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Benefits of Physical Activity for Students With Autism Spectrum Disorder

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BENEFITS OF PHYSICAL ACTIVITY FOR STUDENTS WITH AUTISM SPECTRUM DISORDER

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Abstract

Adolescents with autism live a more sedentary lifestyle than those without an autism spectrum disorder diagnosis. Lack of exercise results in increased health risks, obesity, and decreased quality of life, exercise, motor skills, and peer interaction. Exercise can serve as a treatment for those with autism that increases quality of life, improves peer relationships, overall health, and increases expected behaviors. Special education providers should receive training about the benefits of physical activity along with strategies to best incorporate physical activity into daily routines, instruction, and goals. Due to lack of systemic resources and social opportunities, researchers cite many benefits to incorporating physical activity in the school setting as part of academic programming, including reduced parental stress, improved behavior and improved social skills and mental health. In addition, newly designed educational experiences improve the overall quality of life for students and their families.

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CHAPTER I: INTRODUCTION

Autism Spectrum Disorder has been on the rise worldwide in recent decades. The cause remains unknown despite the rising numbers, labeling the phenomenon as an "autism epidemic" (Zhao & Chen, 2018). The first studies of autism were conducted around 1966, but have increased along with those affected with autism. In 2020, the Center for Disease Control reported 1/54 children are diagnosed with autism in the United States (Zhao & Chen, 2018). Children with autism have a set of challenges and impairments that typically development children do not. Examples include motor development, physical activity, behavior, impairments in social communication interactions, limited interests, repetitive behaviors, and low rates of participation in physical and recreational activities (Memari, et al., 2016).

Many children with autism live a sedentary lifestyle resulting in obesity, chronic health issues and concerns, limited social interactions, mental health issues, low self-esteem, social isolation, and many more (Memari et. al., 2016). The increased availability and usage of technology resulted in a sedentary outlet for some children with an autism diagnosis. Examples included video gaming systems, iPads, computer gaming, and increased availability of Wifi. These outlets turned into habits, and therefore promoted a lifestyle lacking appropriate physical activity. This led to longer term issues and concerns relating to both mental and physical health for this population.

Autism can be diagnosed during the pre-school years, resulting in early, structured interventions but remains to have a curative treatment (Sefen, et al., 2020). Within the past decades, more research studies indicated physical, social, and psychological benefits of physical activity not only for the general public but the targeted population of those diagnosed with autism. However, research has indicated physical activity participation is limited within the

autism population (Memari et. al., 2016). With the overwhelming benefits of physical activity, it is essential to understand how physical activity can support the needs of ASD students both within and outside of the educational setting to create a healthier lifestyle for all those impacted by autism spectrum disorder.

Physical activity is an essential component of physical, mental, and emotional health. The importance of incorporating physical activity into daily life begins at an early age and continues throughout childhood with state-mandated physical education minutes and endless opportunities to involve children in youth sports or activities at school and community levels. The importance placed on physical activity continues into adulthood with strong recommendations from medical physicians backed by data. Children spend at least nine months, five days a week, for seven to eight hours a day in an educational setting. Habit formation, interests, and neuron connections are established during these early years. Advertising opportunities for youth sports and activities are common in the school setting to promote a sense of community and belonging as well as to increase activity and create healthy habits. However, when an individual does not thrive in social settings, their activity also decreases. An individual's inability to socially interact with peers and adults, along with personal beliefs, may hinder the positive effect that physical activity can have on the brain and body, especially for those with an autism spectrum disorder.

Education is slowly transforming from a stationary learning environment to one that is more active and social. From a lecture teaching style to a more active, hands-on approach, best-practice methods are constantly evolving to meet student needs. Students on the autism spectrum often struggle with both social interactions and physical activity due to a multitude of reasons. "Adolescents with autism spectrum disorder are less likely to be active than their age-related peers" (Gregor et al., 2018, p. 53). Struggles with social skills, the inability to

establish peer connections, gross or fine motor deficiencies, and parental perceptions all impact one's level of activity. Even with copious amounts of research regarding these challenges for students with autism, the socio-behavioral mechanisms that hinder student participation have not been examined closely (Gregor et al., 2018). However, a deeper look into how physical activity can be more successful within the ASD population and how to develop socio-behavioral skills within an educational setting could provide a stronger foundation for physical activity implementation.

Physical impairments, the desire to live a sedentary lifestyle, and sensory challenges all challenge students with ASD. However, inactivity is the root of these challenges (Gregor et al., 2018, p. 53). Students with disabilities are legally provided services in order to offer an equal and equitable educational opportunity similar to their peers according to IDEA. Physical and occupational therapy are two of the offered services. Utilizing physical therapists can play a key role in increasing physical activity for students with ASD (Gregor et al., 2018, p. 60). Incorporating physical activity into the mainstream and special education settings and utilizing support staff can increase the physical activity of students with autism spectrum disorder, improve their social interactions, and create a healthier brain.

How does physical activity support the needs of ASD students? Many studies have been conducted regarding the benefits of physical activity on the mind and body. When targeting a specific population, ASD students, the question holds true. How can physical activity help ASD students with social and emotional health? How does physical activity improve academic performance? How can physical activity be incorporated into educational settings to best meet the needs of ASD students?

Since the 1960s, ASD has increased from four in 10,000 individuals to one in 59. Social, communicative, and behavioral challenges are characteristics of this disability. Due to these challenges, those with ASD are more likely to live a sedentary lifestyle and lack social play skills. ASD can be classified into three levels: level one requires support, level two requires substantial support, and level three requires extreme support at all times. Each level has its own educational setting to legally meet the needs of students with trained professionals. Furthermore, those with ASD struggle with motor skills and therefore are less physically active. Developing and incorporating those basic skills to promote physical activity within and outside the classroom can lead to many long term benefits.

Camp Nugget is an intervention for students with ASD with the goal of providing quality individualized physical activity instruction for students ages of five through 12. Camp Nugget was utilized in the Bittner et al. (2021) study with a primary purpose to quantify the intensity of exercise through heart rate and energy expenditure during physical activity. The second purpose of the study was to determine program effectiveness in improving participants' overall level of fitness.

Eighteen participants were recruited through convenience sampling. All participants were classified as level one or two, were between the ages of five and 12, and had verbal capabilities to communicate basic needs. Participants completed aquatic, health-related fitness, fundamental motor skills, lead-up games, sports, and cooperative activities and relaxation activities throughout Camp Nugget. Activities took place three hours per day, five days per week for four consecutive weeks, and were led by university preservice students preparing to be adapted to provide physical education teachers. The program had sufficient frequency, intensity, and duration of exercise programming. Parents completed a medical history questionnaire to provide

information about their children. There were three acclimation days to aid in the transition into a new routine for the participants. During the first day, protocol and equipment for the study were introduced, height and weight were measured using a digital scale and stadiometer, and the Actiheart monitor that utilized a piezoelectric accelerometer and a heart rate monitor. The heart rate was recorded every 15 seconds and maximal heart rate was estimated with an age-predicted formula. Day two resulted in two participants responding with negative sensory experiences to the Actiheart system. They were replaced. On the third day, the Brockport Physical Fitness Test, an empirical assessment instrument, was utilized as a pre-assessment. Included in the test were: progressive aerobic cardiovascular endurance run (PACER), isometric push-ups, curl-ups, and back saver sit-n-reach. The daily physical activity routine started with a 15-minute warm-up, 20 minutes of individual time, 30 minutes of group station lessons, and a 30-minute chunk of aquatic lessons. The four-week physical activity program resulted in an overall completion rate of 15 boys and three girls at 77.32%. Improvements were shown in the isometric push-ups, curl-ups, and back saver sit-and-reach tests. There was relatively little change in the heart rate and energy expenditure responses among sessions. ASD students also had decreased heart rate responses to nine-year-old submaximal physical activity.

The Transtheoretical Model of Behavioral Change stated habits and behaviors do not change quickly. In conclusion, children with ASD who attended Camp Nugget also showed improvements in muscular strength, endurance, and flexibility. Success can be attributed to a positive, motivating setting and trained staff. However, there was no improvement in cardiovascular endurance. Therefore, with properly trained professionals, and a controlled, safe and motivational setting, physical activity can be implemented into the daily life of individuals with ASD-reducing chronic health issues, improving social skills and quality of life.

CHAPTER II: LITERATURE REVIEW

Literature Search Procedures

The literature for this thesis can be located in searches from the Journal of Developmental and Physical Disabilities, Elseiver, Hindawi, Sage Journals, Frontiers, and neuroscience databases, along with the Journal of Developmental and Physical Disabilities. Publications of studies included 2013-2020. The publications used were focused on autism spectrum disorder and the benefits and impacts of physical activity on the population impacted by the disorder. References were determined from peer-reviewed journals after reviewing empirical studies with a concentration on autism and physical activity that addressed the guiding question of how physical activity supports the needs of ASD students. The keywords utilized in the search databases included "physical activity and autism," "autism and exercise," "benefits of physical activity," "benefits of physical activity and autism." The structure of this chapter is to review the literature on the various benefits of exercise on those with autism in three sections in this order: physical activity and social and emotional health of students with ASD; physical activity and academic performance of students is ASD; and physical activity incorporated into educational settings to meet ASD student needs.

Multifaceted Benefits of Physical Activity for the ASD Population

Memari, Mirfazeli, Kordi, Shayestehfar, Moshayedi, Mansournia (2016) noted that children with autism spectrum disorder had deficiencies in motor development and physical activity behaviors along with impairments in social communication, maladaptive repetitive behaviors, and limited interests. The researchers wanted to determine an association between

cognitive and social function and physical activity behaviors in a sample of autistic children. Sixty-eight children were selected for the study, ages six to 16. Participants were evaluated for physical activity using a triaxial accelerometer and for cognitive flexibility using the Wisconsin Card Sorting Test; parents were surveyed by rating the social profile of their children, which resulted in qualitative data. Due to restricted interests, less participation in physical activity and recreational programs occurred. Although children with autism were less likely to socially interact with their peers, physical activity provided a direct opportunity for social engagement. Benefits of physical activity included enhanced motor skills, reduction of negative emotions, and maintenance of a healthy lifestyle. Other benefits included decreased anxiety, depression, stress and anger, and increased feelings of coherence and social interaction. Study results showed poor cognitive flexibility correlated with decreased physical activity. Age and gender were two variables that directly correlated with the level of physical activity that occurred in children with autism. It was suggested that older children, due to increased focus on academics and puberty, participated less in physical activity and were less motivated. Furthermore, due to fewer social opportunities, girls were more inclined to have a sedentary lifestyle than boys (Memari et al., 2016).

The lack of confidence and self-esteem were two reasons noted for the lack of involvement in physical activity for students with ASD. Even when students were motivated to engage in physical activities, the social and cognitive challenges caused hesitation or avoidance. Physical appearance was a key element in self-esteem. Physical activity was a solution to living a healthier lifestyle, decreasing obesity, and increasing self-esteem. According to Memari et al. (2016), and the Temporal Self- Regulation Theory for typically developing children, physical activity and executive functioning were positively correlated, with examples noted in cognitive

flexibility and planning. The research discovered that the prefrontal cortex, cingulate, and temporal cortices, and subcortical brain networks were activated during physical activity and associated with self-regulation skills and executive functioning. Therefore, a direct correlation between cognitive inflexibility and lack of physical activity due to complex stimuli and interacting with others could be made. The cognitive control theory for physical activity and sedentary behavior explained "empowering cognitive capacities can result in greater motivation, better planning for activities and evaluating physical activity costs and benefits...Individuals with higher cognitive flexibility may have better self-regulation skills" (Memari et al., 2016, p.26). Increased self-regulation skills, cognitive flexibility, and motivation increased opportunities for academic learning. One example of a way to implement physical activity into education settings included adapted physical education classes. Children with ASD demonstrated improvement in parallel play and physical activity after participating in adapted physical education programs.

