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Engaging Students with Autism Spectrum Disorder in Physical Activity to Improve Health and Educational Outcomes

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Engaging Students with Autism Spectrum Disorder in Physical Activity to Improve Health and Educational Outcomes

by

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Chapter 1: Introduction

Physical activity is an essential aspect of all individuals' physical and mental well-being. This is especially important for adolescent and school-aged children. Current recommendations for youth ages 6-17 is 60 or more moderate to vigorous physical activity (MVPA) minutes per day (United States Department of Health and Human Services, 2018). This includes time spent on aerobic, muscle strengthening, and bone-strengthening activities. Unfortunately, youth with developmental disabilities (DD), specifically autism spectrum disorders (ASD), are highly likely to not get the recommended amount of physical activity (PA). Leading this population to be at a greater risk for obesity and lower fitness levels when compared to their typically developed peers (Hinckson et al., 2013). In a review of data collected by the National Survey of Children's Health, it was found that youth ages 10-17 are 60 percent less likely to engage in regular physical activity when compared with typically developing (TD) peers (McCoy & Morgan, 2019). The same data also shows they were also 27 percent more likely to be overweight and 72 percent more likely to be obese (McCoy & Morgan, 2019). Lack of physical activity and obesity are proven risk factors for several health concerns including heart disease and diabetes. These statistics point to a major health concern that needs to be addressed. Placing importance on quality physical education with a focus on generalization, combined with in-class movement opportunities would have a positive impact on this population's health outcomes throughout their lives.

Several unique characteristics cause students with ASD to have difficulties in the classroom. According to the American Psychiatric Association's Diagnostic and Statistical

Manual, Fifth Edition (DSM-5), the three main areas of deficits of ASD are social-emotional reciprocity, nonverbal communicative behaviors, developing and maintaining relationships. Along with these aspects, there are varying levels of severity based on the restriction of interactions or repetitive behaviors. According to the Centers for Disease Control's (2020) Autism and Developmental Disabilities Monitoring (ADDM) Network, it is estimated that 1 in 54 (18.5 per 1000 8-year-olds) children in the United States are identified with ASD. The same resource states that boys are 4 times more likely to be identified with ASD than girls. These social deficits associated with ASD specifically hinder these youth in playing social games that require multiple modes of frequent communication.

Along with social barriers to physical activity, many students with ASD exhibit lower gross motor functioning and hand-eye coordination (Fournier et al., 2010). This is logical due to the fact that ASD is a neurodevelopmental condition and children typically show delayed milestones in motor functioning early in life and continue as they age without intervention. Gross motor skills can be measured effectively using several assessments including the Bruininks-Oseretsky Test of Motor Proficiency-2 (BOT-2) and Test of Gross Motor Development (TGMD). Using these tools, Liu et al. (2021) cite several studies that show over 70 percent of adolescents with ASD show this lack of motor abilities. Many team and some individually-based activities require skills such as throwing, catching, or kicking. The ability to practice these skills outside of a group setting may be a beneficial way to increase engagement in PA.

Other barriers self-reported by parents of students with ASD were negative affective reactions, teasing, bullying, and social isolation (Pontifex et al., 2014). Self-identified barriers by students with ASD include physical activity include fear of injury, bullying, sensory issues, and physical ability (Healy et al., 2013). All of these are part of the equation leading to lower participation in physical education classes in these students. Social isolation leading to sedentary behavior is a clear factor in the lack of PA. While it may be assumed that youth with ASD have more screen time (watching tv, video games, etc.), it is shown to be very similar to their TD peers at around 3.5 hours per day (Montes, 2016). Other studies have confirmed this but also show a statistically significant difference in PA levels as children age from 9-17 years of age (Dahlgren et al., 2021). Interestingly, social interactions with typically developing peers has been shown to increase MVPA in students with ASD (Pan et al., 2016). No matter the barrier, it is clear that youth and adolescents with ASD have more difficulty meeting the recommended PA levels.

Importance of Topic

Overweight and obesity in all youth is highly concerning due to recent trends and the other health issues it can lead to such as diabetes and cardiovascular disease. Self-reported results from the Youth Risk Behavior Survey show that adolescents with disabilities are more likely to be obese, have at least one unhealthy weight control behavior, and are less likely to be physically active (Papas, et al., 2016). The same report states the fact that youth with limitations in PA are twice as likely to be overweight or obese as those without limitations (Papas et al., 2016). Importantly, as youth with ASD age from 10-17 their odds of obesity rise consistently when compared with youth without ASD (Must et al., 2017). This type of data shows the critical need for finding effective early interventions for youth with disabilities.

There is concern that these trends of overweight and lack of PA in youth with ASD may continue into adulthood. This would keep them with higher risk factors for the previously mentioned health issues. A meta-analysis by Li et al. (2020) found that as youth with ASD aged into adulthood normal weight decreased from 63.7% to 32.9% and obesity increased from 14.8 to 31.3. Those are dramatic results that can have big impacts on the overall health of this population. As cited by Kuschner and Malow (2021), adults with ASD have an 'increased health burden of disease...and higher odds for needing additional health services'. Although there is no doubt that several factors such as diet, medication, and compounding health factors also play a role in these facts, emphasizing physical activity should still be thought of as an important path to helping reduce these trends.

Along with the physical benefits, there is emerging research into the improvements that can be seen in necessary classroom behaviors with bouts of physical activity (Tan et al., 2016). Specific benefits are in areas of stereotypic behavior, cognition, attention, and social-emotional behavior (Bremer et al., 2016). Although there is research to suggest academic benefits from PA, there are several variables such as type of activity and intensity. Understanding the effects PA may have on student behavior needs to be continually researched. Students with ASD already have difficulties in the classroom, typically causing a deficit in their educational progress. Any proven effective strategy, including PA, should be utilized to improve their academic performance.

As a physical education instructor at a Federal Setting IV high school serving several students with ASD, this topic is highly relevant to my work. I see the barriers described in this paper on a daily basis and am striving to further my ability to serve them as best as possible. Having effective communication and relationships with my students is important. A better understanding of their difficulties regarding physical activity, along with increasing my knowledge of engaging practices will help me design the most appropriate curriculum.

Research Questions

Two research questions will guide this review of literature:

1. What educational benefits can physical activity have on this population?
2. What are the best practices along with unique strategies for engaging students with ASD in physical activity?

Focus of Paper

This paper will attempt to describe how physical activity can have lifelong and short-term benefits for youth and adolescents with ASD. Emphasizing positive behavioral impacts that PA may have on other aspects of a student's learning experience. It will explore some of the barriers these students face in getting enough PA and more importantly the practices that should be utilized to overcome these obstacles. Simply finding ways for positive engagement in this population is a strong predictor of success. With that in mind, there will also be a focus on unique strategies or types of activities that students may not typically receive in a standard physical education class. The literature review in the following chapter will examine the most current studies and analysis on the topic.

Chapter 2: Review of Literature

This literature review looks at 12 articles examining the topic of physical activity in adolescents with ASD. The first 2 articles will set the stage by describing current perceptions, experiences, and barriers to PA in school for this population. These articles will briefly voice the perspective of students and educators on this topic. The qualitative information contained in the opening articles is important to keep in mind when developing appropriate curricula and strategies for working with this population towards increasing their physical education. The next 5 articles will focus on the research question regarding strategies for increasing students' engagement in PA. A majority of these studies will focus on technology-based interventions. The final 5 articles reviewed will analyze the benefits that PA can have on student achievement in school. This will incorporate effects on both behavioral and cognitive aspects. Here again, technology-based interventions will be highlighted as useful tools for not only increasing engagement but also providing educational benefits to youth with ASD.

