

Intensity Levels in Physical Education

The Effects of Higher Intensity Levels on Physical Fitness in Physical Education

A Synthesis Project

Presented to the

Department of Kinesiology, Sports Studies, and Physical Education

State University of New York, Brockport

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In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Education

(Physical Education)

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by

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May 10, 2023

STATE UNIVERSITY OF NEW YORK  
BROCKPORT, NEW YORK

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The Effects of Higher Intensity Activities and Physical Fitness Levels in Physical Education

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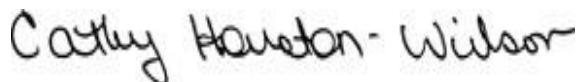
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Instructor Approval

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Date

Accepted by the Department of Kinesiology, Sport Studies, and Physical Education, State University of New York at Brockport, in partial fulfillment of the requirements for the degree of Master's of Science in Education (Physical Education: Teacher Ed/Pedagogy)



May 11, 2023

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Chairperson Approval

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Date

### **Acknowledgements**

This page is dedicated to expressing my heartfelt gratitude to those who have helped me along the way. Thank you, more than anyone else, to my mother for always listening, encouraging, and supporting me. Thank you to my husband, Mark, for providing the means for me to pursue my master's degree. Thank you to Olivia, a colleague who crossed my path early in the program. Thank you to the College at Brockport for allowing me to pursue an online master's while teaching full-time, coaching, and raising my daughter. Thank you to anyone and everyone who I had the pleasure of getting to know and learning from throughout the program.

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### **Abstract**

Obesity is considered by many to be an epidemic at all age levels. Specifically, adolescents between the ages of 2 to 19 have increased to body fat percentages of 19.7% over the last five years. Obesity can be caused by (but not limited to) low socioeconomic status, poor nutrition, genetics, and/or physical inactivity. Those with obesity demonstrate a decrease in muscular strength, muscular endurance and cardiovascular endurance; and an increase in an fat mass, BMI, waist circumference, Fat Mass percentage, and waist circumference. An important component when it comes to overcoming or preventing obesity is exercise and exercising at the appropriate intensity level. Physical Education is an opportunity in which adolescents can achieve the recommended daily of 60 minutes of moderate to vigorous physical activity (MVPA). The purpose of this synthesis project is to review the literature on the beneficial effects of incorporating higher intensity activities on physical fitness levels in Physical Education. It was concluded that integrating higher intensity activities into Physical Education improves health related fitness and body composition, can be incorporated at the primary and secondary levels, and can be added to current curriculums.

## Chapter 1 — The Introduction

Obesity is defined as an excessive amount of fat in the body, and it may affect people of all ages, from adolescents to the elderly. The 2017-2022 National Health and Nutrition Examination Survey (NHANES) reported rising obesity levels at an alarming rate. In this report, over the age of 20 were considered an adult, in which 41.9% were obese and 9.2% were severely obese. Furthermore, the authors reported an alarming rate of hypertension (45%) and diabetes (14.8%). Obesity rates in children are lower, but still cause concern with 19.7% of children aged 2 to 19 years of age obese (Bryan et al., 2022).

Obesity can be influenced by a variety of causes such as socioeconomic and environmental influences, nutritional consumption, genetics, and/or a sedentary lifestyle. Furthermore, obesity contributes to health problems such as decreases in muscular strength, muscular endurance, and cardiovascular endurance ( $V_{O2}$  Max); and increases body mass index, waist circumference, body mass index, fat mass percentage. (Ferkel., 2018) Each of these variables contribute to one's level of physical fitness and general physical preparedness.

Moderate to vigorous physical activity (MVPA) has been shown to decrease the risk of obesity, while also improving individual physical fitness levels. However, the biggest reason behind not exercising long enough to increase fitness levels is a lack of time (Jürimäe, 2020). In recent years, fitness training has introduced higher intensities, such as high intensity interval training (HIIT), tabata, bootcamp, and fitness skill based games. There are many health benefits to incorporating greater intensities during exercise, including enhanced cardiovascular fitness, bone mineral content, muscle mass, muscular strength, and flexibility, as well as decreased body

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fat percentage (Brisebois et al., 2021). Light intensity exercise level has been shown to be ineffective in terms of maintaining physical fitness levels.

Light intensity activities include shopping, taking a walk, and walking around the house. This intensity level is commonly referred to as lightest because it requires little effort, a minimal increase in heart rate (40-50% of maximum), little sweating, and no recognizable change in breathing patterns. Walking is a low intensity activity that promotes physical activity; yet it is ineffective for improving physical fitness levels in limited durations. Unfortunately, walking is a typical occurrence in physical education classes, and it has been reported that students progressed through higher grades and fitness levels in physical education courses. The amount of time spent walking increases as students move from primary to secondary levels. Elementary students spent 30% of physical education class walking, while middle school students spent 33% of class time walking and high school students spent 41% of class time walking (Kwon et al., 2020). The World Health Organization (WHO) recommends that children and adolescents should engage in an average of 60 min of moderate to high intensity physical activity (MVPA) per day to obtain health benefits.

Moderate exercise is performed at 55-75% of maximum heart rate and is demanding enough that the heart rate increases, body temperature rises, a sweat begins and breathing pattern changes. Some examples of moderate activities are jogging, basketball, swimming, and skipping. As intensity becomes vigorous, heart rate is maintained at 70% or above of the MHR, the heart rate increases quickly, body temperature rises rapidly and sweat develops early on. Compared to moderate levels, high intensity activity levels breathing patterns become substantially faster deeper and much faster leading to quick improvement in physical fitness levels (Brisebois et al., 2021).

