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Review Article

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A Systematic Review of Swimming Programs for Individuals with Autism Spectrum Disorders

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ABSTRACT

Drowning is the leading cause of death for individuals with Autism Spectrum Disorder (ASD) and accidental drowning accounted for 91% of total U.S. deaths reported in children with ASD ages 14 and younger. The purpose of this systematic review was to conduct an in-depth analysis of studies pertaining to swimming programs for individuals with ASD to enhance our current swimming program for individuals with ASD and to guide future research endeavors. This systematic review identified 23 studies that met the following inclusion criteria: 1) published within the last 35 years; 2) included children or adolescents with ASD; 3) involved any aquatic activity including swimming programs; and 4) met definition of empirical study. Gender ratio of participants in the 23 studies exceeded the general male to female ratio and favored boys. Variation was found in terms of program duration and assessments used. Small sample sizes were used due to mixed methodology designs. All 23 studies reported significant findings. Future research should address: effective teaching strategies for basic safety and swimming skills for individuals with ASD; implementation of sensory programs and visual supports to swimming programs, examination of relationship between swimming and decrease in repetitive behaviors; larger sample sizes and qualitative studies.

Keywords: autism, ASD, swimming, children, and adolescents

INTRODUCTION

Autism is defined as a neurological disorder that includes difficulty with: brain functioning, social skills, repetitive behaviors, and communication (nonverbal and verbal; APA, 2013). Etiology includes a combination of genetic and environmental factors (Autism Speaks, 2017). Diagnostic and Statistical Manual of Mental Disorders (DSM-5) identifies a spectrum of autism disorders referred to as Autism Spectrum Disorder (ASD) that ranges from low functioning to high functioning (APA, 2013). The Centers for Disease Control and Prevention (CDC) "estimates autism's prevalence as 1 in 68 individuals in the United States. This includes 1 in 42 boys and 1 in 189 girls" (Baio, et al., 2018). ASD is diagnosed more and more each year. Prevalence of ASD is increasing at a rate of 10-17% each year (Baio, 2018). Individuals with ASD tend to have immature gross motor and fine motor skills (Auxter et al., 2010). Bilateral movements are difficult and require a lot of time to master. Given that, many individuals with ASD may not participate in physical activity. Absence of knowledge about or access to physical activities may also contribute to low participation rates (Lang, et al., 2010).

Swimming is a popular physical activity and many individuals with ASD enjoy the aquatic environment (Pan, 2011; Yilmaz, et al., 2004). Improvement in fundamental motor skills can be experienced in the aquatic environment because it allows for more freedom of movement (Lee & Poretta, 2013; Pan, 2010; Yilmaz et al, 2004). The unique properties of buoyancy, turbulence, and resistance assist to enhance acquisition of fundamental motor skills (Lee & Poretta, 2013). Buoyancy reduces any load on the swimmer and keeps the swimmer upright (Becker, 2004). Turbulence is motion of the water that is a result of the swimmer moving (Lee & Poretta, 2013). Water resistance is caused by a combination of buoyancy and turbulence and results in the need for greater force to produce movements along with a decrease in speed (Lee & Poretta, 2013). The combination of buoyancy, turbulence, and resistance allows for increased movement that can be more constrained out of the water due to gravitational forces that are absent in the water (Lee & Poretta, 2103; Prins & Murata, 2008). Lee and Poretta (2013) employed a pool-based approach to enhance motor skills of individuals with ASD and found that because of the properties of water, skills can be modified and adapted to ensure the success of students.

According to the National Autism Association, (NAA), "drowning is the leading cause of death among individuals with ASD" (para 1, p. 1). Elopement (or wandering) can be a frequent occurrence with individuals with ASD; about 48% are reported to elope/wander (NAA). Individuals with ASD are

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attracted to water due to the calming and peaceful properties. The combination of attraction to water, elopement/wandering, and lack of communication skills can present very dangerous situations. When individuals with ASD elope/wander and are near a body of water, they may jump in to feel the calming effects and if they are non-communicative, they may not be able to ask for help. In 2009, 2010, and 2011, accidental drownings accounted for 91% of total U.S. deaths reported in children with ASD ages 14 and younger (NAA).

