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Students' Time In Their Heart Rate Zone With And Without Polar Display

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31 Pages

The lack of physical activity (PA) and rise in sedentary behavior has become an increasing problem in the United States (Owen, Sparling, Healy, Dunstan & Matthews, 2010). The U.S. Department of Health and Human Services (USDHHS) recommends sixty minutes of daily PA for young people ages 6-17 (CDC, 2013). Despite this recommendation, the 2012 National Health and Nutrition Examination Survey (NHANES) data reported that only 24% of youth 12-15 years of age were obtaining sixty minutes of moderate-to-vigorous physical activity (MVPA) every day (Fakhouri, et al., 2014). Physical education (PE) is one of the few environments where all children are provided the opportunity to engage in PA, learn the skills and knowledge necessary for engagement in health enhancing PA, and develop the disposition that lifelong health enhancing PA is important (SHAPE America, 2016a). It is recommended that students spend the majority of time during PE engaged in PA (SHAPE America, 2016b). According to the U.S. Department of Health and Human Services (USDHHS), 2010, PE should strive to include at least 50% time spent in Moderate to Vigorous Physical Activity (MVPA). Many PE programs are not meeting the goal of 50% of the class time spent in PA (SHAPE America, 2016b; USDHHS, 2000). Researchers have found that using heart rate monitors with children in PE classes increased the amount of PA (Duncan et al., 2012). The purpose of this

study was to examine the effects of displaying versus non-displaying of heart rates during two 7th grade junior high PE classes on the amount of time students spend in their target heart zone.

The study took place at one Junior High in the Midwest United States, with an enrollment of 796 students. The sample size was two classes of 7th grade students (n=51). Students' ages ranged from 12-13. The study took place during ten fitness based lessons. The lessons were taught to the classes with a visual display for five lesson and without a visual display for five lessons. The students' percent of time in their target heart rate zone was monitored through Polar software. Average percent of time in target heart rate zone were documented and recorded through Polar software.

The results indicated that the mean percent of time in their target heart rate zone in the display setting (M = 62.41, SD = 13.52) was significantly greater than the mean heart rate percent of time in the non-display setting (M = 52.07, SD = 15.52), $t(50) = -5.31$, $P < .01$. No significant differences existed between males and females in either the display or the non-display groups. Students who participated in the display group first had higher percentages of time in their target heart rate zone averages in the non-display setting (M = 62.9, SD = 9.41) than the students who participated in the display setting second (M = 42.44, SD = 13.42). Students who participated in the non-display group first had lower percentages of time in their target heart rate zone averages in the display setting (M = 56.4, SD = 14.05) than the students who participated in the non-display setting second (M = 69.14, SD = 9.2). Overall, the use of heart rate monitors increased students' time in their target heart rate zone.

KEYWORDS: Physical Activity, Physical Education, Heart Rate Monitors, Target Heart Rate Zone

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CHAPTER I: STUDENTS' TIME IN THEIR HEART RATE ZONE WITH AND WITHOUT POLAR DISPLAY

Introduction

The lack of physical activity (PA) and rise in sedentary behavior has become an increasing problem in the United States (Owen, Sparling, Healy, Dunstan & Matthews, 2010). The U.S. Department of Health and Human Services (USDHHS) recommends sixty minutes of daily PA for young people ages 6-17 (CDC, 2013). Despite this recommendation, only one in three U.S. children is physically active every day (National Association for Sport and Physical Education, 2009). The 2012 National Health and Nutrition Examination Survey (NHANES) data reported that only 24% of youth 12-15 years of age were obtaining sixty minutes of moderate-to-vigorous physical activity (MVPA) every day (Fakhouri, et al., 2014). Overall, research indicates that as children age their participation in PA decreases (CDC, 2013; Hoffman, 2009; USDHHS, 2012).

Physical education (PE) is one of the few environments where all children are provided the opportunity to engage in PA, learn the skills and knowledge necessary for engagement in health enhancing PA, and develop the disposition that lifelong health enhancing PA is important (SHAPE America, 2016a). It is recommended that students spend the majority of time during PE engaged in PA (SHAPE America, 2016b). According to the U.S. Department of Health and Human Services (USDHHS), 2010, PE should strive to include at least 50% time spent in Moderate to Vigorous Physical Activity (MVPA). Many PE programs are not meeting the goal of 50% of the class time spent in PA (SHAPE America, 2016b; USDHHS, 2000).