Physical Education offers the opportunity to engage in MVPA. Even though physical education classes are frequently time-limited, increasing the cumulative time spent in MVPA can greatly improve physical fitness levels. Integrating greater intensity exercises in physical education can be time efficient, integrated into a variety of curricula, age appropriate, and tailored based on individual fitness levels. Through physical activity, physical education provides a chance to encourage and model behavioral change in adolescent students. For example, implementing a split-week program into physical education can be an effective and efficient strategy to execute a health-related fitness education curriculum, while also giving chances for learning in sport, outdoor leisure, and rhythmic activities (Ferkel et al., 2018).

### **Statement of the Problem**

Obesity is a widespread epidemic, affecting people of all ages, including the elderly, adults, and adolescents. According to Bryan et al. (2022), adolescents aged 2 to 19 have an alarming obesity rate of 19.7%. Obesity reduces physical fitness by lowering cardiovascular endurance (V02 max), muscular strength and endurance, and increasing fat mass, body mass index, and waist circumference. Adolescents in physical education have the opportunity to participate in and recognize the impact of intensity levels on physical fitness levels. Incorporating higher intensity activities into physical education, can help to combat obesity while also improving overall physical fitness levels.

### **Purpose of the Study**

The purpose of this synthesis project is to review the literature on the beneficial effects of incorporating higher intensity activities on physical fitness levels in Physical Education.



### **Operational Definitions**

1. Physical Education: A planned, sequential, curricular subject area for adolescents K-12. Physical Education can have a favorable impact on a student's health, attitude, and academic achievement.
2. Obesity: Determined by an individual's Body Mass Index (BMI), 25-30% is considered overweight, 30% or higher is considered obese.
3. Intensity: Measurement of effort exerted (light, moderate, vigorous). Intensity levels are often based on percentages of maximum heart rate (MHR).
4. Physical Fitness: An individual's state of well-being, general health, and physical preparedness.

### **Research Questions**

1. Does incorporating higher intensities into physical education improve student fitness levels?
2. Are higher intensities appropriate for primary and secondary physical education? Can results be seen at both levels?
3. Can higher intensity activities be incorporated into current curriculum?

### **Delimitations**

1. The articles used were peer reviewed and within the current 2013-2023 date range.
2. The articles all explored higher intensities within adolescents in P.E. class.
3. All participants in the studies were in grades K-12.

## Chapter 2 — The Methods

The purpose of this synthesis project is to review the effects of higher intensity levels on physical fitness in Physical Education. An extensive literature search was conducted at Brockport's Drake Library website, using the EBSCO database. This synthesis benefits by utilizing the most recent and up-to-date material available between 2013 and the present year. Selection criteria included scholarly, peer-reviewed literature and full text references. Within the EBSCO database four specific databases contributed supporting evidence on the statement problem: SPORTDiscus with Full Text, Academic Search Complete within the KSSPE database, Google Scholar, and PsycINFO.

The SPORTDiscus database was used for the initial literature search. The original search terms were HIIT training and obesity. There were 142 articles, which decreased to 140 after entering the 2013-present date range. After selecting Full Text and Peer-Reviewed, the number of articles decreased further, resulting in only 69 articles. Furthermore, the keywords physical education, HIIT training, and obesity resulted in a significant decrease down to 21 articles. The five articles had one thing in common: they all investigated different intensity levels and their impact on the subjects' physical fitness/body composition.

Academic Search Complete was another database that was used. The initial search terms were HIIT, obesity, and physical education. This generated 78 articles, which were reduced to 36 after applying the full-text and peer-reviewed criteria. Three articles fit the inclusionary criterion of being incorporated into a contemporary physical education class to be included in my critical mass.

The key words used in the original search in Google Scholar were: HIIT, physical education, and high school. There were initially 24,600 articles, which decreased to 17,900 when

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entering the 2013-present time frame. Using 2015-present resulted in a slight decrease to 17,500 articles. The keyword high school was changed to adolescents, which decreased the total number of articles to 4,580. The one article utilized from this database implemented different intensity levels while maintaining their regular physical education program.

The key phrases used in the original search in the PsycINFO database were: HIIT training and adolescents. There were initially 22 articles, which decreased to 21 after entering the 2013-present time frame. The number of articles decreased further after selecting full text and peer-reviewed, resulting in only 19 articles. Narrowing the search even further, the keywords were changed to physical education, HIIT training, and obesity. This changed the total number of articles to 21. Though this synthesis focuses on the benefits of physical fitness at higher intensities, one article from this database supports both physical fitness and the importance of cognitive knowledge of physical activity knowledge.

The literature review included in the critical mass were chosen based on inclusionary or exclusionary criteria. Participants in all studies ranged in grade levels from K-12 and engaged in physical education. Once the age range was shown to be inclusive, the next characteristic addressed was obesity levels. Students that were considered overweight or obese were included. The third key feature was the incorporation into a current physical education program. Exclusionary criteria included designs, techniques, and procedures that did not address the problem statement, such as participants that were at a post-secondary level, that did not classify the students as overweight or obese, or did not take place in setting of physical education.

### **Chapter 3 — The Literature Review**

The purpose of this synthesis project is to review the effects of incorporating higher intensity activities into physical education school curriculum and students' physical fitness levels.

