HHS Public Access

Author manuscript

Prev Med. Author manuscript; available in PMC 2017 August 01.

Published in final edited form as:

Prev Med. 2016 August ; 89: 98–103. doi:10.1016/j.ypmed.2016.05.021.

Physically Active vs Sedentary Academic Lessons: A Dose Response Study for Elementary Student Time on Task

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Abstract

Background—Physically active academic lessons are an effective intervention to reduce sedentary time and increase student physical activity. They have also been shown to enhance task engagement, as indicated by observations of attention and behavior control, Time On Task (TOT). However, it is not clear if the improved TOT stems from the physical activity or if it is the result of an enjoyable break from traditional instruction? If it is due to physical activity, what dose of intensity is required for the effect? This study was designed to test these questions.

Methods—Participants were 320 children (7–9 yrs) recruited from school districts in Central Texas in 2012. They were assigned by classroom (n=20) to one of four conditions: 1) sedentary, standard lesson (n=72); 2) sedentary academic game (n=87); 3) low to moderate intensity PA (LMPA), academic game (n=81); and 4) moderate to vigorous intensity PA (MVPA), academic game (n=76). Measures included PA via accelerometer; and TOT.

Results—Mixed-method RMANOVA indicated TOT decreased following the standard lesson ($p < 0.001$), showed no change following the sedentary academic game ($p = 0.68$), and increased following the LMPA ($p < 0.01$) and MVPA ($p < 0.001$) academic games.

Conclusions—While the sedentary, academic game prevented the reduction in TOT observed in the standard lesson, PA resulted in increased TOT. Future research should be designed to examine the potential academic benefits of the change in TOT.

Keywords

Elementary school; academic engagement; child; physical activity

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Conflict of Interest

Beyond the support acknowledged above, the authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Introduction

Physical activity is an important aspect of children's health and development. Although children are recommended to obtain at least 60 minutes of moderate-to-vigorous intensity physical activity each day (CDC, 2010), it is estimated that by 12 years of age, fewer than half of U.S. children are meeting these recommendations (Fakhouri, et al., 2014). Concurrently, negative health outcomes historically occurring in the adult population have been diagnosed in children, including type 2 diabetes, elevated blood pressure and low HDL cholesterol. Estimates show as high as 5% of children are diagnosed with metabolic syndrome (Dubose et al., 2006) and only 18.6% of overweight and 15.4% of obese children meet the recommendation for physical activity (Sun, Gao, Ransdell & Johnson, 2010). Because the level of physical activity declines from childhood to adolescence (Troiano et al., 2008), it is important to intervene in the elementary years.

Given that children spend up to 30 hours at school – with 92% of that time being sedentary (Burns, et al., 2015) - it is important to consider interventions to create opportunities for increased physical activity in this context. Typical strategies include increasing the amount of time or the intensity of the activity in P.E. class or recess, and have been met with general effectiveness in increasing overall activity (McKenzie et al., 2001; Sallis et al., 1997; Huberty et al., 2011). However, with increasing prevalence of high stakes standardized testing, PE and recess time has been reduced (Trost et al., 2009). This increases the need to consider interventions that target the regular education classroom. These interventions are particularly attractive as they replace sedentary, classroom behavior with physical activity and are in-line with the idea of physical activity throughout the school day (Carson, et al., 2014). However, as teachers often view physical activity interventions as a competing demand during classroom time (Ward et al., 2006), it is unrealistic to expect support from school administrators without demonstrating a clear academic benefit to in-class physical activity. In this vein, programs such as "Take 10!" (Kibbe et al., 2010), "Physical Activity Across the Curriculum" (Donnelly & Lambourne, 2011), and "Energizers" (Mahar et al., 2006) utilize physically active, academic lessons to inject 10–15 minutes of MVPA while incorporating academic content. These programs have been shown to be both feasible (Delk, et al., 2014) and cost effective (Babey, Wu & Cohen, 2014). More importantly, they have been consistently shown to increase physical activity (Stewart, Dennison, Kohl & Doyle, 2004; Donnelly, et al., 2009; Erwin, et al., 2011; Holt et al, 2013) and contribute to factors that are associated with academic performance.

