METHODOLOGY

Investigation of Pupils' Levels of MVPA and VPA During Physical Education Units Focused on Direct Instruction and Tactical Games Models

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Abstract

We investigated the moderate to vigorous physical activity (MVPA) and vigorous physical activity (VPA) levels of pupils during coeducational physical education units focused on direct instruction and tactical games models (TGM). Thirty-two children (11–12 years, 17 girls) were randomly assigned to either a direct instruction (control) or TGM (intervention) group. Children wore RT3 triaxial accelerometers over 6 physical education lessons focused on field hockey to measure time spent in MVPA and VPA objectively. The System for Observing Fitness Instruction Time (SOFIT) was also used during each lesson to examine pupil physical activity,

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lesson context, and teacher behaviors. Results from accelerometry show MVPA and VPA were significantly higher in the TGM class compared to the class taught using direct instruction. SOFIT lesson context data show the TGM teacher spent less time managing and more time in skill practice and game play. The results of this study indicate that a shift in games pedagogy to TGM, in which the central aspect is participation in modified/conditioned games, is more likely to provide pupils the opportunity to achieve current physical activity guidelines stipulated by the Department of Health (2011) and the Institute of Medicine (2013).

In physical education (PE) programs, there is a current overreliance on a direct instruction model (Metzler, 2011) in which constituent parts of sports and games are broken down and techniques are practiced in isolated, decontextualized conditions during which practice is unlikely to generalize to game conditions (Roberts & Fairclough, 2011). This approach has been criticized on a number of levels, which include a lack of opportunity for learner empowerment and creativity (Butler & McCahan, 2005), and its nonsituated nature that fails to prepare learners appropriately for the complexities of games (Kirk & Macdonald, 1998). Further criticisms lie in the role the teacher adopts within this approach, as they are the primary decision maker (Light, 2013).

As a way of expanding the focus of PE and its goals and purposes beyond a skills-first direct instruction model, Metzler (2011) proposed seven alternative pedagogical models including the Tactical Games Model (TGM). The TGM is an Americanized derivative of teaching games for understanding (TGfU; Bunker & Thorpe, 1982). In game-centered approaches (GCAs) such as TGfU and TGM, teachers begin the lesson by locating learning within modified games or game-like activities, therefore presenting the game first and before the introduction of skill practice. GCAs such as TGM therefore refute the notion that quality game play cannot emerge until the core techniques are mastered a priori (Oslin & Mitchell, 2006) and instead offer a way of linking techniques and tactics with the aim of promoting skillful and intelligent performance. These situated learning contexts further enable the teacher to step back, observe, and critically "emphasize questioning to stimulate thinking and interaction" (Light & Mooney, 2014, p. 2) to guide the pupils about the ways of overcoming the tactical problem set by the game and help them understand why certain skills are needed to elevate game performance.

Researchers have suggested that given the focus of GCAs such as TGM on locating learning within small-sided and conditioned/modified games (Light & Mooney, 2014), this model of teaching PE may aid pupils in reaching current physical activity (PA) goals within PE lessons (McKenzie, 2012; Roberts & Fairclough, 2011; Van Acker, Carreiro Da Costa, De Bourdeaudhuij, Cardon, & Haerens, 2010). Current goals outlined by the Institute of Medicine (IOM, 2013) in the United States indicate pupils should engage in moderate to vigorous physical activity (MVPA) for at least 50% of the PE lesson, a figure that is not regularly met in most lessons, especially when games are not used as the organizing center for learning (Yelling, Penney, & Swaine, 2000). For example, Roberts and Fairclough (2011) found that English PE lessons centered on 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) during which some pupils were left to "sit out" on the sidelines. Roberts and Fairclough (2011) suggested that involvement in small-sided modified/conditioned games, a staple feature of GCAs such as the TGM (Mitchell, Oslin, & Griffin, 2006), could increase pupils' levels of PA.