Teacher and student experiences with PA in school

Healy et al., (2013) sought to examine the positive and negative experiences of students with ASD in a mainstream physical education setting. A majority of research in this area before this article was focused on the experiences of students with physical disabilities. Gaining perspective specifically from this audience is important to understanding barriers and thinking about possible solutions.

The participants were youth ages ranging from nine and thirteen. Eleven boys and one girl made up the group of twelve. All had a formal diagnosis of ASD and were receiving their physical education in a mainstream setting. Semi-structured interviews were administered and transcribed to provide consistent themes of responses by the participants. The interview was well thought out and planned by researchers with experience working with students in this population. Delivery of the interview utilized strategies such as unfinished statements, visual aids with text, and slideshows to help guide students through the process. The process of developing the interview resulted in high accessibility for participants and minimal interviewer bias.

The transcribed interviews were reviewed by researchers. A process known as thematic analysis, a functional way to analyze qualitative data, was used to translate responses into four common themes. Research bias was also addressed through the use of recording assumptions. The data was reviewed several times and researchers concluded the four themes were more accurately described in three categories: Individual challenges, peer interactions, and exclusion.

A frequently documented barrier identified in the interviews was physical ability (n=10). Multiple statements from the students stated that the group game they were participating in was moving too fast. Sensory issues accounted for n=3 concerning individual challenges. One student claimed, “I feel good cause I’m going to exercise and stuff in a fun way but I hate it when I get all hot and sweaty”. Peer interactions brought out some of the positive responses from students with n=4 describing camaraderie as part of their classroom experiences. Two from the group identified PE as an opportunity to initiate friendships. Alternatively, there were several responses surrounding bullying (n=5) and other negative peer interactions (n=4). “I can’t catch a ball and they just keep shouting at me,” one participant told the interviewer.

Exclusion was the final category that was a theme from responders (n=7). Exclusion was reported in multiple ways. The lowest type (n=2) was teachers requesting a student to not participate in an activity. Followed by a student requesting to sit out and the teacher allowed it (n=4). Lastly, a student sitting out due to lack of ability (n=5).

The results of this research help give an honest perspective on a variety of experiences had by students with ASD in a physical education setting. The discussion on providing best practices begins with understanding these experiences. The ratio of male to female participants in this study was not reflective of the larger population of youth with ASD. It is also limited by the number of participants and the specific setting of a mainstream physical education classroom. Despite these, the implications for educators are important to consider. It also reinforces some of the barriers which may contribute to youth with ASD engaging in less physical activity in a class setting than their typically developing peers (Pan et al., 2016).

Looking at teachers' perceptions and knowledge of incorporating PA into this population's school day is also an important aspect to consider. This was the purpose of a survey study recently completed by Oriel et al. (2020). The authors also wanted to identify barriers seen by teachers and provide helpful recommendations.

A 20-question survey was designed to gather comprehensive results from teachers all across the country that were in the Council for Exceptional Children database. In total, 121 teachers completed the online survey which produced qualitative and quantitative results of their experiences. The student population in the classrooms was ages 3-18 (44.9%) with an average of 3.5 students with ASD. One outlier was a teacher who had 35 students diagnosed with ASD in the class. Outside of classroom demographics, the survey focused on knowledge, perceptions, and barriers to their use of PA. Every teacher surveyed agreed that PA is beneficial for these students. The themes of benefits identified were many and are shown below in Table 5. The study did not describe if teachers were able to agree with multiple behaviors for this question.

Table 1

Identified Benefits of PA

Behavioral improvements described by teachers	**Percentage of teachers who agreed**
Focus/Attention	24.9
Sensory/Self-regulation	18.3
Mood	15.6
Socialization/Peer interaction	11
Energy	9.8
Motor function/Fitness	8.4
Behavior	7.1

Other aspects inquired by Oriel et al. (2020) were the type of PA and engagement levels. The largest percentage of teachers (31.9%) responded that they used music or directed movement videos to incorporate PA. General aerobic exercises such as pushups, jumping jacks, running, etc. accounted for 21.8% of responses. The others were yoga/stretching (16.5%), brain breaks (14.7%), and fitness center/equipment (14.7%). These bouts of PA lasted at least 5 minutes for 44.6% of teachers and students participated in at least half of the session 68.8% of the time.

Barriers to implementing PA in school for students with ASD were important questions asked of the participants. The responses were both regarding students' abilities as well as logistical reasons. Table 6 shows a breakdown of the main themes identified. Overall, 47% of participants at least somewhat agreed that they had difficulty engaging students with ASD in PA. Other responses less cited were safety-related. An open-ended question on this topic was answered by one teacher stating "pressure from higher ups to keep things academic".

Table 2

Identified Barriers to PA

Barriers	**Percentage of teachers' responses**
Time/Space/Equipment	26%
Lack of motivation	18.4%
Sensory/Motor difficulty	16.8%
Poor behavior	14.4%
Social skills	13.6%
Lack of administration support/staffing	10.4%

Oriel et al. (2020) could have provided more robust qualitative data by analyzing responses from specific student demographics. This study was by no means comprehensive but does attempt to capture useful themes for educators. Importantly, a majority strongly agreed that PA is beneficial for their students, yet only 19.4% received any specific education in their undergraduate studies about the benefits. Also, 53% of teachers stated that PA is not a regularly scheduled part of their students' school day. Providing education, resources and eliminating logistical barriers are steps that can be taken to help teachers effectively provide PA in their classes.

Table 3

Staff and Student Survey Studies

Authors	Study Design	Participants	Procedure	Findings
Healy, Msetfi & Gallagher (2013)	Qualitative	12 youth ages 9-13 with ASD in a general PE class with no other supports. 11 boys and 1 girl	Informal interviews using unfinished questions, PowerPoint slides, and other visuals.	Three themes were identified based on their responses: individual challenges, peer interaction, and exclusion.
Oriel, Reed, Saufley, Wetzel & Wilt (2020)	Quantitative and qualitative	121 teachers from across the country with students ranging from 3-18 years old. Their class sizes averaging 17.2 and the average number of students with ASD is 3.5(range 1-35)	An online survey was offered through Council for Exceptional Children database and social media. Survey collected qualitative data on teachers' perceptions of PA in relation to students with ASD.	Themes that described positive benefits from PA included: improved focus, increased self-regulation, improved mood, improved motor skills, and increased social interaction. The majority of responses stated that PA was a part of their classroom time most days. Methods and time varied widely among responses.

Best Practices and Unique Strategies for Engagement

Providing more precisely measured data on student engagement in PA can help give light to best practices for teachers to use in the classroom. Pan et al. (2011) attempted to do this by examining physical movement among participants in a physical education class. They were able to provide data to correlate with environmental and personal factors. The group of authors posited that the students with ASD would have lower engagement overall.

The study population was 19 male students with ASD with an average age of 14.19 and 76 of their TD peers with a similar median age. Students were sampled from across nine Taiwanese schools and data was collected during 45-minute physical education classes with a total of 38 lessons being taught. Setting and type of lesson were also part of the data collection. Eighteen lessons were classified as team activities, 14 were individual activities and 6 lessons were fitness testing and free play. Outdoor lessons comprised 57.89% while 15.79% took place indoors. Ten lessons took place in both settings.

The tool used to measure activity levels was an accelerometer that tracks vertical motion as well as steps. This type of device is used in current fitness trackers and has been used in previous research in similar fields. The data gathered from the accelerometers is designated as counts per minute (CPM).

