Objectively Measured Physical Activity of Different Lesson Contexts

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Abstract

Physical activity (PA) recommendations suggest students reach 50% moderate-vigorous physical activity (MVPA). However, studies show that many physical educators fail to meet this recommendation with their students. Researchers have argued that teachers' utilization of game-centered approaches (GCAs) such as the Tactical Games Model (TGM) may help students meet these recommendations because the game-skill-game lesson structure increases the time spent in game play. However, there are no published reports of whether students are meeting recommendations of 50% MVPA during these different learning tasks/activities (i.e., game and skill practice). Consequently, this study investigated whether students could accrue MVPA recommendations in three lesson contexts, which mirrored the game-skill-game format of the TGM: a) game play portion 1, b) skill practice, and, c) game play portion 2. Participants were 78 seventh and 96 fourth/fifth grade co-educational physical education (PE) students from two different schools. Two teachers taught 24 (middle) and 30 (elementary) level one TGM basketball lessons. Students wore Actigraph GT3X® triaxial accelerometers. Data were analyzed using two repeated measures ANOVAs. Neither the middle or elementary school students met national PA recommendations in any of the three lesson contexts. However, both middle and elementary school students had significantly higher MVPA during game-based activities. Middle school students accrued their highest levels of MVPA in the second game-play portion, whereas the elementary students accrued their highest levels of MVPA in the first game play lesson portion. These results suggest that in game-based physical education lessons, teachers should spend a greater portion of time in game play if their aim is to encourage student PA.

Keywords: physical activity; tactical games model; accelerometers; game-play

Introduction

A recent publication by the Institute of Medicine (IOM, 2013), *Educating the Student Body*, has reinforced the recommendation that students in physical education class engaged in 50% moderate to vigorous physical activity (MVPA). On face value, this seems a reasonable recommendation. However, research shows that many physical educators fail to meet this recommendation with their students (Hollis, Williams, Sutherland et al., 2015).

However, some recent research suggests that the lack of evidence demonstrating teachers can meet this recommendation may be about the model of teaching that is being utilized by the physical educator (i.e., Harvey et al., 2016a; Miller et al., 2016; Smith et al., 2015; Van Acker et al., 2010). For example, Smith et al., (2015) showed that a physical education teacher who utilized the Tactical Games Model could reach meet this 50% MVPA recommendation when compared to a teacher who used a more traditional, direct instruction approach to teaching games. In the TGM, learning is located predominantly small-sided and conditioned games (Mitchell, Oslin, & Griffin, 2006) potentially affording student's opportunities to accrue increased percentages of tie in MVPA (Roberts & Fairclough, 2011). In contrast, Roberts and Fairclough (2011) demonstrated that students who participated in physical education lessons situated on teachers' using the direct instruction model resulted in high levels of pupil inactivity. In addition, they noted high levels of teacher management time, time centered on skill and drill practice, and a focus on full-sided versions of games (i.e., 11-vs.-11 soccer).

While some studies have demonstrated the students' ability to reach MVPA goals (Harvey et al., 2016a; Smith et al., 2015; Van Acker et al., 2010) when a teacher has employed a tactical approach, some studies have also demonstrated that this cannot be achieved (i.e., Harvey et al., 2015; Harvey et al., 2016a; Harvey et al., 2016b). There are several reasons why this 50% MVPA goal may not be reasonable, even if a teacher utilizes a tactical approach. First, the nature of some sports do not lend them to high levels of MVPA. For example, research shows that the highest level of MVPA is accrued in fitness and invasion game units, with MVPA levels

suppressed no matter of the model of teaching used in other activities such as target games, outdoor activities and/or net-wall games (Brusseau & Burns, 2016; Fairclough & Stratton, 2005, 2006). Secondly, the nature of the measurement device utilized to record MVPA may be factor. For example, it is well documented that when using heart-rate telemetry that girls MVPA may be overestimated (Smith et al., 2015), thus questioning some of the data recorded in studies such as Van Acker et al. (2010). Moreover, recording MVPA with behavioral observational measures such as the System for Observing Fitness Instruction Time (SOFIT; McKenzie, 2012) may lead to overestimations in MVPA due to issues in classifying intensity of activity (Pope et al., 2002). And while other objective measures of physical activity can be used, the MVPA accrued by students may only be as good as the cut-off point selected for these studies. Some studies may have, therefore, inflated MVPA records, while some studies MVPA may be underestimated (Trost, Loprinzi, Moore, & Pfeiffer, 2011).