Healy and Garcia (2018), focused on screen-time and physical activity correlates among 55 nine-year old ASD children and 55 typically developing (TD) children. This study also examined how screen-time and physical activity correlated with peer relationships and mental health. Three physical activity measures were taken: hours of moderate to vigorous physical activity, daily activity, and sports participation. Health behavior measures were conducted via parent completion of a leisure time exercise questionnaire using a five-point scale that rated activity from the previous two weeks. Another parent questionnaire posed questions using a six-point rating scale for the amount of screentime during a normal weekday. The research found males and typically developing children participated more compared to, both TD and ASD females. However, individuals with ASD lived a more sedentary lifestyle and engaged in more screen time than their TD peers. More specifically, children ages 3-11 with ASD spent an hour

longer engaged in sedentary behaviors, including screen time, than their TD counterparts. Increased screen time and sedentary behaviors can result in delayed language development, sleep problems, and attention problems. There was also considerable evidence of bullying during light physical activity for students with ASD. This study indicated it is necessary to account for differing psychosocial factors in students with ASD and TD students when creating interventions to increase physical activity. Self-efficacy, perception of physical and sport competence, presence of peers, and peer activity levels were psychosocial attributes and social influences of TD that dictated the effectiveness of a physical activity program. Contrarily, sedentary behavior psychosocial factors included depressive symptoms, absence of social support, and TV-related parenting for TD peers. ASD psychosocial correlates compared to their TD peers remain largely unknown. When comparing psychosocial factors for physical activity and screen time, the Piers-Harris Children's Self Concept Scale, 2nd Edition, was utilized. Freedom from anxiety, popularity, and happiness, and satisfaction were measured using correlating scales. The results of the study concluded that children with ASD compared to TD peers had significantly fewer days of moderate to vigorous exercise, participated less in sports, and had fewer days of at least 60 minutes of exercise. Furthermore, children with ASD reported more problems with peers, lower perception of popularity, and lower ratings of prosocial behavior. Increased exercise resulted in social skills gains, decreased stereotypical ASD behaviors, hyperactivity, self-injury, and aggression (Healy & Garcia, 2018).

In regards to screen time, two psychosocial factors existed: the number of close friends and prosocial behavior. Although children with ASD exercised less time and less vigorously than their TD counterparts, there was no significant participation difference between the two groups for screen-time engagement or light physical activity. Increased exercise could result in social

skills gains, decreased stereotypical ASD behaviors, hyperactivity, self-injury, and aggression (Healy & Garcia, 2018).

The research attempted to compare typically developing children and children with autism regarding the correlates of physical activity and screen time. Nine-year-old children from Ireland participated in the study, 55 diagnosed autistic and 55 typically developing children. Variables of interest included: self-concept, peer relationship problems, prosocial behaviors, and time spent with friends. The hypothesis stated that the two populations presented different psychosocial correlates of health behaviors. Three measures were collected for regression analyses: moderate to vigorous physical activity (MVPA), daily physical activity, and sports participation. Results showed that parents prioritized and valued interventions that focused on behavior and communication over physical activity during the adolescent stages of their children's lives. Furthermore, some parents utilized screen time as a behavior management technique for their ASD children. Parents reported too much supervision was necessary for their ASD child to participate in physical activity. Barriers included societal and systemic challenges with accessing physical activity programs and having the necessary support available for their autistic children (Healy & Garcia, 2018).

Physical activity aided in maintaining a healthy weight and decreased the risk of chronic disease. Chronic illness directly affects emotional wellbeing. Therefore, by reducing the risk of chronic disease, there are decreased emotional repercussions found in chronic illness. Establishing strong relationships with students, specifically students with ASD provides a strong foundation and knowledge of specific child needs. Understanding physical activity, sedentary correlates, and the differences, for each child, allows for the creation of appropriate individualized intervention for ASD students. Furthermore, peer involvement within

interventions has proven successful. Inclusive interactions existed in settings including recess, physical education, and community-based programming. However, it was in these settings where bullying occurred, especially towards ASD students. The increased vulnerability resulted from ASD social deficits, ASD acting as a hidden disability, and lack of support within schools (Healy & Garcia, 2018).

Menear and Ernest (2020) investigated the correlation between the level of physical activity and screen time use between participants with Autism Spectrum Disorder (ASD) and their typically-developing (TD). The study was the first to incorporate the plethora of electronic devices used by society today. The study compared data from participants aged 0-17 without ASD to those with ASD by levels of ASD severity. Surveys were conducted via random mail sampling to United States households with at least one child under 18 years old. In total 71,811 surveys were completed in either English or Spanish, electronically or in paper form. The research questions focused on the different age groups for subjects with varied ASD severity levels and TD peers and included only week day data. The research questions included: the amount of weekly exercise of at least 60 minutes, the average amount of time spent watching TV or playing video games, and the average amount of time using laptops, cell phones, portable video games, and other electronic devices doing non-related school work. Results showed 21% of ASD children did not participate in at least 60-minutes of physical activity, compared with 8% of TD children. The older the participants, the less that exercise occurred. In each age group, ASD participants participated in physical activity for at least 50% less time than their TD peers. However, children with ASD engaged in screen-time significantly more than their TD peers. Children with ASD ages 12-17 used a portable electronic device for at least three or more hours/ weekday than the TD peers. In fact, 2.5 times as many children 6-17 did not engage in at least

60-minutes of physical activity compared to their TD peers. Consequently, ASD children ages Birth-5 watched more than four hours of TV/ videos.

Physical activity has many health benefits according to the New Physical Activity Guidelines for Americans. Lack of physical activity in this study resulted in many consequences: poor cognitive and social skills, obesity and weight issues, among others. Inversely, physical activity improved sleep quality, cognition, motor skills, executive functioning, physical fitness, and other health-related domains. Research highlighted that individuals with ASD lived a more sedentary lifestyle than their TD peers. A sedentary lifestyle resulted in less physical activity. Instead, electronic devices occupied ASD participant time. As of 2015, 68% of adults had a smartphone and 45% had a tablet. In 2017, 98% of children under the age of 8 had a home with a portable electronic device. Data was collected for 202 ASD children and 179 TD children regarding portable electronic device usage. Results showed ASD children spent more time engaging in screen time. Furthermore, if four or more hours of screentime occurred, ASD children were more likely to be obese or overweight than those who did not use devices. In conclusion, ASD students were more likely to be sedentary, occupying their time with significantly more screen time behaviors than the TD peers. Furthermore, increased student age resulted in increased screen time and reduced the likelihood of participation in physical activity (Menear & Ernest, 2020).

As of 2014, one in 59 children were diagnosed with autism. An increase in autism identification resulted in an increased need for school support and therefore evidence-based practices. However, evidence-based practices have been limited in the area of physical education. Along with impaired social skills, speech, and behavior, those diagnosed with autism face challenges such as lack of muscular strength, coordination, and balance. In order to best meet

student needs, Ables, Sillman-French, and French (2020) studied the impact of video modeling reinforcement on push-up performance for five-elementary aged males with ASD. The study used three treatment conditions: video modeling, primary reinforcers, and neither video modeling nor primary reinforcers. Video modeling was considered an evidence-based practice. Each participant was shown a video of a person who modeled a desired behavior with observational learning as its core attempt. For observational learning to occur, attention, retention, production, and motivational processes needed to occur. Video modeling was derived from Badura's social learning theory which suggested that human behavior was primarily learned by observing a model. The reinforcements in the study were derived from the National Professional Development Center on Autism Spectrum Disorder whose research suggested primary reinforcements were life-sustaining, naturally reinforcing, and tangible. Video modeling and primary reinforcements were utilized in a North Texas school district with five autistic boys with a co-morbid speech disability who participated in general physical education. Five phases were conducted: parent permission, baseline, and treatment sessions were conducted in the participants home setting; 12 parents chose primary reinforcements via a snack menu; baseline data was collected in the three baseline sessions using FITNESSGRAM; 24 treatment sessions were conducted on consecutive weekdays that started the day following baseline assessment; the generalization phase occurred at the participant's school where they performed as many push-ups as possible in a one-minute time frame. The objective of the intervention was for each participant to complete as many correct push-ups as possible within one-minute under each of the three conditions. During video modeling the, a participant observed a similar-aged peer correctly completing push-ups. The participant then completed as many push-ups as possible using the correct form for one minute. The number of push-ups and seconds performed was recorded.

Instruction and demonstration were provided during the primary reinforcement treatment condition. Participants then completed as many push-ups as possible in one minute with the goal of matching or improving the number of push-ups from the last session. If the goal was achieved, a primary reinforcer was obtained. The control treatment condition used no modeling and no primary reinforcement was completed by asking each participant to complete as many push-ups as possible in one-minute.

The study included a randomized alternating-treatment design with push-ups performed as the dependent variable. Each treatment series had eight sessions for a total of 24 sessions. Results concluded that each participant improved performance from the baseline. All participants increased their push-ups by almost 50% from the baseline to generalization phase. Although all participants improved during all three treatment conditions, the most progress occurred under treatment I and II. During the video modeling, children focused on a single task, actively participated in the initial attention process, and were successful in the retentional process. Furthermore, all five participants demonstrated success in the production and motivational processes. Three of the five participants were most successful in the video modeling treatment while the other two were most successful in the positive reinforcement processes. In conclusion, video modeling served as a successful technique for children with autism. Incorporating video modeling and positive reinforcement into physical activity instruction improved the upper body strength, posture, endurance, and overall health of students with autism.

Pan, Tsai, Chu, Sung, Ma, & Huang (2016) study compared PA and physical fitness and their interrelationships using Taiwanese male students with ASD and TD peers. The importance of this study derived from previous findings that PA modified lifestyle behavior. Obesity, particularly high in the ASD population due to dietary habits, medications, fewer opportunities

for PA, and increased sedentariness, portrayed the importance of PA. Previous research indicated TD and ASD youth engaged in similar levels and types of PA. However, only 23% of ASD youth meet MVPA criteria. Physical activity level was considered a behavioral factor that influenced aerobic and musculoskeletal fitness, flexibility, and body composition. The researchers hypothesized ASD participants would show reduced physical fitness levels and positive relationships would occur between PA and that physical fitness while a negative relationship would occur between PA and BMI. Furthermore, participants who met the 60 recommended minutes of MVPA would be more physically fit than ASD or TD participants who did not meet the recommendation.

Thirty-five ASD students who regularly attended school resource rooms and 35 TD students without a disability. Physical activity was assessed using the uniaxial accelerometer. Participants wore the device for seven consecutive days, except during water activities. The 20 meter Progressive Aerobic Cardiovascular Endurance Run (PACER), isometric push-up test, curl-up test, and back-saver sit-and-reach were conducted to assess endurance and strength. Height and weight was also measured. The individual physical fitness assessments were conducted at the primary researcher's university gym in a quiet, isolated setting. Results of the study showed no differences in demographic variables between the ASD and TD populations. PA was higher on weekdays than weekend days for TD and ASD participants. There were significant differences between the populations in regards to the PACER, isometric push-ups, curl-ups, and sit-and-reach tests. Furthermore, participants with ASD who did not meet the recommended 60 minutes performed substantially lower on all physical fitness tests, except the body composition tests, in comparison to their TD and ASD peers who met the guideline. In conclusion, only 37% of ASD and 60% of TD participants met the daily 60 minute

recommendation of MVPA. While 42% of TD participants were enrolled in extracurricular activities, only 14% of ASD participants engaged in similar activities. Reasons for this included societal treatment and lack of social acceptance and support. Physical fitness interventions need to target explicit instruction, prompting, and consistent reinforcement with the goal of a PA lifestyle. Muscular strength and endurance are positively related to daily PA. Therefore, incorporating the goal-oriented physical activity interventions could enhance a PA lifestyle in both TD and ASD youth (Pan et al., 2016)

Barriers to Implementation of Physical Activity

Parental involvement was a key factor in the amount of physical activity present in the lives of children with ASD, especially if parents' attitudes were positive. Two-parent households were most successful. Personal and family perceptions also had multidimensional effects on the presence and willingness to exercise (Toscano et al., 2018). This study took place in Brazil with 64 adolescents (ages 6-12) diagnosed with ASD. The students were placed into either a control or experimental group. The experimental group went through a 48-week physical activity program while the control group exercised as a result of their regular routines and activities. The experimental group had 96 bi-weekly sessions over a period of 48 weeks. Each session included a preparatory phase, a development phase, and a calming phase (Toscano et al., 2018). This study consisted of both qualitative and quantitative data analysis. For example, participants' body mass was measured with a calibrated portable balance. Blood sampling, body measurements, and stature were collected by experienced individuals. Qualitatively, the parents of the participants completed the Portuguese version of the Child Health Questionnaire multiple times throughout the study. An experienced child psychologist completed the Portuguese version of the Childhood Autism Rating Scale.

