EFFECTIVENESS OF AN INCLUSIVE, SMALL-GROUP ADAPTED AQUATICS PROGRAM ON INCREASING VO_2MAX IN CHILDREN WITH AUTISM SPECTRUM DISORDER

By

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ABSTRACT

EFFECTIVENESS OF AN INCLUSIVE, SMALL-GROUP ADAPTED AQUATICS PROGRAM ON INCREASING VO_2MAX IN CHILDREN WITH AUTISM SPECTRUM DISORDER

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There is a need to examine the effectiveness of interventions, such as swimming, that are aimed at increasing physical health and developing psychomotor skills in an inclusive setting for children with ASD. The purpose of this study was to examine the effectiveness of an inclusive, small-group adapted aquatics program on increasing VO_2max in children with ASD. Participants included two 11-year-old children diagnosed with ASD. The study took place over eight weeks and included a six-week Small-Group Adapted Aquatics (SGAA) program. Participants were assessed for VO_2max using the 20m PACER test during week one and week eight of the study. Both participants showed a significant increase in VO_2max scores over the course of the study, indicating that an inclusive, small-group adapted aquatics program is effective in increasing VO_2max in children with ASD. Limitations of this study are discussed and recommendations for future studies can be found in conclusions.

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INTRODUCTION

Autism spectrum disorder (ASD) is defined as a developmental disability that can cause significant social, communication and behavioral challenges (CDC, 2023). Although autism can be diagnosed at any age, it is described as a developmental disorder because symptoms generally appear in the first 2 years of life (USDHHS, n.d.). Characteristics of ASD include persistent deficits in social communication and interaction, and restricted, repetitive behaviors and interests (DSM-5; American Psychiatric Association, 2013). Disturbances and deficiencies in motor skills are also commonly associated with ASD (Leary and Hill, 1996; Ghaziuddin and Butler, 1998; Ozonoff et al., 2008; Green et al., 2009).

The Center for Disease Control and Prevention's (CDC) Physical Activity Guidelines state that children and adolescents aged 5-17 years should engage in at least an average of 60 minutes per day of moderate-to-vigorous physical activity (MVPA) across the week (CDC, 2017). Evidence indicates that children and adolescents with ASD are not adequately active and fall short of meeting the CDC's guidelines (Bandini et al., 2013; Obrusnikova & Cavalier, 2011; Memari et al., 2015; MacDonald, Esposito & Ulrich, 2011). Several studies have noted that youth with ASD are less physically active than their typically developing (TD) peers (McCoy, Jakicic, & Gibbs, 2016; Pan et al. 2016; Tyler et al., 2014). Additionally, children with ASD reportedly participate in activities less frequently and with less variety than TD children (Bandini et al., 2013; Little, Sideris, Ausderau, & Baranek, 2014), which may account for some differences

between groups. Low levels of physical activity (PA) and high levels of sedentary behaviors (SB) are associated with short- and long-term health consequences starting in early childhood, and throughout childhood and adolescence (DHHD, 2008). Consequences of SB include cardio-metabolic risk factors, impaired psychosocial well-being and cognitive functioning and poorer weight status (Tremblay, et al., 2011).

Sedentary behavior is defined as any waking activity conducted in a sitting or reclining position at ≤1.5 metabolic equivalent of tasks (METS) (Pate et al., 2008). In contrast, physical activity, such as running, may use 9-10 METS (Harvard, 2023). Screen-time activities (e.g., watching television, computer use, and video games) are the most easily identifiable sedentary pursuits, however reading, sitting, and socializing, and sitting at school are also considered SBs (Biddle et al., 2010). Tyler et al. (2014) conducted an objective assessment of physical activity of school-aged children (ages 9–17 years) with and without ASD. Across 7 days of wear time, children with ASD were found to spend significantly more time in SB compared to TD children (Tyler et al., 2014). Results of this study were consistent with another investigation which documented that during weekdays, children with ASD engage in an hour more of SB daily, especially television and video games, compared with TD peers (Must et al., 2014).