Notwithstanding measurement concerns, one major factor that may lead to students meeting slated recommendations of 50% MVPA is nature of the task or learning activity within which the students participate in for most the class period (i.e., skill practice, game). While we appreciate that different activities may be used for very different outcomes in physical education, activities should be set up in a way to enable students to accrue MVPA. This includes providing activities with a high number of opportunities to respond, and, thus, not using lines, elimination games, and/or large/full-sided games, are some ways to encourage greater levels of MVPA *within* the activity itself. It is with this sentiment in mind that we conducted this study.

The data we collected were in the context of a unit of basketball taught via the Tactical Games Model. We investigated the following research questions:

- a) Do students reach 50% MVPA in game-based and skill practice activities?
- b) Do differences exist in MVPA in different lesson contexts (i.e., game-based or skill-based activities)?

Materials and methods

Participants and Setting

Participants were 174 students (83 girls), 78 middle school (44 girls) and 96 (39 girls) elementary school students from four seventh and five fourth/fifth grade co-educational classes at two schools in the Eastern United States, respectively. Informed consent was received from participants using standardized procedures after approval from the Institutional Review Board for the protection of human subjects at a large Mid-Western United States University. Permission was also gained from the County School Board, school principals and the resident physical education (PE) teachers who signed an informed consent. The study therefore conformed to the ethical directives of the Helsinki Declaration.

There were two teachers in this study, one middle school teacher and one elementary school teacher, both male. Both teachers had over 20 years of teaching experience. Teachers had no previous experience teaching using TGM. TGM lessons were taught in an indoor gymnasium of 40 x 30 yards and had six baskets available at both schools. Lessons covered were a replication of the level one TGM basketball lessons from the *Teaching sports concepts and skills: A tactical games approach* text (Mitchell et al., 2006).

The middle school students had daily PE and lesson periods were between 43-47 minutes' bell to bell, which included dressing out time. The elementary school students only had one PE lesson per week and lesson periods were 40 minutes' bell to bell, which included the teacher needing to collect classes from their classroom and bring them to the gym. However, actual lesson instructional time averaged $M_{\text{length}} = 35\text{mins } 53\text{ secs}$ and $M_{\text{length}} = 27\text{mins } 37\text{ secs}$ for observed sessions in the middle and elementary school, respectively. Lesson length at the elementary school was slightly shorter because the actual allocated lesson time was shorter but also because some lessons were truncated due to unplanned issues, such as assembly (two lessons) and two-hour delays on days where there was inclement (wintery) weather and lessons were reduced by 10-minutes (three lessons). The middle school teacher taught a total of 24 lessons (four per day, six per class period) during the month of November. The elementary teacher taught a total of 30 lessons (one TGM lesson per week, six per class period) from January to March.

Research Design

This project used a quasi-experimental design since MVPA data were collected from two different schools in three lesson contexts, which mirrored the game-skill-game format of the TGM: a) game play portion 1, b) skill practice, and, c) game play portion 2.

The Unit

Pre-study training of teachers. Teachers were supported in learning about and using the TGM via the lead researcher. Initially, the lead researcher met with the two teachers individually and overviewed the tenets of the TGM, concluding this meeting by asking if they would be able to participate in the study. After this initial meeting, the lead researcher provided the two teachers with copies of the first three chapters of Mitchell et al. (2006) and chapter 14 from *Instructional Models in Physical Education* (Metzler, 2011). They were additionally provided with a copy of chapter 5 from Mitchell et al. which outlined the lesson content for basketball. Once the teachers had read this material, the lead researcher conducted a second individual meeting with each of the

teachers to discuss the content covered in chapter 5 (Mitchell et al., 2006) and address any questions and/or concerns.