Social interaction was another focus of the study and was categorized into interactions with adults or peers. An interval-based recording system was used every 10 seconds to track occurrence or nonoccurrence. Social initiation was documented using the same interval recording method. Three researchers were trained in observation methods. During the study interobserver agreement was monitored to keep a consistent rate of 85%.

The two groups being observed were students with ASD (n=19) and their typically developing peers (n=76). Since there is a clear difference in group size the researchers used a non-parametric one-way ANOVA on ranks to find statistical significance regarding social engagement. In order to measure connections between PA and social variables, Spearman rank-order coefficients were used as well to analyze data.

The only significant difference in overall PA levels between the two groups was steps per minute as measured by accelerometers. A Cohen's d medium effect size of .60 was found with p=0.24. More interesting differences were found when comparing environmental factors and social engagement concerning levels of PA. They were, however, calculated for all participants and not distributed into ASD and TD peers. Higher MVPA was shown during fitness testing and free play with a Cohen's d effect size of .74 along with individual activities with a 1.55 of the same statistic. The contrast of MVPA in a physical setting resulted in more PA in outdoor classes vs. indoor classes with a high confidence p-value of .001. The Spearman rank correlation was used to investigate social engagement and activity levels among the ASD group (n=19). Positive associations were found between social initiation with peers and steps per minute (.48 with a p-value of <.05) along with MVPA (.54, p-value < .05).

If the goal is to increase PA in youth with ASD, Pan et al. (2011) have given us some considerations for best practices in the physical education classroom. Outdoor lessons, allowing for free play and fitness testing, social initiation, and inclusive lessons with TD peers all were seen to be productive ways to increase activity levels. This study was limited by the lower number of ASD participants. Assumptions were made regarding how TD peers may have helped improve PA in the ASD group, but this is difficult to do with this study alone, considering all the testing was done in inclusive groups with no control group to compare data against.

Judge (2015) sought to study the effects of a computer-based fitness schedule (CBFS) to assist a transition-age student with ASD. Best practices for this population need to keep in mind the generalization of skills and routines for success outside of school settings. Predictable routines and visual supports are already used interventions in classrooms for this population. Judge builds on this in her study by also adding a computer-based delivery system.

The single participant in this study was a 19-year-old male student with ASD. He participated in a non-inclusive physical education class. He was described as having “periodic episodes of aggression while transitioning from one task to another”. The student was noted for being capable of performing fitness routines safely but did struggle with transitioning between exercises.

The intervention was a simple CBFS created specifically for the student. It was presented using PowerPoint on a laptop computer. The program was created to be navigated by the participant by clicking through the slides and providing sound tones. Upon completion, the program played an applause sound, tone, and then the student was offered a preferred activity. The study took place in a public high school fitness center that had several cardiovascular and muscle strengthening machines. Judge (2015) utilized an A-B-A-B study design through 15 fitness sessions to test the effectiveness of this CBFS on the independent transitioning of the student. An independent transition was defined as moving to the next exercise within 1 minute without a cue from the adapted physical education teacher. The sessions were 15 minutes long and during baseline phases, the student transitioned to exercises of his choice.

Both sections of baseline data recorded a mean of 1.5 independent transitions. The intervention phase produced 7 independent transitions consistently. The table below shows the data collected, reflecting that there were no recordings during the training section of the study.

Table 4

Successful Independent Transitions Between Exercises

Session	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Treadmill	x	x				x	X	x	X		x	x	x	X	X
Toe Touches						X	X	X	X	X				X	X
Butterfly						X	X	X	X	X				X	X
Arm Stretch						X	X	X	X	x				X	X
Chest Machine			X			X	X	X	X					X	X
Row Machine			X			X	X	X	X					X	X
Overhead			x			X	x	X	x					x	X
Total transitions	1	1	3			7	7	7	7	3	1	1	1	7	7

This study has clear limitations in that it only has one participant and a limited number of sessions included. Another aspect to consider is that the participant already had the knowledge and ability to complete all exercises needed. If implementing a CBFS with this population, skill, and understanding of exercises must come first. Even with these considerations, Judge did show a positive relationship between CBFS and improving independent transitions. This intervention is highly customizable and can be individually programmed for different students or fitness routines.

Another use of technology that is widely accepted as an evidence-based practice in the classroom setting for students with ASD is video modeling. This refers to the behavior or skill being modeled on a device to provide cues and instruction. This practice has been shown to show gains in other areas such as behavioral and vocational. It is thought that providing access to repeated instruction at their own pace may help reduce distractions. Video modeling falls into broader Albert Bandura's Social Cognitive Theory which states that people learn through observation and reinforcement.

A study done by Bittner et al. (2017) hoped to show increased levels of PA through the use of video modeling. Through several measures, they set out to compare its success against traditional, in-person, practice-style teaching methods. An application called Exercisebuddy (EB app) was downloaded onto school IPads as the platform for the video modeling. The EB app contains several exercises and movements demonstrated and was developed specifically with students with ASD in mind.

Six participants were recruited and given consent by their guardians. Five males and 1 female were also diagnosed with ASD and between the ages of 6-10. Each student was also given the Test of Gross Motor Development-2 (TGMD-2) prior to the study and needed to successfully demonstrate a skill in both of the two subtest categories of this assessment: object control and locomotor. Each of these subtests is comprised of 6 skills designed for evaluating functional movement. Activities chosen as part of the study were highly aligned with the TGMD-2 and broken up into the same two subgroups.

Students began with an entry session where basic physiological measurements were taken. They were also familiarized with testing equipment. A heart monitor with multiple electrodes was used to measure heart rate and calculate energy expenditure during the following 4 physical activity sessions. PA sessions were scheduled for 12 minutes once per week over the next 4 weeks. Sessions contained 5 movements that students were expected to spend 2 minutes on each. They were first given object control and locomotor activities through practice-style teaching, where a teacher verbally instructed and then performed a visual example. Locomotor exercises are based more on large muscle movements such as running, galloping, and jumping. Object control exercises were more skill-based and included catching, kicking, and dribbling a basketball. In the final 2 weeks, they were given the same groups of exercises using the EB app. The independent variables in the study were the 2 teaching styles and the 2 types of activity. The dependent variables were the measured average and peak of energy expenditure and heart rate. A Wilcoxon signed-rank test was used to find differences in physical activity between the two teaching methods across all motor skills.

Statistical analysis showed that there was only a significant difference between teaching methods on two measured data points. The video modeling EB app showed higher peak energy expenditure while performing the locomotor exercises ($p=.043$) and increased peak heart rate during the same set of exercises ($p=.028$). Peak heart rate in this category increased from a mean of 174 (practice-style teaching) to 187 (EB app). All measured areas of object control activities showed no significant difference in energy expenditure and heart rate for either teaching method.

The results of this study did provide some evidence for using video-based modeling apps to increase the physical activity of youth with ASD. Although averages of physical responses were not drastic, peak levels of energy expenditure and heart rate can contribute to improving the overall health levels of these students. Adding time spent in increased aerobic intensity will help them meet recommended guidelines. During locomotor activities, all students fell within 70-75% of their maximum heart rate. The small sample size and limited age range are limitations of this study. Researchers state that the implications can be useful for teachers or parents who have limited experience with teaching physical activity.