#### **Background Information**

Bryan et al. (2022) reviewed the The National Health and Nutrition Examination Survey (NHANES) in the United States combining in-person interviews with standardized physical examinations and laboratory tests. Within this data is the 4-year (2019-2022) American community survey results. Results of the NHANES show that adults (20+ of age) were 41.9% obese, with 9.2% severely obese. Obesity resulted in a 14.8% diabetes prevalence and a 45% hypertension rate. Children obesity rates were lower but still raise concerns, with 19.7% of children aged 2 to 19 obese. Obesity prevalence increased with age among all children and adolescents aged 2-19 years (12.7% for those aged 2-5 years, 20.7% for those aged 6-11, and 22.2% for those aged 12-19). Obesity prevalence among children and adolescents aged 2 to 19 years was similar in boys and girls (20.9% vs. 18.5%). Males aged 6-11 years showed a greater prevalence of obesity than girls.

In addition, Hollis et al. (2017) conducted a systematic review and meta-analysis to determine the amount of time spent in moderate to vigorous physical activity (MVPA) throughout secondary physical education participation. The study included 7 middle school classes and 18 high school classes and was conducted between 2005 and 2014. Teacher observations, accelerometers, heart rate monitors, and pedometers were just a few instruments used. Depending on the tools used, the percentage of time spent in MVPA varied. However, a common finding across studies is that many classes fall well short of the CDC's recommendation

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of at least 50% MVPA time. A large percentage ranging from 12.9% to 68.2% shows that many of the studies in this analysis were below the recommendation. Concerns were that most lessons do not meet the bare minimum recommendation, and there is a common decrease in the percentage of time spent on MVPA as students move into secondary physical education. Middle school classes averaged 48.6% of time in MVPA, while high school classes averaged even less time at only 35.9%.

Similarly, Kwon et al. (2020) explored the relationship between Physical Education (PE) class characteristics like lesson context, teacher physical activity promotion behavior, lesson location and student engagement in moderate to vigorous intensity physical activity (MVPA) during PE lessons in both primary and secondary physical education. The study indicated that elementary level physical education students spend the least amount of time walking, averaging 30%. Middle schools had the lowest average of 33%, while high schools had the highest average of 41%. Although high school indicated the highest amount spent in MVPA (54%), they still accounted for the lowest time spent in vigorous physical activity at 13%. Elementary levels indicated the second highest percentage in MVPA with 47%, but also indicated the most time spent in vigorous physical activity with 16%.

## Gender Differences

Racil et al. (2016) collected data that could be important for exercise prescription and for evidence-based exercise programming in obese female adolescents. This study investigated the effects of high versus moderate intensity interval training on cardiovascular fitness, leptin levels and ratings of perceived exertion (RPE) in obese female adolescents. Forty-seven female adolescents were randomized into three groups of moderate intensity interval training (MIIT), high intensity interval training (HIIT), or a control group. Both the MIIT and HIIT had three

sessions per week which differed based on at their maximal aerobic speed (MAS), with the MIIT group at 80% MAS, and the HIIT group at 100% MAS. The control group had no exercise training. Body mass index z-score (BMIZ) and body fat percentage (BF%) decreased significantly from baseline intervention to post intervention measures in both MIIT and HIIT training groups. The HIIT group decreased their BMIZ range from 3.0 (+/- 3.8) to 2.8 (+/- 3.4), and the MIIT group decreased theirs from 3.6 (+/- 4.2) down to 3.2 (+/- 4.0). BF% had the strongest effect size relationship with type of training and decrease in body fat. BF% decreased the most in the HIIT group ranging from 38.8% at baseline down to 34.9%. The MIIT group also showed a decrease from baseline range of 39% down to 36% post intervention. Like BMI and BF%, both the HIIT and MIIT groups significantly increased their absolute VO<sub>2</sub>max. The MIIT group experienced the largest improvement from 2.71 (+/- 3.31 L/min) to 2.78 (+/- 3.46 L/min). The HIIT group saw an increase as well, going from a 2.7 +/- 3.25 L/min range to 2.76 +/- 3.34 L/min. In the HIIT group, waist circumference (WC) decreased significantly from a baseline range of 88-100/cm to a post-intervention range of 85-97cm.

Furthermore, Meng et al. (2022) conducted a randomized controlled study in obese boys aged 10 to 13 years to determine the effectiveness of a real-world school-based high-intensity interval training intervention on body composition, cardiorespiratory and cardio metabolic fitness. Participants were randomly assigned to one of three groups: control, moderate intensity continuous training (MICT), or high intensity interval training (HIIT). The MICT and HIIT groups each included fifteen participants who took part in 12-week program three days a week. The only difference between the groups was the participants' maximum aerobic speed (MAS) percentage at which they exercised. The MICT group performed 30 minutes of activity at 60%, 65%, or 70% of individual MAS. On the other hand, the HIIT group exercised for 30 minutes at

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90%, 95%, or 100% of individual MAS. Both groups saw improvements in cardio-respiratory fitness levels and body composition. The V02 max posttest showed significant improvements, with the HIIT group improving the most from pretest scores of 40.1-43.5 to posttest scores of 45.2-50.5. Participants in the HIIT group also improved the most in waist circumference (WC) and body mass index (BMI). Waist circumference measures decreased from 76.4-91.2cm pretest to 72.7-84.9cm posttest. Similarly, participants' BMI decreased from 23.4-25.6% to 21.7-23.7%. The MICT group improved the most in fat mass percentage with a decrease in score from 17.4-26.6% pretest to 14.9%-21.7% posttest.