The most studied aspect of academic performance in response to these interventions has been task engagement or time-on-task (TOT). TOT refers to the amount of time students spend attending to school-related tasks (Prater, 1992). It is a direct measure of attention and behavioral control and, thus, student engagement, and it is positively associated with academic performance (Stallings, 1980). Mahar et al. (2006) tested the effects of active lessons on TOT in third and fourth grade children. TOT was measured prior to and following a physically active lesson and a standard, control lesson. Results indicated that TOT increased by 8% in immediately after completing the active lesson but no change following the control lesson. A follow-up study (Grieco, Jowers, and Bartholomew, 2009) found somewhat contradictory effects in that TOT decreased significantly following the sedentary,

standard lesson, while there was no change in TOT following active lessons. While both studies demonstrated a benefit – either increasing TOT or preventing a reduction in TOT - it is not clear why these studies differed in the pattern of effect. One possibility is that these reflect ceiling effects due to differences in pretest TOT in each study. Mahar (2006) found pretest TOT scores of approximately 71%. In contrast, Grieco and colleagues (2009) found pretest scores of approximately 84%. One might expect physically active lessons to enhance TOT in those students experiencing depressed levels of engagement, while maintaining TOT for those already strongly engaged. In addition, neither study reported the intensity of the activity during the lessons. Differences in the lesson content, the person leading the activity, the students, and the environment may all contribute to differences in the dose of physical activity intensity that might impact the resulting TOT. In addition, these physically active academic lessons are designed to be enjoyable (Vazou & Smiley-Oyen, 2014; Vazou, et al., 2012), with children often acting out movements from stories or competing as teams to answer academic questions. As a result, physical activity has been confounded by an enjoyable break from traditional lessons. Thus, it may be that an enjoyable - though sedentary - lesson would be just as effective as an active lesson for a change in TOT. This study was designed to address these limitations by having a large group of children complete a traditional, sedentary lesson, or one of three competitive, academic lessons that were completed at sedentary, light or vigorous intensities. Intensity was directly measured through accelerometery, and TOT was directly observed by research staff blinded to condition. Thus, this study is designed to determine if physical activity is required to produce the benefit for TOT and, if so, the dose of activity intensity required.

METHODS

Design Overview

This study utilized a mixed factorial design, with two levels for the within-subjects factor (pre, post-lesson) and four levels for the between-subjects factor (activity intensity dose). Participants were randomly assigned to condition by classroom (n=20; 5 classes for each condition): (1) traditional sedentary lesson; (2) sedentary game (high interest control), (3) low to moderate-intensity physically active (LMPA) lesson, and (4) moderate to vigorous intensity physically active (MVPA) lesson.

Participants

Participants were a part of an on-going study to compare the impact of active lessons on physical activity conducted in 2012 in Central, TX. For the larger study, a 660 students across experimental and control schools were required to achieve 80% power to detect a significant effect for physical activity. The present study utilized children from the experimental schools. Specifically, 320 children aged 7 to 12 years (M = 9.5; 51.2% female) drawn from twenty 3rd, 4th and 5th grade classrooms within a central Texas, suburban school district. This age-range reflects the participant demographic in studies designed to examine similar outcomes (Mahar et al., 2006; Donnelly et al., 2009) and represents the age range during which physical activity declines significantly (Fakhouri, Hughes, Brody, Kit, & Ogden, 2012; Sun, Gao, Ransdell & Johnson, 2010; Trost et al., 2002). Participation was limited to those students whose physical abilities allowed them to participate in their

physical education class without significant modification, i.e. children who could perform the actions required for the mod-vigorous intensity condition. No data were collected on learning disabilities and, thus, this was not a consideration for inclusion. In line with the procedures as outlined by the Institutional Review Board, parental informed consent was collected for all participants who then provided written assent for participation.

Physically Activity Academic Lessons

The physically active academic lesson used was "spelling relay." This lesson requires 10–15 minutes of physical activity and is similar to other active lessons (Stewart, Dennison, Kohl & Doyle, 2004; Gibson et al., 2008; Mahar et al., 2006). Students are divided into groups and given a word from their required curriculum. Upon a starting cue, the first child in each group would write a letter, followed by the second child who would add a letter or make a correction. This would be continued through the group until the word was completed. Finished words were evaluated and feedback provided for errors. The process would begin again and continued until the 15-minute lesson expired. The intensity of the activity was varied to create the four conditions: (1) *Sedentary, non-competitive Traditional Lesson*. Students were seated and instructed to write the given word in "pyramid style." This commonly used classroom activity consisted of students writing the first letter of the word on one line, then two letters on the second line, and so forth until the full word is completed. The order was then reversed, removing a letter at each line. (2) *Sedentary Competitive Lesson*. Students were seated in a group of four and worked off of a piece of paper that was passed around the circle, with each subsequent student adding a letter. Group of students worked in a relay competition with one another. (3) *Low-Moderate Intensity Physical Activity (LMPA) Competitive Lesson.* Students were divided into four groups, with approximately 5 students per group. Students were instructed to walk to and from the board and to sit down between turns. (4) *Moderate-Vigorous Physical Activity (MVPA) Game.* Students were divided into six lines, with approximately 3 students per group. Students were instructed to run to and from the board and execute various jumps (e.g., star jumps) as they awaited their next turn. Classrooms were randomly assigned to each of these four conditions. To ensure treatment fidelity, the lead researcher implemented all conditions within each class. Finally, to ensure that the implementation did not impact TOT ratings, a separate group of trained researchers, who were blind to condition, conducted all TOT assessments. Likewise, children were blind to condition until after the pretest questionnaires and observations were complete.