Cardiorespiratory fitness is defined as the ability of the respiratory and circulatory systems to supply fuel during prolonged activities and eliminate fatigue, translated by the maximal oxygen uptake (VO_2max), (Caspersen, 1985) which is an internationally accepted parameter to evaluate cardiorespiratory fitness (Chatterjee et al., 2005).

Currently, sixteen states mandate school-based physical fitness testing (SB-PFT), with ten states providing data to the public. Of the states providing data, 92% to 100% perform the pacer/mile, curl-up, and push-up. 54.2% to 78.5% of elementary and 44% to 66.5% of high-school youth are in the "healthy fitness zone" for aerobic capacity (Krochmal, et al, 2021). Information about cardiorespiratory fitness evaluated by a standardized method in the laboratory in the ASD population is scarce (Bricout, et al., 2018).

Autism spectrum disorder is one of 13 disabilities covered in the Individuals with Disabilities Education Act (IDEA), the primary federal program that authorizes state and local aid for special education and related services for children with disabilities (IDEA, 2022). Adapted physical education (APE) is one such related service that accommodates students of all ages and functional abilities with data-driven designed instructional programs that focus on functional mobility skills, motor and physical fitness, and age-appropriate gross motor competencies (Yun & Beamer, 2018). Despite qualifying for accommodations and APE services, many students with ASD are not engaged in PA at the same rate as their typically developing peers, as children with ASD tend to withdraw from participation in PA due to the negative social and behavioral outcomes associated with the symptom (Pan, 2009). Research has shown that, in addition to increasing PA, swimming may have ancillary benefits for individuals with ASD, such as reduced stereotypic behavior, and enhanced social behavior and social interaction skills (Chu & Pan, 2012).

Swimming is an essential safety skill and is recreationally age-appropriate across the lifespan. In the United States, swimming is second behind walking as the most popular sports activity (Lazar, et al., 2013). Past studies have demonstrated significant improvements in submaximal heart rates, blood lactate levels, and ratings of perceived exertion with swimming, indicating an overall improvement in cardiovascular fitness (Tanaka, et al., 1997). Swimming is perceived by parents as highly beneficial for enhancing quality of family life and promoting development of life-long leisure skills and interests (Caputo et al., 2018), yet several barriers exist for enrolling children with ASD in community-based swim programs.

According to the National Autism Association, accidental drowning accounted for approximately 91% of total deaths (US) reported in children with ASD ages 14 and younger from 2009 to 2011. The CDC reports that for every 1 child who dies from drowning, 5 more receive emergency department care for nonfatal submersion injuries (CDC, 2022). Nearly 50% of children with ASD attempt elopement from various safe environments, which is around 4 times higher than TD children (National Autism Association). Most fatal drownings in children with ASD occur near the victims' homes, with 52% occurring in ponds, 13% in rivers, and 13% in lakes (Guan, 2017). Elopement poses an even greater risk of drowning in rural areas that feature easy access to unattended bodies of water (Shannon, et al., 2021).

Lack of access to staff trained in adaptive techniques aimed at the learning needs of children with ASD is another barrier impacting participation in most community-based

swim programs (Jull & Mirenda, 2015). Impairments in sensory, behavioral, and communication skills make participation in group activities challenging for children with ASD (Potvin et al., 2013). There is little research about small-group adapted aquatics, although a pilot study on group swimming and aquatic exercise for children with ASD suggests that small groups adapted instruction is feasible and has potential for improving swimming ability in children with ASD (Fragala-Pinkham, et al., 2011). There is a need to examine the effectiveness of interventions, such as swimming, that are aimed at increasing physical health and developing psychomotor skills using multisystem techniques designed to address real-world issues in an inclusive setting for youths with ASD (Battaglia et al., 2019). Therefore, the purpose of this study is to examine the effectiveness of an inclusive, small-group adapted aquatics program on increasing VO_2max in children with ASD.

METHODS

Participants

Participants included two children diagnosed with ASD through formal evaluation by a trained specialist. Participants were recruited through local area public elementary schools in Humboldt County via recruitment flyers sent to families by individual school administrators. Inclusion criteria for this study consisted of a diagnosis of ASD, an Individualized Education Program (IEP) in place at school, ages 10 to 12 years old, ability to follow instructions, and parental support. Participants were allowed to be experienced or inexperienced swimmers. Exclusion factors included fear of water and incontinence.

