical activity goals. The sport education format, with its focus on small sided teams, substantive time allocated to game play, and a competitive game ethic, may then be one way in which physical education can provide situations where students reach high levels of activity. Of particular note is that this allocation to game play need not be achieved by trading-off for the development of skill.

The high levels of MVPA exhibited during the beginning or skill practice phase was a noteworthy finding. Skill practice is often associated with significant teacher instruction and students working through repetitions of skill drills. It was less surprising that the game play phases were accompanied by high participation, particularly as games "count" in sport education and are taken seriously. However, it is important to note that MVPA levels were not compromised by students taking passive roles (e.g., scorekeeper) during some lessons in this phase.

The first explanation for high activity levels relates to specific teaching situation present in this study. During the pre-season, all students were equipped with a stick and ball, allowing for individual skill practice without the need to wait for turns. A number of activities also involved running, first without the ball, then with the ball. Couple this with a large space and the enclosed nature of the playing area, meant that little time was spent in chasing loose balls and almost no waiting was experienced. In addition to using active tasks, the teacher used a number of hustle statements, like "move to that loose ball," as well as skill-related cues that emphasized high energy. Furthermore, the instructional tasks later in the skill development phase were similar to mini-segments of games. None of the skill drills learned by these boys involved passively passing the ball back and forth, all involved movement, and defenders were used frequently. A lot of two versus one activities were included. When students began to practice in their teams, many would play a form of "two versus 2 keep away."

It is important to foreground this study as representing an ideal setting, and hence this study was designed as an efficacy project. That is, its purpose was to examine whether, under ideal conditions, sport education could reach the Healthy People 2010 objective of 50% of lesson time in MVPA.

First, the students were able to select from a number of sporting electives, and hence could be regarded as more motivated than if there were no choice involved. Second, the teacher was experienced with the sport education model, and taught these same students using this model in previous units of work. Third, the activity of floor hockey was conducive to continuous activity (compared with, for example, softball), a factor that may elevate MVPA levels.

Despite these limitations in terms of generalizations, it is again reinforced that this study's major goal was to determine whether sport education could indeed reach the target goals. Hence, it provides somewhat of a standard from which future research could examine the variables that may serve to decrease the potential effectiveness of sport education.

As noted, this study was designed as an efficacy study, to determine levels of MVPA achieved during a sport education season conducted under ideal settings. Despite these positive findings, it would be inappropriate to generalize to all sport education formats. First, the game of floor hockey (particularly 4-a-side games played on a large area) may be conducive to higher MVPA levels than another sport played under this format (e.g., tennis). Second, that these students elected this particular activity may have given them a motivational incentive to work harder. Finally, the tasks and teaching style presented encouraged continuous activity with little time devoted to waiting and transition. Nevertheless, the data clearly demonstrate that this season of hockey achieved activity levels well in excess of the recommended minimums of the Healthy People 2010 document.

In conclusion, this study presents a sport format that is conducive to achieving high levels of physical activity. While previous studies in physical education have shown difficulty in reaching the 50% lesson time activity criterion, these data show sport education to be one curriculum model with the potential to significantly elevate activity levels. Nevertheless, a number of conditions need to be addressed in order to maximize the potential for achieving these goals.

First, consideration needs to be placed upon the selection of the sport. Some games are more likely to produce elevated MET levels (e.g., Frisbee, basketball, lacrosse, team handball or soccer). However, a further positive aspect of these games is that they all are easily adapted for play with small-sided teams. Small-sided teams result in more intense playing conditions and more active involvement for all players. Second, teachers need to be creative in selecting nonplaying roles that can provide some activity (e.g., linesperson, ball retriever), and particularly, in scheduling matches so that all students have the opportunity to receive MVPA each day. There is no need in sport education for games to be long, and in most classes, two games per day can be scheduled. Finally, teachers also need to develop sufficient management protocols so that the transitions between these games is short, thereby allowing more game play time.

What is needed from this point is further research using controlled randomized trials to (a) investigate MVPA levels in other sport education settings, and (b) comparing sport education seasons to other methods of instruction in physical education.

That such potentially high levels of MVPA can be described as a value-added component of sport education, which has as its central objective, the development of competent, literate, and enthusiastic sports players. Indeed, this study added support for the competency intent. Sport education can thereby provide a series of quality learning experiences across a number of domains (psychomotor, affective and cognitive), while assuming specific health benefits, making it a particularly attractive curriculum model.

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