Of particular significance in this study is that current PA guidelines for children in countries such as the United Kingdom (UK) have recently been updated to emphasize the importance of including vigorous physical activity (VPA) on at least 3 days a week, in the context of a daily 60-min MVPA target (Department of Health, 2011). An additional accumulation of higher intensity PA (VPA and above) components during PE is highly significant given that VPA (or higher) is a stronger predictor of cardiorespiratory fitness (Aires et al., 2010; Dencker et al., 2008; Gutin, Yin, Humphries, & Batbeau, 2005), body fatness (Abbott & Davies, 2004; Parikh & Stratton, 2011; Ruiz et al., 2006), and vascular function (Hopkins et al., 2009) in children compared to moderate-intensity PA.

What This Study Adds

Given the growing concerns regarding low PA levels among children (Trost et al., 2002), more research is required into whether GCAs such as TGM, if taught appropriately, can realize the potential of aiding pupils in reaching current PA goals within PE (IOM, 2013; Van Acker et al., 2010; Yelling et al., 2000), especially compared to the direct instruction model. In addition, there is scope to examine how lessons taught using TGM affect levels of VPA. The purpose of this study was to investigate the MVPA and VPA levels of pupils during PE units focused on direct instruction and TGM. We hypothesized that pupils would gain greater levels of MVPA and VPA during the TGM unit compared to direct instruction.

Methods

Participants and Setting

This study was conducted in one coeducational state middle school in the East of England. Thirty-two students from two classes in the Year 7 age group (aged 11–12 years) participated in the study (*n* = 17 girls). Free school meal (FSM) eligibility was stated as 21.5% for the school, which is above the national average of 12.1% (Department for Education and Skills, 2005). In total, 543 students were enrolled at the school with 78.6% of students ethnicity stated as White British. All research procedures received approval from the university research committee, head teachers, and PE teachers from the schools who were involved in the study. Informed consent was obtained from parents/guardians as well as pupil assent using approved university and school system protocols.

Research Design

The aim of this study was to investigate the MVPA and VPA levels of pupils during PE units focused on direct instruction and TGM using a quasi-experimental pretest–posttest design. Harvey and Jarrett (2014) noted that in 10 of the 44 GCA studies published since 2006, this same quasi-experimental comparative approach was used, demonstrating that it is a popular research design in this specific area of research (e.g., Gray & Sproule, 2011).

Two coeducational classes from the school participated in the study; each class was randomly selected to be taught using the TGM intervention (*n* = 16, 8 girls) and one acting as a control class that was taught through the direct instruction model (*n* = 16, 9 girls). One male and one female teacher taught the control and intervention classes, respectively. Different teachers taught the control and TGM classes to avoid contamination of the data (i.e., aspects of the TGM intervention filtering into the control sessions). Twelve field hockey lessons were observed over 3 weeks (six control, six intervention).

Prior to data collection, a meeting was held with the teachers selected to plan lessons using either Mitchell et al.'s (2006) TGM and/or the direct instruction model as well as to overview model benchmarks (Metzler, 2011). The TGM teacher had experience of TGM as she had previously attended a university-based training course focused on TGM. The control group teacher was familiar with the direct instruction model and reported at this meeting that the direct instruction model mirrored his current approach to teaching games. Teachers were not aware, however, of the specific aims of the study. Additional descriptions of the direct instruction and TGM model sessions are provided in the next section.

Intervention

The weekly control and TGM sessions ran in parallel at the school. Teachers adapted their lesson objectives and delivery according to whether the TGM or the direct instruction model was used in the session. For the direct instruction model, teachers followed a "traditional" lesson structure outlined by Blomqvist, Luhthaten, and Laakso (2001) in which an introductory activity was followed by a skills phase focused on developing and improving skill technique, and this then progressed into a game in the latter part of the lesson. For example, in the hockey lesson (attacking play and maintaining possession), the teacher sent the pupils on a warm-up. They were then split into pairs and asked to make two lines. The task was to pass the hockey ball back and forth in pairs across the width of the hockey field in their pairs, finishing the drill with a shot on goal. A defender was then added to increase the difficulty of the attacking play and maintaining possession to develop this drill further. After a brief discussion about the drill, the teacher then placed the pupils in a game situation (11 vs. 11). The units of work were organized so the teacher centered learning in each lesson on one major technique/skill with a subsequent game situation.