Experimental Design

The study took place over eight weeks, including one week of pre-assessment, six weeks for the Small-Group Adapted Aquatics (SGAA) program intervention, and one week of post-assessment. During pre-assessment (Week 1), a meeting was held to introduce the SGAA to participants and their parents. Additionally, during pre-assessment, each participant was assessed for VO_2max using the Progressive Aerobic Cardiovascular Endurance Run (PACER) Test. Next, participants engaged in the SGAA program (Weeks 2-7). In post-assessment (week 8), participants were assessed for VO_2max using the PACER test.

Small Group Adapted Aquatics

Two researchers served as co-instructors, both of whom completed a Water Safety Instructor (WSI) certification training course through the American Red Cross training program as well as an adapted aquatics certification training prior to the study. During each SGAA session, two children with ASD participated in SGAA with both instructors. The 6-week SGAA intervention (Weeks 2-9) consisted of 12 instructional sessions (two sessions per week, 50 minutes per session) at the Cal Poly Humboldt swimming pool. Each session was divided into 3 parts, including social and warm-up activities (10 minutes), small group instruction (30 minutes), and games and cool-down activities (10 minutes). Warm-up activities included learning about water safety through the American Red Cross series "Longfellow's Whale Tales Water Safety for Children" and stretching and calisthenics on the pool deck. Small group instruction included moderate to vigorous activities, such as stroke development and relay races. Games and cool-down activities included moderate to vigorous activities, such as the water game "Marco Polo" and ring toss and dive. The SGAA instructional design was developed and adapted from the American Red Cross Water Safety Instructor's Manual (American Red Cross, 2014) by the two researchers.

Instruments

The FITNESSGRAM 20m PACER Test, which is one of the three Aerobic Capacity test options available in the FITNESSGRAM, is based on student sex, age, and

laps only. Pre- and post- VO_2max 20m PACER tests were administered to participants by the researchers inside Forbes Gym at Cal Poly Humboldt.

Data Analysis

The Physical Fitness Test (PFT) VO_2max Calculation Worksheet, provided by the California Department of Education (cde.ca gov), calculates $V0_2$max based on participants' gender, age, and number of 20m PACER laps. VO_2max is measured in milliliters of oxygen consumed per minute, per kilogram of body weight (mL/kg/min). Pre and post PACER Tests were recorded through observation and video recordings. Video recordings were observed and assessed by two researchers. Data is presented in a table format.

RESULTS

Results for Participant 1 are listed in Table 1. Results for Participant 2 are listed in Table 2.

Table 1. Pre- and Post- Assessment VO_2max for Participant 1

Participant 1	Gender	Age	20m PACER Laps	20m PACER VO_2max
Pre-Assessment	Male	11	23	41.4*
Post-Assessment	Male	11	43	48.5*

Note. * Indicates that the participant met or exceeded the Healthy Fitness Zone (HFZ) VO_2max. HFZ VO_2max for 11-year-old males is ≥ 40.2

Table 2. Pre- and Post- Assessment VO_2max for Participant 2

Participant 2	Gender	Age	20m PACER Laps	20m PACER VO_2max
Pre-Assessment	Male	11	18	39.6
Post-Assessment	Male	11	25	42.1*

Note. * Indicates that the participant met or exceeded the Healthy Fitness Zone (HFZ) VO_2max. HFZ VO_2max for 11-year-old males is ≥ 40.2

DISCUSSION

Results from this study indicate that an inclusive, small-group adapted aquatics program is effective in increasing VO_2max in children with ASD. The two participants in this study were 11-year-old males. The minimum number of 20-meter (20m) laps needed for an 11-year-old male to achieve the Healthy Fitness Zone (HFZ) for the PACER is 20 laps. During pre-assessment, Participant 1 ran 23 20m PACER laps, demonstrating a VO_2max score of 41.4 mL/kg/min, placing him slightly above the minimum requirements for HFZ. In post-assessment, Participant 1 ran 43 20m PACER laps, which increased his VO_2max to a score of 48.5 mL/kg/min, nearly doubling his pre-assessment scores and placing him well above the minimum requirements for the HFZ. During pre-assessment, Participant 2 ran 18 20m PACER laps, indicating a VO_2max score of 39.6 mL/kg/min, placing him slightly below the minimum requirements for the HFZ. In post-assessment, Participant 2 ran 25 20m PACER laps, which increased his VO_2max to a score of 42.1 mL/kg/min, placing him above the minimum requirements for the HFZ.