With equally supporting improvements, López-Sánchez et al. (2017) revealed that a 12-week program of vigorous-intensity physical activity improved 10 and 11 year-old children's body composition in both males and females. Participants were randomly assigned to one of two groups: experimental or control. The experimental group incorporated a 12-week higher intensity training program into physical education class three times each week. The control group's physical education program remained unchanged. As a result, the males in the experimental group experienced significant improvements in the measurement of fat free mass (kg) with an improvement of 1.9kg and a significant decrease in fat mass, decreasing by 2.4%. As a result, the males in the experimental group saw a fat mass index pre-test measurement of 5.0 kg/m<sup>2</sup> decrease to 4.5 kg/m<sup>2</sup>. Females in the experimental group experienced a significant increase in fat free mass of 1.9kg, a significant decrease in fat mass of 2.4%, and a significant decrease in fat mass index of 5.0 to 4.5 kg/m<sup>2</sup>.

## Primary Grade Levels

Recently, Delgado-Floody et al. (2019) analyzed the feasibility of incorporating a 28-week HIIT program into physical education programs. This study included 197 students aged six

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to eleven years old: 108 females and 89 males. Then, students were split into four separate groups: experimental group 1, experimental group 2, control group 1 or control group 2. Students in experimental and control group 1 were classified as overweight; whereas students in experimental and control group 2 were classified as obese. The main difference in the experimental groups versus control groups was the intensity level in which the students participated in physical education class. The experimental groups performed a HIIT warmup with a 1:1 work to rest ratio (30s work/30s rest) followed by higher intensity games at 80-95% of their max heart rate, with a five-minute cool down. The control group performed a lower intensity warm up, followed by their regular curriculum and a 10-minute cool down.

Significant differences were observed between experimental and control groups. In terms of physical fitness there were four significant categories that showed improvement with the higher intensity implementation. Body Mass Index (BMI) improved significantly in both experimental groups but decreased in the control groups. Females in experimental group 2 decreased their BMI by -1.26, while males decreased by -1.13. Waist circumference (WC) decreased the most in experimental group 2, with a mean of -2.61; while control group 1 increased by +4.91. Body Fat Percentage (BF%) improved the most in experimental group 2, with a -5.41% decrease; while control group 2 increased by 1.95%. Resting heart rate (RHR) improved significantly for experimental group 2, with a -3.37 mean. Control group 1 increased by +10.25.

Similarly, Lambrick et al. (2015) explored the differential intensity levels and their association with health benefits in youth. Recommendations from the World Health Organization (WHO, 2014) identifies children ranging from 5-85<sup>th</sup> percentile as normal weight (NW), while 85<sup>th</sup>-95<sup>th</sup> percentile is considered obese (OB). In this study an even amount of NW and OB



children were randomized into two categories: exercise (ex) or control (con) group. The ex-group received an additional six-week, high intensity interval training (HIIT), child specific, game-based curriculum along with their regular physical education class. The curriculum was delivered twice a week for 60 minutes, maintaining higher intensity levels for at least 40 minutes of class time. The con group continued their regular scheduled physical education curriculum with no changes or alterations. A positive relationship was found in both OB and ex-students for VO<sub>2</sub> max in relation to fitness related components. The most significant improvement was seen in the OB baseline versus post intervention comparison, which resulted in a 4% improvement. The NW adolescents improved slightly, with a 1% change from baseline to intervention. The measurement of waist circumference was another area where both OB and NW students improved. The OB students from the ex-group showed the greatest improvement, with a -3% decrease in fat mass, and 6% improvement of muscle mass from baseline to post intervention measurements. This study not only demonstrated health benefits, but all children in the ex-group demonstrated participation with a 96% attendance rate and enjoyment with high paces score of 72 out of 80.

In addition, Llorente-Cantarero et al. (2022) performed a study consisting of 513 children ranging from 6-14 years of age. The children were randomized into four groups according to quartiles of moderate-vigorous physical activity (MVPA). The four categories were: Very Low Active (VLA), Low Active (LA), Moderate Active (MA), or High Active (HA). The VLA group recorded the least number of minutes in MVPA/day with 27.1 ( $\pm$  6.7min/day). The VLA group recorded the highest body weight with 52.6 ( $\pm$ 17.9kg). In contrast, the HA group had the highest minutes in MVPA with 79.9 ( $\pm$ 14.8 min/day), and recorded the lowest body weight of 49.8 ( $\pm$

19.2kg). Similarly, they recorded the lowest body mass index with a range of 17.6kg-28.4kg, and the smallest measurement of waist circumference of  $78.1 \pm 16.1$ cms.

### **Secondary Grade Levels**

Like previous studies, Harris et al. (2021) performed a study to determine the feasibility of generalist schoolteachers delivering curriculum connecting high intensity interval training in a school's physical education class time. The participants were four physical education classes from two schools consisting of 84 students ranging from 10-13 years old, and 64 males and 19 females. Similar to other studies, participants were randomized into two categories: intervention or control group. Participants in the intervention group experienced HIIT style workouts of 15-20 minutes two times a week. Participants in the control group had no alterations to their physical education curriculum. Scores from pre-test to post-test showed an improvement in both groups in modified pull-ups and higher intensity efficacies. However, the intervention group improved significantly in the modified pull-ups, improving from 10.7 to 19.9. Similarly, the intervention group improved slightly more than the control group in HIIT efficacy, improving from a pre-test score of 36.5 to a post-test score of 42.5. The intervention group significantly improved their cardiovascular endurance levels tested through the beep test, improving from a score of 38.8 to a post-test of 44.7. The intervention group improved significantly in lean body mass, improving from 33.9kg to 34.3kg.