Given these statistics, it is critical to implement basic swimming and water safety programs for individuals with ASD. Researchers have conducted studies on various types of swimming programs (Alaniz et al., 2017; Caputo et al., 2018; Fragala-Pinkham, 2010; Ennis, 2011; Pan, 2010; Pan, 2011; Yilmaz, Konukman, Birkan, O¨ zen, et al., 2010) and have found that swimming skills have improved with children with ASD. The purpose of this systematic review was to conduct an in-depth analyses of studies pertaining to swimming programs for individuals with ASD to enhance our current swimming program for individuals with ASD and to guide future research endeavors.

The objectives were 1) to analyze the methods of each of the studies to gain a better understanding of what elements could be included in our swim program and what elements could be added in the future for improvement and 2) to expand our research and add to field of knowledge in this area.

METHODS

Search Procedures: Procedures identified by Lang et al. (2010) and Sowa and Meulenbroek (2011) served as guidelines. A three-step process was used to identify articles for the review. First, seven electronic databases were identified: Academic Search Complete; Education Resource Information Center (Eric) via EBSCOhost; Physical Education Index; ProQuest; PsycInfo via APA PsycNet Pubmed Central (PMC); and Google Scholar. Studies were limited to English and peer reviewed journals. Three sets of search criteria were consistently used for all seven databases: Criteria 1: "autism or ASD or autism spectrum disorder or autistic"; Criteria 2: "children or adolescents"; and Criteria 3: "swimming," "aquatic fitness or aquatic therapy or aquatic exercise or water exercise"; "water orientation or water skills"; "motor skills", and "social behavior". Criteria 1 and 2 were used with each set of keywords under Criteria 3. For example, the first search included the criteria: "autism or ASD or autism spectrum disorder or autistic", "children or adolescents", and "swimming". The next search included the criteria: "autism or ASD or autism spectrum disorder or autistic", "children or adolescents" and "aquatic fitness or aquatic therapy or aquatic exercise or water exercise, etc. This process identified 66 articles for possible inclusion in the review. Second abstracts of the 66 articles were checked against the inclusion criteria which resulted in 23 articles. Third, reference sections of 23 articles were then examined to see if any additional articles that may have been missed. No additional articles were identified.

Inclusion Criteria: To be included in this systematic review, studies had to meet the following four criteria: 1) Published within the last 35 years (1984-2019). Because the research topic is narrow, we increased the range in publication years to be able to include earlier articles and to make the searches as inclusive as possible; 2) Included children or adolescents (ages 2-19) with a diagnosis of Autism Spectrum Disorder (ASD) as participants. Childhood signifies the period of development from age two to up to adolescents; whereas, adolescence signifies the period of development from ages 13-19 (Payne and Issacs, 2016); 3) Involved any aquatic activity including swimming programs; and 4) Met definition of empirical study. Empirical research studies were defined as research based on data, meaning that the scientific method was used: research questions or hypotheses were generated; a design was developed based on the research questions, design was tested, and results and conclusions were generated (Thomas, Nelson, and Silverman, 2015).

Data Extraction: Once search procedures were completed, studies were analyzed and summarized according to the following characteristics: research methodology; participant characteristics; program duration and frequency; instruments/assessments; and results. The purpose was to provide an in-depth overview of the studies included in the review. Data were extracted further by analyzing participant characteristics and program duration and frequency. Participant characteristics included: Total N, gender, and mean age. Frequency and duration included: months or weeks; number of sessions per week; minutes per session; estimated total minutes for the entire program. Estimated total was calculated in the following manner: duration in weeks x number of sessions per week x minutes per session.

Interobserver Agreement: Once search procedures were decided upon and prior to beginning searches, interobserver agreement (IOA) was established. Interobserver agreement was defined by Kilian et al. (1984) as "the percentage of agreement between the data of the two observers." (p. 289). Interobserver agreement "was calculated by dividing agreements by agreements plus disagreements and multiplying by 100" (Chu & Pan, 2012, p. 1216). Agreements are those that are coded the same and disagreements are those that are coded differently (Thomas et al., 2015). Search procedures were discussed in-depth between the two authors to establish complete understanding followed by multiple practice searches for application. Both authors then independently ran searches and compared results with each other. A high percentage of agreement was achieved between both authors: Author # 1- 88% and Author # 2- 92%.