The TGM teacher followed a three-part lesson recommended by Mitchell et al. (2006), which was focused on an introductory modified (representative and exaggerated) game, followed by a skills phase before returning to the initial modified game form. For example, in the third hockey session, the lesson was focused on attacking play and maintaining possession of the ball. The teacher sent the pupils on a warm-up and provided general knowledge about attacking play. The teacher then set up a 3-vs.-3 game with the condition that there was no tackling and if a team missed a shot that possession would go to the opposing team. Pupils were then taken out of the game and a "dodging" practice was set up to enhance the skill of getting away from a player's marker. Before, during, and after the dodging practice, the teacher asked guided questions in line with guidelines outlined by Mitchell et al. (2006) to aid learning (e.g., "How were you able to get closer to the goal?" "What dodges can you use to get away from your marker?" "What should other players on your team do when their teammate has the ball?"). The final part of the lesson involved the same conditioned game, this time, with the condition that each team could shoot from anywhere within the attacking half of the pitch.

Fidelity of Intervention

The TGM and control lessons were assessed using benchmarks to ensure that both approaches were implemented correctly and were not detrimental to learning outcomes (Metzler, 2011). A researcher and assistant were present at each PE lesson (control and TGM) to assess the teachers' fidelity to model benchmarks. Lesson plans for both models were obtained prior to lesson implementation to ensure lessons followed the characteristics of each pedagogical model. For example, in the TGM condition, lesson plans were checked for deductive questions and that the teacher planned to begin each lesson with a game form to assess pupils' knowledge. When necessary, the second author provided feedback on the teachers' plans for both models.

Data Collection

RT3 triaxial accelerometry. The RT3 accelerometer was used to measure acceleration of movement across three axes (x, y, and z), and these data were subsequently converted to activity counts that have been successfully validated in a laboratory setting against oxygen uptake relative to body mass ($R = 0.87$, $p < 0.01$; see Rowlands, Thomas, Eston, & Topping, 2004). RT3 activity counts for each lesson were converted to metabolic equivalents using the cutoff points outlined by Rowlands et al. (2004) . Frequencies were then calculated to establish time spent in MVPA. Activity thresholds (counts/min) were as follows: sedentary < 288 (< 1.5 METs), light 288–969 (1.5 METs), moderate 970–2332 (3 METs), and vigorous > 2333 (6 METs) activity (Rowlands et al., 2004). These were then reintegrated to match the 1-s epoch setting used for this study to minimize underestimation of any short bouts of high-intensity exercise that may occur with longer duration epochs (Rowlands, 2007).

Children were assigned a specific number by the research staff. Body mass and stature were measured using Tanita bioelectrical impedance scales (BC-418MA) and a portable Leicester height stand, respectively, prior to pupils being issued an accelerometer that had been programmed with the specific details of each pupil. Accelerometers were placed in a clear plastic bag with the pupils' assigned number written on it. While in the changing rooms prior to each PE lesson, pupils located the bag with their assigned number, took the accelerometer that was connected to a waistband out of the bag, and placed it around their waist with the accelerometer on the right hip (Rowlands et al., 2004), wearing it for the duration of the lesson.

System for Observing Fitness Instruction Time. The System for Observing Fitness Instruction Time (SOFIT) is described as "a momentary time sampling and interval recording system designed specifically to quantify factors believed to promote health-related PA" (McKenzie, Sallis, & Nader, 1991, p. 196). SOFIT provided an additional measurement of PA levels alongside accelerometers and was also deemed useful as it provided important lesson information that helped link lesson contextual factors and teacher behavior to PA levels (Fairclough & Stratton, 2005c; Scruggs, Beveridge, & Clocksin, 2005). SOFIT is split into three phases (McKenzie et al., 1991).