Time On-task (TOT) Observations

Calculation of TOT—Time on-task (TOT) was measured though Momentary Time Sampling (MTS), a type of ecobehavioral assessment. This is based on direct observation of student behavior, in which research staff conducts a series of observational sweeps across the classroom. The order was predetermined in a set direction through the class to reduce the likelihood of missing a child on any sweep. This order was repeated throughout the observation period. During each "sweep" the research staff spends 5 seconds on each child and notes his/her behavior as either on or off task. On-task behavior was defined as any behavior in which a student is attentive to the teacher or actively engaged in the appropriate task, as assigned by the teacher. Off-task behavior was defined as actions whereby a student

was disengaged or distracted from the assigned task (i.e., behavior outside of the specifications of "on-task" behavior). Examples of off-task behavior included a student: gazing off, placing head on the desk, reading or writing inappropriate or unassigned material, talking to or looking at other students when not part of a given assignment, and leaving the desk without teacher permission. To ensure equal time per child, the rater was provided an auditory MP3 file that signaled each 5 seconds. With 15 minutes of observation, this resulted in 16–22 observations per student (depending upon class size). TOT score was then calculated as the percent of time the child was rated as on-task. Observers were trained for TOT assessments in a separate set of elementary classrooms to prevent contamination. Training was considered complete when inter-rater reliability (IRR) exceeded 90%. IRR was 92% at a pretest assessment (one-week prior to the experiment) and 95% at one-week retest.

Study Protocol: Observations were conducted on non-PE days and during the language arts period. Each observation period (pretest and posttest) lasted 15-minutes. Pretest observations were completed within 10 min of beginning the assigned, experimental lesson. Posttest observations were begun within 10 min following the assigned lesson.

Measurement of Physical Activity and Physical Descriptors

Demographic information was taken from school records. Student heights and weights were taken by the physical education teachers and school nurse and were used to calculate BMI. Fitness was based on the PACER score from the Fitnessgram. Physical activity was assessed using accelerometers (Actigraph GT1M). The sampling interval (epoch) was set at 5-seconds to best capture variability in children's activity (McClain et al., 2008); and reintegrated to 60s epochs for MET rate calculation. Although placement has not been supported as a key issue in interpreting accelerometer data (Nillson, et al., 2002), hip placement has been effectively used with children (Treuth, et al., 2003; Trost, et al., 2002). Accordingly, accelerometers were affixed to an elastic belt and placed by trained staff on children's right hip at the beginning of the school day once children reported to their classroom. Accelerometers were removed as they exited their classroom at the end of the day. Accelerometer data were processed using ActiLife v5.5 software. Time spent per lesson at various intensity levels was calculated using child-specific cut-points (Freedson, 2005).

Measurement of Situational Interest

Student interest ratings for each condition were measured using a single-item, 5-point Likert-type question, "How much did you like the activity in which you just participated," with response scores ranging from 1 ("not at all liked") to 5 ("liked a lot"). These were supplemented with a visual scale of faces depicting each point on the scale from 1 (frowning face) to 5 (smiling face). This scale was developed for this experiment and while it has no existing validity information, it is based on the use of facial expressions to capture mood-related constructs in children (Derbaix & Pecheux, 1999).