RESULTS

Participants: A total of 240 participants, diagnosed with ASD, were included in the 23 studies. Participants that were part of control groups, as well as participants that were diagnosed with other developmental disabilities were not included in this count. Participants with ASD that took part in an aquatic intervention (N = 199) were reported to be 175 males and 24 females. This number (N = 199) only includes those that reported gender. The N = 199 correlates to a gender ratio of 7:1, favoring the males. The average age of all participants with

ASD (N = 240) was 9 years. The study with the youngest participants (Rogers, et al., 2010) showed an average age of 4 years, while Pimenta, et al., (2016) investigated adolescents that were 15 years, which was the highest average age in the 23 studies. Four studies did not mention any details to the subjects' age (n = 95 children with ASD).

Program Duration: The shortest duration was performed by Killian et al. (1984), lasting 3-weeks, while Napolitano, et al. (2017) established an aquatic intervention of 96 weeks within a 2-year period, which resulted in the highest total amount of intervention minutes in the water. The average duration of all 23 studies was 18 weeks. In regards to frequency of aquatic sessions offered, all 23 studies included at least 1 but no more than 3 swimming sessions per week- the average being 2 sessions. The length in minutes of sessions varied from 30 min (Lawson, et al., 2016) to 90 min (Pan, 2010).

*Settings:*All 23 studies conducted their research in standardized swimming pool facilities. Nine out of 23 studies reported that their research was performed in a controlled indoor environment. The remaining 14 studies did not provide information regarding facility characteristics. Water depth was referred to by 5 studies (Fragala-Pinkham, et al., 2010; Fragala-Pinkham, et al., 2011; Rapp, et al., 2004; Rogers, et al., 2010; and Yanardag, et al., 2015) and ranged from a minimum of 0.5m (M = 0.8m) to a maximum of 3.0m (M = 1.5m). Only Fragala-Pinkham, et al. (2010) and Killian, et al. (1984) mentioned information pertaining to water temperature. Fragala-Pinkham, et al. (2010) used two pools with temperatures at 30.6°C and 27.8°C. The temperature in the Killian, et al. (1984) study was 30.3°C.

Research Methodology: Of the 23 studies, 21 employed a muti-method approach, which was defined as implementing numerous methods of data collection (Thomas et al., 2015). Three studies reported using an experimental design (Fragala-Pinkham et al., 2011; Pan, 2010; Shams-Elden, 2017) that included a control group and experimental group. Four studies (Rogers, et al., 2010; Sahin Kaftkas & O'Zen, 2015; Yilmaz, et al., 2005; Yilmaz, Konukman, Birkan, O'Zen, et al., 2010) used a multiple baseline across participants design to evaluate the effects of a constant time delay intervention. A constant time delay intervention utilizes a target stimulus, waits a certain amount of time after presentation of the stimulus, and then presents a controlling prompt, which is slowly faded over time (Yilmaz, et al., 2005). The constant time delay intervention is commonly used for individuals with developmental disabilities (Yilmaz, et al., 2005).

Studies that employ videotaping and systematic observation instruments are common for measuring attainment of behavior skills in the social domain. Five studies (Battaglia, et al., 2019; Rapp, et al., 2005; Yanardag et al., 2015; Yilmaz, et al., 2005; Yilmaz, Konukman, Birkan, & O¨ zen, et al. 2010) used these methods. Chu and Pan (2012), Killian, et al. (1984) and Rogers, et al. (2010) used systematic observation as part of their methodologies. Questionnaires and surveys are another common method used to measure behavior outcomes. Surveys are used to determine present practices common in physical activity, education, sociology and psychology and questionnaires are a type of survey (Thomas & Neslon, 2015).

Both studies conducted by Fragala-Pinkham, et al. (2010, 2011) used a non-randomized design. Three studies (Pata & Rata, 2013; Pimenta, et al., 2016; Yilmaz, et al., 2005) utilized a single subject design. Various designs have been established in these studies and all have resulted in significant outcomes, establishing the success of the designs used.