Integrated physical education combined with unique strategies for engagement was the basis for a study by Jozkowski and Cermak (2019) published in the International Journal of Developmental Disabilities. With the exponential rise of technology providing new opportunities in the classroom, they sought to assess the physical and psychological benefits of utilizing interactive video games in the physical education classroom. The term exergaming defines utilizing technology or video games that are interactive and require physical exertion or exercise. A few examples will be discussed throughout specific studies here and further in this paper.

Jozkowski and Cermak (2019) designed their study with two independent variables, the type of video game and the social setting. More specifically, exergaming vs. traditional seated video games (TSVG) were compared along with solitary vs. playing with a peer. To do this they had participants play 3 games. The first being a TSVG along with a tennis and boxing exergame. The two exergames chosen were purposefully chosen. They do not require taking turns and therefore should have less impact on HR differences. With each game being played alone and with a TD peer there were six conditions for measurement. Two situations were given each session with a gameplay time of 10 minutes on each game. Though the order the games were presented was posited to have little effect on the results, they were randomized to control for any possible effect. The participants in this study ranged in age from 18-25, reflecting transition-age students. Sample sizes were N=18 participants diagnosed with ASD and N=18 typically developing (TD) peers. They were gathered from a community-based program for youth with ASD associated with a university, from which the TD participants were recruited. Before beginning the experiment, members were given the Bruininks-Oseretsky test of motor proficiency-II subtest of body coordination. They were also given time to learn how to navigate the video game menu to alleviate frustration with that aspect of delivery.

Measurable data from the study came from tracking heart rate, body mass index (BMI), perceived exertion, enjoyment ratings, and activity counts. Participants rated their exertion level based on a 10-point scale with corresponding descriptions (e.g. 1=not tired at all). To rate their enjoyment the Pre-Adolescent Attitudes toward Physical Education Questionnaire (PAAPEQ) was slightly modified by the authors, by utilizing a 4-point Likert scale for responses. Several data points were also collected before the study began including resting HR, height, weight, self-described activity levels, and enjoyment.

Separate three-way ANOVAs were done for each dependent variable to investigate differences in HR, PA, and enjoyment between TSVG and exergaming. Authors had originally believed there would be little difference between groups in HR and activity level while exergaming but they were shown to be incorrect. Therefore they completed paired t-tests to help interpret these results. Post hoc ANOVA testing was also done and found effects for several components in the diagnostic group.

Across all participants, analysis showed that playing with a partner created greater enjoyment ($p < .05$), higher activity counts ($p < .001$) and perceived exertion ($p < .001$). One group-related difference did show that participants with ASD did rate their exertion lower when playing with a partner even though their measured activity level was higher during the exergaming sessions. The TD group also showed more intense activity when playing with a peer (HR, time in MVPA, and activity counts) but reported a corresponding rating of perceived exertion (RPE). Across all exergaming sessions, participants with ASD did have higher intensity activity ($p < .001$). Through video reviewing and regression analyses including pre-study values (height, weight, body fat, coordination scores), the authors posited that the ASD group could have had higher HR and activity counts due to using bigger, less effective body movements during exergaming. Although Jozkowski and Cermak (2019) were not comparing exergaming to other physical activities, this study does show high enjoyment relating to increased PA in individuals with ASD. Especially, when paired with a partner. Overall, the participants with ASD reached MVPA 86% of the time, indicating that a 20-minute session of exergaming could help contribute 15 minutes towards those individuals' recommended daily activity.

McMahon et al. (2019) also saw a need for utilizing unique practices to increase health for this population. They investigated another type of gaming technology, virtual reality (VR), effect of PA on individuals with an intellectual and developmental disability (IDD). IDD includes several diagnoses, one of which can be ASD. Their goal was to not only increase the intensity of activity levels, but also the duration.

This study was limited to only four participants with varying diagnoses and ability levels with ages ranging from14-21. Included were one female and three males. One 17-year-old male had a specific diagnosis of ASD while the others were classified with fetal alcohol syndrome, Down syndrome, and intellectual disability. All students were a part of a self-contained high school transition special education classroom.

The study used a gaming program that combines virtual reality and a stationary exercise bike. The students controlled the speed of the vehicle options of the game (horse, helicopter, race car, bike, or kayak) by pedaling. The resistance level was set at the same low setting for all participants and observers used an Apple watch to measure HR and duration of exercising. Heart rate, along with age, weight, and gender were used to calculate energy expenditure (EE) and calories burned.

The baseline data was created by offering the opportunity for the students to ride the bike for up to 30 minutes. They were instructed to tell staff when they wanted to be done riding. When 80% of data fell within 20% of the mean, the authors ended baseline data collecting. The intervention was then added and students were introduced to the VR games while riding the exercise bike. They were able to choose between several game options for the same 30-minute session and were able to stop at any point after they decided. To confirm results inter-observer agreement and procedural reliability data were collected with both equaling 100%.

The results of the intervention showed impressive improvements in all metrics measured. Specific student results are shown below in Table 5.

Table 5

Participant PA Data

	Baseline Time	Baseline HR BPM	Baseline calories burned	Intervention time	Intervention HR	Intervention calories burned
Student 1	2 min 57s	124.8	27.8	16 min 01 s	133.5	182.83
Student 2	4 min 09 s	91.2	29.4	16 min 57 s	101.5	135
Student 3	5 min 49 s	113.6	48	17 min 22 s	118.17	136.6
Student 4	3 min 30 s	113.8	29.25	20 min 41 s	131.33	181.8

The average difference between baseline and intervention time spent on the exercise bike increased by 14 minutes 09 seconds. All the students, at the least, tripled their amount of activity time. Informal questioning for social validity showed that all participants highly enjoyed the VR experience, despite the author’s concern that the technology may cause discomfort or fear.

Despite the positive results across all activity criteria, this study is limited in multiple ways. Firstly, this is a very small sample size along with having different specific diagnoses under the label IDD. While students with IDD can have some similar abilities, the range of skills between these groups of students should be considered when looking at the data. The maintenance of this intervention can also be called to question with this study. No maintenance phase was conducted and some of the improvements could be attributed to novelty. Lastly, the cost of a VR system used in this study is a barrier to school programs and individuals.

Table 6

Engagement Strategy Studies

Authors	Study Design	Participants	Procedure	Findings
Pan, Tsai & Hsieh (2011)	Quantitative	19 youth with ASD and 76 NT peers with a median age of 14.19 from 9 Taiwanese schools in integrated 45-minute physical education classes	Accelerometers used to track PA along with interval recording of social interactions of participants during class.	Found increased PA in outdoor settings, during free play and fitness testing times. Also found a correlation between social interactions and PA levels.
Judge (2015)	Quantitative	1 19-year-old Hispanic male with ASD in a segregated adapted PE class	ABAB designed study on a 7 exercise program completed with and without a computer-based fitness schedule	The student was able to complete more independent transitions during intervention phase of experiment

Table 6 (continued)

Bittner, Rigby, Silliman-French, Nichols & Dillon (2017)	Quantitative	6 youth diagnosed with ASD with ages ranging from 6-10. 5 males and 1 female classified as normal or underweight.	Monitored PA levels during brief bouts of physical exercise. Compared typical practice style instruction to video modeling app on locomotor and object control exercise routines.	Non-significant results for several physical activity measurements. Video-based modeling app did provide higher peak heart rate and energy expenditure.
Jozkowski & Cermak (2019)	Quantitative	36 participants, 18 with ASD and 18 neurotypical ages ranging from 18 to 25	Repeated measures crossover design study. Independent conditions of exergaming vs. seated video games and solitary vs. social play. Dependent variables were PA and enjoyment.	Group with ASD expended more energy than neurotypical peers while exergaming. When playing with a peer ASD participants rated their exertion level lower when in fact is their PA was measured higher.
McMahon, Barrio, McMahon, Tutt & Firestone (2019)	Quantitative	Four youth with varying diagnoses that are considered intellectual and developmental disabilities ranging in age from 14 to 21.	Calories burned and duration of exercise was measured on a stationary bike with and without virtual reality gaming.	The intervention showed to be effective at increasing measurements of PA while riding the bike. Students with ASD increased PA time by over 10 minutes on average.