TGM lesson delivery. Students were arranged into mixed ability teams of three by each of the two teachers using their previous knowledge of the students. Before each lesson the first author met both teachers individually and reviewed lesson content, which included the three lesson sections (game-skill-game) and transitions between the three, as well as the teachers' deductive questions from the Mitchell et al. (2006) lesson plans (e.g. 'When you receive the ball, what are your three options?'). The first author also provided the teachers with suggestions on how games or skills drills could be simplified to make games more developmentally appropriate (e.g., both hands behind back defense).

Post-lesson teacher feedback. Researcher/teacher post-lesson discussions occurred between taught sessions so that the teacher could ensure that they continued to meet model benchmarks controlling for possible teacher drift over the course of the study.

Instrumentation

Lesson context. Lesson context was coded using definitions from the System for Observing Fitness Instruction Time (SOFIT) training manual (McKenzie, 2012).

Accelerometry. PA levels during each lesson were measured using Actigraph GT3X® triaxial accelerometers (Pensecola, FL). The GT3X® measures acceleration of movement across three axes (x, y and z) and these data are subsequently converted to activity counts. The GT3X® activity counts for moderate and vigorous have been validated through indirect calorimetry (Evenson, Catellier, Gill, Ondrak, & McMurray, 2008; Trost et al., 2011). Cut point thresholds for MVPA (>2296 counts/min) (Evenson et al., 2008) were used.

Procedures

Lesson context. Four coders were trained to code lesson context information every 20 seconds for four randomly selected students (McKenzie, 2012). Lesson context codes were recorded as follows; M = general content (transition, break, management), P = knowledge content (physical fitness), K = general knowledge (rules, strategy, social behavior, technique), F = motor content fitness, S = skill practice and G = game play. These coders conducted all four parts of the SOFIT training included in the SOFIT manual and reached the acceptable levels of Inter Observer Agreement (IOA) with the gold standard within the lesson context section. When acceptable IOA levels (i.e. 80%) were reached (McKenzie, 2012), observers undertook live coding on at least two occasions alongside the first author. On each occasion, acceptable IOA levels were reached (McKenzie, 2012).

Accelerometry. Each participant was assigned a specific identification (ID) number by the first author. Accelerometers with these corresponding numbers were pre-programmed by a member of the study team for the individual specifications of each participant (i.e., height, weight, date of birth). Stature and body mass were measured using standardized procedures (CDC, 2011)¹ and date of birth information was gained from school records with parental and school consent and approval by the Institutional Review Board.

On data collection days, accelerometers were placed in a clear bag that had the participants' ID number written on the outside, which corresponded with the ID number of the accelerometer inside the bag. Immediately on entering the gymnasium prior to the start of each PE lesson all participants placed their accelerometer onto their waistband with the assistance of members of the study team where needed. This procedure was pilot-tested with all classes in a PE lesson at both the middle and elementary schools prior to the start of the study.

Once each lesson was completed, the devices were returned into the correct clear plastic bags, collected and placed into a box and taken back to the first author's office. Here the devices were connected to a personal password protected computer and the information downloaded via the Actigraph software. The utilization of the Actigraph software permitted GT3X® activity counts for each lesson at a 1-second epoch. Data were extracted by applying a filter with the specific times of the lesson activity segment, which had previously been noted during data collection at the school. This enabled the mean percentage of time spent in MVPA in each of the lesson activity segments to be calculated using the Evenson et al. (2008) cut off points. These data were then exported from the Actigraph software to Microsoft Excel™ for subsequent data management before being imported into Version 21 of SPSS (SPSS Inc, Chicago, IL) for statistical analyses.

Observer reliability. Inter-observer reliability checks for lesson context data were completed for 18.52% (10) of the 54 lessons (randomly selected based on observer availability and training; McKenzie, 2012). Interval-by-interval agreement between observers was 95-100%, exceeding minimum agreement levels (McKenzie, 2012).

Data analysis

Lesson Context. Descriptive SOFIT data (means and SDs) were calculated using per cent of class time as the unit of measurement following standard protocols outlined by McKenzie (2002).

Accelerometry. Once accelerometry data for each child had been downloaded for each lesson by two members of the study team and exported to SPSS, this enabled computation of mean scores for MVPA over the six lessons.