Instruments/Assessments: Various instruments and assessments were used in all studies. Interestingly, there was not a lot of overlap on instruments and assessments used as we had expected. This resulted in a wider range of instruments and assessments that were used. All 23 studies used a swimming/aquatic skills assessment and some researchers used the swimming/aquatic skills assessments in combination with gross motor assessments, social and behavioral assessments, and adaptive assessments, and Autism Rating Scale. Across the 23 studies, 12 different swimming assessments were used, 1 assessment measuring general motor skills was used, 3 different assessments measuring social behaviors were used, 1 assessment measuring adaptive behavior was used, and one assessment measuring autism was used.

Most researchers used standardized instruments; however, some developed instruments specific to their studies. Alaniz, et al. (2017) developed their own Aquatic Skills Checklist (ASC) which was adapted and modified from the American Red Cross (ARC) Water Safety Instructor Manual (2009). The researchers modified it by choosing what skill elements from the ARC list they were interested in measuring. They also developed a Goal Attainment Scale (GAS), which assisted therapists in developing measurable goals for attainment of swimming skills listed on the ASC (Alaniz, et al., 2017). Fragala-Pinkham, et al. (2010) and Fragala-Pinkham, et al. (2011) developed the Swimming Classification Scale (SCS) for use in their studies. The SCS contains five levels that measures varying degrees of ability to swim laps (with and without the assistance of floatation devices). Pimenta, et al. (2016) developed a swimming protocol following an adapted aquatics programming guide written by Lepore, Gayle, and Stephens (1998) and also Winnick (2004). Pata and Rata (2013) developed their own swimming protocol based on the objectives of: water adjustment skills; basic swimming skills; floating skills; floating skills moving from one position to another in the water; kinesthetic ability; muscular strength; and posture. Napolitano (2017) developed a similar swimming protocol that included: water orientation skills in the initial phase and then advanced to floating and swimming skills in the later stage. Swimming skills taught followed a progression of basic skills (breathing, floating) to advance skills (freestyle, backstroke).

Caputo, et al. (2018) and Battaglia, et al. (2019) both implemented the Multi-Systematic Aquatic Therapy that uses a cognitive-behavioral approach to enhance social, emotional, and functional skills while learning swimming skills (Battaglia, et al., 2019; Caputo, et al., 2018). Four studies (Caputo, et al.,

2018; Chu & Pan, 2012; Pan, 2010, 2011) employed the Humphries Assessment of Aquatic Readiness (HAAR) Checklist (Humphries, 2008). The HAAR assesses aquatic skills in five stages: mental adjustment; introduction to water environment; rotations; balance and control; and independent movement in the water (Humphries, 2008). Ennis (2011) used the Water Orientation Test of Alyn 1 and 2 that measures ability to adjust to water along with the ability to use multiple methods to navigate through the water (Ennis, 2011).

Fragala-Pinkham (2011) implemented a YMCA Water Skills Checklist. Similar to Alaniz, et al. (2017) who developed the ASC using the ARC Water Safety Instructor Manual (2009) as a guide, the YMCA has a similar checklist of swimming skills that can be used. The YMCA checklist consists of seven levels with 10-12 skills contained in each level (Fragala-Pinkham, 2011). Similarly, Lawson, et al. (2016) used the ARC Swimming Skills Checklist which consists of six levels for the "Learn to Swim" program.

Kilian, et al. (1984) and Yilmaz (2004) used the Aquatic Orientation Checklist (AOC) which measures both water orientation skills and beginner swimming skills. A behavior scale of the following: spontaneous; voluntary; demonstration; manipulation; and objection are used to gauge performance on a set of six skills (Kilian, et al., 1984). Yilmaz (2004) used the AOC in combination with the Halliwick Method (Martin, 1981).

Multiple researchers used various methods to teach skills rather than using standardized assessments. Four studies (Rogers, et al., 2010; Sahin Kaftkas & O'Zen, 2015; Yilmaz, et al., 2005; Yilmaz, Konukman, Birkan, O'Zen, et al., 2010) implemented a constant time delay intervention. Rapp, et al. (2004) used reinforcement at a fixed interval to encourage positive behaviors and swimming skills. Napolitano (2017) conducted the study in several phases by using developmentally correct progressions. Phase one included water orientation skills and once the child established comfort then he or she progressed to phase two which included floating and advanced swimming skills (freestyle and backstroke; Napolitano, 2017).