Children with a disability were more likely to be obese than children without a disability, in part because children with ASD were more likely to have a food sensitivity, gastrointestinal disturbance, sleep problems, and psychotropic medication that affected their body mass and body composition (Toscano et al., 2018). The results of the study showed no significant changes in body mass or body mass index, but there were positive changes metabolically for those in the experimental group, such as lower total cholesterol. The experimental group also experienced improved perception of quality of life, total physical score, and psychosocial. Reduction of autistic traits was also observed in the experimental group. This particular study, however, did not lead to weight status improvements in youth with ASD. Exercise intervention, especially through organized sports and exercise, portrayed a decrease in stereotypical autistic behaviors and an increase in verbal and nonverbal social communication skills (Toscano et al., 2018). Important interventions for children with ASD included physical activity and exercise to improve basic coordination and strength (Toscano et al., 2018). Once these basic needs were established, there was an increased likelihood children will be able to increase their academic attention and performance.

A Canadian study was one of the first completed in 2017 regarding parents' perspectives of physical activity participation among youth with ASD (Gregor, Bruni, Grkinic, Schwartz, McDonald, Thille, Gabison, Gibson, Jarchyra, 2018). Research suggested that adolescents with ASD were less likely to participate in physical activities compared to their peers, which resulted in a sedentary lifestyle and higher health risks in the future (Gregor et al., 2018).

This exploratory study used a descriptive qualitative methodology along with transcribed, semi-structured parental interviews. The Nvivo 10.0 was utilized for data analysis and management after the interviews were conducted by two researchers. All ASD diagnosed

participants lived in Toronto, Canada, communicated in English, and were between the ages of 11 and 20 years old with a diagnosis of ASD. The study's participants involved parents and targeted a focus on beliefs, values, attitudes, and behaviors as predictors of the personal value of the physical activity. Nine mothers and one father ranged in ages from 39 to 60. Semi-structured interviews were conducted in a setting of the interviewee's choice and were transcribed and reviewed to collect data and to explore interrelationships. Three themes emerged: the interpersonal and intrapersonal family mechanisms that impact physical activity, the limitations on available programs that offer physical activity, and the barriers of systemic accessibility to community resources. Another way physical activity was incorporated into educational settings was to educate staff members on ASD and how to provide social opportunities while incorporating physical activity. Barriers included: lack of general awareness of the challenges of ASD, monetary restrictions to get involved in physical activity, limited options to meet their children's interests, and therefore an overall lack of physical activity among adolescents with ASD. In conclusion, physical activity was measured at an independent level and influenced by ability, need, personal preferences, and previous experiences. An effort from both systems and individuals was required to improve physical activity in youth with ASD. Including physical therapists in schools was one recommended way of incorporating physical activity into the lives of youth with ASD (Gregor et al., 2018).

Autism spectrum disorder is partially characterized by resistance to change. Other deficits include motor coordination, physical fitness, and physical activity that only increase with age for ASD students. Oh, Escalante, and Gentry (2018) focused on simple functional fitness activities and the impact and improvements noted for daily living as a result of developing strength, endurance, flexibility, and stability through specific activities. Functional fitness training was

defined as a motor-skill integrating neuromotor exercise program. Motor skills practice included balance, coordination, gait, agility and proprioceptive training. Functional fitness utilized multi-joint exercises and required strength, coordination, agility, and balance to be successful. The earlier these skills are learned, the healthier a person's lifestyle will be, decreasing the likelihood of falls and development of lifelong habits related to moving and healthy choices.

Functional fitness activities were implemented in adapted and general physical education settings. Many challenges occurred in these settings; however, functional fitness activities increased student engagement and activity levels. Functional fitness was effectively delivered based on teacher instructional methods. Research indicated that understanding students and their unique needs and interests and abilities affected the delivery of instruction which determined program effectiveness. For example, Oh, et al. (2018) recommended using picture cards as visual cues to reinforce auditory instructions to increase performance in students with ASD. Furthermore, limiting distractions, introducing new objects and ideas slowly, and allowing students to investigate new equipment through touch allowed for more successful outcomes during functional fitness interventions.

The study selected four activities requiring strength, endurance, flexibility, or stamina; they were purposeful, provided stimulation, and had the goal of improving daily life. The first activity "water-bottle shake up" included various sized water-bottles filled one-third with water, followed by a few drops of food coloring, topped with oil. The exercise required students to vigorously shake the water across different planes and positions. The visual stimulation of the contents inside the water bottle distracted students from the physical exertion. Muscular and cardiovascular endurance was achieved. The goal of the second activity, named "color-changing chair sit-to-stands," was to move from a sitting to a standing position while engaging the proper

muscles and improving coordination and flexibility. Students sat on a surface with color-changing paper to begin the activity. The paper provided visual stimulation as it changed with touch. Teachers provided objects of different heights, increasing the distance and height with student success. The “medicine ball toss activity” required upper and lower body coordination and core control. Medicine balls of various sizes along with targets were provided. The students held the ball at their chest and executed a basketball chest pass to the target. Visual stimulation was provided through the different targets. Muscular strength and lower to upper body transfer was achieved in this exercise. Lastly, “the resistance band walk” challenged the core, upper and lower body, strength, and balance. Students were in control of the resisting force as they controlled the distance away from the anchor with the resistance bands. Heat-activated color-changing paper and/ or a tape line were visually stimulating targets as movement cues for students (Oh et al., 2018).

In conclusion, incorporating functional fitness into physical education and adapted physical education settings promoted lifelong functional fitness for ASD students. Training educators to teach motor and physical fitness skills to students with ASD led to more active lifestyles, promoted daily life independence, and allowed for more student success. Strong management and content were necessary skills for a teacher to execute. The ultimate goal for physical education teachers was to include four domains: psychomotor, cognitive, affective, and social. With proper training, delivery methods, and lessons, physical education professionals produced life-changing results for ASD students (Oh et al., 2018).

Worldwide, soccer is the most popular sport due to its low cost, environmental accessibility, and intuitive skills required. With the recent research on physical activity as an intervention, Barak, Oz, Dagan, and Hutzler (2019) investigated the Game of Life Soccer

Initiative and the effect on soccer skills, fitness, and mobility for adults with either intellectual disabilities or autism spectrum disorder. Other background research revealed those with schizophrenia improved their psychophysical health following a physical activity intervention. The earliest similar study was conducted in 1987 by Luyben, Funk, Morgan, Clark, and Delulio. Whose study focused on individuals with intellectual disabilities learning a soccer skill taught by three trainees. In 2012, Baran et al. (2012) also studied the soccer effect for individuals with and without intellectual disability through the Special Olympics Unified Sport. A literature review revealed physical activity reduced stereotypic behaviors, but was limited to jogging, swimming, horseback riding, cycle and weight training, walking, and other physical activities. The Game of Life (GOL) Initiative consisted of once per week 90-minute sessions. It was the first ball game-based study conducted. Effectiveness was measured using within-/between group analyses. The program was designed and implemented by Mifalot Chinuch, a non-profit organization targeting fitness development, soccer skills, and improved quality of life for children and adults with disabilities or disadvantages. The organization trained soccer instructors on general skills and provided continuous professional development. Training included improvements in social skills and health-related behaviors associated with soccer training. Like many other interventions, funding and transportation remained limitations.

A multisite cohort was formed for this study consisting of adults with intellectual disabilities (ID) and ASD. The participants were recruited from residential care centers based on the site paperwork. Ten adult soccer teams were selected from GOL. Initially the program consisted of 24 teams with 236 participants, all of whom had no soccer experience. The teams were organized by geographic location and city name. Participants were diagnosed with mild to moderate ID or ASD, were 18 years old or older, and did not have a comorbid diagnosis.

One-hundred participants began the initiative, with 69 finished. Participants completed pre and post testing in soccer skills, physical fitness skills, and mobility skills. Soccer skills were evaluated with a point system rewarded with completed tasks and number of successes. Physical fitness evaluated muscular strength, endurance, and flexibility, with muscle strength as the best predictor of functional task success. The chair-rising test recorded the number of times an individual could sit and stand from a chair in 60-seconds, testing lower-extremity muscular strength and endurance. The sit-up test, standing long jump, and sit and reach test were also conducted to test physical fitness. Mobility was evaluated by the Timed Up and Go (TUG). The TUG consisted of participants sitting in a chair, standing, walking three meters, then returning a sitting posture. The program consisted of an educational briefing, warm-up, fitness training, technical and tactical training, a game, and debriefing. Results of the initiative concluded that the intellectually disabled group significantly improved in the sit-up test while the ASD group improved in both the sit-and-reach and sit-up tests. The sit and reach, particularly benefited the soccer program because participants improved hamstring and lumbar flexibility. Despite improved flexibility, the ASD group showed no significant progress in soccer skills development due to the rapid progression of skills. Visual modeling, physical guidance, and breaking the task into smaller components allowed for more success with the ASD population. Furthermore, the pre-test demonstrated 7/19 ASD participants passed the TUG. Following the soccer intervention, the entire group fell in the normal TUG range. Although soccer training only occurred once per week, positive effects from physical activity were noted in both the ASD and ID populations (Barak et al., 2019).

Obrusnikova and Cavalier (2011) used photovoice methodology to assess the barriers and facilitators that determined whether after school physical activity was impacted for children with

ASD. Participants included 12 boys and two girls between the ages of eight and 14 who were recruited from a community organization in Delaware that served children with autism. Racial classification identified 12 Caucasian, one Asian, and one Filipino participant. All participants received Special Education services under the autism diagnostic category, had sufficient verbal skills, and the ability to use a digital camera. Once participants were chosen, both the children and their parents participated in two 45-minute training sessions. Participants were given two weeks to take pictures, wear accelerometers, and complete seven activity logs. Many tools were used to collect data. Participants wore an accelerometer for seven days to keep track of their activity. The Social Responsiveness Scale was administered to parents to validate the autism diagnosis, where raw scores were converted to T-scores. Photovoice was used to collect participant perceptions of barriers and facilitators to physical activity opportunities after school. Photovoice allowed underrepresented populations to take pictures of their reality for later reflection. From photovoice, digital photography, online questionnaires, and a semi-structured interview was conducted for data collection. A 4-point scale was used for reflective purposes versus a 5-point scale to avoid neutral responses.

Obesity in children has increased over three times within the past 20 years. With increase obesity rates, type two diabetes emerged along with cardiovascular disease, cancer, arthritis, and other health issues. The US Department of Health and Human Services recommends that children between the ages of 6-17 need 60-minutes of moderate to vigorous exercise seven days a week in 20-minute increments. It should be noted that children with ASD live a more sedentary lifestyle for reasons such as: loss of recess, decreased physical education requirements, lack of interest in physical activity, limited attention spans, poor coordination, auditory, visual and tactile

overstimulation, lack of interpersonal skills, and narrow interests (Obrusnikova & Cavalier, 2010).

Based on previous studies by Gyrucsik et al. (2004, 2006), the socio-ecological model classified personal and environmental factors into five categories: intrapersonal, interpersonal, institutional, community, and public policy. Intrapersonal factors were internal and individual, such as motivation, age, and gender. Interpersonal factors included a support system. Institutional factors included contexts within social institutions such as too much homework. Community factors included organization relationships defined by geographic boundaries such as programs available in the community. Lastly, public policy factors included laws and policies at the local, state, and federal level that influenced participation in physical activity. Data revealed only three participants met the daily 60-minute physical activity recommendation. Five participants didn't achieve any of the recommendations. In fact, participants spent about 79% of their monitored 10-hour period engaged in sedentary activities. About 160 photos were collected, averaging 11 photos per participant. All participants included intrapersonal barriers: playing video games, computer time, watching TV or listening to music, feeling tired, or being bored with exercise. All participants also reported interpersonal barriers: lack of a same-age exercise partner, parent commitments, or traveling in the car. Physical barriers included weather conditions, lack of safe equipment, or outside nature conditions such as bugs. The community barriers included lack of transportation and opportunities. The only institutional barrier reported was too much schoolwork. On the contrary, many facilitators were also reported. All participants reported both physical and intrapersonal facilitators: presence of exercise equipment and motivation to play different types of sports. However, individual, dual, and Wii sports were more common than team sports. Interpersonal facilitators included their social support network that made physical

activity more fun. Community facilitators included programs, parks, and playgrounds while the only institutional facilitators included basic activity skills taught in school (Obrusnikova & Cavalier, 2010).