¹ Stature and body mass (calibrated Tanita BF-682 scales; Tanita Corp, Tokyo) were measured to the nearest 0.1cm and 0.1kg.

Accelerometers that did not contain any data either due to absence or neglecting to wear the device were excluded (5.77% and 6.94% – 27 of 468 and 40 of 576 observations – at the middle and elementary school, respectively). All available data was therefore included in subsequent analyses. Two repeated measures ANOVAs were utilized to test for significant differences in MVPA as a function of the different lesson activity segments (i.e., game-based and skill practice activities). If the assumption of sphericity was violated for the main effects of MVPA, degrees of freedom were corrected using the Greenhouse-Geisser estimates of sphericity. The alpha level was set at $p < 0.025$ for the two analyses being conducted (Bonferroni corrected).

Results

Lesson Context

At the middle school, 23.72% ($SD=3.36$) of lesson time was spent in the first bout of game play, 20.95% ($SD=5.96$) in the second bout of game play, 25.03% ($SD=4.72$) in skill practice, with the remaining time comprised of 15.70% ($SD=4.86$) management and 14.63% ($SD=4.08$) knowledge. At the elementary school, slightly less lesson time was spent in the first and second bouts of game play, 22.48% ($SD=3.57$) and 19.34% ($SD=5.77$), respectively, with 21.90% ($SD=4.86$) skill practice, 17.01% ($SD=4.57$) management time and 19.27% ($SD=5.22$) knowledge (see Table 1).

Table 1. Percent time spent in different lesson contexts

Lesson Context	Middle School ($N=24$) M ($\pm SD$)	Elementary School ($N=30$) M ($\pm SD$)
Management	15.70 (± 4.86)	17.01 (± 4.57)
Knowledge	14.63 (± 4.08)	19.27 (± 5.22)
Game play 1	23.72 (± 3.36)	22.48 (± 3.57)
Skill practice	25.00 (± 4.69)	21.90 (± 4.86)
Game play 2	20.95 (± 5.96)	19.34 (± 5.77)

Accelerometry

At the middle school, there was a significant main effect of MVPA ($F(2, 154) = 88.97, p = .000, \eta^2 = .54$) (see Table 2). Due to the significant main effects, post-hoc comparisons between lesson contexts were conducted. There were significant differences between all three lesson contexts for MVPA; Game 1 and Game 2 ($p = .000$; $CI = 1.58-4.64$), Skill Practice and Game 2 ($p = .000$; $CI = 7.50-10.81$), and Game 1 and Skill Practice ($p = .000$; $CI = 4.21-7.88$).

For the elementary school data, Mauchly's test indicated that the assumption of sphericity had been violated. Therefore, degrees of freedom were corrected using the Greenhouse-Geisser estimates of sphericity ($\epsilon = .82$). There was a significant main effect of MVPA ($F(1.63, 155.22) = 230.18, p = .000, \eta^2 = .71$) (see Table 2). Due to the significant main effects, post-hoc comparisons between lesson contexts were conducted. There were significant differences between all three lesson contexts for MVPA; Game 1 and Game 2 ($p = .000$; $CI = 1.56-4.97$), Skill Practice and Game 2 ($p = .000$; $CI = 13.04-17.66$), and Game 1 and Skill Practice ($p = .000$; $CI = 15.96-21.27$).

Table 2. Percent time spent in MVPA according to lesson context

School/Activity (N =lessons)	Game 1 % activity M ($\pm SD$)	Skill Practice % activity M (SD)	Game 2 % activity M (SD)
Middle School ($N=24$)			
MVPA	36.57 (± 11.57)	30.54 (± 9.46)	39.52 (± 10.98)
Elementary School ($N=30$)			
MVPA	44.24 (± 13.83)	25.63 (± 8.52)	40.97 (± 12.04)

Notes: There were significant differences between all three lesson contexts for MVPA in both middle and elementary school settings.

Discussion

A recently published report has reinforced the recommendation that students in physical education class engaged in 50% MVPA (IOM, 2013). Previous research demonstrates that, overall, teachers struggle to meet this recommended level of MVPA in physical education lessons, with lessons focused on invasion games and fitness activities yielding the highest MVPA (Fairclough & Stratton, 2005, 2006). However, in this study we investigated the MVPA yield from within lessons activities that engage students in different activities, for example game play and skill practice. We investigated this in the context of basketball lessons taught through the

TGM, where lessons are broken down into a game-skill-game format. Recent studies have demonstrated that this format may assist students in meeting MVPA guidelines.