Yarnadag, et al. (2015) employed a "most to least" prompting (MLP) technique. The teaching method is similar to the constant time delay intervention used by Rogers, et al. (2010); Sahin Kaftkas & O'Zen, (2015); Yilmaz, et al. (2005); and Yilmaz, Konukman, Birkan, O'Zen, et al. (2010) in that physical prompts are used at the beginning to assist in learning a new skill and then are gradually faded to prompts such as modeling and verbal prompts that are less intrusive than physical prompts. Seven studies (Pan, 2010; Pan, 2011; Shams Elden, 2017; Yilmaz, et al., 2004; Yilmaz, et al., 2005; Yilmaz, I., Konukman, F., Birkan, B., et al., 2010, and Yilmaz, Konukman, Birkan, O¨ zen, et al., 2010) used the Halliwick Method (Martin, 1981) for teaching swimming skills. The Halliwick Method (Martin, 1981) is grounded in biomechanical principles along with natural progressions of human movement (Pan, 2010; Shams Elden, 2017). According to Yilmaz, et al. (2004), the Halliwick Method (Martin, 1981) is "based on known scientific principles of hydrodynamics and body mechanics, and is divided into four phases: adjustment to water, rotations, and control of movement in water and movement in water" (p. 625). Pan (2010) employed a Water Exercise Swimming Program (WESP), which is a combination of HAAR (Humphries, 2008) and Halliwick (Martin, 1981) methods and the TEACCH model. The TEACCH model was developed by Schopler and Reichler (1988) and specifically for individuals with ASD. It uses a method referred to as "structured TEACCHing" which is tailored to the unique needs of individuals with ASD (Autism Speaks, 2019). The model consists of three aspects: external organizational supports; visual information to supplement and enhance verbal information; structured support to complement and augment social communication (Autism Speaks, 2019).

Various researchers used assessments to measure gross motor skills (Battaglia, 2019); social skills (Alaniz, et al., 2017; Chu & Pan, 2012; Pan, 2010); adaptive behaviors (Battaglia, 2019; Caputo et al., 2018); and the Childhood Autism Rating Scale (CARS; Schopler et al., 1993) which is used to diagnose autism (Caputo, et al., 2018; Shams Elden, 2017). Battaligia (2019) used the Test of Gross Motor Development (TGMD; Ulrich, 1985) which measures locomotor (jumping, hopping, skipping), non-locomotor (turning, twisting, curling), and object control skills (kicking, hand and foot dribbling, swinging a bat).

Assessments to measure social skills included: Social Skills Improvement System (SSIS; Gresham & Elliott, 2008); Computerized Evaluation Protocol of Interactions in Physical Education (CEPI-PE; Klavina & Selavo, 2006); and the School Social Behavior Scales (SSBS-2; Merrill, 2002). The SSIS (Gresham & Elliott, 2008) was used by Alaniz, et al. (2017). The assessment measures social skills, problem behaviors, and academic competence (Gresham & Elliott, 2008). Alaniz, et al. (2017) used the Autism Rating Subscale of the SSIS. The CEPI-PE (Klavina & Selavo, 2006) was used by Chu and Pan (2012) and is a program that contains multiple interaction behavior measures geared towards elementary physical education inclusive settings (Klavina & Selavo, 2006). The SSBS-2 (Merrill, 2002) was employed by Pan (2010) and is commonly used by teachers and school personnel to assess social competence and antisocial behaviors (Merrill, 2002). The social competence scale consists of three subscales: peer relations; self-management/compliance and academic behavior whereas the Antisocial scale consists of: hostile/irritable; antisocial/aggressive; and defiant/disruptive subscales (Merrill, 2002).