In conclusion, the majority of participants did not meet the 60-minute suggestion of moderate to vigorous physical activity daily. Those that met the requirements recorded more facilitators than barriers while those who did not reported the same number of facilitators and barriers. The most common barrier included technology. Incorporating visual stimuli via screens in a game format based on student interest resulted in positive social, behavioral, language, and academic outcomes for ASD children. Physical education, interventions, and other activity programs targeted psychomotor impairment. Family was a prominent indicator for physical activity in children with ASD. Pets, including canines, also promoted physical activity. Furthermore, the setting and surroundings of students with ASD were plentiful with physical activity opportunities such as sidewalks, parks, playgrounds, pools, and equipment. Overall, many barriers existed for children with ASD regarding moderate to vigorous physical activity after school (Obrusnikova & Cavalier, 2010).

The proficient development of motor skills predicted the mental and physical health of children and youth. Motor skills are also positively associated with physical activity, fitness, perceived competence, healthy body composition, and mental health outcomes. Research also reveals children with ASD are less fit and less active than their typically developing peers. One factor included the motor delays experienced by this population. Therefore, interventions focused on improving motor skills for ASD individuals. Interventions in the motor domain had a positive influence on physical activity, fitness, and body composition. Another challenge for the ASD population includes adaptive behavior. Bremer and Cairney (2019) hypothesized the

relationship between motor skills, and physical fitness activity would be moderated by adaptive behavior. The purpose of the study included two major components. The first examined the Stodden et al. (2008) conceptual model of children with ASD. Specifically, the relationships between motor competence and fitness, and physical activity and BMI. Secondly, it hypothesized that a significant interaction occurred between motor competence and adaptive behavior which affected both physical activity and fitness.

The Bremer and Cairney study used a cross-sectional design. The 27 participants (89% male) ranged in age from seven to 12 years were diagnosed ASD and recruited through a mailing for families on a waitlist for government funded ASD treatment services. Some participants also had a secondary disability including ADHD or an intellectual disability. All participants scheduled four appointments at the researcher's lab. Data was collected during the final three visits. Visit one introduced the lab, exercise equipment, and research team. Visit two assessed participant motor competence while parents completed behavioral questionnaires. Visit three and four assessed fitness and weight status. The data for the current study was part of a larger study that examined the reliability of fitness assessments in students with ASD (Bremer and Cairney 2019). Half the participants participated in two additional appointments for further fitness testing. The Vineland Adaptive Behavior Scales-2, the Movement Assessment Battery for Children-2, and Wingate anaerobic cycling test were also completed for data purposes. The standing long jump provided lower body muscular power data. The digital handgrip dynamometer measured grip strength and indicated total muscular power. The sit and reach test measured flexibility. All tests were completed by a trained kinesiology graduate student. The Actigraph accelerometer was placed at the right hip for the participants waking hours for seven consecutive days. Height and weight and BMI were calculated for all subjects. Half of the

sample was normal weight, with 3.7% being underweight, 29.6% overweight, and 14.8% obese. Results that concluded motor competence was positively related to the composite score of health related fitness. Adaptive behavior moderated the relationship between motor competence and fitness. This occurred in over three-fourths of the sample. However, there was no association between motor competence and physical activity. Findings also showed fitness is an independent predictor of mortality and morbidity. ASD children are 2.5 times more likely to be at risk than their typically developing peers. The study found physical fitness is a necessary priority for individuals with ASD. In conclusion, a positive relationship between fitness and motor competence suggested intervention through motor skills to produce meaningful health benefits.

Students with ASD had behaviors that negatively impacted their participation and performance in a school environment. Physical exercise had been proven to reduce stereotypic and disruptive behaviors, which resulted in more on-task behaviors. Exercise also proved to improve academic performance, cognitive and behavioral functioning, and increase social and communication skills. The purpose of the Oriel, Wetzel, Reed, Wilt & Saufley, (2020) study was to assess teacher knowledge and perception of PA use for children with ASD. Another purpose was to study how physical activity was implemented into a school day for children with ASD. The last purpose was to assess the barriers teachers face while implementing physical activity into classrooms.

The study was conducted as a survey and distributed to 1,000 teachers of students with ASD. 121 teachers completed the 20 question survey with open ended, multiple choice, and select option questions. Demographic information was collected including the participants' education level, school location, student age, classroom characteristics and size, males and females in the class, and number of children with ASD in the class. Participants were selected

through the Council for Exceptional Children member database. Survey questions had a specific frequency, duration, intensity, and mode. Both qualitative and quantitative data were collected using descriptive statistics and analyzed by researchers. Teachers were between 25 and 44 years old, and 69.7% had a master's degree. The average teaching experience was 12.8 years and students ranged from three to 18. An average of 3.5 children with ASD were part of each classroom. Of the 121 participants, only 19.4% received formal education about ASD. The majority of teachers agreed physical activity had benefits in attention, increased sensory/self-regulation, improved mood, increased energy exertion, improved motor function/fitness, increased good behavior, and increased socialization. Only 47% made physical activity a regular routine. Themes of physical activity incorporated into classrooms included music/ dance/ GoNoodle, yoga and stretching, heavy exercise, brain breaks, and centers/equipment. Physical activity increments lasted between five and 30 minutes. During these exercises, students were reported to have a moderate physical activity level. Recess occurred daily for 42.7% of participants and physical education classes occurred one to two times per week for 60% of the participant population.

Many barriers existed to physical activity implementation. Lack of time, space, and equipment include a few. Difficulty engaging ASD students, lack of motivation/interest, sensory/motor difficulty, poor behavior, decreased social skills, and lack of administrative and support staff included other common barriers. Another important barrier included lack of teacher and administrative education on how to implement physical activity within a school setting. A study by Katz et al. (2010) identified the Activity Bursts in the Classroom (ABC) program for fitness. The program incorporated various activities throughout the day totaling 30 minutes. In conclusion, physical activity had copious cognitive, behavioral, and social benefits for students

with ASD. Educated teachers were necessary to provide a successful implementation of PA into the educational setting.

Physical activity and parental involvement are highly intertwined. Previously, little research explored parental support with physical activity and children's physical activity levels within the autism spectrum population. The purpose of the Brown, Arbour-Nicitopoulos, Martin Ginis, Latimer-Cheung, Bassett-Gunter (2020) study was to examine this relationship and the effect of parent perspectives on children's physical activity behaviors. There were 201 parents of school-aged children with ASD who participated in the study. Parent physical activity support was organized into intentions, behavioral regulation, and support behavior. Until adolescence, physical activity patterns are similar among ASD and TD children. However, parental support was proven to be a key factor in PA behavior. Parents of youth with ASD acknowledged several barriers to PA, including having fewer friends, exclusion, and need for greater supervision. Although parents had great intentions to incorporate physical activity into daily life, intentions often did not convert to actions. The multi-process action control framework (M-PAC) consisted of three processes: reflective, regulatory, and reflexive. It allowed an investigation between parental support behavior, parental psychological processes, and PA participation among children with ASD.

The cross-sectional examination occurred in Canadian school-aged children and youth with disabilities. Parents had children diagnosed with ASD between four and 17 years old, lived in Canada, and proficient in English. A demographic questionnaire assessed education, household income, PA behavior, geographic location, and child age, ethnicity, diagnosis, severity disability, gender, height, and weight. Parents rated their child's disabilities using the Washington Group Short Set of Questions on Disability four-point scale across five domains: vision, hearing,

mobility, cognitive, and self-care. The Health Behavior in School Children Survey assessed children's PA behavior. Per Ajzen's recommendations, two questions were posed to parents to determine the intentions of supporting PA. Parents responded to the statements on a five-point scale. The first stated, "I tend to provide support to help my child participate in physical activity 60-minutes each day in the next month," and the second stated, "In the next month, I will try to provide support to help my child participate in physical activity each day for 60-minutes."

In conclusion, the study determined parent PA support was highly related to the child's PA behavior. Behavioral regulation of parent PA behavior was the strongest predictor of PA levels for children with ASD. Parental intentions were important, but insufficient in increasing their children's PA as 72.6% of parents with ASD youth struggled to move beyond the intention phase because they only supported PA once per week. This was less than TD parents. Managing ASD condition-specific deficits contributed to the lack of PA support. Collaborative intervention efforts are needed to translate parent intentions into action.

Physical Activity and the Connection to Improved Social Skills

Communication was another skill impacted by autism. Zhao and Chen (2017) established a 12-week structured physical activity program that consisted of 24 hour-long exercise sessions in an effort to observe the impact on students' social interaction and communication. There were a total of 50 children with autism who participated in the study. Twenty-five of the students were placed in the experimental group and the other 25 were placed in the control group that engaged in regular physical activity. Consistency, a reward system, and structure were utilized within the intervention group. A quasi-experimental design along with qualitative and quantitative instruments were used for this study. Both Social Skills Improvement System Rating Scale (SSRI-RS) and Assessment of Basic Learning and Language Skills-Revised (ABLLS-R) results

showed improvement in social interaction and communication skills for the experimental group. Data was collected from the perspectives of teachers, parents and students. The intervention program consisted of four features within each 60 minutes session for 24 sessions: warm up, one-to-five small group instruction, whole group exercise, cooldown and reward activities.Three test phases monitored growth at the beginning, middle, and end of the program. Data was collected using the Social Skills Improvement System Rating Scales (SISS) and Assessment of Basic Language and Learning Skills- Revised (ABLLS-R) quantitatively, while qualitative interviews with parents and staff were conducted.The ABLLS-R and SSIS-RS monitored social interaction and communication progress. Surveys, questionnaires, and semi-structured interviews gathered perception of progress from the participants' family members (Zhao & Chen, 2018). The study found that physical activity improved many deficiencies for ASD students. The study also showed that ASD students participated in fun activities with their peers and learned critical interpersonal skills. Self-determination, increased strength, and positive effects on cognition and adaptability are a direct result of physical activity. Furthermore, findings showed social behavior and function, enhanced communication, exercise stamina and ability, body mass index, sensory needs, stereotypical behavioral patterns, and overall participation improved as a positive result of physical activity interventions. According to SSRI-RS, ASD students in the experimental group significantly improved in social skills over time (Zhao & Chen, 2018). The effectiveness of physical activity on social intersections resulted from the natural setting of promoting positive social interactions, building relationships, and engagement in cooperative play or teamwork. Based on qualitative data from parents and teachers, a specific physical activity intervention included physical activity, purposeful design, a structured program, teaching tools, low teacher-student ratio, and a comfortable environment (Zhao & Chen, 2018).

Autism Spectrum Disorder is characterized by poor social and communication skills. Structured individualized interventions are necessary to address these deficiencies. Autism can be diagnosed as young as 18 months, creating the need for early, structured interventions but remains to have a curative treatment. Two examples include comprehensive treatment models and focused intervention practices as reviewed by Sefen, Al-Salmi, Shaikh, AlMulhem, Rajab and Fredericks, (2020). Their research revealed the positive benefits of structured exercise interventions for youth with ASD, including creating schedules and routines, improving motor control, increasing self-esteem, and reducing undesired stereotypical ASD behaviors. Though it may be counterintuitive, it was beneficial to deliver isolated, individualized programs away from the group to develop social skills with ASD individuals. Simplified programming structure was important along with physical structure, schedules, and task organization. Meta-analysis and systematic reviews concluded that physical activity directly benefited behaviors and social skills for children with autism. Programs such as Treatment and Education of Autistic and Related Communication-Handicapped Children (TEACCH), dance, horseback riding, and martial arts showed positive results. Exergaming was another form of innovative physical activity. "Exergames are defined as any game that has a combination of video games and physical interaction with participants online" (Al-Salmi et al,. 2020, p. 5). Results included: improved social involvement, behavior, communication skills, body awareness, and mental health. More specifically, after a 14-week karate training program, significant improved communication and improvements in stereotypical behaviors were noted. Self-regulation, self-awareness, and concentration were also improved. Professionals such as pediatricians, child psychiatrists, occupational therapists, speech therapists, psychologists, specialist-teachers, and parents are all necessary members of ASD interventions. Other programs involved included: Applied Behavior

Analysis (ABA), Early Intensive Behavioral Therapy (EIBI), Verbal Behavioral Intervention (VBI), Picture Exchange Communication System (PECS), speech therapy, and sensory integration therapy. Furthermore, physical exertion was considered an evidence-based practice that decreased problem behaviors or increased desired behaviors (Sefen et. al., 2020).