In addition, Costigan et al. (2015) investigated the worldwide obesity pandemic and insufficient physical activity levels that accrue to health benefits. The study itself investigated the effectiveness and feasibility of embedding high intensity interval training (HIIT) into the school day and the impact of physical fitness levels of 9th -10th graders. Sixty-five students (45 males and 20 females) were randomly divided into three groups: gross motor and cardiorespiratory

focus (AEP), bodyweight+ cardiorespiratory (RAP) or a normalized physical education curriculum (CON). Both the AEP and RAP groups received HIIT training three times per week in addition to two times per week of physical education. The control group did not do any additional high-intensity interval training and instead followed their usual physical education program. All three groups used a HIIT workout for their class warmup before rejoining classes. To determine the effectiveness of the programs, a comparison of mean scores between the pre-test and post-test identified any differences. The RAP group had the greatest improvement for the cardio-respiratory variable measured using the fitness gram shuttle test, with an increase of +5.2 laps. Waist circumference improved in both the AEP and RAP groups, with the RAP group improving by -2.1cm. Muscular fitness was measured using acceptable test-retest methods for both the upper body (pushup) and lower body (standing long jump). All groups increased their mean number of pushups, with the AEP group improving the most (+3.8). Lower body scores improved in all groups, and the AEP group improved the most by +10.2cms.

Ultimately, Carson et al. (2014) examined the longitudinal associations between different physical activity (PA) intensities and cardiometabolic risk factors among a sample of Canadian youth, consisting of 513 youth ranging from nine-15 years of age. Three groups of exercise intensities: Light Intensity (LI), Moderate Intensity (MI), and Vigorous Intensity (VI) were broken up into four quartiles of Q1, Q2, Q3, and Q4. Significant changes were shown in body composition and health-related components within the two-year time span. The VI group had the greatest improvement in body mass index, decreasing from a 0.72 score in Q1 to a 0.31 in Q4. Both MI and VI groups experienced a decrease in waist circumference; however, the VI group improved from 78.75cm decreasing to 73.25cm. Respectfully, all groups experienced an increase

in their V02 max throughout the two years. However, the most significant improvement in V02 max, was the VI group, increasing from 0.81 in Q1 to 1.99 in Q4.

On the contrary, Chen et al. (2020) evaluated the limited efficacy of a high-intensity interval training (HIIT) based fitness education unit in middle school physical education (PE). Six PE classes consisting of 232 students: 148 females and 84 males in middle school participated in the study. The participants were randomly assigned to experimental group (n= 3 groups) or the control group (n=3 groups). Students in the experimental group participated in a 20–30-minute HIIT specified training embedded into their 50-minute PE class two or three times a week for eight weeks. The control group did not alter or embed any specific high intensity training. The experimental group improved the most in the push up posttest, with a score of +1.74. The pacer test declined minimally by -.29, and the curl-up test decreased dramatically by -2. The control group's findings were comparable, with the push-up test demonstrating the most improvement, with a +2.29 difference in scores. Similarly, the curl up test reduced the most considerably by -9.5 pushups; while the pacer test showed just a +0.4 difference. This study also looked at cognitive understanding of physical activity knowledge; whereas, the experimental group increased their knowledge scores by +9.57%, compared to students in the control group who decreased by 7.49%.

### **Chapter 4 — Results, Discussion and Recommendations for Future Research**

The purpose of this synthesis project is to review the literature on the beneficial effects of incorporating higher intensity activities on physical fitness levels in Physical Education. The purpose of this chapter is to present the results of the review of literature on higher intensities in physical education class as it relates to student physical fitness levels and how these results align with the examined research questions which guided this synthesis project. In addition,

recommendations for future research are presented as they relate higher intensities and physical fitness levels. Many conclusions were taken from the findings of this literature research. First, integrating greater intensity activities into physical education programs at both the primary and secondary levels both improve health-related and body composition components. Second, taking into consideration developmental appropriateness and safety, higher intensities can be incorporated at both primary and secondary levels. Third, there are a variety of ways in which higher intensities can effectively be added into the current curriculum.

### **Interpretations**

Several research questions were posed as part of this literature review. The first research question investigated if incorporating higher intensities into physical education increased student fitness levels. All but one article supported that higher intensity activities by adolescents improves physical and health-related fitness, as well as cardiometabolic risk factors. An example is Racil et al, (2016), who concluded several correlations between higher intensities and positive changes in body mass, body fat percentage and waist circumference. Similar results were discovered by Llorente et al., (2022), where the high activity group also had the most improvement in body mass index, waist circumference, and the least number of students considered obese. Comparably, many studies supported improvements of student fitness levels. For example, Costigan et al. (2015) saw improvements in cardiovascular endurance, waist circumference, and body mass index. In addition, the study showed an increase in student motivation to participate in HIIT style workouts. Supporting Costigan results, Harris et al (2022) displayed similar results with improvements in cardiovascular endurance, muscular strength, lean body mass, and higher intensities efficacy scores.

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The second research question examined was whether higher intensities are appropriate for primary and secondary physical education? Both levels of primary and secondary levels have concerning obesity rates. Adolescents 6 to 11 years of age have a 20.7% obesity rate, while secondary level students ages 12 to 19 have a 22.2% obesity rate (Bryan et al., 2021).