Statistical Analyses

A 2 (pre-post) x 4 (condition) ANOVA with repeated-measures (RMANOVA) on the first factor was conducted for the analysis. With random assignment at the class-level, this results in a 3-level model: (1) condition, (2) nested within individual (pre-post) and (3) nested

within class. This is problematic as nesting violates the standard assumption of independent observations underlying the general linear model. That is, variance at the posttest is dependent, in part, upon variance at the pretest. Likewise, TOT is likely to vary as a function of class dynamics as well as individual differences. Accordingly, SAS PROC MIXED (SAS Institute, Inc., Cary, North Carolina) was used to consider the nested nature of these data (Wolfinger & Chang, 1995).

RESULTS

Descriptive Statistics

Descriptive statistics are provided in Table 1. No differences in demographic variables existed at baseline between conditions for BMI category ($\chi^2_{6, 299} = 6.67$, $P > 0.05$), or sex ($\chi^2_{3, 320} = 1.53$, $P > 0.05$). Differences between conditions existed for age ($\chi^2_{15, 320} = 47.62$, $P < 0.001$) and grade ($\chi^2_{6, 320} = 65.33$, $P < 0.001$).

Physical Activity Intensity

Accelerometer data were used to assess the physical activity manipulation. Physical activity levels for each condition (see Table 2) yielded values in concert with targeted intensities. Trends emerged such that physical activity conditions yielded significantly ($P < .001$) higher intensities than the sedentary conditions; and the MVPA condition over the LMPA condition. No significant differences ($P > .10$) in intensity categories existed between the sedentary conditions.

Time On-task (TOT)

A two-way (time: pre- vs. post-observation x condition [control, control game, LMPA game, MVPA game]) mixed-methods RMANOVA, controlling for age, compared TOT between observation periods. This analysis revealed the hypothesized time by condition interaction ($F_{3,316} = 19.63$, $P < 0.001$). Main effects were significant for time ($F_{3,316} = -8.97$, $P < 0.01$) and condition ($F_{3,316} = 8.54$, $P < 0.001$). In order to examine the nature of the interaction, simple effects were assessed for time within each condition. Results indicated that TOT decreased significantly from pre- to post- in the sedentary, standard lesson condition ($t_{3,316} = 3.88$, $P < 0.001$), showed no pre-, post- change in the sedentary competitive lesson ($t_{3,316} = 0.42$, $P = 0.68$), and increased significantly from pre- to post- in the LMPA ($t_{3,316} = 2.70$, $P < 0.01$) and the MVPA competitive lessons ($t_{3,316} = 6.70$, $P < 0.001$) conditions. Means, standard deviations and effect sizes (Cohen's *d*) across all students for TOT are presented in Table 3. These changes were unrelated to fitness, BMI or sex categories, all $P > .10$.

Situational Interest

A univariate analysis on situational interest ratings indicated a significant difference among conditions ($F_{3, 307} = 6.89$, $P < 0.001$). Post hoc tests indicated significant mean differences in interest rating between the standard, sedentary lesson and the LMPA game ($P < 0.05$, d=.53) and MVPA game ($P < 0.001$, d=.70); and the control game and the MVPA game ($P < 0.05$, d=.43). Because of the differing interest ratings between conditions, tests for moderation were conducted to further examine the effect of situational interest on the main outcome variable of TOT. To avoid low response rates in any individual category, situational

interest was recoded from the 1 to 5 scale of student reported ratings designed to reflect the underlying construct of interest in the lesson. Scores of 1 and 2 were coded as “dislike,” a score of 3 was coded as “neutral,” and scores of 3 and 4 were coded as “like.” Thus, a 2 (time [pre- vs. post-observation]) x 4 (condition [control, control game, LMPA game, MVPA game]) x 3 (situational interest category) RMANOVA on percentage TOT yielded a non-significant time by condition by interest interaction ($F_{6, 295} = 0.93$, $P > 0.10$). The three-way interaction was also not significant ($F_{6,295} = 1.55$, $P > 0.10$).

DISCUSSION

This study was designed to assess the possibility of a dose response impact of physical activity intensity on the change in TOT in pre-adolescent children. Physical activity was incorporated into academic lessons for children in the classroom and compared to a sedentary control that was based on traditional, seated academic lessons. Because the physically active lessons were built around a competitive game, a second sedentary, competitive lesson was added to address the possibility that the benefits of these lessons are merely due their competitive nature during a break from traditional instruction. Results indicated that the students’ TOT decreased significantly after a standard, sedentary lesson. This mirrors the effect found in early research (Grieco, et al., 2009). TOT did not change following the sedentary competitive lesson. Thus, even a sedentary but competitive activity was sufficient to prevent the reduction in TOT that followed the standard, sedentary control. In contrast, both physically active lessons were followed by an increase in TOT relative to each control condition. The magnitude of this effect was similar to the results found by Mahar and colleagues (2006). Finally, while the effect of the MVPA game was nearly three times the effect of the LMPA game, baseline TOT in the MVPA condition was significantly lower than all other conditions – which is likely to have impacted the magnitude of change.