Educational and Behavioral Benefits of Physical Activity

Students with ASD show typical behavioral deficits in educational settings that affect their success. Although the range of severity can be wide, aspects such as difficulty with attention, being easily distracted by sensory stimuli, repetitive behaviors, and disruptive outbursts are common in this population. Because of this, finding behavioral benefits associated with physical activity is another important area of study for educational professionals.

Tse et al. (2017) created a study to look at the effects of PA on certain repetitive behaviors, also known as stereotypy, in youth with ASD. Stereotypy is widely defined as being maladaptive and inappropriate for the environment that is repeated for its sensory stimulus. Current research suggests that 88% of individuals with ASD show some type of stereotypy (Chebli et al., 2016). PA along with other interventions have been shown to reduce stereotypy generally, but Tse et al. (2017) designed their study to find the effect on specific stereotypy behaviors. They used a ball-tapping exercise hoping to reduce hand flapping and body rocking behaviors.

A crossover design was used to introduce control and experimental conditions in an A-B sequence with an interim washout of 1 month between the control and experimental phases. A total of 30 students from ages 9-to 12 were selected for the study. Other requirements students needed to meet were: ASD diagnosis, ability to follow the study directions, no PA outside of physical education class in the past 6 months, and must demonstrate the stereotypy behaviors being studied. Stereotypy behaviors were video recorded and measured during the first 10 minutes of the student's recess period. A 4-point Likert scale in the Gilliam Autism Rating Scale – 3rd edition (GARS-3) was used to determine the intensity of the behaviors for each student. These scores were scaled and Wilcoxon signed-rank tests were used to compare behaviors across all phases of the experiment.

After a control condition of staff reading a story to the students, the experimental condition was introduced. This was a session of a 15-minute ball-tapping exercise, followed by a 5-minute body stretching activity.

There were significant differences found between control and experimental conditions. Most notably, a difference of $p < .001$ was shown to reduce hand-flapping behavior between the pre-control condition and the post-experiment condition. They were able to confirm that the control phase had no statistical effect on either stereotypy ($p > .05$). This is considered with the range of medians between scaled GARS – 3 scores of all experimental conditions was 4.

As they originally hypothesized, Tse et al. (2017) were able to describe a positive effect on one of the stereotypies (hand flapping) with the use of a specified physical exercise (ball tapping). This is logical since it is suggested that stereotypy behaviors help create enjoyable sensory for the individual. Providing a safe environment for a student with ASD to satisfy a similar feeling should be a role of the physical education classroom whenever possible. Further research should continue to investigate other stereotypy behaviors including audible self-stimulation in relation to PA.

Another possible benefit to PA that has been studied is its effect on academic engagement. Nicholson et al. (2010) added to the research on this topic hoping to see an improvement in academic engagement with antecedent PA. They also designed the study to determine maintenance levels after the intervention was removed. Their study population was targeted to higher functioning elementary students who participate in an inclusive physical education class. This eliminated any student who showed disruptive behaviors for self-stimulation. In total, 4 third-grade boys diagnosed with ASD were selected. Despite all students meeting the criteria for being able to participate in a physical education classroom, they were a range of special education services between them.

The intervention or independent variable Nicholson et al. (2010) used was a basic jogging circuit laid out in the gym lasting 12 minutes with a 5-minute cool-down period. The time frame was chosen due to previous research and limited time out of class. Teachers and paraprofessional support encouraged maximum engagement in the exercise. Precise distance measurements were recorded along with a time sampling at 15-second intervals to help create intensity data by noting if the student was walking, jogging, or not engaged (refusing).

Student academic engagement was the dependent variable and measured using the Behavioral Observation of Students in Schools (BOSS). This tool allows observers to track 2 types of on-task behavior (active and passive) and 3 types of off-task behavior (verbal, motor, and passive). The behavioral observation window was 15 minutes in the classroom. Momentary time and partial-interval time sampling were used to observe task-oriented behavior every 15 seconds.

This was a simple subject multiple baseline study. Baseline behavioral data was collected during the student’s first class of the day for 2 weeks. After this one student at a time proceeded to the intervention each week for 2 weeks of intervention programming as well. Observers spent 15 minutes in the classroom within 1 hour of the PA intervention. This was done during the same period as the baseline to ensure that the same subjects were being taught. Post-intervention data was then gathered similarly to the baseline 4 weeks after the final student finished the jogging program. All of this was done with multiple observers which had an 85% IOA.

Effect sizes (ES) were used to describe the results of the intervention and post-intervention data. These were calculated by the differences between each of these phases mean and the baseline mean, then divided by the standard deviation (SD) of the baseline phase. To help interpret the results shown for each student, Cohen's categorizing of effect sizes gives an idea of which aspects showed significant results.

Table 7

Student 1 Data

Student 1	Total engaged time	Active engaged time	Passive engaged time
Baseline Mean (SD)	82.16 (8.76)	47.61 (7.28)	34.58 (10.02)
Treatment Mean (ES)	88.29 (-0.7)	66.66 (-2.6)	21.52 (1.3)
Post-Intervention Mean (ES)	87.1 (-0.6)	66.68 (-2.6)	20.36 (1.4)

Table 7 shows Student 1's data. Large effect sizes were found throughout many data points specifically active and passive engaged time when compared to baseline levels. Only medium ES were found for total engaged time. Importantly, this data does show that after treatment was removed Student 1's active engaged time in class did remain elevated.

Table 8

Student 2 Data

Student 2	Total engaged time	Active engaged time	Passive engaged time
Baseline Mean (SD)	78.12 (4.17)	30.47 (14.47)	47.6 (13.75)
Treatment Mean (ES)	84.3 (-1.5)	52.17 (-1.5)	32.2 (1.1)
Post-Intervention Mean (ES)	76.94 (0.3)	27.74 (0.2)	49.7 (-0.15)

Table 8 shows large ES for all treatment phases for student 2. Again, as in Student 1, active engaged time increased and passive engaged time decreased. There was only small ES for post-intervention engagement time.

Table 9

Student 3 Data

Student 3	Total engaged time	Active engaged time	Passive engaged time
Baseline Mean (SD)	64.39 (9.49)	32.39 (16.07)	31.94 (16.29)
Treatment Mean (ES)	74.03 (-1.02)	46.8 (-0.9)	27.22 (0.3)
Post-Intervention Mean (ES)	67.18 (-0.3)	31.2 (.07)	35.98 (-0.25)

Student 3 only showed large ES for total and active engaged time during the treatment phase. Similar to Student 2, a regression to baseline levels for engagement is seen in the post-intervention phase.

Table 10

Student 4 Data

Student 4	Total engaged time	Active engaged time	Passive engaged time
Baseline Mean (SD)	61.11 (9.07)	45.24 (20.41)	15.84 (14.67)
Treatment Mean (ES)	69.32 (-0.9)	41.92 (0.2)	27.28 (-0.8)
Post-Intervention Mean (ES)	63.3 (-0.2)	23.8 (1.05)	39.5 (-1.6)

Student 4 is a slight outlier when looking at the data, being the only participant to not have a large ES in active engaged time during the treatment phase. Interestingly, this student also fell below the others in the intervention metrics (distance and time jogging). There is also quite a high increase in passive engaged time post-intervention.