The Vineland Adaptive Behavior Scale (VABS; Sparrow, et al., 1984) was used by Battaglia, et al. (2019) and Caputo, et al. (2018) and is a parental report of observed behaviors of their child or children. It is a measure of adaptive behavior skills for individuals up to age 18 (Sparrow et al., 1984; 2005). In addition to examining swimming skills and social interaction skills, five studies investigated other motor skills (Battaglia, et al., 2019; Fragala-Pinkham, 2010; Pan, 2011; Shams Elden, 2017; Yilmaz, et al., 2004). Other motor skills included: various locomotor (running, hopping, skipping), object control skills

(kicking, batting) from the TGMD (Battaglia, et al., 2019); climbing, stretching, shooting a basketball (Fragala-Pinkham, 2011); Progressive Aerobic Cardiovascular Endurance Run (PACER) multi-stage shuttle run (Pan, 2011); 20m run, standing broad jump, mushroom float, walking in the pool (Shams-Elden, 2017); six minute walking test, balance standing broad jump, grip strength, and speed (Yilmaz, et al., 2004). Significant improvement in motor skills was found in all five studies. Teaching these skills in the aquatic environment has resulted in successful outcomes. The importance of swimming on motor skills, social interaction, and communication skills has been established in the 23 studies.

DISCUSSION

The analysis resulted in 23 studies related to swimming programs for individuals with ASD. The purpose of this systematic review was to conduct an in-depth analyses of studies pertaining to swimming programs for individuals with ASD to enhance our current swimming program for individuals with ASD and to guide future research endeavors. The objectives were 1) to analyze the methods of each of the studies to gain a better understanding of what elements could be included in our swim program and what elements could be added in the future for improvement and 2) to expand our research and add to field of knowledge in this area. Discussion has been organized by objective.

Objective 1 to analyze the methods of each of the studies to gain a better understanding of what elements could be included in our swim program and what elements could be added in the future for improvement.

Participants: The findings of the systematic review indicated a higher male to female ratio (7:1) of participants in the studies. This gender distribution clearly exceeds the general male-to-female ratio for the ASD population of 4:1, reported by Newschaffer et al. (2007) and 5:1, reported by Lawson, et al. (2016). Therefore, the total samples of this review are not representative of the overall ASD gender distribution reported by Newschaffer et al. (2007) and Lawson, et al. (2016). According to Baio, et al. (2018), autism is four times more common in boys and our findings agreed with this statistic (p. 1). Even though the gender distribution found in the studies was not representative of the findings of Newschaffer et al. (2007) and Lawson, et al. (2016), it is aligned with the higher prevalence of autism in boys.

The average age of participants in the 23 studies ranged from 4-15 years. The findings in this review are in agreement with Ianelli (2020) who recommends that children begin formal swim lessons around age four. Prior to age four, preschool swim classes may be helpful. Whether or not to enroll a child in formal lessons at age four also depends on social-emotional maturity and developmental readiness (Ianelli, 2020).

Payne and Isaacs (2008) define adolescent as the period of time from age 12 to age 20, which is considered early adulthood. The period of time from birth to age 7 is considered early childhood and age 8-11 is considered middle childhood and late childhood (Payne & Isaacs, 2008). Future studies that examine outcomes of swim programs on individuals with ASD in early childhood versus adolescents would be helpful to lend insight into program design.

Program duration: The review found a variation in program duration. The average weeks for program duration of the 23 studies was 18, ranging from 3 weeks (Killian et al., 1984) to 96 weeks (Napolitano, et al., 2017). There were two studies that could be considered outliers (43 and 96 weeks; Caputo, 2018, Napolitano, et al., 2017) and when removed, the average was 12 weeks. When determining the duration of the program, frequency per week, and minutes per lesson, the recommendations vary according to the age of the child (Red Cross). For the most effective learning environment for any age, repetition and consistency are key (Lawson, et al. (2016). The findings of this review are in agreement with the findings of Lawson, et al (2016), Pan (2010) and the ARC Learn to Swim Program (Red Cross). They all recommend 8 to 10, 30-45 min lessons. Adolescents with ASD may take time to become comfortable in the aquatic environment due to responses to sensory stimulation along with variations in social and communication skills and therefore different durations may be more conducive depending on the child. Future studies comparing outcomes of program duration and frequency would lend insight into a comparison of differences between neurotypical developing peers and children with ASD in average time is takes to learn strokes.

Settings: The American Red Cross (ARC) Scientific Advisory Council (2013) recommends temperature values to range from 28.3°C to 30.0°C to enable the best possible learning outcomes from a physiological perspective. In this review, water temperatures reported by Fragala-Pinkham, et al. (2010) and Killian, et al. (1984) were aligned to the ARC Scientific Advisory Council (2013) guidelines. Repetitive behaviors may or may not be increased or decreased by the temperature of the water. Future research that examines this area would be helpful to learn what temperature would be most conducive for learning for individuals with ASD in addition to teaching strategies that could be implemented to assist with this.