In response to the above recommendations and current failure of many PE programs to meet the 50% MVPA threshold, many PE programs are searching for ways to help students

increase the amount of time spent in MVPA during PA. Technology-based interventions in PE have become very popular in recent years. Pedometers, heart rate monitors, and Dance Dance Revolution have all been used as a means of motivating technology savvy students in PE class (Gidlow, Cochrane, Davey & Smith, 2008). Technology can be an important tool when it is used to give students immediate feedback and the ability to self-monitor their PA (Steele, et al., 2010). Self-monitoring of PA intensity is often very difficult for children (Conley, Gastin, Brown & Shaw, 2011). Heart rate monitors are one viable way to help teach children to understand what their bodies feel like when engaging in their Target Heart Rate Zone (THRZ) (Pangrazi, Beighle, & Sidman, 2003). Being able to self-monitor how your body feels while in your THRZ during MVPA has been shown to increase student motivation to participate in MVPA (Gidlow et al, 2008). One of the more recent innovations of heart rate monitors has been the development of a display board that allows students to individually monitor their heart rate and activity zone in real time during PA. With the use of technology to motivate students and help them self-monitor during PA, more students are able to work in a moderate to vigorous zone for an adequate amount of time in class (Simmons-Morton, et al., 1999).

One major gap in this research is the lack of links between the use of display boards that display heart rate to students' awareness of staying in THRZ and its impact on the amount of time students spend in their THRZ. Therefore, the purpose of this study was to examine the effects of displaying versus non-displaying of heart rates during two 7th grade junior high PE classes on the amount of time students spend in their target heart zone.

Methods

Participants and PE Setting

This study was conducted at a junior high in a Midwestern suburban middle school. Participants were PE students (N = 51) in two intact 7th grade classes. The average age of the participants was 13 years of age. The school and the participants were selected by convenience sampling. Each class was a total of 58 minutes with the main activity averaging 30-40 minutes long. One certified PE teacher with four years of experience taught all of the lessons. The PE setting was a junior high school that has one gym and a fitness center. PE classes were taught in the gymnasium only. The students had four months of prior experience using the heart rate monitors in both fitness and sport-based lessons. The study was explained to all students and parent consent was sent home. The students had the choice to opt out of the study but still participated in PE class as they normally would. The study was IRB approved.

Instrumentation

Polar H7 Heart Rate Monitors. The students wore Polar H7 heart rate monitor sensors. This sensor was worn on a heart rate sensor strap that went around the student's chest. No wristband was worn during the data collection. Students with personal devices (FitBits, Apple Watches, etc.) were asked to remove them. The students had no information on their heart rate or time in MVPA. A sensor was then connected via Bluetooth to an iPad where it is then projected during real time. The students had been wearing their heart rate monitor sensors for four months prior to the data collection. The students were informed how to properly wear their heart rate sensor band. They were also reminded as to what their target heart range is, that it is beneficial to work in your target zone so that they would be getting moderate to vigorous activity and which colors represent the different zones on the Polar software. In the Polar zones, green or higher

(orange and red) represents time spent working in your THRZ. When students are working in their desired THRZ they are getting MVPA. Each student was assigned a heart rate monitor number at the beginning of the year that connected to their own account in the Polar software. Their profile includes their name, birthdate, and ethnicity. Through the creation of their profile and the information imported from each student, the Polar software calculates the student's maximum heart rate and uses it to create their target heart zone. Essner, Sjöström, Ahlgren & Lindmark (2013), assessed the validity and reliability of Polar heart rate monitors in comparison to simultaneously recorded electrocardiogram (ECG) data, measuring the heart rate of dogs during standing position and at trot on a treadmill. The study's results showed that the criterion validity and instrument reliability were excellent in the Polar heart rate measuring system. The equipment was seen to be valid and reliable in measuring BPM in cardiovascular conditions. Giles, Draper, and William (2016) assessed the validity of RR intervals (where R is a point corresponding to the peak of the QRS complex of the ECG wave; and RR is the interval between successive Rs) and short-term heart rate variability (HRV). The data was obtained from Polar heart rate monitors in comparison to an electrocardiograph (ECG). The agreement between time, frequency and non-linear HRV parameters for the Polar V800 and ECG were excellent. The results showed that in healthy subjects, the Polar V800 can produce RR intervals that records consistently with an ECG and that HRV parameters from these recordings are comparable.