Nicholson et al. (2010) did recognize that there are several variables that could affect the data that were not accounted for in this study. Although this research does show similar results to previous studies, the limited number of participants makes it difficult to generalize the results to the broader ASD population. Lastly, reinforcers were used to encourage participation in the interventions, and the effects of this practice are not accounted for in the study.

A study published in the Journal of Autism and Developmental Disorders by Tse (2020) used a similar intervention to investigate the behavioral impacts of a jogging circuit on students. Participants in this study were recruited from special education schools in Hong Kong. Beyond having a clinical diagnosis of ASD, several criteria were put in place to select participants that had similar abilities and behavioral difficulties. From the original 86 youth selected, 27 (intervention group n=15, control group n=12) met all criteria and were included in the study.

The intervention used was a 30-minute jogging activity. This was added to the students' schedules 4 times per week for 12 weeks, resulting in 48 individual sessions. During this time, attendance for sessions was 97.10% overall. Each session consisted of 20 minutes of jogging with 5-minute periods of warming up and cooling down. Levels of intensity were intended to be moderate to vigorous. However, there were no official data points for this, and researchers relied on the qualitative threshold of students having flushed faces and increased breathing rates. Students were encouraged with verbal praise and visual aids to show their progress after each session.

The Emotion Regulation Checklist (ERC) and the Child Behavior Checklist (CBCL) for ages 6-18 were the two surveys that served as the primary tool for assessing behavioral impacts through t-tests and paired-samples t-tests. The ERC is composed of 24 questions and broken into emotional regulation (ER) scores and a lability/negativity (LN) score. The CBCL uses 113 questions to assess several areas of behavioral functioning. Results from this survey are reported by internal and external measurements, along with a Total Problem Scale. The surveys were completed by caregivers before and immediately after the intervention phase. Cronbach's alpha of ERC (.70) and CBCL (.76) were used to show high reliability for these assessments. Results were also controlled for age, gender, and nonverbal IQ.

Results calculated through repeated measures ANCOVA showed some increases in emotional skills. Gains in students' ERC-ER scores were significant across pre and post-surveys.

The intervention group showed a p=.03 with a small effect size of d=.15. Results indicated no significant interactions between the LN scores for the intervention or control group. The CBCL survey also showed varied results of the jogging circuit on student behavior. There was no effect on the internal subset of scores for the CBCL for either control or intervention group. However, the external behavior scores showed significance with a p=.001 and a medium effect size (d=.54). Along with the total problem scores of the CBCL changing between pre and post-study in the control group (p=.10), d=.29) and the intervention group (p=.001, d=.56).

In this current study Tse (2020) provides significant data on small sample size (n=27), of closely paired groups. Against the control, the 30-minute PA at a moderate to vigorous rate was able to prove effective in increasing certain behavioral abilities. Two surveys, completed pre and post by caregivers, was the only data used to confirm the author's hypothesis. Caregivers were not blinded to the study and therefore could be biased in their reporting. The results are best representative of students with ASD who have a higher non-verbal IQ and the ability to complete physical exercise independently.

Another area that could be improved from physical activity is cognitive functioning. Anderson-Hanley et al. (2011) cite that PA has previously been shown to improve executive functioning in typically developing individuals. With this, they attempted to contribute to the research into the effect on youth with ASD. Their study was unique in that it utilized newly emerging exergaming technology as the PA intervention to test impacts on repetitive behavior and cognition.

Participants in the study were attending an extended school year program in the northeastern United States. They were all diagnosed with ASD and parents completed a GARS – 2 Likert scale rating form for further background information and to make sure the students had some level of expressive language skills. Repetitive behaviors were measured using the GARS – 2 as well throughout the experiment. Participants were videotaped during 5-minute individual sessions before and after the control and intervention phases. Researchers used the repetitive behavior scale at 15-second intervals.

Cognitive assessments were also critical to this experiment and three separate tasks were used. A number task in which participants had to repeat digits they were told forwards and backward. The length of the list of numbers increased and was stopped once a student failed twice. The Color Trails Test was also used to measure executive function. This timed assessment asks the participant to order numbers and colors. Lastly, the Stroop task was administered and timed for study data. The Stroop task is a well-known psychological tool where someone is asked to say aloud the color of a printed word of a different color.

The study comprised of a control, along with two exergaming interventions. Through all of these scenarios, the behavior coding and cognitive test were done before and after. The control used a 20-minute video of a talent show. The exergaming interventions then replaced the control. Two separate groups of students were used for two different exergames. First, was a dancing game that utilized a pad in front of the screen as the interactive portion of the game. The other was a cybercycling game that had the students on an exercise bike with a video screen that coincided with their effort level biking. The dancing game showed significant results for repetitive behavior ($p = .001$) and ability to recite digits backward ($p = .03$). The group of 12 youth (median age = 14.8) also showed positive improvements on the Stroop test after the intervention but also did after control. Researchers attributed this to the possible practice effects that are sometimes seen with this assessment. The cybercycling game also showed positive results for improved cognition. This group was comprised of 10 youth (mean age = 13.2) with an average GARS-2 score of 78.8. Three repeated measures of analysis did provide less significant numbers than the dancing exergame. Regarding repetitive behaviors and digits backward both had a p-value of .03.

Anderson-Hanley et al. (2011) did well to provide significant results regarding cognition and repetitive behavior effects from two separate exergames. Using two different games and receiving similar results helps to show generalization across exergaming experiences. Although they did not measure PA intensity, the authors do note that both exergames do require more large muscle movement than some other more mainstream interactive video games (Wii, Xbox Kinect). The lack of exertion data is a limitation of this study.

Although interactive video games such as the Wii may not utilize some of the large muscle groups, they are highly accessible to schools and families. In a study that combines the use of this exergaming system and behavioral benefits, Dickinson and Place (2014) added to the growing research of PA and youth with ASD. Specifically, they were interested in measuring the social benefits associated with this newer technology. The impact of a computer-based activity program on the social functioning of children with autistic spectrum disorder has limited research and typically low numbers of participants.

This study had a population of 100 students with ages ranging from 7 to 16 years old. The pooled subject design randomly assigned half of the participants to either control or intervention groups. The students came from three separate schools in the United Kingdom and were part of specialist classes that had one teacher and up to three assistants. The game 'Mario & Sonic at the Olympic Games' on the Nintendo Wii system was exclusively used as the exergaming intervention. This game provided for students to choose between several different mini-games or events. Both the control and intervention groups participated in their regular physical education program. In addition, the intervention group had 15-minute sessions exergaming 3 times per week over 9 months. The students participated in groups of 2 to 4 at the same time of day as allowed by their daily schedule.

The Staff Questionnaire: Social Behaviour at School was used as the main tool to measure participants' behavior with two versions, depending on the student's age. For ages 5-10 the survey consists of 42 behaviors rated by teachers as present or not. The questionnaire for older students used a Likert scale focusing on peer relationships, general social behavior, and relationships with adults. Along with this data, the researchers had families complete the Family Adaptation and Cohesion Evaluation Scales (FACES – IV). This was done to provide more background information on students and evaluate family differences on the effects of the study. All of these surveys have been shown to be reliable in previous research.