Seventeen males and four females with Autism Spectrum Disorder participated in a study conducted by Tes, Liu and Lee, (2020), that sought to demonstrate whether physical exercise reduced stereotypical behaviors resulting from ASD. The study targeted hand-flapping and body-rocking behaviors. Three conditions were established: one for the control condition, one for the 10-minute ball tapping condition, and one for the 10-minute jogging condition. Participants were defined according to three weight categories: underweight, normal, and overweight per the international standardized age and gender-specific cut-off determining BMI. Participants were 9-13 years old, diagnosed ASD, had a nonverbal IQ over 40, were able to follow directions, and scored a 9 or greater in the Gross Motor Development subtests. They had not had regular physical activity outside of school in the past six months and demonstrated observable hand-flapping or body-rocking. The measurements were recorded by a video study and coded by two independent raters. Each participant was required to take part in one control and two intervention conditions on three separate days. Many aspects of the study were familiar to students, including the setting, schedule, and activities. The ball-tapping exercise intervention required the participants to tap the ball as many times as possible in ten minutes. Participants were required to jog around a basketball court for ten consecutive minutes during the jogging exercise intervention. Verbal cues and reinforcements to encouraged continuous exercise. The results showed participants achieved the required physical activity level. Reduction in hand-flapping occurred during the ball-tapping exercise intervention, but the jogging exercise

was not effective in eliminating hand flapping. There was some success with reduced body-rocking with jogging, but not ball-tapping. The study confirmed that stereotypical behaviors were reduced by a corresponding exercise, not the fatigue effect. Results revealed an individualized reduction in specific behaviors related to the exercise involved. Hand-flapping was reduced with the ball exercise condition and rocking was reduced with the jogging exercise condition. These behaviors stayed absent for 45 minutes

Behaviors such as repeated speech and movements, hand-flapping, body-rocking, and circular body movements, interfered with peer social engagement, learning ability, and the learning environment for the individual with ASD. Many interventions were available for ASD children, but most were expensive and required professionals. Physical activity was low cost and easy to implement (Tes, Liu, Lee, 2020).

Howells, Sivaratnam, May, Lindor, McGillvray, and Rinehart used meta-analysis to research and clarify the impact of organized physical activity (OPA) on social and communication for children with Autism Spectrum Disorder. Autism is heterogenous, resulting in differentiation. The study was conducted following an interest in motor interventions and the potentially benefitted for ASD populations during social functioning and communication with peers, siblings, and instructors. Physical activity improved the social component of ASD and reduced the presence or risk of psychiatric disorders. Life-style based interventions successfully prioritized life skills versus academics. Successful intervention occurred in a natural setting for participants, where effective learning opportunities occurred. OPA was defined by Okely (1990) as physical activity supervised by an adult in a formal or structured setting. In addition to the communication and social challenges in ASD, subjects also portrayed motor impairments. Researchers found a direct correlation between motor and social impairments. Physical activity

programs improved motor function. The study focused on several systematic reviews including: the increased effectiveness of individualized exercise interventions over group interventions and the lack of age groups and settings within a study. Research indicated that an individualized exercise intervention was more effective than group-based. However, group interventions increased interpersonal and social skills development. Providing a variety of developmental stages and settings allowed for generalization of results (Howells et al., 2019).

Study participants were diagnosed with a Pervasive Developmental Disorder, including a DSM-5 ASD diagnosis and other variations and were between three and 16 years old. The intervention program was delivered in small groups for at least 30 minutes a week. The interventions included horseback riding, kata techniques, soccer skills, multi-sport camps, and an outdoor adventure camp, and varied with both frequency and length. Two outcomes were measured: social functioning and communication. Social outcomes included social communication, relationships, peer interactions, social motivation, and awareness. The Social Responsiveness Scale and Vineland Adaptive Behavior Scale were used for meta-analysis. Data extraction was achieved by one independent reviewer. The data extracted included: study design, sample age range, number of group participants, diagnosis, severity, and comorbidities, OPA type, additional medication or therapies, measures used to assess social outcomes, and results. Results indicated 379 participants took part across 11 studies, with 348 included in the qualitative analysis. Eight of the studies noted improved social functioning improvement. Two of the 6 studies found communication improvement. Bias, however, was likely to have occurred. Six of 11 studies included equine therapy. Motor functioning, behavioral skills, and self-care improved from these programs (Howells et al., 2019).

Tarr, Riner-Hershey, and Larwin (2019) found that about 90% of the autism population experienced stereotypic behaviors. These behaviors occupied up to 60% of the time for ASD individuals and resulted in social stigma, social disconnect, and inhibited learning new information. In addition to the stereotypic behaviors, those with autism were impacted by anxiety, hyperactivity, sensory integration problems, increased response latencies, play behavior interference, self injury, and problem behaviors. Problem behaviors were defined as "behaviors that interfere with a person's ability to function" (Tarr et al., 2019, p. 26). The goal of reducing stereotypic behaviors was to create space for increased socially desirable behaviors that promoted a better quality of life.

Stereotypic behaviors are a hallmark characteristic of autism for most individuals. Tarr et al. (2019) investigated three meta-analyses on the effects of physical activity and stereotypic behaviors for ASD participants who had stereotypic behaviors. The three research questions focused on the effect of stereotypic behaviors in aggregate score studies of single subject design studies that included functional analysis, and stereotypic behaviors. The studies part of the analysis were conducted between 1980 and 2017, written in English, used physical exercise as the independent variable, stereotypic behaviors as a dependent variable, and included individuals diagnosed with ASD.Ten studies published the effects of physical exercise on stereotypic behaviors based on the inclusion criteria. The aggregate scores included eight females and 46 males for a total of 54 participants. The single-subject design studies included 10 males and three females for a total of 13 participants. The analysis focused on the effects of physical activity on stereotypic behaviors according to sex, age, autism severity level, types and functions of stereotypies, and types of (taught) exercise. Moderators in the study included preference/choice-based, intervention setting, implementers of the interventions, duration and

intensity of interventions, behavior assessment methods and behavior measurement techniques. The large effect sizes found in the study concluded that stereotypic behaviors decreased with physical activity. Three hypotheses attempted to explain the phenomenon: neurotransmitter hypothesis, fatigue hypothesis, and matching hypothesis. The neurotransmitter hypothesis claimed that neurotransmitters were directly impacted by physical activity. Those with autism had deficiencies in serotonergic, dopaminergic, and GABA neurotransmitters. Moderate to vigorous exercise proved to positively change the synthesis and metabolism of these systems. The fatigue hypothesis suggested stereotypic behaviors decreased due to decreased stimulation in the basal ganglia, resulting in the reduction of skeletal muscles and increased fatigue. Results of the study indicated that aerobic exercise in small doses temporarily reduced stereotypic behaviors because of the effect on neurotransmitters which resulted in fatigue. The meta-analysis concluded that the effect size of physical exercises that topographically matched the stereotypic behavior was greater than when the physical activity was not topographically matched. Therefore, coordinating a physical activity with a stereotypic behavior tends to be most effective. An alternative hypothesis suggested different exercises affected different parts of the brain and therefore different behaviors. For example, aerobic exercise was associated with improved cognition, and resistance training correlated with improved executive functioning and memory. Stereotypic behaviors occurred in the following brain locations: cerebellum, cerebellar vermis, whole brain volume, frontal lobe. The basal ganglia, parietal lobe, and cerebellum were impacted by sports drills. Martial arts was deemed most successful during the meta-analysis by obtaining the greatest effect size.

Stereotypic behaviors can be non-functional, repetitive, self-stimulatory movements which involve both fine and gross motor movements and/or verbal and nonverbal behaviors. Lee,

Vargo, and Porretta (2018) analyzed three preschool autistic boys and how locomotor activities and object manipulation affected stereotypic behaviors (SB). None of the Caucasian boys were medicated or had other diagnosed medical conditions that impeded physical activity. The study setting was conducted in an empty preschool classroom in the Midwest. Two participants were nonverbal and one was verbal. All three boys had SBs that debilitated their school success. The independent variable included locomotor activities or object manipulation activities. The dependent variable was the percentage of 10-second intervals with SBs. Task engagement, and appropriate on-task behaviors, were measured. A three-component test sequence used three, five-minute phases to identify changes in stereotypic behaviors: pre-physical activity, physical activity, post-physical activity. Two professionals observed participants during 38% of the physical activity sessions and 50% of the functional activity sessions to calculate interobserver agreement. Sessions were one-to-one and videotaped. Six objects, determined by teacher recommendations, were placed in front of each of the three boys. Participants were given 30-seconds and then directed to select one item. The trial continued until all items were chosen or until the participant stopped choosing, producing a hierarchy of preferred items. Functional analysis was conducted once per day for four 5-minute conditions: attention, demand, play, and alone. The physical activity intervention had three, five-minute components in the same order: pre-PA, PA, and post-PA. Each participant experienced eight locomotor and eight object manipulation sessions. General verbal prompts prevented irrelevant effects. Moderate SB rates were present in all conditions, partially due to automatic reinforcement. Results revealed locomotor physical activity sessions reduced SB percentages more than the object manipulation intervention. However, only one of three participants demonstrated greater task engagement. SBs also remained similar during pre-PA sessions and decreased similarly across participants in

post-PA sessions. Contrarily, higher levels of SBs were found after the object manipulation physical activity. Heart rates increased for both locomotor and object manipulation activities.

Physical activity not only decreased SBs, but was also associated with social, academic, and overall health improvements. SBs interfered with psychosocial functions, caused learning delays and disruptions for teachers and peers, and impaired the inclusive environment. Interventions attempted to decrease SBs including differential reinforcement, noncontingent reinforcement, inclusion of match stimuli, and punishment. However, physical activity intervention promoted both physical and mental health. Although proven effective, the mechanism behind behavior changes was unknown. The fatigue effect proved ineffective due to no differential effect between low and high intensity exercise. Physical activity, though, decreased motivation to engage in SBs. For example, jogging vigorously was more effective than walking. The locomotor activities resulted in decreased percentages of SBs post activity. Furthermore, the decreased SBs allowed for increased task management. It was also possible that activities led to fatigue at faster and greater rates, reducing the risk of SBs. Object manipulation sessions resulted in more SBs during the post-PA sessions. Research also concluded that automatically reinforced behaviors may be more difficult to treat than socially maintained behaviors. The study found that teachers who provided physical activity for ASD students needed to be selective due to the stimulating effects. Even small doses of locomotor activities resulted in decreased SBs (Vargo & Porretta, 2018).

Autism, according to the Diagnostic and Statistical Manual of Mental Disorders, has two categories of symptoms. The first includes deficits in: social-emotional reciprocation, nonverbal communication, and relationship understanding, development and maintenance. The second includes: repetitive patterns of behaviors, inflexibility to change, and restricted interests. Many

autism deficits are also symptoms observed in individuals experiencing executive functioning issues.

Executive functioning (EF) was observed as a key component in basic cognitive processes such as sensation, attention, and memory. EF is referred to as a cognitive control system responsible for thought and action formulation and integration, goal identification and achievement, and self reflection. Mason, Zimiga, Anders-Jefferson & Paap (2021), studied 200 university students between the ages of 18 and 45 who completed multiple tests including: AQ scale of autism traits, five measures of EF in everyday life based on self-ratings, three laboratory tasks of cognitive ability, a comprehensive survey on various demographics including languages spoken, frequency of music performance, video gaming, and meditation. The goal of the study was to explore the relationship between the Autism Quotient Scale (AQ), Executive Functioning (EF), and the frequency of engaged life activities related to EF (Mason et al., 2021).