Physical Education Lessons. The students participated in 10 fitness based lessons. Lessons 1-2 were workouts of the day where students worked through a series of exercises they had been performing all year. The exercises included squats, lunges, push-ups, sit-ups and box jumps while their partner was running the perimeter of the gym. Lesson three was a game called "Fitness Cornucopia" where the students worked in groups to retrieve items that correlated with

different exercises. Lesson 4 was a fitness game called "The Shamrock Shuffle" where students collected shamrocks and leprechaun that correlated with different exercises. Lesson 5 was "Fitness Tic-Tac-Toe" where students worked in teams playing tic-tac-toe running back and forth to a life-size board. Lesson 6 was "Fitness Sharks & Minnows" When students were tagged they participated in different exercises that correlated with their target heart rate zone. Lesson 7 was Hula-Hoop Fitness, where the students did specific exercises to earn hula-hoops to build their own hula-hut. Lesson 8 was "Roll with the Mustangs". The students rolled a dice with each number assigned to an exercise. After completing the exercising, the students earned a piece to the puzzle which created the schools' mascot, a mustang. Lesson 9 was "Fitness Scrabble". The students worked together in relays using different locomotor movements to retrieve letters to create words that had to do with PE. Lesson 10 was scooter ball. Participants rotated in and out of the game every 3 minutes. During the 3-minutes window where students did not participate in scooterball they worked through a series of exercises (squats, lunges, sit-ups, push-ups, etc.) based on their heart rate.

Data Collection Procedures

Two 7th grade P.E. classes participated in this study. All PE students in the two specific PE classes were verbally informed of the study. Following IRB approval from the school's review board, parents were informed of the study and asked to return a consent form. Only data from students whose parents signed the consent form were used in this study. All students participated in the activity as a part of their normal PE class. The students followed a normal PE schedule. The curriculum and activity did not change. However, data was only collected for students whose parents returned a consent form. The students were connected to their heart rate monitors at the beginning of class. The instructor made sure that all of the students were

connected to the software correctly by wearing their monitors. The students went through their normal warm-up where data was not collected. Each class had a schedule of meeting every other day. The data collection process took a total of 20 school days. Both classes were taught the same ten lessons throughout the study. Each lesson was a fitness-focused activity and the students were urged to participate in their target heart zone (THRZ) for 50% of the time. Heart rate data was only collected during the main class activity which typically lasted for 30-40 minutes of class time. Class A had their heart rate displayed in the gymnasium for them to self-monitor and their heart rate data was collected via Polar software for the first five lessons. For the second five lessons, the students were still connected to their heart rate monitors for data collection via Polar software but the students did not have a visual display of their heart rate. Class B was connected to their heart rate monitors for data collection via Polar software for the first five lessons but there was not a visual display for them to self-monitor. For the second five lessons the students wore their heart rate monitors. Their heart rate was visually displayed in the gymnasium for them to self-monitor and data was collected via Polar software.

Data Analysis

Inclusion criterion for participants in this study was attending 4 out of 5 days for each condition. Thus each participant included in the study attended 4 out of 5 display days and 4 out of 5 non-display days. Of the initial 64 participants, only 51 met the inclusion criteria. Students who did not meet the criteria participated in the lesson as normal. Descriptive statistics for the total sample and separated by gender and setting were completed and are presented as means ± SD. Average Percentages Time in THRZ for each individual were computed (see Table 1).

Statistical analysis was completed using SPSS v20 (Armonk, NY, USA). A paired samples *t*-test was computed to determine whether there were significant heart rate differences

between settings (display and non-display). Independent-sample *t*–tests were computed to determine whether there were significant heart rate differences between gender and to determine if there was an order effect of having heart rates displayed or not displayed first. The a priori alpha level was set up at $p \leq 0.05$.

Results

A paired samples *t*-test was conducted to evaluate the heart rate differences among the display and non-display settings. The results indicated that average percent of time in their THRZ during the display setting condition ($M = 62.41$, $SD = 13.52$) was significantly greater than the average percent of time in their THRZ in the non-display setting ($M = 52.07$, $SD = 15.52$), $t(50) = -5.31$, $P < .01$.

An independent samples *t*-test was conducted to evaluate the PA differences among males and females in both the display and non-display setting differences. No significant differences existed between males and females in either the display or the non-display groups.

A second independent samples *t*-test was conducted to examine if there was an order effect to being in the display group first and if it affected the average percent of time in THRZ. The test was significant, $t(49) = -6.22$, $p = .01$. Students who participated in the display group first had higher average percent of time in their THRZ in the non-display setting ($M = 62.9$, $SD = 9.41$) than the students who participated in the display setting second ($M = 42.44$, $SD = 13.42$). (see Table 2)

A third independent samples *t*-test was conducted to examine if there was an order effect to being in the non-display group first and if it effected average percent of time in THRZ. The test was significant, $t(49) = -3.76$, $p = .01$. Students who participated in the non-display group first had lower average percent of time in their THRZ averages in the display setting ($M = 56.4$,

SD = 14.05) than the students who participated in the non-display setting second (*M* = 69.14, *SD* = 9.2). (see Table 3)

Discussion

The purpose of this study was to examine the effects of displaying versus non-displaying heart rates during two 7th grade junior high PE classes showing the percent of time students spend in their target heart zone. There were many similarities as well as additional information found when using self-monitoring during PA.