These findings suggest there may be some benefit for a game-type format in lessons - regardless of the intensity or even the presence of physical activity - as the sedentary competitive lesson outperformed the standard, sedentary lesson. This provides support for theories of attentional reset (Evans & Pellegrini, 1997). The control game may have been sufficient to provide a break from their routine thereby providing an opportunity for an attentional shift sufficient for children to refocus attention during subsequent lessons. Additionally, the control game, as a break from the norm of instruction, could have impacted students’ experience of variety or felt variety. Experience of variety can be defined as a person’s perception of whether they have experiences variety, denoted by feeling as though they pursue and experience diverse activities, behaviors, and opportunities in their social environment (Sheldon & Lyubomirsky, 2012; Sylvester, Standage, Ark, Sweet, Crocker, Zumbo, & Beauchamp, 2014) – in this instance, a novel academic game. Research has suggested that experiencing variety stimulates interest (Silvia, 2006), and thus, may explain the benefit of a game-type lesson format, regardless of presence of physical activity.

Despite the benefit of the sedentary competitive lesson, there is a large, further benefit (ES = 0.43 for LMPA; ES = 1.22 for MVPA) of adding physical activity to the lessons. Both the LMPA and MVPA conditions had significant increases in TOT compared to no change for the sedentary, competitive lesson. Given the benefit of physical activity over both the

standard, seated lesson and the sedentary controls, these data can be used to infer that there is a benefit to physical activity beyond merely providing an enjoyable break from traditional classwork. This is in line with neurophysiological studies which indicate that physical activity impacts baseline electrocortical function by increasing amplitude and reducing latency in the P3 component, which is considered beneficial to cognitive processes related to allocation of attentional resources (Hillman, Erickson, & Kramer, 2008). The interpretation of the dose response data is less clear. Although the effect size was much larger in the MVPA than the LMPA condition, the posttest values were similar. This is likely due to significantly lower pre-test TOT for the MVPA condition (MVPA=56%; LMPA=70%) – a difference that occurred despite random assignment to condition and after controlling for baseline differences in age. This suggests that the LMPA condition may have merely reached a ceiling and the relative differences between the MVPA and the LMPA conditions should, therefore, be interpreted with caution until replicated.

Study Strengths and Limitations

This is the first experiment to include objective measures of both physical activity and of TOT. Thus, the results are likely to provide a more accurate test of the hypotheses. Despite this, a primary limitation includes the lack of any assessment of TOT beyond the 15-minutes following the lesson. Although in line with other research, a single assessment of post-intervention TOT does not allow for an assessment of attention decay. Both this and a previous study (Grieco et al., 2009) indicated that TOT was highly variable, declining by 15 percentage points over 45 minutes in the control groups. It is not clear how long the benefits of physical activity are for TOT. In addition, there was no assessment of on-going or diagnosed behavioral problems, e.g. ADHD, or academic performance. Unfortunately, the participating district would not release these data (e.g. referrals to administration, document behavioral problems, standardized test scores, etc.). It is likely that either variable could impact TOT and the response to this intervention. As such, future studies would do well to investigate the potential moderating role of pre-existing behavioral conditions. Indeed, Mahar (2006) found physically active lessons to have the greatest impact on a subsample of the least on-task students. This emphasizes that these lessons will be competing with other, more traditional approaches to instruction. If they do not result in improved academic performance, for those least on task and all other students, then teachers are not likely to implement these lessons. As the lessons were implemented by research staff, we did not assess teacher response to these lessons. While previous work has revealed positive responses (Bartholomew & Jowers, 2011), this is an area in need of more research. Finally, additional limitations include the pretest TOT differences in the MVPA condition. However, the other three conditions: traditional, sedentary; sedentary competitive; and the LMPA competitive lessons did not differ in pretest TOT. As such, these comparisons allow for a strong comparison amongst physical activity vs sedentary competitive and traditional lessons. Given the observed difference in posttest TOT between these conditions, we can be confident in the unique benefit provided by physical activity on subsequent TOT.