The first phase involves the observation of pupils' PA levels. The activity level is coded against numbers 1–5, with 1 = lying down, 2 = sitting, 3 = standing, 4 = walking, and 5 = very active. The second coding phase involves coding the context of the lesson. Lesson context codes are 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. The final phase involves the coding of teacher behavior: P = promotes fitness, D = demonstrates fitness, I = instructs generally, M = manages, O = observes, T = off task.

The second author and an assistant were present for all observed SOFIT data collection (SOFIT data were collected for each lesson within the study). As per the SOFIT training manual (McKenzie, 2012), the PA levels of four randomly selected pupils (different each lesson) were observed on a rotational basis as well as the lesson contexts in which they occurred and teacher behaviors. These three elements were coded every 20 s using momentary time sampling as per standard SOFIT protocols (McKenzie, 2012).

Observer Reliability

Each lesson was analyzed using SOFIT, following an intensive training period. This consisted of the second author and research assistant coding protocols and analyzing other PE lessons with an experienced SOFIT observer. Observer agreements were calculated following the training, and observer agreements in excess of 85% were achieved for both observers with the expert before the study lessons were coded (van der Mars, 1989). Interobserver reliability checks were calculated for 20% of the lessons (randomly selected) and were greater than levels recommended in the SOFIT training manual (McKenzie, 2012). Interval-by-interval agreements between observers were 88% for activity level, 91% for lesson context, and 89% for teacher behavior, which exceeded both the minimum levels of agreement suggested by van der Mars (1989) and the minimum levels of reliability for SOFIT (McKenzie, 2012).

Data Analyses

RT3 triaxial accelerometry. RT3 data for each child were downloaded after every lesson. RT3 accelerometers that did not contain data because of either absence or neglecting to wear the device were excluded. Mean percentage of time spent in MVPA and VPA during PE over the six lessons overall and according to condition were calculated. Levene's tests were employed to establish if the parametric assumptions were met (Field, 2009). MVPA and VPA PE data for all schools met the assumptions of a parametric test. Data were therefore analyzed using an independent samples *t* test. Effects of gender were assessed using a 2×2 between groups ANOVA. Data were analyzed using SPSS 19.0 (SPSS, Chicago, IL).

System for Observing Fitness Instruction Time. SOFIT data were analyzed using the methods outlined in the SOFIT training manual (McKenzie, 2012). For example, time spent in MVPA and VPA was aggregated into percentages for each lesson, before mean percentages for the six lessons were calculated according to condition. Independent samples *t* tests were employed to establish significant differences between conditions, and Bonferroni correction factors were employed to each section of the analysis. For example, two behaviors were tested in the pupil PA level section, so the alpha level = 0.05/2 = 0.025. In the lesson context and teacher behavior sections, the alpha level was set at 0.01 because of the multiple behaviors being analyzed.

Results

In this section, we overview the results from each of the data collection methods. The section begins with reference to data generated from the accelerometer before continuing on to results from the SOFIT analysis.

RT3 Triaxial Accelerometry

MVPA according to the RT3 accelerometry data was significantly higher in the intervention class (see Table 1), which related to 10.25 ± 3.40 and 18.49 ± 7 .10 min of MVPA for the control and intervention classes, respectively. In addition, the VPA data were also significantly higher in the intervention class compared to the control (see Table 2). This was despite the large variation in MVPA and VPA, particularly within the intervention groups. No significant effects of gender were revealed for MVPA ($p = 0.81$) or VPA ($p = 0.48$) between groups, indicating gender is of no further theoretical interest.

Table 1
Descriptive Statistics: Overall Percentage of MVPA According to Condition

Activity	Condition	*n*	% MVPA (*M* ± *SD*)	*t*	Sig.
Hockey	CON	16	31.89 ± 9.82	−2.94	.006*
	INT	16	47.08 ± 18.19		

Note. CON = control; INT = intervention.
*$p < 0.01$.