The results of this study made it clear that there is a difference in average percent of time in THRZ when heart rate is being displayed vs. a non-display setting. The results indicated that the average percent of time in THRZ in the display setting was significantly greater than the average percent of time in THRZ in the non-display setting. This shows that when the students are able to see their heart rate and self-monitor activity levels they spend more time in their target heart rate zone than with no display. A similar study by Simmons- Morton et al., (1999) examined time spent in MVPA among third and fourth graders and showed the boys and girls were in MVPA for a longer period of time when using technology than when they were not. Ignico and Corson (2006) found similar results in that their fourth and fifth grade PE students performed better on the mile test while using a heart rate monitor then those who did not. Using this technology helps teachers not only see if their students are working in their target heart range but also to see if their students understand how their body feels when working in their target heart rate zone. These are very similar to the current study showing that the display of heart rate increased the percentage of time spent in the target heart rate zone.

A significant relationship was the order effect on participant's average percent of time in their THRZ. Students that participated in the display group first had a higher average percent of

time in their THRZ in the non-display setting then those who participated in the display setting second. Perhaps by participating in the display setting first the students were able to tell what their body should feel like in their target heart range zone therefore having a higher average percent of time in their THRZ than those who participated in the display setting second. In PE, students are taught to understand how their body feels during exercise. Some examples, commonly used are the rate of perceived exertion or having the students rate the activity on a level of difficultly for them using their fingers to indicate levels from 1-5. From self-monitoring with heart rate monitors the students can now tie together how their body feels when working at an appropriate level. Lagally, Walker-Smith, Henninger, Williams & Coleman (2016) examined the relationship of perceived exertion and heart rate in a natural PE setting where the correlation between the two was low to moderate. These results indicated that the students were unable to recognize how their body feels. However, future studies need to explore self MVPA monitoring with and without the technology as done in the current study. From the current study, we were able to see that students learned to recognize how it feels to exercise at appropriate levels even when the heart rate monitor is not available due to their prior use of technology.

Results of the current study indicated that girls had a higher average percent of time in their THRZ than the boys in both the display and non-display settings. The result is contradictory to numerous research studies that indicate boys are typically more active than girls. For instance, Nader (2003) examined 814 students in PE classes at 10 sites. The results indicated that boys spent more time in very active and MVPA, which is different from what the current study found. In the current study girls' average percent of time in THRZ was slightly higher than boys in both the display and non-display settings. Myers, Strikmiller, Webber & Berenson (1996) examined children and adolescents ages 9-15 (N=995) using a 24-hour recall instrument, the Self-

Administered PA Checklist. Sedentary behavior was also examined including television watching and video-/computer game playing. Overall, boys were more physically active than girls and were more engaged in heavy PA. Although most PA occurred after school, the children who reported no PE during the school day had less PA. Telford, Telford, Olive, Cochrane & Davey, (2016) collected data on both boys (N=276) and girls (N=279) from 29 different schools. The study examined effects on individual, family and environmental level correlates on pedometer measured PA. Cardio-respiratory fitness (multi-stage run), eye-hand coordination (throw and catch test) and perceived competence in PE (questionnaire) were used. The results showed that girls were 19% less active than boys. Girls in comparison to boys had less favorable individual attributes with PA at age 8 years, including 18% lower cardio-respiratory fitness (3.5 vs 4.2, $p<0.001$, CI [0.5,0.9]), 44% lower eye-hand coordination (11.0 vs 17.3, $p<0.001$, CI [5.1,9.0]), higher percent body fat (28% vs 23%, $p<0.001$, CI [3.5,5.7]) and 9% lower perceived competence in PE (7.7 vs 8.4, $p<0.001$, CI [0.2,0.9]). The lower PA levels among girls were associated with weaker influence at the school and family levels.

It is inconclusive why females in the current study had higher average percent of time in their THRZ than males. Two confounding variables that could have effected these results would be the gender of the teacher (gender bias) and the type of PE lesson. Since the PE teacher for all of the lessons was female she could have had some gender bias in the amount of feedback she was offering. Additionally, the fitness activities taught were more gender neutral. Many research studies examining male and female PA focus on team and individual/dual sports. The females in this study could have felt more comfortable engaging in higher levels of PA because the lessons were fitness based and not competitive in nature. Although these variables were not measured

one must consider the potential impact on this result of the study. More research should be conducted controlling for these two variables.