Methodology: Many of the methodologies used in the 23 studies would be categorized mixed method designs, which are studies that use both qualitative and quantitative designs (Patton, 2002; Thomas, et al., 2015). According to Patton (2002), "the differences between quantitative and qualitative methods involve trade-offs between breadth and depth." (p. 227). Mixed methods studies can attribute to a stronger design by expanding the depth of the research (Driscoll, et al., 2007; Thomas, et al., 2015). Qualitative methods are often used to enhance and add justification to quantitative findings (Thomas, et al., 2015). The findings in this review support the fact that many of the studies used a mixed method design. Future studies continuing to implement mixed method designs will add continued validation for the use of such methodologies.

Smaller sample sizes are typical in qualitative research studies. In order to gain an in-depth understanding of human behavior, it is common to look at much more detailed information of a smaller number of participants (Patton, 2002). It can be common to study one or two participants over a longer

period of time to see changes (Patton, 2002). Almost half of the studies in this review contained sample sizes less than 7 participants. For future research, conducting studies with larger groups of participants and longitudinal studies that lend to greater comparisons are recommended.

Instruments/assessments: Assessment was defined by Buck, et al. (2007) as gathering multiple methods of data to gauge learning and teaching effectiveness. A variety of assessments were used in all the studies in this review. All studies used at least one type of swimming assessment and many used a swimming assessment in combination with a gross motor assessment, social and behavioral assessment, adaptive assessment, and or the Autism Rating Scale. This review did demonstrate that a variety of assessments should be used to result in stronger outcomes.

Objective 2 to expand our research and add to field of knowledge in this area.

The current review resulted in 23 studies with significant findings that contribute to the field of knowledge pertaining to swimming and individuals with ASD. In agreement with the findings of Sowa and Meulenbroek (2012), our systematic review did not produce any studies with non-significant findings. This is more likely due to studies not being accepted with non-significant findings with the universal thought of non-significant findings not contributing to the general knowledge in the field (Sowa & Meulenbroek, 2012). There is a tendency to solely accept studies with significant findings.

While researchers have established the positive effects of cardiovascular exercise on repetitive behaviors of individuals with ASD (Lang, et al., 2010; Yilmaz, 2004), few have examined swimming. Yilmaz, et al., (2004) did find that repetitive behaviors decreased after swimming. Future research that continues to examine the effect of swimming on repetitive behaviors to validate the findings of Yilmaz, et al., (2004) would be useful for parents and practitioners.

The calming effects of water has been established for individuals with disabilities (Lee & Poretta, 2013); however, it has not been studied in-depth with individuals with ASD. Qualitative studies to examine why individuals with ASD find water to be calming would assist to understand the attraction to water in order to implement preventative strategies for safety measures.

Studies have not been conducted pertaining to teaching basic safety skills to individuals with ASD. Studies that examine the implementation of basic safety skills in the water and the retention of those techniques would lend to an understanding of effective teaching strategies that can be used to teach those skills to individuals with ASD.

Lawson, et al. (2014) examined swimming skills of individuals with ASD using a sensory based profile along with the ARC Learn to Swim program (https://www.redcross.org) and found that the sensory based supports were effective. Individuals with ASD do present unique sensory issues and conducting more studies that implement sensory programs to teach swimming to individuals with ASD will assist in determining best practices for teaching.

As with most individuals, individuals with ASD tend to be visual learners and navigate the world by how they see it (Shane, et al, 2012). Studies that implement video modeling and comparison of pre and post-swimming tests will also assist in contributing to best practices.

Individuals with ASD demonstrate deficits in communication skills (Lawson, et al., 2014; Pan, 2010). The use of technology and visual supports to assist with communication skills has been used with individuals with ASD (Shane, et al., 2012), but few have used communication boards in the aquatic environment. Studies that examine the use of technology and visual aids to supplement and enhance teaching swimming to individuals with ASD would add to knowledge of effective teaching for individuals with ASD.

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