Throughout the literature review, all studies implemented higher intensities at either the primary or secondary levels, with positive correlations to student fitness levels. However, higher intensities of physical activity in physical education should take into consideration student development, motivation, interest, and safety. According to Blackshear (2019), “the benefits of higher intensities in physical education include short and sweet training, student choice, teacher assessment, enhanced student fitness, and enjoyment of participation in physical activity.”

Lastly, the third question examined was whether higher intensities can be incorporated into the current curriculum. The literature supports a variety of ways in which teachers can incorporate higher intensities into the current curriculum. At the primary levels, Lambrick et al. (2015) examined the incorporation of high-intensity game-based intervention on primary students. With success, students in the intervention group continued their regular physical education unit while monitoring their intensity percentage based on their heart rate. Similarly, Costigan et al. (2015) implemented a HIIT warmup versus a traditional warm up followed by the current physical education curriculum. This study yielded positive results, as students saw a decrease in waist circumference while improving their V02 max. Ferkel et al. (2018) recommends the utilization of split-week programming and the introduction of many training methods to improve knowledge and fitness movement principles so that students will be able to pick the style of programming that best fits their interests, enjoyment, and goals.

## **Implications**

The literature review performed in this synthesis examined a variety of ways to incorporate higher intensities at both the primary and secondary levels of physical education. The findings in the literature suggest that incorporating higher intensity activities can help improve students' physical fitness levels. While most research focuses on the effect at the secondary levels, the literature used in this synthesis supports positive outcomes at the primary levels. There were two articles that did not show correlation between higher intensities and physical fitness levels; however, they did support the cognitive aspect of fitness and physical activity. Chen (2022) & Harris (2020) saw minimal changes in physical fitness levels, but both noted significant improvements in physical activity knowledge and efficacy.

## **Recommendations for Future Research**

In reviewing the database on the effects of higher intensity activities on student physical fitness in physical education, the following limitations were noted regarding the studies used. First, all participants within the studies were overweight or obese, with some participants considered severely obese. Another limitation is the frequency of physical education that the students participate in weekly. And the biggest limitation that poses a large challenge for physical fitness levels is nutrition.

## **Summary**

The purpose of this synthesis project was to review the literature on the beneficial effects of incorporating higher intensity activities on physical fitness levels in Physical Education.

Delimiting variables such as “published within the last 10 years,” “peer-reviewed,” and “incorporated into physical education class” were utilized to help narrow the literature to help shape the paper.

The research showed positive relationships between incorporating higher intensities in physical education curriculum on student participation, student enjoyment, student knowledge and student physical fitness levels. With many physical education classes facing time constraints, the implementation of higher intensities is shown to be time effective and easily incorporated in a variety of ways. At the primary levels, based on student developmental appropriateness, low to moderate intensities may be effective. A focus on higher intensities is shown to be more effective while included in the current games-based curriculum. Lambrick et al. (2015) saw an improvement in adolescent muscle mass and cardiovascular endurance after a 6-week high-intensity, game-based intervention on health in normal and obese children. At the secondary levels, the replacement of current warmups with a higher intensity warm up, such as HIIT, MICT, or Tabata, can make tremendous improvements in student physical fitness levels. Delgado et al. (2019) saw improvements on BMI, body fat percentage, waist circumference and cardiovascular endurance with the implementation of a higher intensity warm up. The literature supports that physical education classes should incorporate higher intensities through a variety of ways to help reduce obesity and improve students’ physical fitness levels.



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## Appendix

Author	Title	Source	Purpose	Methods & Procedures	Analysis	Findings	Discussion/ Recommendations Research Notes – Commonalities/Differences
Chen, S., Liu, Y., Androzzi, J., Wang, B., & Gu, X. (2020)	High-Intensity Interval Training-Based Fitness Education in Middle School Physical Education: A Limited-Efficacy Study	Human Kinetics: Journal of Teaching in Physical Education  PsyncINFO	The purpose of this study was to evaluate the limited efficacy of a high-intensity interval training (HIIT)-based fitness education unit in middle school physical education (PE)	232 students 148 F 84 M  6 <sup>th</sup> -8 <sup>th</sup> Grade	EG: HIIT 2-3 days/week 10-20 min 20s/10s 65-95% intensity	EG: Pacer= -.29 Curl Up=-2.5 Push Up= +1.74  Control G: Pacer= +0.04 Curl Up= -9.57 Push Up= +2.29	Knowledge Experience Individuality  Not much difference in 8 weeks in fitness, but cognitive domain is IMPORTANT  Cognitive: HIIT: +9.24% Control= -7.49%
Costigan, S. et al., (2015)	Preliminary efficacy and feasibility of embedding high intensity interval training into the school day: A pilot randomized controlled trial	Elsevier: Preventive Medicine Reports  Google Scholar	The purpose of this study was to assess the effectiveness and feasibility of embedding HIIT into the school day	65 Children  M-45 F-20  Grade Levels 9 <sup>th</sup> & 10 <sup>th</sup> grade  52 classified as Healthy Fitness Zone	AEP- HIIT= gross motor+ cardiorespiratory  RAP- HIIT= bodyweight+ cardiorespiratory  CON- Normalized P.E. curriculum	RAP: -2.1cm waist circumference  Increase of 5.5ml vo2 max (6.1%)  AEP and RAP decreased BMI and BMI-z	AEP+RAP= 3x/week + 2x/week for P.E.  Geared towards the impact of a HIIT warm up versus traditional warm up  Once warmup was complete; groups merged for remainder of class
Delgado-Floody, P., Espinoza-Silva, M., García-Pinillos, F., & Latorre-	Effects of 28 weeks of high-intensity interval training during physical education classes on cardiometabolic risk factors in	European Journal of Pediatrics  Academic Search Complete	The purpose of this investigation was to determine the effects of 28 weeks of high-intensity interval training (HIIT)	197 students 108 F 89 M  6-11 years	EG: HIIT twice per week for 28 weeks (56 sessions-60 min) 4-6min reps 1-2min recovery	EG 1&2 experienced improvements in BMI.	4 groups: <u>Experimental Group 1 (EG1)</u> = 59 overweight (OW) schoolchildren <u>Experimental Group 2 (EG2)</u> = 92 obese (OB) schoolchildren <u>Control Group 1 (CG1)</u> = 17 overweight (OW) children