In conclusion, the results of the study support the notion that technology, specifically heart rate monitors, are useful to teach students how their body feels while in their THRZ while participating in PE activities. This study was delimited to two 7th grade PE classes in the Midwest. Future studies should explore multiple grade levels in multiple schools, teacher interactions (gender bias) and use of the RPE scale during the non-display setting.

Table 1

Percent of time in THRZ by gender (ie., Polar zones)

	Boys	Girls	Total
Display	62.0309	63.1189	62.4149
Non-Display	49.2667	57.2111	52.0706

Table 2

Order effect of percent of time in THRZ: Display group first

	Display 1st	Display 2nd
Mean	62.9	42.44
SD	9.41	13.42

Table 3

Order effect of percent of time in THRZ: Display group second

	Display 1st	Display 2nd
Mean	69.14	56.4
SD	9.2	14.05

CHAPTER II: EXTENDED LITERATURE REVIEW

The purpose of this study was to examine the effects of displaying versus non-displaying of heart rates during two 7th grade junior high PE classes on the amount of time students spend in their target heart zone. Physical Activity was measured by Polar H7 heart rate monitors.

"The U.S. Department of Health and Human Services recommends that young people aged 6–17 years participate in at least 60 minutes of PA daily" (U.S. Department of Health and Human Services, 2008, p. 16). This review of literature is organized into three sections (a) MVPA and gender PA levels, (b) an investigation into health-related fitness knowledge and (c) the use of technology and its impact to increase MVPA time in PE. The literature reviewed had commonalities such as lack of MVPA, difference in PA levels based on gender, difference in PA levels based on knowledge and increasing PA with the use of technology.

The articles in this review were chosen based on if the topic worked with PE students, gender of PE students, knowledge of PE students, MVPA, if the use of technology was present, and if the use of technology was present to report PA. As the terms are used in the study they will be defined and explained. Some terms that were used were, PE, gender, MVPA, monitoring PA, heart rate monitors, and pedometers.

Physical Activity

Moderate-to-Vigorous Physical Activity

When students are participating in PE class, due to the nature of classes, more than just PA is taking place. Physical Education class time is devoted to, but not limited to, the following: class management (dressing and attendance) instruction in all three learning domains (Affective, Cognitive and Psychomotor) and transitions between tasks/activities. However, it is recommended that PE teachers should strive for their students to be engaged in MVPA 50% of

class time (Scruggs, Beveridge & Clocksin, 2005). There are many benefits to MVPA, including but not limited to, better blood pressure and physical function (White, Gabriel, Kim, Lewis & Sternfeld, 2015). Increasing MVPA in PE can also generate more energy expenditure, contribute to obesity prevention, reduce anxiety and stress, improve self-esteem, and reduce risk of chronic disease (California School Board Association, 2009).

> "Moderate-intensity activities are those that get you moving fast enough or strenuously enough to burn off three to six times as much energy per minute as you do when you are sitting quietly, or exercises that clock in at 3 to 6 METs, the unit of measure of the rate at which your body expends energy that is based on energy expenditure while sitting at rest. Vigorous-intensity activities burn more than 6 METs (Harvard T.H. Chan School of Public Health, 2017)."

Students should be in MVPA for at least 33% of the time spent in class, if not 50% (Scruggs et al., 2005). However, research studies have consistently indicated that PE programs are not meeting the Healthy People 2010 goal of 50% of the class time spent in PA (USDHHS, 2000). A study by Sallis (1997) found that PE class provided only 18 minutes per week of PA that was of moderate to vigorous intensity. Seven schools and 955 students were assigned to two conditions, a health-related PE class compared to traditional PE as the control group. The results found that the traditional PE only had 18 minutes of MVPA in comparison to the health related PE where they were in MVPA for 40 minutes.

A study by Simmons-Morton, Taylor, Snider, Huang, & Fulton (1994) found that the average amount of PA observed in a regional sample of schools was less than the national recommendation of a minimum of 50% with the results being less than 27%. With our students not getting enough MVPA, interventions need to be implemented so that PE time is used wisely.

In 2006, Fairclough & Stratton examined the actual time children spent in MVPA during structured PE lessons. They observed 90 different lessons that were taught by 25 teachers using the System for Observing Fitness Instruction Time (SOFIT). Results indicated that students spent

somewhere between 30% and 40% of class time in MVPA. Although the approach to each lesson was to achieve 50% of MVPA the students were still left short from that daily recommendation.