Both participants showed an increase in VO_2max scores over the course of the study, though Participant 1 showed more gains than Participant 2. This discrepancy is likely due to Participant 2 falling ill during the study and missing Weeks 4 and 5 of the SGAA intervention. Other factors could include that Participant 1 entered the study with a higher VO_2max score than Participant 2, which might indicate that Participant 1 was in better cardiorespiratory health to begin with, and therefore, continued to improve at a greater rate than Participant 2.

Table 3. PACER Look-up and Goal Setting Table for females from the California Department of Education

Age	Females Minimum Number of 20m PACER Laps	Females Aerobic Capacity HFZ VO_2max
10	17	≥ 40.2
11	20	≥ 40.2
12	23	≥ 40.1

Table 4. PACER Look-Up and Goal Setting Table for males from the California Department of Education

Age	Males Minimum Number of 20m PACER Laps	Males Aerobic Capacity HFZ VO_2max
10	17	≥ 40.2
11	20	≥ 40.2
12	23	≥40.3

The results from this study indicate that gains in VO_2max made by both participants could be attributed to the maintenance of moderate-to-vigorous physical activity (MVPA) for 50 continuous minutes, twice a week, with participant families indicating that the participant's overall enjoyment of being in the water served as motivation for both participants and families to stay in fidelity with the SGAA program. Family support in attending the program supported the participants' success, particularly regarding attendance. The success of these participants is reflected in several studies which have shown that children with ASD can be successful in aquatics, acquiring functional and social skills (Dulcy, 1992; Huettig & Darden-Melton, 2004; Killian et al.,

1984). The authors of those studies indicated that often children with ASD experience greater success in achieving motor competencies in an aquatic environment, opposed to a gym setting. One study expressed that the combination of buoyancy and hydrostatic pressure may allow individuals with ASD to explore important play skills with fewer body constraints (Prupas et al., 2006). Additionally, parental support is often pivotal to a child's ability and willingness to participate in physical activities (Buchanan et al., 2017; Nichols et al., 2019; Obrusnikova & Cavalier, 2011). Both participants in this study were highly motivated to be in the water and were supported in their participation by their parents.

Limitations

Limitations for this study included number of participants and illnesses that occurred over the course of the eight-week study.

The initial number of participants for this was four children, two 11-year-old males, and two 11-year-old females. Both female participants were withdrawn from the study before pre-assessment due to family concerns over missing SGAA lessons due to issues surrounding the girls' menstruation cycles. Despite the researchers offering support in terms of providing absorbent swimsuits and flexible attendance, both families were worried about their children having an accident in the pool and experiencing stigmatization from peers. The researchers reassured the families that this was an inclusive program but were not able to assuage their fears. As a result, the two female participants did not engage in the SGAA program.

CONCLUSIONS

The purpose of this study was to examine the effectiveness of an inclusive, small-group adapted aquatics program on increasing VO_2max in children with ASD. Both participants showed an increase in VO_2max scores over the course of the study, indicating that an inclusive, small-group adapted aquatics program could be effective in increasing VO_2max in children with ASD. Swimming is a highly desirable activity for many children with ASD and their families. The success of this intervention can likely be attributed to the participants engaging in moderate-to-vigorous physical activity (MVPA) twice a week for 50 continuous minutes, personal motivation on the part of each participant, and parental support. Limitations of this study included number of participants and participant illnesses. Future studies should use the co-teaching model with a maximum of four participants and they should take into consideration the necessary accommodations or modifications for the successful participation of menstruating youth and their families.

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