Conclusions and Future Directions

Despite these limitations, these data have clear implications for school policy. It is hoped that behavior change through the usage of in class physically activity will enhance learning

by increasing TOT during subsequent academic instruction. If future research demonstrates this impact, then teachers may well be motivated to use active lessons to modify behavior and maximize learning in their students. This is a critical question for future research. School districts are rightly focused on the academic development of their students. Evidence for the benefit of in-class activity on academic-related outcomes will do much to inform the decisions to change policy and support this intervention strategy. In contrast, evidence for the dose response of physical activity intensity was mixed and are insufficient to argue for a specific intensity of activity. Future studies should extend these findings to further investigate dosage of activity intensity and the length of improvement following the physically active lessons. In addition, although the ability to attend to the task at hand is believed to be integral to learning and academic performance, these relationships should be directly measured in future, randomized controlled trials. Positive effects would provide a much stronger justification for the use of physical activity in the elementary classroom.

Acknowledgments

Research reported in this publication was supported by the National Institutes of Diabetes and Digestive and Kidney Diseases of the National Institutes of Health under award number: R21DK071975. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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Highlights

- Teachers will implement in-class physical activity if it improves academic factors.
- Child time on task improves following in-class physical activity.
- This study tests the dose of physical activity needed to increase TOT.

Table 1

Descriptive Characteristics for Participants by Condition (n = 320)

Variable	Control Lesson	Control Game	LMPA Game	MVPA Game	Total
Age, μ(*SD*), years **	9.8 (±0.9)	9.2 (±1.0)	9.8 (±0.8)	9.1 (±0.9)	9.5 (±0.9)
Gender %					
Female	38	45	38	43	164
Male	38	42	43	33	156
Grade % *					
3rd	10	48	10	35	103
4th	28	15	36	30	109
5th	38	24	35	11	108
Body mass index %					
Normal	45	61	53	53	212
At-risk	16	10	10	7	43
Overweight	9	10	12	13	44
Missing Data	6	6	6	3	21

* Significant between condition difference, P < 0.05,

** Significant between condition difference, P < 0.001

Data collected from Central Texas school districts, 2012.

Table 2

Mean Accelerometer Values in Average METs, Total Counts per Lesson, Counts per Minute; and Percentage of Time in Sedentary, Sedentary/light, Light, Moderate, Vigorous, Very Vigorous, Low/Moderate, and Moderate/Vigorous Physical Activity Intensity Categories for Control Lesson, Control Game, LMPA Game and MVPA Game Conditions.

Condition	Avg. METs	Total Counts	Counts /min	% in Sedentary	% in SLPA	% in LPA	% in MPA	% in VPA	% in VVPA	% in LMPA	% in MVPA
Control lesson	1.38	1852	154	73.6	97.4	23.9	2.6	0.0	0.0	26.5	2.6
Control game	1.85	4694	391	46.9	90.8	43.9	9.2	0.0	0.0	53.1	9.3
LMPA game	3.79	23501	1958	4.33	32.1	28.0	59.9	7.4	0.4	87.8	67.8
MVPA game	5.56	47346	3946	6.3	16.2	10.1	44.7	28.7	10.3	54.8	83.8

Abbreviations: METs, Metabolic Equivalents; SLPA, sedentary/light intensity physical activity; LPA, light intensity physical activity; MPA, moderate intensity physical activity; VPA, vigorous intensity physical activity, VVPA, very vigorous intensity physical activity; LMPA, low/moderate intensity physical activity; LMPA, low/moderate intensity physical activity. Data collected from Central Texas school districts, 2012.

Table 3

Means, standard deviations and effect sizes for percentage TOT for all students (N = 320)

	Pre-	Post-	Effect Size (*d*)
Control lesson $^{*@+}$ (n=72)	69.8 (±23.3)	54.5(±26.5) ***	−0.61
Control game $^{*\#}$ (n=87)	67.8 (±26.0)	69.3 (±27.6)	0.06
LMPA game$^{@}$ (n=81)	70.4 (±24.3)	80.7 (±23.9) **	0.43
MVPA game $^{+\#}$ (n=76)	56.2 (±23.6)	82.7 (±19.6) ***	1.22

*Significant difference between conditions, $P < 0.05$.

$^{@}$Significant difference between conditions, $P < 0.001$.

$^{+}$Significant difference between conditions, $P < 0.001$.

$^{\#}$Significant difference between conditions, $P < 0.05$.

**Significant pre-, post-difference, $P < 0.01$.

***Significant pre-, post-difference, $P < 0.001$

Data collected from Central Texas school districts, 2012.