Of the 550,000 ASD children in the United States, it is anticipated that 45% will enroll in post-secondary education due to improved interventions. Participants were diverse with 29% Hispanic, 28% Asian, and 21% White, and 57% identified as female, which matched the ratio of female to male students at the university. The study included one, 90-minute session. All participants participated in the following: color-shape switching, spatial Stroop, visual search, Raven's Progressive Matrices, AQ, Barkley Deficits in Executive Functioning Scale, Trait Self Control and Impulsivity, Premeditation, Urgency, Perseverance, Comprehensive Exercise Survey (CES), and a background questionnaire that discussed history, demographics, music engagement, video gaming, and mindfulness. Three different tasks allowed for five performance-based measures of EF. Only the spatial Stroop cross-task correlation was significant. Overall, performance-based measures of EF were not correlated and did not predict AQ. Contrarily,

self-rated measures of EF did both. Therefore, AQ scores were predicted by self-rated executive dysfunction, but performance-based measures of EF did not predict AQ. This study concluded that performance based measures did not correlate with cognitive ability. AQ scores were negatively associated with playing music, meditation, and physical activity. Furthermore, a greater number of autism traits resulted in fewer benefits from physical activity. However, intense, high frequency physical activity interventions provided benefit to the general ASD population (Mason et al., 2021).

Children with ASD have impairments in motor skills, social communication and social interaction. Poor balance hinders the quality of life and daily activities such as bathing, dressing, and leisure. More specifically, the impairments include: poor motor anticipation, motor pattern disturbances, clumsiness, impaired postural control and stability, and impaired gross and fine motor skills. To address these needs, many interventions were created, including the motorized elephant-assisted therapy program (METP). This study originated from Thai culture and the prevalence of elephants within the culture. Three occupational therapists recognized the costs and inability to work with live animals so they created robotic replicas. Prior studies concluded even robotic animals reduced anxiety and promoted self calming for the owner. The goal of the study was to create the METP and discover whether the program affected balance movement control within the ASD population. The two guiding questions included “Do the balance controls of the control and experimental groups differ at pretest and posttest?” (Nuntanee & Daranee, 2019).

Good balance in this study resulted in healthier sensory, motor, perceptual, cognitive, emotional, neurological, musculoskeletal, and cardiovascular systems. The project was a quasi-experiment with the 20 participants split into two groups. Participants ranged in age from

eight to 19 years, were selected from occupational therapy clinics within Chiang Mai city, and included nine males and one female in each of the two groups. Participants scored poorly on the Bruininks Oseretsky Test of Motor Proficiency, must have the ability to communicate basic needs, and were diagnosed with ASD. The swaymeter, a tool that measures balance control among participants was used. Data was collected for four conditions of 30-seconds per condition in 4 trials. Each trial participant stood on the floor, barefoot. The trials included: floor with eyes open, floor with eyes closed, foam with eyes open, and foam with eyes closed. Two motorized elephants were also used during the study under the supervision of an occupational therapist. The control and experimental group worked with occupational therapists. Four activities were conducted by the experimental group. Although both the control and the experimental group received occupational therapy, only the experimental group participated in METP. The treatment included four activities: washing the entire elephant, getting on and off the elephant, and playing games. Activities were made more challenging if needed, and were conducted twice a week for 90 minutes at a time. Ten minutes were designated for warm-up, 20 for washing and drying the elephant, 20 for riding and following commands to control the elephant, 30 minutes for playing games with peers, and 10 minutes for wrapping and clean-up. The pretest for both the experimental and control groups highlighted no difference in postural sways. Both groups significantly struggled with closed eyes. The experimental group significantly improved with their eyes open and eyes closed Qualitative data stated 60% of parents from the experimental group reported better postural control and balance during everyday activities. The control group showed no balance coordination improvement. In conclusion, the METP facilitated better balance control in individuals with ASD.

One of the most cost-effective, healthy, underutilized interventions for children with ASD included physical activity. During COVID-19, the Simons Foundation Powering Autism Research surveyed over 8,000 families of children with ASD to discover coping strategies. Results found many parents utilized breathing exercises, yoga, prayer, meditation, and other mindfulness exercises to reduce stress and increase activity. The increased stress of a disrupted routine, lack of comfortable social interactions, and confinement led to the SPARK organization providing practical pointers and suggestions for parents to reduce stress and increase activity based on previous research findings (Block, 2020).

The tips included flexibility. Children's strengths were incorporated and preferred routines were established during physical activity. Consideration of time of day, type of activity, amount of time, intensity of the activity, and participants involved was included in the flexibility consideration. Children were more attracted to physical activity when fun was involved. Examples included: using videos with cartoons, action, and music; listening to music while on a walk or completing an exercise routine; incorporating a child's strong interests; and incorporating pets and siblings. A predictable schedule for physical activity also provided more successful results. Parents either added one 45-minute exercise session or three, 15-minute sessions. Positive reinforcement made these activities more successful. Parents who provided choices and set goals or targets were also more successful incorporating physical activity into daily life routine. Furthermore, relaxation exercises proved important during the high-stress quarantine of COVID-19. Incorporating these strategies into daily life resulted in lifelong habits, improved physical and mental health, and produced a more relaxed environment (Block, 2020).

Block, Nichols, and Bishop (2020) investigated an affinity-based approach to an ASD child with strong interests. The strong interests were part of the Diagnostic and Statistical

Manual of Mental Disorders, 5th edition, that stated that stating characteristics of ASD included highly restricted and fixated interests, intense in focus and/or abnormal. Instead of viewing these strong interests as negative, the affinity approach positively identified the strong interests as affinities and applied them to promoting physical activity. A research study was conducted using a single 14 year old boy with autism from Bluford High School outside of Philadelphia. JJ spent too much time on the internet, playing video games, and eating junk food like many other teenage boys. Since being diagnosed with ASD, JJ faced even more challenges due to obesity, inactivity, and sedentary lifestyle habits. JJ spent most of his education in the special education setting due to being nonverbal. He communicated with an assistive technology ipad. He was easily distracted and occasionally got upset on occasion, but wasn't dangerous. Mrs. Gonzalez, JJ's physical education teacher freshman year, found JJ to be easily distracted but pleasant. The purpose of the study was to present an affinity-based approach that celebrated affinities with an application to physical activity in children with ASD.

According to Merriam-Webster online, 2018, affinity is defined as "an attraction to or liking for something." Like JJ, another boy with autism, Owen, had an affinity. Owen's affinity was Disney movies. The Block et al. (2020) study Owen's affinity for Disney and created physical activity options with the attempt to get ASD children more active. Owen's family was an integral part of this affinity process, participating and using these affinities to teach him to speak, read, and make sense of the world. To reach their potential, children with ASD needed additional support and accommodations. Suskind and Suskind (2015) presented the following strategies to promote physical activity with affinities. Perseverance was promoted with a video game template- the start involved much struggle, the middle involved improvement, and the more a person played, the better he or she became. JJ had a strong affinity towards cats.

Perseverance was incorporated through youtube videos of athletic cats to demonstrate running, jumping, and climbing to be replicated by JJ. Attention was aroused by creating anticipation of fun. Controlled competitions were implemented, along with cooperative activities and baseline timings to develop goals. Involvement and creation of fun through novelty, slapstick, and being cartoonish proved effective when incorporating affinities into physical activity. The usage of scripts of quotes from a child's affinity are deemed effective with both application to real life and creating desired behaviors. A blended form of all recommendations showed most success. In conclusion, a ASD child's strong interests were viewed as positive and encouraged during physical activity to create a connection, interest, and habit of physical activity into daily life (Block et al., 2020).

In the United States, ASD was present in one out of every 68 children. ASD is a neurological disorder that also results in higher risks of cancer, diabetes, down syndrome, or spina bifida among children. ASD is also correlated with repetitive and restrictive behaviors, known as stereotypical stimulatory behaviors (SBB). SSB differ among each individual, and are disruptive to many life components. Olin, McFadden, Golem, Pellegrino, Walker, Sanders & Arent (2017) acknowledged the need for effective treatment methods to reduce SB without drugs or aversive therapies. Aerobic exercise, in particular, proved to reduce SBB in children with ASD. It was a desirable treatment method due to its affordability, ease of administration, and added health benefits that improved the quality of life. Olin et. al (2017) sought to quantify the effect of exercise, intensity, and duration on the frequency of stereotypic behaviors in children with ASD.

The study included seven male children with autism with a mean age of 13. A younger age group was desired due to a higher presence of SSB. The two primary stereotypic behaviors

within this population included hand flapping and echolalia. Furthermore, all participants were part of a developmental program for children with autism. The design of the study conducted pre exercise baseline behavior measurements, and postexercise measurements in a familiar classroom setting. The precondition was 15 minutes of observation, with the experimental conditions conducted in the gym. The condition substituted regular physical education time, two or three times per week for five total sessions at the same time of day. The control session had no exercise treatment. During the first exercise condition, four participants selected the treadmill while the other three selected the stationary bike. Aerobic, continuous exercise was maintained for 10 or 20-minute increments. The OMNI scale provided pictorial representations of a perceived exertion scale that forced participants to rate how hard they were working. Subjects completed their self-rating system every three to five minutes during exercise. After the exercise, participants performed a cooldown and were observed via video camera for an hour post exercise. These videos were scored in 15 minute increments. The results showed a reduction in SBB after exercise. The biggest reduction resulted from shorter duration and lower intensity exercise. Contrarily, with more exhaustive and high intensity exercise interventions, SBB increased from the baseline level post exercise. These results contradicted previous studies. However, a lack of standardized criteria and a different set of students and their individual needs accounted for the differences. In all, physical activity as an intervention improves academic skills, SBB, and overall health for children with autism while also reducing anxiety.

Lifelong Implications and Effects of Regular Physical Activity within the ASD population

Children with ASD often have trouble sleeping, which transfers into adolescence and adulthood. In fact, Benson et al. (2018) found 50-80% of children with ASD experienced sleeping problems. This sleepiness resulted in daytime sleepiness, fatigue and even contributed

to core stereotypical symptoms. Furthermore, individuals with ASD had significantly lower physical activity rates than their typically developing peers. Explanations included challenges in social communication, sensory and behavior domains, and motor deficiencies. It was found children with ASD who are more physically active had higher quality of sleep. The study measured the amount of physical activity and the correlation to quality sleep in the young adult ASD population. The purpose of the study included exploring objective sleep, physical activity levels, and the relationship between physical activity, sleep, and daytime sleepiness in adults between the ages of 18 and 35 with ASD.

Participants of the study included young adults between the ages of 18 and 35, 15 of which were diagnosed with autism and 17 typically developing individuals. 13 of the 15 ASD participants were medicated, with 66% of medications prescribed for sleep. 10 of the 15 participants also relied on parent involvement to complete the questionnaires due to low intellectual functioning. The Godin-Shephard Leisure-Time Physical Activity Questionnaire was completed to analyze subjective physical activity levels. Caloric expenditure per week was calculated according to the frequency of at least 15 minute increments of leisure physical activity. Participants also completed the Perceived Sleep Quality, Insomnia and Sleep Apnea Risk questionnaire (PSQI) to categorize sleep disturbance. The Snoring, Tiredness, Observed apnea and high blood pressure (STOP-Bang) questionnaire predicted the risk of obstructive sleep apnea. The Karolinska Sleepiness Scale (KSS) used a nine-point Likert scale to assess behavioral sleepiness. A combination of sleep parameters and physical activity levels were measured through the Motionlogger actigraph. Physical activity levels were averaged weekday and weekend scores. The results of the study showed no differences between the two groups with BMI, PSQI, insomnia risk, or sleep apnea risk. However, the ASD population took over 30

minutes longer to fall asleep after the intended sleep onset-lights out (SOL). In fact, SOL was twice as long as the TD sample. The participants with ASD went to bed, on average, 96.4 minutes earlier on weekday nights, and 126.4 minutes during weekends. The average moderate to vigorous physical activity (MVPA) measured twice as much in the TD population compared to the ASD population. Physical activity also impacted sleep within the ASD population. Those who met the recommendations of 150 minutes or more went to bed 111 minutes earlier and woke up 97 minutes earlier than those who did not meet the recommendations. The TD population reported more sleepiness at bedtime than the ASD sample. The ASD sample took twice as long to fall asleep than the TD population. Explanations included prolonged sleep latencies, pre-sleep arousal, and the inability to stop thoughts. In conclusion, the benefits of PA and healthy sleep habits are beneficial to both populations. With the physical activity and sleep struggles that individuals with ASD face, using physical activity as a tool for better sleep is important.