Results were compared between control and intervention groups by age as well as gender to look for significant impacts video gaming had on social functioning. Mann-Whitney U tests were used as it was determined that nonparametric type reporting was better suited to compare data. Then, an analysis of covariance was used to determine the impact of the intervention on students' social behavior. Using this statistical analysis, the study showed only significant impacts on boys in the young (5-11) and older age category (12-16) with scores of $p<.001$ and $p<.05$ respectively. Of note was the difference in the size of groups with total girls represented $n=21$ and boys $n=79$.

With really only one staff questionnaire as the main data point, this study does have its limitations. Home and family factors were taken into account through the use of the FACES-IV survey and showed no significant differences prior to the intervention. However, several other factors could have affected social behavior throughout the course of the study. The biggest contribution of Dickinson and Place (2014) was adding to the research of behavioral impacts through the use of highly accessible exergaming technology. The study was a useful combination in terms of increasing physical activity, technology and assessing social benefits for a wide range of youth with ASD.

Table 11

Studies of Behavioral and Educational Benefits

Authors	Study Design	Participants	Procedure	Findings
Tse, Pang & Lee (2017)	Quantitative	30 youth ages 9-12 with stereotyping ASD behaviors	AB sequence experiment that introduced ball tapping and stretching activities to see the effect on hand flapping and body rocking behaviors	Statistically lower frequency of hand flapping but no difference in body rocking behaviors.
Nicholson, Kehle, Bray & Heest (2010)	Quantitative	Four 9-year-old high functioning students with ASD males. 2 with previously diagnosed Asperbergers syndrome. All in regular PE class of 23 total students	Single subject, multiple baseline design. 2-week baseline, then introduced jogging (independent variable) at 1-week intervals, along with a 4-week post-intervention data collection	Increased observed academic engagement during PA intervention. Results were also affected by level of PA, less conclusive results of retention after the intervention was removed.
Tse (2020)	Quantitative	27 youth with ASD ages 8-12 with emotional and behavioral troubles according to the Child Behavior Checklist (CBCL)	12-week jogging intervention with a similarly matching control group. Multiple caregiver surveys were used to measure behavioral effects.	Found significant effects on certain behavior aspects on emotional regulation and external behaviors using both measurement tools.

Table 11 (continued)

Anderson-Hanley, Tureck & Schneiderman (2011)	Quantitative	22 youth with ASD with an average age of 14, including students from a school in the northeastern US and the community	2 pilot studies to determine the effect of multiple exergames on repetitive behavior and cognitive functioning. Control was watching a video instead of exergaming	Statistically significant results were found in reducing repetitive behaviors and improving cognition based on the assessment used. Positive results were found for both.
Dickinson & Place (2014)	Quantitative	100 youth with ASD ages 7-16. 79 boys and 21 girls in total.	Intervention group was introduced to the exergaming fitness option for 15 minutes 3 times per week over 9 months. Measured social functioning through staff completed surveys.	The intervention showed significant results in social behavior in boys only when compared to the control group. No impact on girls group.

Chapter 3: Summary and Conclusions

This paper was intended to explore effective options for increasing physical activity in adolescents with ASD and consider school-related benefits that PA can have on this population. The opening chapter highlights the clear need for increasing engagement in PA in youth with developmental disabilities. It has been proven through several studies that youth with ASD do not get the same level of activity as their typically developing peers (Hinckson et al., 2013; Dahlgren et al., 2021; McCoy & Morgan, 2019). There are several contributing factors to this, but the end result is this population not getting the recommended PA and being at higher risk for health-related conditions. In chapter II I reviewed several quantitative and qualitative studies to address my two research questions. This chapter will be to further discuss my findings, recommendations for future research, and most importantly, the implications this knowledge will have on my current field of practice.

Conclusions

In total, I reviewed 12 articles on my topic. The first two studies (Healy et al., 2013; Oriel et al., 2020) were meant to give a voice to student and educator experiences with physical activity in a school setting. The next section reviewed 5 studies (Pan et al., 2011; Judge, 2015; Bittner et al., 2017; Jozkowski & Cermak, 2019; McMahon et al., 2019) and focused on best practices and unique strategies for increasing engagement in youth with ASD in PA. The final 5 research studies (Tse et al., 2017; Nicholson et al., 2010; Tse, 2020; Anderson-Hanley et al., 2011; Dickinson & Place, 2014) investigated possible behavioral and cognitive benefits of physical activity and continued with a focus on youth with ASD.

There are clear and defined barriers that need to be overcome for this population to maximize its accessibility to PA. The use of multiple modes of communication in team games and highly stimulating environments in a physical education class are among the difficulties noted (Menear & Nuemeier, 2015). The survey completed by Healy et al. (2013) highlighted the positive and negative impacts peer interaction has on students' experiences. They described comradery as a benefit but also shared experiences of bullying, particularly during structured team games. Adapting lessons and the classroom environment is critical in physical education, just as it is in other subjects for this population. Limiting some of the communication demands while still providing opportunities for social interaction is an option that should be utilized when possible. This was proven by Pan et al. (2011), which showed positive correlations between social initiation and accurately measured PA levels. The same study also showed that free play activities increased movement, highlighting the need for less structured or specific skill-based PA opportunities.

Other best practices and strategies for increasing engagement that this paper focused on were technology-based. As was highlighted in Chapter I, as youth with ASD age into adulthood, they are likely to be at increased risk of obesity (Li et al., 2020). Utilizing technology that can be accessed outside of a school setting to increase independent transitions and PA levels is important to combat this trend. Although Judge (2015) only studied one transition-age participant with ASD, the results of a computer-based fitness schedule were worth including in this review. In the ABAB-designed study, the participant independently completed 1.5 exercise transitions without the intervention and 7 with the CBFS. This is a simple intervention that could be utilized in the classroom and easily generalized for future use.

The question of possible behavior benefits of PA was reviewed in several studies in Chapter II. Simple physical activity, such as jogging was used as the intervention in both Nicholson et al. (2010) and Tse (2020). The main difference between the physical interventions used was time, with Nicholson et al. (2010) implementing 12-minute PA, and Tse (2020) testing a 30-minute jogging session. Nicholson et al. (2010) used the Behavioral Observation of Students in Schools (BOSS) to assess on-task classroom behavior post-intervention. This study concluded with significant results in improved engagement (passive and active forms) in class within an hour of the intervention. Through activity tracking, they were also able to find some correlation between the intensity of PA and engagement. Highlighting the need for continuing PA, Nicholson et al. (2010) found an overall regression to baseline engagement data for participants after the removal of treatment. Tse (2020) used a control group for his study of emotional regulation. Using the Emotional Regulation Checklist (ERC) and the Child Behavior Checklist (CBCL) completed by caregivers, he was able to show significant improvements in only certain areas. The results were strongest for the intervention group in regards to emotional regulation and external behaviors measured by the surveys. Internal behavior scores and lability/negativity subset scores did not show significant results.

Only one study (Tse et al., 2017) reviewed considered the impact of PA on stereotypy. This was important to include considering current studies show that 88% of individuals with ASD display some form of stereotypy (Chebli et al., 2016). The maladaptive and educationally disruptive nature of these behaviors can vary greatly in the ASD population. This study differed from previous studies on stereotypy and PA in that it meant to assess specific PA on the movements of hand flapping and body rocking. Tse et al. (2017) were able to find significant reductions in hand flapping only when using a ball tapping exercise as a PA intervention. These results seem like an obvious conclusion but it is important for educators to keep in mind. The physical education setting can be a safe place for students with ASD to meet their self-stimulatory needs and reduce disruptive stereotypy behaviors in other educational situations. This study shows the necessity for PA to closely mimic the stereotypy behavior educators may be hoping to reduce.