Despite breaking the investigation of MVPA into the different lesson components, students, on average, did not meet guidelines of 50% MVPA within any of the different lesson activities. However, the investigation showed that students were more likely to attain the 50% MVPA level in game-focused instruction than skill-focused instruction. This mirrors previous findings that invasion game-type lessons yielded higher amounts of MVPA for students (Fairclough & Stratton, 2005, 2006) and studies that have argued that GCAs such as the TGM are more likely to create a context for higher MVPA levels when compared to direct instruction games lessons where the emphasis is predominantly technical skill instruction (i.e., Harvey et al., 2015; Miller et al., 2016; Smith et al., 2015).

For the middle school students, in the second part of game play MVPA was significantly higher than both the first part of game play, and skill practice. Results suggest that middle school teachers should spend less time in the first game play portion to be able to progress to skill practice and get to the second game play portion as MVPA is higher in game 2. However, we would contend that spending more time in the second game play portion may be problematic and this may create a ceiling effect where the participation in game play does not allow MVPA levels to increase any further, which has previously been observed by Slingerland and colleagues (2014). In sum, teachers should become skilled in the TGM to know how to pace their lesson appropriately to meet the needs of the students. In other words, they will know when enough time has been spent in the first portion of game play and in skill practice to help them achieve the lesson learning outcomes. Indeed, the first portion of game play is important for the purposes on engaging students at the affective level, and creating a level of motivation to learn. The first part of game play is also important for the teacher to assess the levels of students' tactical understanding and detecting players' skill demands (Bunker & Thorpe, 1982). Skill practice is conducted with the aim of improving game performance, which could also trigger higher MVPA levels (Bunker & Thorpe, 1982). This is what we could argue occurred at the middle school. For example, once the middle school students practiced skills in a simplified context, they transferred these skills into the second game play context, which led to the significant improvements in MVPA. However, in the elementary school we saw the opposite where MVPA was highest in the first portion of game play. This can be explained by these younger students beginning lessons at a higher intensity level, which drops as they become fatigued later in the lesson, despite working on skills in the middle portion of the lesson.

There were several strengths to this study. First, we examined PA at the level of the lesson activity, where previous studies measure PA over the course of the whole lesson. This is important given that much of the PE lesson can be spent in management and knowledge lesson contexts. It is therefore important to know which types of activities that students do engage in (i.e., skills and games) provide a PA benefit and in what way. A further strength was the utilization of an objective measure of PA such as accelerometers. Third, we conducted this study over a continual number of lessons focused on basketball, where lessons were delivered using the TGM. Finally, we also assessed PA at both the middle and elementary school levels.

While there were several strengths in this study, it was not without limitations. One such limitation was the fact that our sample size, while higher than has been observed in some other studies, could still be increased (Brusseau & Burns, 2016). Moreover, increasing sample size may also enable researchers to examine gender differences, something we did not do in this current study. In addition, researchers may also collect data on an increased number of outcomes across different learning domains. For example, researchers may ask students to complete a short motivation survey, such as the Intrinsic Motivation Inventory (IMI; McAuley, Duncan, & Tammen, 1989) and/or video lessons to be able to report on game performance using the Game Performance Evaluation Tool (GPET; García López et al., 2013) or conduct motor appropriate or motor inappropriate engagement of students using the System for Observing the Teaching of Games in Physical Education (SOTG-PE; Roberts & Fairclough, 2012).

Conclusions

This study investigated MVPA contributions within different lesson activities in the context of basketball lessons taught through the TGM and that followed a game-skill-game format. The study showed that none of the lesson activities resulted in students accruing over 50% MVPA. However, game-focused instruction portions of the lesson accrued higher levels of MVPA for students when compared to skill-focused lesson portions. These results suggest that in game-based physical education lessons, teachers should spend a greater portion of time in game play if their aim is to encourage higher levels of student MVPA in PE and meet slated recommendations.

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