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Román, P. (2018)	Chilean schoolchildren: a pilot trial		during physical education classes on the weight status, cardiorespiratory capacity, and blood pressure of overweight and obese schoolchildren		Circuit Warmup: 30/30 or 60/60 work/rest 45 min HIIT games @ 80-95% MHR CG: 15 min low intensity warmup 35 min regular PE curriculum 10 min cool down		<u>Control Group 2 (CG2)</u> = 29 obese (OB) schoolchildren MHR= Max Heart Rate
Hollis Sutherland, Williams, Campbell, Nathan, Wolfenden (2017)	A systematic review and meta-analysis of moderate-to-vigorous physical activity levels in secondary school physical education lessons	International Journal of Behavioral Nutrition and Physical Activity  Academic Search	The purpose of this study was to determine the proportion of secondary (middle and high) school physical education (PE) lesson time that students spend in moderate to vigorous physical activity (MVPA)	28 papers/ 25 Studies 2005-2014 7 M.S. 18 H.S.  7 Countries Quantitative measurement  % of time in MVPA vs class time	Observational Accelerometers Heart Rate Monitors Pedometers	<b><u>M.S. Time in P.E.:</u></b> 37-90 min <b>MVPA</b> M.S.:48.6%  <b><u>H.S. Time in P.E.:</u></b> 20-90 min <b>MVPA:</b> H.S.: 35.9%	students spent 34.7% (25.1–44.4%) of PE lesson time in MVPA; in comparison to: observational methods 44.4% heart rate monitors 43.1% pedometers 35.9% ** lessons that included activities that fell into multiple categories; MVPA was not reported separately for each lesson type
Kwon, S., Welch, S., & Mason, M. (2020)	Physical education environment and student physical activity levels in low-income communities	BMC Public Health	The purpose of this study was to examine the association of physical education (PE) class characteristics with student engagement in	Suburban Area 40% of students qualify for free/reduced lunch.  40 schools: 26 elem 6 M.S.	An activity level was evaluated as a percentage of PE class time (frequency) spent in the activity level.	Class time/Length Elem: 32→ 31 M.S. 46→ 41 H.S. 46→ 41 Activity Level Elem:	System for Observing Fitness Instruction Time (SOFIT) Student participation, lesson context, teacher engagement: time sampling/interval recording  ← Teacher= Teacher behavior of promotion of in class physical activity.

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			moderate- and vigorous-intensity physical activity (MVPA)	8 H.S. =2,063 p.e. classes		Walk: 30% Vig: 16% MVPA: 47% Teacher: 19%  M.S. Walk: 33% Vig: 11% MVPA: 44% Teacher: 13%  H.S. Walk: 41% Vig: 13% MVPA: 54% Teacher: 9%	
Lambrick, D., Westrupp, N., Kaufmann, S., Stoner, L., & Faulkner, J. (2015)	The effectiveness of a high-intensity games intervention on improving indices of health in young children	Journal of Sports Sciences  SPORTDiscus	The purpose of this study was to examine the effectiveness of a 6-week high intensity game-based intervention on health in normal and obese children.	55 students 23 females 32 males  8-10 years Normal Weight (NW) 5 <sup>th</sup> -85 <sup>th</sup> percentile  Obese (OB) >95%	EX Group 6- week HIIT child-specific 2/weekly 60 min PA time-40 min  CON Group Regular P.E. classes no additional exercise focus	BF % OB 33.7 ± 7.1 decrease to	6 weeks can improve oxygen uptake and running speeds; improve body composition in both NW & OB adolescents
Llorente-Cantarero, F. J., Aguilar-Gómez, F. J., Bueno-Lozano, G. et al., (2022)	Impact of Physical Activity Intensity Levels on the Cardiometabolic Risk Status of Children: The Genobox Study	Human Kinetics: International Journal of Sport Nutrition and Exercise Metabolism	This study aimed to evaluate the impact of physical activity intensities and practice on inflammation, endothelial damage, and	1,444 children (706 males and 738 females), aged 3– 17 years Subsample: 513 children white; 6-14 years	ActiGraph GT3X and GT3X+ accelerometers  4 Groups: Very Low Act. Low Act. Moderate Act. High Act.	63.3% Boys MA-HA 61.9% Girls LA-VLA  HA group lowest weight range: 30.6kg-60kg Lowest BMI:	Very Low Active (VLA) Low Active (LA) Moderate Active (MA) High Active (HA)  Differences by sex  VLA Group                      HA Group NW- 25%                              30.4%