Throughout the process of exploring my research questions, exergaming became a clear area of interest for me due to the unique possibilities it has to engage and improve wellness in students with ASD. Exergaming can be considered any technology-driven physical activity. Two studies (Jozkowski & Cermak, 2019; McMahon et al., 2019) were chosen to show the ability of exergaming to increase PA engagement. Jozkowski and Cermak (2019) used a well-designed study, utilizing interactive video games and comparing activity levels to typically developing peers. An interesting aspect of the results was that youth with ASD showed higher measured PA levels when playing with a peer, but self-rated their exertion lower. They also showed overall higher levels of PA intensity in youth with ASD compared to typically developing peers. Revealing that exergaming may be a productive tool for reducing the gap in activity levels between these populations. To me, this study also emphasizes the importance of a social component to PA in youth with ASD.

Virtual reality combined with an exercise bike (aka cybercycling) was the exergaming intervention used by McMahon et al. (2019). Across the small sample size, students increased the amount of time they spent on the exercise bike by 3 times when compared to biking without the VR component. Crucially to that statistic, students were not encouraged by any other means to increase their engagement besides the technology introduced. Healy et al. (2013) also used a cybercycling intervention to find a decrease in repetitive behaviors and cognitive functioning. Using the GARS – 2 for behaviors and multiple cognitive assessments they found p values >.05 for decreasing both areas after cybercylcling.

Overall, students with ASD encounter several barriers to increasing their PA in physical education settings. Reducing the need for continual gameplay communication while still providing social interaction showed to be successful in increasing engagement in the Pan et al. (2011) study. Jozkowski and Cermak (2019) also created positive engagement results allowing for social interaction through parallel play while exergaming. Although they used two different types of exergaming, Jozkowski and Cermak (2019) and McMahon et al. (2019) both showed how technology can significantly impact attitudes and engagement in PA for youth with ASD. Various types of exergaming were also shown to increase positive social and classroom behaviors by Anderson et al. (2011) and Dickinson & Place (2014). Other, non-exergaming, PA interventions used in studies by Tse et al. (2017), Anderson et al. (2011), and Tse (2020) were able to decrease possible disruptive behaviors and increase academic engagement times post-intervention.

Recommendations for Future Research

Despite the reliable results the studies I researched provided, there were also a variety of limitations that should be addressed in future research. A majority of the studies were made up of small sample sizes. The mean sample size of all 12 studies was 38.17. The range of participants was n=1 (Judge, 2015) to n=121 (Oriel et al., 2020), which was a survey of teachers. Two studies (Pan et al., 2011; Jozkowski & Cermak, 2019) also included control groups of typically developing peers which was important but does reduce the overall number of ASD youth represented among the studies. Dickinson & Place (2014) had the highest number of diagnosed ASD students included with a sample size of 100.

Accurate representation is another area for improvement in future research. Currently, boys age 8 are 4.2 times more likely than girls of the same age to be diagnosed with ASD (Meanner et al., 2018). The resulting ratio from the studies provided here is 1:4.82, with 1 study (Anderson-Hanley et al., 2011) not specifying gender in their sample size of 22 youth. I was able to end up with this close ratio due to my thoughtfulness when selecting studies. Research going forward should continue to ensure their samples are representative of national averages.

One difficulty in providing a comprehensive review of studies that provide generalizations to youth with ASD on this topic is the wide variety of ability levels within the diagnosis. Autism is a developmental disorder that affects several aspects of student functioning in physical education. From physical or gross motor abilities to intellectual and communication levels, the interventions studied here will not work for all youth diagnosed with ASD. The research articles I focused on did their best to keep the ability levels of participants similar, but the differences among them could create less confidence in the overall findings of this paper. For example, only 2 studies (Tse et al., 2017; Anderson-Hanley et al., 2011) included students with repetitive behaviors or stereotypy. Additional research on PA across all ability levels of youth with ASD will help create a larger sample size of results that can create more reliable data for educators of this population.

The final focus of future research will have to be attempting to keep up with the continually changing technologies that can be utilized for PA. Specifically, virtual reality (VR) is an emerging technology that could be utilized similarly to the exergaming interventions reviewed in this paper. However, there is very little research on its use related to the topic of PA and students with ASD. Naturally, technology is advancing very quickly, posing a real challenge for research to maintain relevancy. Throughout my research, I found studies that concluded with positive results for specific applications or technology that are now not readily available. Educators should focus on the variety of supports and levels of engagement these technologies provide in the case the specific platforms are not accessible to them.

Implications for Current Practice

Currently, I am working in a Federal Setting IV program serving high school to transition-age population. I serve as the physical education and health instructor for multiple different diagnoses including students with ASD who have varying abilities. The topic and purpose of this paper developed from my very real need of finding ways to increase the engagement of my students who experience many of the same barriers described in the previous chapters.

Being more thoughtful in addressing these barriers will be a practice that I take from this research. Healy et al. (2013) found physical ability to be one of the biggest obstacles self-reported by students. Especially by their later adolescent years, it stands to reason that this type of exclusion from PA has been experienced several times in a physical education setting. In turn, depleting their motivation to be included. This is one area that excites me about exergaming. These students may be able to perform gross motor movements without necessarily all the skill aspects needed to participate competitively (eg: tennis, baseball, boxing, etc).

Another practice that I will use going forward based on my research is implementing more computer-based fitness scheduling. Creating opportunities for independently engaging in PA is highly important, especially when working with transition-age students. The study done by Judge (2015) showed the positive impact on independent transitions by delivering a fitness routine using technology. There are several fitness applications available today that I could use to provide the same support for my students. This type of technology should be considered an essential tool when I am developing fitness goals in my classes. It is highly accessible and the skills can be generalized for community settings after they leave high school.

Integrating PA into students with ASD school days as shorter breaks in educational instruction is one way I can use the research of this paper. Of the studies that showed significant educational benefits of PA, the average length of the interventions was 20 minutes. Unfortunately, not all the studies reviewed provided accurate measurements of intensity. Only 9.8% of teachers surveyed in the Oriel et al. (2020) study that saw increased behavioral benefits of PA in their classroom claimed that the physical intervention lasted longer than 30 minutes. As the physical education instructor, I can advocate for and help facilitate short structured PA breaks. As opposed to typically lengthier physical education class periods.

The biggest takeaway from my research is the unique and exciting ways that I can implement exergaming with my students. The studies I reviewed have given me clear examples of how effective exergaming can be at increasing PA engagement in students with ASD. I will use what I have learned going forward to advocate to the school administration to include exergaming equipment budgeting. I am now highly motivated to find grants and any available funds to help supplement the higher costs of some of this equipment. Many of my current students in this population are interested in gaming technology already. Using the many interactive options that exergaming provides will help me find specific interests that may help overcome the barriers to PA they have previously experienced. Where research will struggle to keep up with each emerging exergaming technology, I can start to find the most applicable platforms for my population immediately. Seeing significant improvements in my students' health and well-being will be the reward of my research for this paper.

Summary

The research in this paper provides a clear explanation for the importance of increasing PA among students with ASD. As educators of this population, it is critical that we recognize this importance and work to expand our students' access to positive PA experiences. Technology is a growing aspect of youth's everyday lives and should be embraced as a unique way to increase their motivation towards PA. Advancing technologies are also more and more integral to classroom education and should be no less utilized in physical education. Increasing PA in youth with ASD will have immediate physical, behavioral, and educational benefits. And hopefully, have a meaningful impact on their overall wellness as they age into adulthood.

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