Gender and Physical Activity Levels

Adolescents are not getting enough PA or taking the opportunity to be physically active. Females especially are lacking an adequate amount of PA. Research results indicate as young people age, their level of PA in participation decreases (CDC, 2013; Hoffman, 2009; USDHHS, 2012). Almost half of younger people aged 12 to 21 are not vigorously active on a consistent basis, 14 percent are completely inactive and young females are twice as likely to be inactive as young males (CDC, 1999). A study by Tudor-Locke, Lee, Morgan, Beighle & Pangrazi (2006) included 81 sixth grade students who wore pedometers for four school days and were prompted to record their steps when they first got to school and when they left school. They also recorded their steps before and after recess, lunchtime, and PE class. Overall, boys took more steps then girls in all settings. When comparing males and females, research shows males take more steps than females overall and they were engaged in MVPA for 24%, while females were engaged for 18% during their PE class time.

In a study done by Trost, et al., (2002) PA was objectively measured in a population based sample of students from 1-12 grade. The participants were 185 males and 190 females. The students wore a CSA 7164 accelerometer for 7 consecutive days. The students were grouped by grade as follows, 1-3(N=90), grades 4-6(N=91), grades 7-9 (N=96) and grades 10-12 (N=92). The minutes spent in moderate to vigorous physical activity was collected. The biggest difference was seen in grades 4-6 where boys were more active than girls. This study followed the trend seen in most research studies of girls being less physically active than boys.

A study by Telford et al., 2016 collected data on both boys (N=276) and girls (N=279) from 29 different schools. The study examined effects on individual, family and environmental level correlates on pedometer measured PA. Cardio-respiratory fitness (multi-stage run), eye-hand coordination (throw and catch test) and perceived competence in PE (questionnaire) were used. The results showed that girls were 19% less active than boys. Girls in comparison to boys had less favorable individual attributes with PA at age 8 years, including 18% lower cardio-respiratory fitness (3.5 vs 4.2, $p<0.001$, CI [0.5,0.9]), 44% lower eye-hand coordination (11.0 vs 17.3, $p<0.001$, CI [5.1,9.0]), higher percent body fat (28% vs 23%, $p<0.001$, CI [3.5,5.7]) and 9% lower perceived competence in PE (7.7 vs 8.4, $p<0.001$, CI [0.2,0.9]). The lower PA levels among girls were associated with weaker influence at the school and family levels.

Dencker et al., (2006) examined PA levels of 140 males and 108 females with a mean age of 9.8 over a 4-day period using accelerometers to track the students' PA. The study was primarily looking for a difference in those students who received daily PE versus those who received PE twice during the four days. The data was shown in mean counts per minute and was in line with many other gender studies showing that within the four days, males were substantially more physically active than females. In this study, males achieved 751 step counts/min and females achieved 618 step counts/min (Dencker et. al, 2006). The conclusion was regardless of the opportunity of PA males were more physically active than females.

These studies indicate adolescents are not getting enough PA. Specifically, females are lacking an adequate amount of PA in comparison to males. Additionally, these studies indicated that males are far more physically active than females.

Health Related Fitness Knowledge

SHAPE America has stressed the importance of developing physically literate children. The concept of mind behind movement has an influence on PA levels. Being physically literate not only helps with the ability to move with competence and confidence but it also gives a student a wide variety of physical activities in many different environments. The benefits help a student as a whole and helps them in all aspects of education. (SHAPE, 2016a)

A study by Lagally et al., (2016) examined the relationship between ratings of perceived exertion and heart rate in a natural PE setting. The students performed cardiovascular and muscular endurance circuits where they then recorded their ratings and their heart rate. When analyzed, the correlation between rate of perceived exertion and heart rate was low to moderate. This result indicates that the students are unable to recognize how their body feels regarding intensity. However, due to the limited research and the low to moderate correlation further studies need to explore self MVPA monitoring with and without technology as a tool.

Thomson & Hannon (2012) examined if health-related fitness (HRF) knowledge is related to self-reported PA of high school students. The study included 165 PE students from two schools. The students were given a 100-point HRF knowledge test. Their PA was assessed using the Physical Activity Questionnaire for Adolescents (PAQ-A). A Pearson correlations coefficient was generated to examine the strength between both tests. The results showed that students who scored higher on the HRF test tended to report being more physically active. This implies that more knowledge of PA leads to higher PA levels.

Studies have shown that a lack of knowledge influences PA time. Sanz & Norma (2017) examined the difference of total daily PA and physical condition variables between two groups of students during two entire academic years using different teaching styles. The teaching styles

were Reproduction of Knowledge (RK) and Production of Knowledge (PK). The control group was Mixed Knowledge (MK). The PA assessment was recorded using an Actigraph GT3X for 10 hours during the week and one 8-hour weekend day. The PK group raised significantly in all of the PA daily patterns except for one. This implies that having the knowledge behind the PA increases the PA levels.