The “Growing Up in Ireland” study took place as a longitudinal study to analyze a group of individuals, their levels of physical activity and screen time, over an extended period of time. The study compared how physical activity and screen time levels changed over a nine year period among the same population. Both neurotypical development and autistic participants participated in the study. The study began in 2006, which followed a cohort of individuals born between November of 1997 and October of 1998. The first wave of data was collected between September of 2007 and August of 2008 from 8,568 children. The second wave was collected when children were 13 years old between August 2011 and March 2012 from 7,525 families. Wave three was collected when students were 17/18 years old between April 2015 and August 2016 from 6,216 children. By wave three, 91 children were diagnosed with ASD. The concluding final sample size consisted of 88 ND youth and 88 ASD youth for a total of 176

participants, 138 males and 38 females. 62.5% of the ASD population received one or more support services while only 8% of ND students received services. There was no race nor ethnicity information reported (Dahlgren, Healy, MacDonald, Geldhof, Palmiere, & Haegele, 2021).

Data was collected through surveys. Questions assessed the amount of MVPA completed for 20 minutes within the past two weeks, light physical activity (LPA) completed in the past 14 days for at least 20 minutes. Response options included none, 1-2, 3-5, 6-8, and 9 days. Screen time was measured with the questions, "on a normal weekday during term-time, how many hours are spent watching TV, videos, or DVDs?" Options included: none, less than one hour, one hour to less than three hours, three hours to less than five hours, five hours to less than seven hours, or seven or more hours. Results concluded at nine years old, 44.3% of children with ASD participated in nine or more days of MVPA. However, 62.5% of ND children participated in the same amount of PA. The amount of MVPA decreased for both groups at 13 years old, but was a greater decrease for the ASD population. For example, those with ASD completed one to two days of MVPA in the past 14 days while the ND population engaged in nine or more days. By age 17/18, those with ASD participated in no days of MVPA compared to ND students who participated in six to eight days of MVPA. Levels of LPA did not differ between the populations at nine years old, with nine or more days of LPA. By age 13, students with ASD completed three to five days of LPA while ND students completed nine or more days of LPA. LPA did not differ between 17/18 years old. Furthermore, groups did not differ with time spent on screens (Dahlgren et al,. 2021).

In conclusion, adolescents with ASD live a more sedentary lifestyle than ND peers. The biggest discrepancies started between nine and 13 years of age. Lack of social support, negative

self image, and lack of skills or competence to perform PA contribute to the sedentariness. In order to increase PA levels among the ASD population, a multi-pronged approach before adolescents is needed such as appropriate physical education, school-based extracurricular PA, and home and community based PA opportunities. An increase in PA would lead to a decrease in screen time, especially within the nine to 13 age range. Thus, a result of a lower presence of obesity, sleep problems, depression, and anxiety would occur (Dahlgren et al., 2021).

The Tyler, MacDonald, Joyce study (2020) examined the correlation between school-day physical activity behavior of children with ASD and components of health-related physical fitness. The study was based on previous research that concluded 60-73% of typically developing children met the 60 minutes of recommended daily moderate to vigorous exercise while only 37-47% of children with ASD met the recommendation. Health-related physical fitness (HRPF) proved to contribute to physical activity participation in typically developing (TD) children. Research also proved aerobic capacity either hindered or enabled physical activity of TD children. 95% of children enrolled in schools in the United States, where schools occupy most time in a child's day, promote physical activity opportunities within the school environment.

There were 49 children between nine and 17 from both public and private nonprofit schools and community programs in the Chicago area who participated in the study. A researcher met with each child in a therapy/movement room located in the child's school or community based site for the initial 45-minute assessment. The assessment included completing paperwork, physical fitness assessments, and administering pedometers. Parents completed a demographic questionnaire. The Omron HJ-720ITC pocket pedometer measured school-day physical activity based on each participant's weight and stride length. The Six Minute Walk Test assessed aerobic fitness by measuring distance walked for six minutes on a 20-meter indoor visually marked

track. A pacing partner was also used to keep the participant engaged and the grip test measured upper body isometric strength. In conclusion, there was a significant relationship between school-day physical activity and aerobic capacity. Furthermore, the number of steps during a school day was positively associated with aerobic capacity when muscular strength, gender, and age were considered. However, muscular strength was not found to be associated with school day physical activity. Therefore, physical education improved health related outcomes in aerobic capacity for all children. A curriculum rooted in physical activities, minimal transitions, and time engaged in moderate to vigorous physical activity aided in positive outcomes (Tyler et al., 2020).

Health benefits of physical activity included improved cardiorespiratory and muscular fitness, improved bone health, decreased body fat, and reduced depressive symptoms. It was recommended that adolescents between six and 17 years old need to exercise for at least 60 minutes at a moderate to vigorous level daily. Previous research utilized the accelerometer to quantify exercise data in both ASD and TD populations. However, this device gave no insight into the types of activities performed nor the frequency. Stanish, Curtin, Must, Philips, Maslin, Bandini (2017) assessed and characterized the participation in moderate to vigorous physical acts (MVPA) for adolescents with ASD. TD and ASD youth were compared for the amount of time spent in MVPA and types of frequencies of physical activity (PA) performed. During the study, 30 adolescents with ASD between 13 and 21 years and 60 TD adolescents were between ages 13 to 18. The age limit was higher for the ASD population due to individuals with disabilities being permitted to attend school until their 22nd birthday. Participants were also in good health with no chronic illnesses or physical disabilities. Accelerometers were utilized for seven days, five weekdays and two weekend days, and recorded over 15-second epochs. A questionnaire was verbally administered to determine the type and frequency of PA performed by adolescents

during the past year. To ensure best practice the interview process occurred with both parents and adolescents. The questionnaire particularly targeted outside-of-school activities during the summer, weekends, and evenings. Each question had two parts. The first queried activities in the past year and the second asked about the frequency of 12 or more times in the past year. Picture cues were also used for visual support (Stanish et al., 2017)..

The results of the study demonstrated lower activity counts among the ASD population compared to the TD population on weekdays, weekend days, and a daily average. Specifically, youth with ASD spent about 29 minutes per day in MVPA compared to 50 minutes per day among TD youth. However, both groups did not meet the recommended 60-minutes per day of MVPA. There was also no difference in frequency of PA participation between groups based on the questionnaire data. TD adolescents reported the most engagement in: running/jogging, active video gaming, walking/hiking, swimming, basketball, bicycling, dancing, football, weightlifting, and baseball/softball. The ASD population shared seven similar activities, but in a different order. Another similarity included lower MVPA on weekend days versus weekdays for both groups. In conclusion, both groups participated in similar activities with similar frequencies. Both groups reported active video gaming, walking/hiking, swimming, running/jogging, bicycling, dance, and basketball as the most performed activities. The preference similarities supported inclusive programming potential. Regardless of preferences, youth with ASD have significantly less MVPA than their TD peers (Stanish et al., 2017).

Tan, Pooley, and Speelman (2016) studied the effects of exercise on cognition and executive functioning. Individuals have unique needs and therefore a unique exercise program was developed for each subject. Previous research acknowledged the limitations and potential benefits of exercise to enhance cognitive functioning. Those who are neurodevelopmentally

diverse demonstrated a less clear correlation between exercise and cognition. For example, a previous study found 31 children with ADHD did not produce cognitive benefits for working memory after a one to 10 minutes of stationary biking. Some ASD individuals had impaired EF domains including: aspects of planning, set-shifting, and working memory. Although previous research was completed on the effects of exercise on cognition in individuals with ASD/ ADHD, there was a lack of practical interpretation of the effect size. The primary purpose of the study was to investigate the efficacy of exercise intervention for ADHD/ASD individuals. Furthermore, based on meta-analytic findings, the significance of applying exercise to cognition was explored.

The inclusion criteria included: participants with ADHD/ADD, exercise intervention studies that evaluated objective cognitive performance, and published between 1968 and 2015. The review process took place between January and June 2015. The articles were assessed based on relevance to the purpose and inclusion criteria for title, abstract, and content. In total, 22 articles were utilized in the meta-analysis and 579 participants between the ages of three and 25. There were 416 males and 48 females. Results of the meta-analysis concluded that positive effects of exercise exist, but the magnitude was not confidently established. In regards to the executive function domain meta-analysis, inhibition and memory functions showed significant small to medium effect size after post-exercise intervention. Memory did not have significant effect size. There was a small to medium effect size for ASD/ADHD individuals during exercise interventions. However, the sample size, age group, type of control group/ condition, and the type of exercise and duration of the interventions did not significantly impact the effect of exercise and cognition. Cognitive tasks had differing results from exercise interventions. On-task duration and simple learning tasks and global executive functions were the two categories used.

The study proved exercise interventions had a larger effect on time spent on-task and simple task completion compared to executive functioning tasks. Furthermore, exercise interventions showed beneficial effects for inhibitory and memory functions. In conclusion, exercise interventions were proven to improve some aspects of cognitive functions in individuals between the ages of three and 25 with ASD or ADHD. Additionally, exercise effects varied among individuals with some cognitive functions more highly affected than others. This study acknowledged the limitations of what exercise can and cannot provide and provided a base for future research targeting the relationship between exercise and cognition (Tan et al., 2016).

As of 2017, ASD impacted 2-4% of the population with a ratio of 3:1 male to female. The diagnosis usually occured by age four, with poor social and mental health and impacted relationships, academics, and independence. The World Health Organization recommends that children aged three to five get at least three hours of physical activity daily while children aged five to twelve achieve at least 60 minutes of daily physical activity. Research revealed that physical activity habits continued into middle childhood. However, children with ASD were less likely to be physically active than their typically developing peers. On average, children with ASD participated in physical activity 86 minutes a day while their typically developing peers participated 135 minutes per day. This Australian study proposed to: explain the moderate to vigorous activity of four to seven year-olds in both ASD and TD populations; use the ecological model to understand moderate to vigorous activity and the variables in each domain. Researchers hypothesized that both ASD and TD populations would experience similar levels of moderate to vigorous physical activity; lower levels of moderate to vigorous physical activity would be associated with individual domain variables (ADHD severity, greater sleep difficulties, and constraints to physical activity); in both TD and ASD populations, familial and physical

environmental domains would result in higher physical activity rates (Thomas, Hinkley, Barnett, May & Rinehart, 2019).

Seventy-seven children between the ages of four and seven were recruited from specialist Autism services and primary schools to this study. Thirty-seven were diagnosed ASD by DSM-IV and 40 were typically developing peers. The parents of the ASD participants rated their children's symptom severity within the past six months using a four-point scale. Participants were invited via letter. Children were assessed within two hours, taking breaks as needed. All participants wore an ActiGraph accelerometer for eight consecutive days. Parents of the ASD participants completed surveys while parents of TD participants completed the survey and a battery of measures at home. The Conners Parent Rating Scale-Revised- Long Form assessed children's hyperactivity and inattention. Intelligence was estimated through the Wechsler Preschool and Primary Scales of Intelligence IV Australian. Sleep problems were assessed with a 33 parent questionnaire, the Child Sleep Habits Questionnaire. Results concluded no significant difference in demographic or child characteristics between TD and ASD populations. Results also proved children between four and seven experienced similar levels of physical activity regardless if children were TD or ASD. There were no significant associations, positive nor negative, between individual domain variables and lower levels of physical activity or association between being independently active and active transport with higher levels of physical activity. The ASD group only had an association between parental beliefs and the amount of physical activity performed. The study also found playground suitability impacted the level of moderate to vigorous activity in the ASD population. In conclusion, the young age group made it difficult to assess physical activity intensities. However, despite the population

differences, both groups engaged in similar levels of physical activity (Thomas, Hinkley, Barnett, May & Rinehart, 2019).

CHAPTER III: DISCUSSION AND SUMMARY

Summary of Literature

All studies concluded that physical activity positively affects youth with ASD. Social skills, undesired stereotypical autistic behaviors, and communication skills were improved through intentional, structured experimental physical activity with professionally-trained staff (Memari et. al., 2016). Many psychosocial correlates existed between physical activity and screen time between TD and ASD participants ultimately concluding resulted in social skills gains, decreased stereotypical ASD behaviors, hyperactivity, self-injury, and aggression (Healy & Garcia, 2018). Those with ASD live a more sedentary lifestyle, resulting in more screen-time than their TD peers (Menear & Ernest, 2020). Age and screen time are directly correlated among the ASD population, resulting in less physical activity. Ables, Sillman-French, and French (2020) studied the impact of video modeling reinforcement which concluded in evidence that video modeling serves as a successful technique for children with autism. Video modeling paired with positive reinforcement proved most successful and resulted in improved upper body strength, posture, endurance, and overall health. A study in Ireland concluded adolescents with ASD lived a more sedentary lifestyle than their ND peers, but increased physical activity lead to a decrease in screen time in children between nine and thirteen years old (Dahlgren et al,. 2021).