Table 2
Descriptive Statistics: Overall Percentage of VPA According to Condition

Activity	Condition	*n*	% VPA (*M* ± *SD*)	*t*	Sig.
Hockey	CON	16	15.40 ± 7.03	−2.77	.009*
	INT	16	27.19 ± 15.47		

Note. CON = control; INT = intervention.
*$p < 0.01$.

System for Observing Fitness Instruction Time

Pupil physical activity level. Table 3 includes the average percentages of lesson time spent in MVPA and VPA and in different lesson contexts according to the SOFIT data. This analysis also demonstrated MVPA and VPA were higher in the intervention class, although this was nonsignificant (see Table 3). There was, however, greater variation in the SOFIT data in the TGM intervention group compared to the control.

Table 3
Percentage of SOFIT Analyses by Condition

Condition	CON (*M* ± *SD*)	INT (*M* ± *SD*)	*t*	Sig.
Student Behavior (% lesson time)				
MVPA	21.5 ± 5.7	33.9 ± 10.2	−2.08	0.09
VPA	4.1 ± 5.4	10.9 ± 9.6	−1.23	0.28
Lesson Context (% lesson time)				
Management	45.8 ± 9.4	31.3 ± 3.5	2.49	0.05
General Knowledge	12.2 ± 4.40	10.4 ± 6.2	0.45	0.66
Physical Fitness	0	0	0	0
Fitness Activity	3.4 ± 2.8	2.5 ± 4.1	0.32	0.76
Skill Practice	15.9 ± 15.3	26.6 ± 18.8	−0.84	0.44
Game Play	16.9 ± 21.8	29.5 ± 14.3	−0.86	0.43
Other	7.4 ± 10.1	0	1.25	0.27
Teacher Behavior (% lesson context)				
Promotes Fitness	0	0	0	0
Demonstrates Fitness	3.2 ± 2.6	0	2.08	0.09
General Instruction	31.5 ± 10.6	39.0 ± 13.9	−0.60	0.57
Manages	32.5 ± 11.9	26.2 ± 2.1	0.86	0.43
Observes	31.5 ± 7.2	25.9 ± 5.6	1.51	0.19
Other Task	1.7 ± 2.2	8.9 ± 6.2	−2.21	0.08

Note. CON = control; INT = intervention.

Lesson context. Lesson length was $M = 36.09$, $SD = 3.14$ min versus $M = 38.79$, $SD = 2.32$ min for control and intervention classes, respectively. There were no significant differences between the control and intervention lessons in any of the lesson context variables. However, the teacher of the control group spent more time in management and other (i.e., free play) as well as less time in skill practice than the intervention teacher who also spent more time in game play.

Teacher behavior. There were no significant differences between the control and intervention lessons in any of the teacher behavior variables. However, management (see above), demonstrating fitness, and observation were slightly higher in the control group. Higher levels of instruction were noted in the TGM group as well as the percentage of time the teacher spent on other tasks such as "attending to events not related to his/her responsibilities to the class at hand" (McKenzie, 2012, p. 12). This was because the TGM teacher is a member of the school senior management team, and thus, the teacher was sometimes distracted away from the class for short periods to deal with specific incidents.

Discussion

The purpose of the study was to investigate the MVPA and VPA levels of pupils during coeducational PE units focused on direct instruction and TGM. We hypothesized that pupils would gain greater levels of both MVPA and VPA during TGM classes compared to those taught using direct instruction.

One major finding of this study was the contribution of PE lesson focused on TGM to the amount of time spent in VPA. On average, PE lessons were focused on TGM provided over 10 min of VPA according to the accelerometer data, which was significantly higher in the TGM group compared to the direct instruction group (see Table 2). This indicates that pupils in the TGM groups were more likely to achieve current PA guidelines that emphasize the importance of including VPA on at least 3 days a week, in the context of a daily 60 min of MVPA (Department of Health, 2011). In addition, the levels of VPA observed in the TGM group were higher than those reported in previous studies in which amounts of VPA during PE of 4.5 and 3.3 min were reported (Fairclough & Stratton, 2005c). Fairclough and Stratton (2005c) outlined that a reason for larger contributions of VPA in lessons focused on team games is the requirement to sustain large muscle groups engaged in PA for large proportions of time and hence its effect on the heart to beat faster to satisfy oxygen demand. Clearly, the lessons focused on the TGM provided lesson contexts within which pupils were provided with opportunities for these high levels of VPA to occur (i.e., high levels of game play and skill practice than was observed in the control group).