In a study by Brusseau, Burns & Hannon (2016) the purpose was to examine PA and fitness content knowledge of students and determine which students accumulate more PA, do more PACER laps, and/or have a lower BMI. The 569 students wore a pedometer for a week, participated in the PACER test, and had their height and weight measured to determine BMI. They were also given a PE Metrics knowledge test. Two-way and three-way ANOVA tests were used to see the potential differences between grades, gender, and PA and health-related fitness performance. Children that had lower BMIs tended to score higher on the knowledge test. Students with more steps and PACER laps also tended to have higher knowledge scores. The correlation between the test scores and PA and BMI can suggest that increased knowledge can increase PA levels.

The development of a physically literate student tends to improve PA. Research using many different methods, including, rate of perceived exertion, fitness testing, different teaching styles, and pedometers tended to show that the more students know the higher their PA levels.

Technology in Physical Education

"Since the majority of U.S. schools are not meeting NASPE's recommendation of adequate instructional time, it is up to PE teachers to maximize the time they have with students to provide experiential opportunities, meaningful content, and appropriate instruction" (Partridge, King & McClary, 2011, p. 31).

Technology-based interventions in PE have become very popular in recent years. Pedometers, heart rate monitors, and Dance Dance Revolution have all been used as a mean of motivating technology savvy students in PE class (Gidlow et al., 2008). Monitoring devices can provide teachers with a reliable and valid method of monitoring students' PA (Wilde, Corbin, & Le Masurier, 2004). Technology can be an important tool when it is used to give students immediate feedback and the ability to self-monitor their PA (Steele et al., 2010). "Perceiving PA intensity can be a difficult task particularly for children who are not as cognitively mature as adults, and research has shown that most children are not instinctively (i.e. without practice) capable of accurately recognizing and monitoring their PA intensity" (Conley et al., 2011, p.155). "Heart rate monitors can show students that they are exercising in their target heart range, which can be beneficial for levels of motivation" (Pangrazi et al., 2003, p.48). Although heart rate does not measure PA directly, there is a linear relationship between oxygen uptake and heart rate (Eston, Rowland & Ingledew, 1998). There are many benefits to students working in their target heart range including developing maximum performance and speed, improving aerobic fitness and performance capacity, and improving basic endurance and muscle tone (Janz, 2002). Students using heart rate monitors gain a new awareness of their PA levels (Romar, Fagerström, & Granlund, 2011). Heart rate monitors individualize instruction for students to meet their needs based on their target heart rang (Gao, Hannon, & Carson, 2009). "By using these devices, students may feel motivated to be physically active (Clapman, Sullivan, Ciccomascolo, 2015, pg.1)." Students frequently use heart rate monitors and pedometers in PE classes (Duncan, Birch, & Woodfield, 2012; Ladda, Keating, Adams, & Toscano, 2013). Through these technologies, students receive augmented feedback and are able to quantify their exercise experience. Both instruments are appropriate to use with children, are self-monitoring

tools, and are useful in promoting PA (Duncan et al., 2012). Researchers have also found that using heart rate monitors with children in PE classes increased the amount of PA (Duncan et al., 2012; Grissom, Ward, Martin, & Leenders, 2005; Schofield, Mummery, & Schofield, 2005). In a study done by Ignico and Corson (2006), 175 fourth and fifth graders students who used heart rate monitors performed better on the mile test then those who did not. In a study done by Simmons-Morton et al. (1999) third and fourth grade boys and girls were in MVPA for longer periods of time when using technology than on the days they were not. These studies show that using technology increases the students' time in MVPA.

Conclusion

The lack of physical activity (PA) and rise in sedentary behavior has become an increasing problem in the United States (Owen, Sparling, Healy, Dunstan & Matthews, 2010). Despite the recommendations for PA our youth is not meeting those recommendations. (National Association for Sport and Physical Education, 2009). PE is an environment where all children should be engaged in PA, develop skill, gain knowledge, and develop a disposition of lifelong health enhancing PA. (Shape America, 2016a) Technology-based interventions and self-monitoring can help PE programs to increase the amount of time spent in MVPA during PA. Using technology helps teachers not only see if their students are working in MVPA but also to see if their students understand how their body feels when working in MVPA.

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APPENDIX A: PARENT PERMISSION

Parents/Guardians:

I am Amy Marzano, Physical Education teacher at Homer Junior High School. I am currently a graduate student and will be conducting a research study under the supervision of Dr. Skip M. Williams from the School of Kinesiology and Recreation at Illinois State University. I will be conducting a research study focusing on physical education students' time in their target heart rate zone when their heart rate is being displayed and when it is not.