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		SPORTDiscus	cardiometabolic risk factors in children.		47.2% Obese 23.8% Overweight	17.6kg-28.4kg Smallest Waist: 62cm-94.2cm	OW- 26.2% OB- 24.4%	24.6% 21.9%
Racil, G., et al., (2016)	Greater effects of high- compared with moderate-intensity interval training on cardio-metabolic variables, blood leptin concentration and ratings of perceived exertion in obese adolescent females	Biology of Sport  SPORTDiscus	The purpose of this study was to examine effects of high- vs. moderate-intensity interval training on cardiovascular fitness, leptin levels and ratings of perceived exertion (RPE) in obese female adolescents	47 healthy obese females; 3 schools	MIIT Group: Moderate Intensity 3 days/ week 12 weeks  HIIT Group: High Intensity 3 days/ week 12 weeks  Control Group: Non-Exercising	Miit: BM: 88.3→ 86.6 BF%: 40.6→ 37.2 WC: 93→ 91  HIIT BM: 87.3→ 84.1 BF%: 40.3→ 36.4 WC: 94→ 91 Control BM: 85.6→ 85.9 BF%: 39.8→ 39.3 WC: 94→ 94	Miit Group: 15s @ 80% Maximal Aerobic Speed (MAS) 15s rest @ 50% MAS  HIIT Group 15s @ 100% Maximal Aerobic Speed (MAS) 15s rest @ 50% MAS  BM=Body Mass BF= Body Fat % WC= Waist Circumference	
Bryan et al., (2021)	National Health and Nutrition Examination Survey 2017–March 2020 Prepandemic Data	National Health Statistics Reports	The purpose of this survey explains the creation of the 2017–March 2020 prepandemic data files, provides recommendations for and limitations of the files' use, and presents prevalence estimates for selected health outcomes	4 year 2017-2020 Sampling Data 19-20 30 PSU's 20-22 30 PSU's	4-year American Community Survey	Ages 2-19 Obesity: 19.7% 20+ Obesity: 41.8% Severe Obesity: 9.2% Diabetes: 14.8%  18+ Hypertension: 45.1%	PSU= Primary Sampling Units	

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Lopez-Sanchez, et al., (2017)	Effects of a 12-week-long program of vigorous-intensity physical activity on the body composition of 10- and 11-year-old children	Journal of Human Sport and Exercise  SPORTDiscus	The purpose was to study the effects of a program of vigorous-intensity physical activity (PA) on the body composition of children	108 students 60m 48f  10-11 years' old	12 week 3x's/week 15 minutes  EG-vigorous CG-no MVPA	EG Decrease in FM% by -2.4%  Decrease in BW -1.2 kg  Both EG+CG minimal change in BMI= -0.1%	Experimental (EG) 48 Control (CG) 60  FM%=Fat Mass % BW= Body Weight BMI= Body Mass Index
Carson, V. et al., (2014)	Vigorous physical activity and longitudinal associations with cardiometabolic risk factors in youth	International Journal of Obesity  Academic Search Complete	The purpose of this study was to examine the longitudinal associations between different physical activity (PA) intensities and cardiometabolic risk factors among a sample of Canadian youth.	315 youth  Ages 9-15  2 year pre and post test		BMI decrease: Greatest in Vig Group with a -0.72→0.31 from Q1-Q4 Waist Circumference: Greatest decrease in Vig Group with -5.5cm V02 Max: All increased throughout the study: largest improvement with Vig. Group with +6.9% increase	3 groups: Light-Intensity PA Moderate-Intensity PA Vigorous-Intensity PA
Meng, C., Yucheng, T., Shu, L., & Yu, Z. (2022)	Effects of school-based high-intensity interval training on body composition, cardiorespiratory	BMC Pediatrics  Academic Search Complete	The purpose of this study this study was to determine the effect of a real-world school-	45 boys 10-13 years old 95%+ BMI	12 week program 3x's week HIIT 30 min @: 90% 95% or 100% of MAS MICT 30 min @:	<u>FM% Fat Mass</u> MICT largest improvement @ 14.9-21.7% post test <u>V02 Peak</u>	HIIT (High Intensity Interval Training) n=15 MICT (Moderate Intensity Continuous Training) n=15 CON (Non exercising Control) n=15 MAS= Maximal Aerobic Speed

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	fitness and cardiometabolic markers in adolescent boys with obesity: a randomized controlled trial		based high-intensity interval training intervention on body composition, cardiorespiratory fitness and cardiometabolic markers in obese boys aged 10 to 13 years.		60% 65% or 70% MAS	MICT + HIIT improve: HIIT 40.1-43.5 increase to 45.2-50.5 <u>Waist Circumference:</u> HIIT greatest decrease from 76.4-91.2 cm → 72.7-84.9cm <u>BMI:</u> similar in MICT + HIIT HIIT greater decrease 21.7-23.7	
Harris et al., (2021)	Feasibility and Provisional Efficacy of Embedding High-Intensity Interval Training Into Physical Education Lessons: A Pilot Cluster-Randomized Controlled Trial	Human Kinetics  Pediatric Exercise Science  SportDISCUS	The aim of this study was to determine the feasibility of generalist school teachers delivering curriculum connected high intensity interval training in a school's physical education class time.	2 schools 4 classes 84 students 10-13 years old 64M;19F	Intervention: 2x/week HIIT focus  Control: Normal P.E. curriculum	Beep Test: Cardioendurance: Intervention improved 38.8→44.7 Mod Pull Ups: Both improved Inter more 10.7→19.9 Lean Body Mass: Inter improved slightly 33.9→34.3 kg HIIT Efficacy: Both improved: intervention 36.5→42.5	