In addition to increased levels of VPA, we found higher levels of accelerometer-based MVPA in the TGM condition compared to the control group, supporting previous research findings (e.g., Fairclough, 2003; Fairclough & Stratton, 2005b) that have shown team game activities to be one of the highest contributors to MVPA levels. These findings also replicate those of Yelling et al. (2000), who found that pupils in skill-dominated lessons gained lower levels of MVPA than pupils in games-focused lessons. However, MVPA levels in this study were slightly below the 50% recommendation of the IOM (2013) and were lower than MVPA levels reported by Van Acker et al. (2010) whereby pupils exceeded the 50% criterion in games-based lessons focused on korfball. Differences between this study and Van Acker et al.'s may be a reason for these differences. First, Van Acker et al. focused on korfball, whereas the game in this study was field hockey. Second, Van Acker et al. observed only one lesson, whereas we examined PA levels over multiple sessions, albeit we observed a smaller number of participants. Third, Van Acker et al. used heart telemetry and we used accelerometers and SOFIT to examine PA levels. Fairclough and Stratton (2005a) outlined that heart rate telemetry can be inaccurate because of increased heart rate from other variables such as stress. Consequently, researchers should consider using devices such as accelerometers in future studies as they can be used to measure actual PA participation and to measure PA continually over multiple lessons.

On a related note, we found that the observational PA assessment through SOFIT did not highlight significant differences in VPA or MVPA between the control and intervention classes, a finding that is contradictory to the objective accelerometry data. Fairclough and Stratton (2005a) outlined that SOFIT may provide different results to objectively measured PA because of the different dimensions of activity that each method is used to measure (i.e., RT3 accelerometry = movement and SOFIT = behavior). An additional suggestion for this difference may be that although SOFIT is a valid and reliable instrument, it may underestimate PA levels because it is based on a momentary time sampling method during which only the final second of a pupil's movement is captured every 20 s (McKenzie, 2012). Moreover, it is also largely dependent on the pupils who are monitored as only four pupils are monitored per class period, whereas all/most pupils within a class/group can be individually monitored using accelerometers.

Our opinion is that SOFIT was a useful data generation tool in this study as it provided important lesson information that linked lesson contexts and teacher behavior to VPA and MVPA levels (Fairclough & Stratton, 2005a; Scruggs et al., 2005). For example, the use of SOFIT demonstrated that the TGM teacher spent more time in game play *and* skill practice and much less time in management and other lesson contexts (i.e., free play) than the control group teacher. From the review of these data, it could be suggested that the greater amount of time in motor content therefore afforded the opportunity for a greater amount of VPA and MVPA and, arguably, the game–skill–game lesson structure of the TGM provided a more coherent lesson structure for the teacher of that unit. Our contention is that this, alongside the small sample size within this study that would be sensitive to individual variation, may explain why there was a larger variation in VPA and MVPA scores in the TGM group compared to the control group because the TGM group spent a greater amount of time in game play and skill learning (approximately 55% of the lesson; see Table 3) and thus had more opportunities to move and learn. In contrast, the control group spent more time being managed by the teacher as a whole group (nearly 46% of the lesson; see Table 3), with all pupils therefore spending more time doing the same thing (i.e., being inactive while listening to the teacher), thus not displaying the variation in scores of the TGM group. Roberts and Fairclough (2011) noted a high level of inactivity was associated with lessons focused on the direct instruction model, largely because of high levels of management and instruction as well as full-sided games. In contrast, McNeill, Fry, Wright, Tan, and Rossi (2008) have shown how the use of the games concept approach, a Singaporean derivative of a GCA, afforded pupils more time in game play in secondary school classes.