The Toscano et al. (2018) research concluded that exercise for children with ASD resulted in positive metabolic changes, decreased undesired autistic traits, and increased quality of life. However, positive parental involvement played a key role in the effectiveness and impact exercise could have on the children with autism. The importance of parental participation and perspectives on physical activity was continued in a study conducted in Canada (Gregor, Bruni, Grkinic, Schwartz, McDonald, Thille, Gabison, Gibson, Jarchyra, 2018). This study exposed

many of the societal barriers, including lack of general awareness of the challenges of ASD, monetary restrictions, limited options, and lack of training for professionals to properly train students with ASD (Gregor et al., 2018). A study completed by Oh, Escalante, and Gentry (2018) focused on simple functional fitness activities and the impact and improvements noted for daily living as a result of developing strength, endurance, flexibility, and stability through specific activities. They concluded incorporating functional fitness into physical education and adapted physical education settings promoted lifelong functional fitness for ASD students. Barak, Oz, Dagan, and Hutzler (2019) investigated the Game of Life Soccer Initiative and the impact on ASD and ID populations. It was concluded, even with once a week soccer training, physical activity benefited both populations. Obrusnikova and Cavalier (2011) assessed barriers and facilitators of children with ASD using photovoice methodology to determine whether after school physical activity was impacted by these factors. They concluded the majority of participants did not meet the 60-minute recommendation of moderate to vigorous physical activity daily. Bremer and Cairney's study concluded a positive relationship between fitness and motor competence suggested intervention through motor skills to produce meaningful health benefits (Bremer and Cairney 2019). Furthermore, an Australian study concluded a correlation between parental beliefs and the amount of physical activity performed. Playground sustainability also played a role in the amount of moderate to vigorous physical activity of both TD and ASD populations (Thomas, Hinkley, Barnett, May & Rinehart, 2019). The purpose of the Brown, Arbour-Nicitopoulos, Martin Ginis, Latimer-Cheung, Bassett-Gunter (2020) study concluded parent PA support was highly related to the child's PA behavior, therefore collaborative intervention efforts are needed to to translate parental intentions to parental actions.

Many social interactions are impacted by ASD. Zhao and Chen (2017) focused on social interaction and communication in a natural setting through authentic relationships, social opportunities, trained professionals, and cooperative play and teamwork. It was concluded a purposeful, structured design with a low teacher-student ratio and comfortable environment were key to success. The Sefen, Al-Salmi, Shaikh, AlMulhem, Rajab and Fredericks, (2020) revealed early detection and intervention was key to reducing undesired stereotypic behaviors and increasing social and communication skills. More individualized instruction to lay a foundation of the skill was important and successful in teaching those social skills. Dance, horseback riding, exergaming, and martial arts proved to be impactful and successful physical activity outlets with a focus on those social and communication skills. Incorporating professionals such as pediatricians, child psychiatrists, occupational therapists, speech therapists, psychologists, specialist-teachers, and parents are all necessary members of successful ASD interventions. Tes, Liu and Lee, (2020) reiterated physical exercise reduced stereotypic ASD behaviors if individualized and specific to a behavior. Organized physical activity also proved to not only improve social and communication skills for individuals with ASD, but also reduced the risk of psychiatric disorders. However, preliminary individualized instruction was necessary before allowing organized group engagement (Howells, Sivaratnam, May, Lindor, McGillivray, Reinhart, 2019). Physical activity as an intervention on stereotypic behaviors found martial arts proved most successful in reduction of undesired behaviors with knowledge of the correlated brain activity to the stereotypic behavior (Tarr, Riner-Hershey, and Larwin , 2019). Physical activity that topographically matched the stereotypic behavior was greater than when the physical activity was not topographically matched. Vargo and Porretta (2018), researched a physical activity intervention and found teachers who provided physical activity to ASD students

needed to be selective due to the stimulating effects. Small doses of locomotor activities resulted in decreased stereotypic behaviors when intentional. The study explored the relationship between the Autism Quotient Scale (AQ), Executive Functioning (EF), and the frequency of engaged life activities related to EF (Mason, Zimiga, Anders-Jefferson & Paap, 2021). It was concluded that performance-based measures of EF did not predict AQ, but high-frequency physical activity interventions provided benefits for the ASD population (Mason et al., 2021). The motorized elephant-assisted therapy program was utilized to increase motor skills, social communication, and social interaction among the ASD population (Nuntanee & Daranee, 2019). Better balance control was achieved while teaching life skills such as washing, getting on and off the elephant, and playing games. A study by Block, Nichols, and Bishop (2020) investigated an affinity-based approach to an ASD children's strong interests. This study concluded when a child's strong interests are perceived as positive and incorporated into physical activity, it is more likely that physical activity will become a habit for those individuals. The Olin et. al (2017) study acknowledged the need for effective treatment methods to reduce stereotypic behaviors without drug or aversive therapies. This study analyzed the effect of exercise, intensity, and duration on the frequency of stereotypic behaviors in children with ASD. It concluded physical activity is an intervention that improves the academic skills, SBB, and overall health of children with autism while reducing anxiety.

Furthermore, each study incorporated fostering a lifelong appreciation and the importance of implementing physical activity into daily life. A study conducted during the COVID-19 pandemic by Simons Foundation Powering Autism Research encouraged flexibility and incorporating a child's interests into physical activity routines. Creating a "fun" atmosphere along with relaxation and physical activity allowed for lifelong habits, improved mental and

physical health, and a more relaxed environment. Sleeping disturbances were examined during the study conducted by Benson et al. (2018). It was concluded physical activity can be used to improve the quality of sleep for individuals with ASD and TD peers. During the school ages, incorporating a curriculum rooted in physical activities, minimal transitions, and more time engaged in moderate to vigorous physical activity can result in positive outcomes, especially for the ASD population. Muscular strength is not improved nor decreased during school physical activity (Tyler et al., 2020). Incorporating interests into physical activity allows for lifelong habits to be established and maintained. However, regardless of preferences, youth with ASD have significantly less MVPA than their TD peers (Stanish et al., 2017). With obesity being a higher concern for the ASD population, a Taiwanese study was conducted by Pan et at., determining goal- oriented physical activity interventions could enhance the physical activity lifestyle in both ASD and TD populations.

Limitations of the Research

Thematic limitations included a lack of previous research or data on the topic, a small, similar demographic sample size, and reliance on parental perception. It's important to recognize ASD is a dynamic process that often intersects and is consequently relational. A common theme consisted of the systemic or personal limitations with implementing physical activity into the daily lives of youth with autism. Possible solutions were mentioned, but there was no common solution. Another limitation included the lack of longevity of the results. Many studies did not collect data for elongated periods of time to see if the benefits and positive outcomes lasted. For example, Memari, et. al (2016) collected data on physical activity for only seven days. Lee, Vargo, and Porretta found locomotive physical activity decreases SBs, but have no research on

the extent of time. Furthermore, due to the small sample size, the general ASD population is not fully represented nor can results be generalized. In the Obrusnikova and Cavalier (2019) study, the 14 participants who volunteered for the study, were selected based on verbal and videorecording abilities, making generalization of findings invalid. For example, children from all school settings and under the age of six were not adequately represented. In Healy and Garcia (2018), the severity of ASD was not defined within the study. Gregor, et. al (2018) had a sample size from a single Canadian metropolitan area. Different geographical and cultural locations resulted in different socio-behavioral mediators. Potential bias occurred throughout the studies due to the subjective qualitative measures and surveys. In Toscano, et. al (2018), there was dependence on parent perceptions; this was fixed with direct observations. When collecting data, many studies relied on self-reporting which resulted in bias. Specifics also went ignored, such as the specific portable electronic device used, gross motor proficiency levels, ASD severity, family engagement in PA, and specific on PA in the Menear and Ernest study. The Barak, Oz, Dagan, and Hutzler (2019) study also had a small sample size and a lack of intensity. Limitations of the Bremer and Cairney (2019) study did not include a measure of aerobic fitness, did not measure perceived competence, did not include a measure of ASD symptom severity or IQ, and had a small sample size.

Implications for Future Research

Future researchers could use the Tse et. al (2020) study findings to investigate an alternative way to assess exercise intensity and its effects on behaviors. Also, with baseline knowledge on the benefits of physical movement on stereotypical ASD behaviors, researchers could investigate different team sports to determine the efficacy of each team sport. Furthermore, more specific research on physical exercise and its effects on stereotypic behavior now has a

solid foundation to build on. Specific examples of further research in this study included: differences in effect sizes in gender, age, severity of autism, types of stereotypic behaviors, types of exercise, intervention setting, intensity, and assessment strategies. Research about how the impact of physical activity changes depending on the environment would be beneficial. The American Academy of Pediatrics' released a policy about screen time discouraging use of screen media for children under the age of 18 months with video chatting exceptions. Future studies should validate each study findings with larger sample sizes, along with interventions to respond to the participants' needs. Future studies need to examine the effects of exercise on varying intensities to determine the best intervention program to reduce SBB. Future studies should incorporate mixed-methods designs to add to the current understanding of physical activity participation in the ASD population. Further research should be conducted revolving around possible determinants of physical activity behavior in students with ASD and what is proven to be most effective and why.

Implications for Professional Application

Tse et. al, (2020) confirmed matched exercises reduced stereotypical ASD behaviors. As little as a 10 minute low-to-moderate exercise condition could reduce unwanted stereotypical behaviors for up to forty-five minutes. Implementing short exercise conditions in an educational environment throughout the day could result in less over-stimulation and more academic focus. Furthermore, with a more likely sedentary behavior in ASD students, incorporating exergaming into academics of childrens' lifestyle could provide many benefits. Exergaming is accessible, adaptable, and allows for individualization to meet developmental levels. Exergaming can increase heart rate and engage those who would normally not exercise. The soccer intervention revealed breaking up tasks into smaller components, providing visual cues, and physical

guidance would result in more success when introducing a new skill to a population of ASD students. Furthermore, even with limited soccer improvements, the physical activity from the intervention had positive health results, even if they were not soccer related. Schools and communities need to provide physical activity opportunities for all populations with proper training, resources, and accessibility. Occupational therapists are an essential part of the intervention team for students with ASD. Nuntanee and Darance (2019) concluded that occupational therapists should use daily life activities, such as washing, cleaning, and play activities to develop goals for students. Professional development in the area of ASD is imperative for teachers and administrators.

More specifically, incorporating physical activity in the educational setting for ASD students is proven effective. Having knowledge about the effectiveness of PA, the desired intensity, parameters, and how to eliminate the barriers that exist are all opportunities to be explored. Utilizing physical education to incorporate moderate to vigorous physical activity with minimal transitions and a curriculum rooted in physical fitness allows for positive outcomes.

Conclusion

Autism Spectrum Disorder has been on the rise over the past few decades. This disorder is accompanied by motor development deficiencies, decreased physical activity behaviors, impairments in social communication interactions, limited interests, repetitive behaviors, and a low rate of participation in physical and recreational activities. Various studies have found exercise to be a treatment, intervention, and daily routine into the lives of students with ASD. Technology is competing heavily for adolescent time. Exergaming combines video games with physical activity and provides similar benefits to that of moderate to vigorous physical activity. After structured and trained moderate to vigorous physical activity interventions, students with

autism often showed improved stereotypic behaviors, social communication and interaction, self-awareness, self-regulation, and concentration, healthier lifestyle and improved physical, mental, and emotional health. After personal relationships with students and families are established, goals are reviewed, and training is complete, individuals trained in helping students with autism would see significant benefits by incorporating physical activity into their daily schedules and routines. This will allow for interdisciplinary goals, promoting healthy lifelong habits, and allowing for trained, monitored social interactions to occur through physical activity. The benefits of physical activity in an educational setting creates a safe setting for students to practice the growth mindset, improve their physical, mental, and emotional wellbeing while making progress towards their individual goals and outcomes.

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