I am requesting your child's permission to use their data (that we already collect during class activity in our physical education class), which will involve wearing a heart rate monitor for ten lessons in fitness based activity lessons to record their time in their target heart rate zone. Your child's participation is required as part of the physical education class requirement (but not graded), however, the use of their data for research purposes is completely voluntary. The data collection process will last approximately four weeks. Again we are not doing anything different than what we typically do each day for physical education. The only difference is that during some of the lessons your child won't have their heart rate displayed on the screen. Your child is not being graded on their participation.

Each student was assigned a heart rate monitor sensor with a number at the beginning of the school year. There is no posting of assigned numbers with student names in the gymnasium, classroom or locker room. The students will be wearing Polar H7 heart rate monitor sensors. This sensor is worn on a heart rate sensor strap that is worn on the chest underneath the shirt. They put this on in the locker room when they change their clothes for physical education. The number on the heart rate monitor sensor corresponds to what is being displayed on the screen. For example if I have heart rate monitor 1 then the number 1 is displayed as my I.D. along with my heart rate. No names are visually displayed. Additionally no students would know another student's heart monitor sensor number since it is underneath their shirt.

If you choose not to have your child's data used for research purposes, there will be no penalty (it will not affect your child's grade). Likewise, if your child chooses not to participate or to withdraw their data from the study at any time, there will be no penalty. The data that will be collected will be kept confidential and any information that might allow someone to identify your child will not be disclosed. Additionally, your child cannot be identified when the heart rate is visualized/displayed in class.

There are no risks involved with participation beyond those of everyday life and the potential loss of confidentiality. Although there may be no direct benefit to your child, a possible benefit of your child's participation is an altered Physical Education curriculum that is better suited to the students' interests and an increased promotion of physical activity within physical education.

If you would like to allow your child's data to be used in this study, you do not have to do anything at this time. Please know that your child's participation is completely voluntary and their information will be kept confidential.

If you would rather your child's data NOT be used for research purposes, please sign and date the attached form, and have your child return it to their physical education teacher by (INSERT DATE HERE). If you have any questions about this study, please feel free to contact me at 708-226-5873 or email at Amarzano@homerschools.org.

Sincerely,
Amy Marzano

Please only sign and date this form if you would rather your child NOT be invited to participate in this study.

Your Signature: _____Date: _____

Print Child's/Children's Name: _____

If you have any questions about you or your child's rights as a subject/participant in this research, or if you feel you or your child have been placed at risk, you can contact the Research Ethics & Compliance Office at Illinois State University at (309) 438- 2529.

APPENDIX B: INFORMED CONSENT

Students:

I am Amy Marzano, Physical Education teacher at Homer Junior High School. I am currently a graduate student and will be conducting a research study under the supervision of Dr. Skip M. Williams from the School of Kinesiology and Recreation at Illinois State University. I will be conducting a research study focusing on physical education students' time in their target heart rate zone when their heart rate is being displayed and when it is not.

I am requesting your permission to use your data (that we already collect and do in our physical education class), which involves wearing a heart rate monitor for ten lessons in fitness based activity lessons to record your time in your target heart rate zone. Your participation is required as part of the physical education class requirement, however, the use of your data for research purposes is completely voluntary. The data collection process will last approximately four weeks. Again we are not doing anything different than what we typically do each day for physical education. The only difference is that during some of the lessons you won't have your heart rate displayed on the screen. You are not being graded on your participation.

If you choose not to have your data used for research purposes, there will be no penalty (it will not affect your grade). Likewise, if you choose to withdraw your data from the study at any time, there will be no penalty. The data that will be collected will be kept confidential and any information that might allow someone to identify you will not be disclosed.

There are minimal risks involved with participation beyond those of everyday life and the potential loss of confidentiality, which will be minimized by storing all data on a password locked computer and office. Although there may be no direct benefit to you, a possible benefit of your participation is an altered Physical Education curriculum that is better suited to the students' interests and an increased promotion of physical activity within physical education.

If you would like to allow your data to be used in this study, please print your name and check the box "I give assent to use my data for research purposes" and return this to me your physical education teacher.

If you would rather NOT have your data be used for research purposes, please print your name and check the box "I don't give assent to use my data for research purposes and return this to me your physical education teacher.

Please know that your participation is completely voluntary and your information will be kept confidential.

If you have any questions about this study, please feel free to contact me at 708-226-5873 or email at Amarzano@homerschools.org.

Sincerely,
Amy Marzano

Print Your Name: _____ **Date:** _____

I give assent to use my data for research purposes ☐

I don't give assent to use my data for research purposes ☐