Capturing the teacher behavior data in this study was also important. It demonstrated the active supervision techniques of the TGM teacher compared to the direction instruction teacher. For example, the TGM teacher spent more time instructing and less time observing as the environment of the TGM lesson meant the TGM teacher was freed up to give feedback and ask questions by moving from game to game and practice to practice, thus reducing the time needed for knowledge and pupil management.

Notwithstanding this larger variation in VPA and MVPA scores for the TGM intervention group, it is promising that students participating in PE lessons focused on TGM, in which the central aspect is participation in modified/conditioned games, accumulated over 10 min of VPA, thus not necessitating alternative "prescribed" interventions (Basquet, Berthoin, & Van Praagh, 2002). Basquet et al. (2002) designed a specific intervention to enhance cardiorespiratory fitness during PE lessons that tended to lack an appreciation and value for the activities in and of themselves as they potentially lack "spontaneity and freshness" (Dewey, 1910, p. 217). In contrast, modified/conditioned games offer an opportunity for playfulness and the "unfolding of the subject on its own account" (Dewey, 1910, p. 219), thus making PE content, arguably, more meaningful and purposeful (Light, 2013).

This study had limitations that should be addressed in future research. First, a greater sample size and longer units of TGM and direct instruction would permit an answer to the question regarding the sustainability of the levels of MVPA and VPA within the TGM and/or would enable greater demarcation in MVPA and VPA between individuals. Clearly, the small sample size observed in this study is susceptible to greater variation from the mean, and a greater sample size in particular would ensure that results were not affected (either positively or negatively) by a small number of individual pupils. Second, although the effects of TGM on boys and girls were not significant in this study, researchers such as Van Acker et al. (2010) have suggested there may be differences. Further research may therefore may be done to examine differences between boys and girls taught in coeducational and single-gender cohorts as only coeducational cohorts were examined in this study. Third, it may also be advisable to investigate the effects of different team and individual sport activities on MVPA and VPA levels (Fairclough & Stratton, 2005c) as most of the previous research, including this study, has been focused on team games being taught with TGM. Fourth, it would be of interest in future research to examine the effects of pupil motivation on the pupils' propensity to engage in higher levels of MVPA and VPA and to investigate which motivational constructs demarcate pupils taught with TGM and direct instruction models (Gray, Sproule, & John Wang, 2008), as well as for which categories of games (i.e., net/wall, invasion) and which activities within these categories (see Mandigo, Holt, Anderson, & Sheppard, 2008). Finally, researchers may attempt to demarcate teacher behavior more specifically using the System for Observing the Teaching of Games in Physical Education (SOTG-PE; Roberts & Fairclough, 2012). This newly validated system was adapted from SOFIT and additionally considers game-specific teacher interaction behaviors such as whether interactions were technically or tactically oriented and whether they were verbal or nonverbal. Using this system would therefore give more insight into the differences in teacher behaviors and provide researchers with more detailed data upon which to link changes in PA levels to the pedagogies associated with TGM that were not uncovered by using SOFIT in this study.

Conclusion

This study has provided much needed research to demonstrate the likely benefits of lessons focused on TGM to MVPA and, in particular, to VPA. Pupils in the TGM group had significantly higher MVPA and VPA levels compared to the control group, as measured by accelerometry, and were therefore more likely to meet current PA goals for MVPA and VPA stipulated by the Department of Health (2011) and the IOM (2013). This was, arguably, because of the greater amount of time the pupils were engaged in game play and skill practice compared to lessons focused on direct instruction during which higher levels of management were observed. Despite these positive findings, these results were subject to a large variation between participants and not corroborated by direct observation of PA through SOFIT, through which no significant differences were found between treatments.

Researchers should attempt to corroborate these findings over longer units in different games, especially with a greater sample of pupils (e.g., from multiple classes/schools), in coeducational and single-gender contexts. Researchers can additionally investigate pupils' motivation (see Mandigo et al., 2008) as a possible mediating factor in the links between teacher pedagogy and pupils' levels of PA with TGM units.

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