

Authors' opinion

## Water-based exercise therapy and improvement in the motor skills and cognitive function of children with autism spectrum disorder: a commentary

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**Abstract:** *Background* — Motor and cognitive dysfunction are common impairments experienced by children with a diagnosis of autism spectrum disorder (ASD). Objective: The main aim of this study was to present suggestions for the incorporation of water-based exercises in rehabilitation for the children with ASD.

*Methods* — Researchers collected the current available data regarding novel methods of water-based exercise therapy for the children with ASD to address motor and cognitive function.

*Results* — Children with a diagnosis of ASD face a number of common challenges that may be addressed by the utilization of aquatic therapy in their rehabilitation plan. Challenges commonly experienced by children with ASD may be addressed by properties of water and aquatic therapies. Presently, aquatic therapy is an underutilized resource as an intervention in the population of children with ASD.

*Conclusions* — Water-based interventions is currently underutilized as a therapeutic intervention should be considered for individuals with a diagnosis of ASD.

**Keywords:** exercise therapy, motor skill, autism, cognitive function.

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### Introduction

Autism spectrum disorder, ASD, in children may result in a wide variety of impairments, functional limitations, and participation restrictions, ranging from mild to severe. Common impairments include challenges with gross and fine motor skills, and cognitive function [1].

Worldwide, the rate of children with ASD is increasing with present rates estimated at 1 in 68 children [2]. To meet diagnostic criteria for ASD, a child must demonstrate persistent challenges in social communication and interaction and restricted, repetitive behaviors [3].

The challenges experienced by individuals with ASD and the impact of those challenges vary widely. It is common that children with ASD also experience a variety of co-occurring conditions, including asthma, dermatitis, gastrointestinal dysfunctions, and seizures [4]. 83% of children with ASD have at least one co-occurring diagnosis [5]. As such, treatment for children with ASD requires substantial resources [6]. These treatment needs can have a significant impact on family employment, finances, and time commitment [7]. The cost of ASD has a significant impact on both the family and the whole of society [8]. To date, ASD has no known cure. However, medications are commonly used to address impairments related to communication, behavior, and co-occurring diagnoses [9].

The benefits of exercise on gross and fine motor skills and cognition have been established for children with ASD [10, 11]. However, impairments common to the diagnosis of ASD may discourage participation in exercise [12]. Therefore, understanding the most effective ways to promote the regular physical activity is important. There is a need to determine and endorse the effective suggestions for physical activity in this group of children [13].

Properties of water have the potential to lend support to the acquisition and refinement of gross motor skill for individuals with ASD [14]. The buoyancy property of water facilitates balance and postural control. Additionally, water provides a reduction in gravitational effects, providing increased opportunity for freer movement [15, 16]. Resistance and hydrostatic pressure may contribute to strength building and increased awareness of body in space [17]. Hydrostatic pressure may also have a positive effect on the nervous system using the regular practice [18].

While prior investigations have examined the effects of physical activity in ASD [19], questions remain regarding the specific benefits water-based exercise therapy as a practical and safe method of exercise for children with this diagnosis.

This commentary highlights the importance of regular physical activity for children with ASD and establishes suggestions for the inclusion of water-based exercise in this population to encourage physical activity.

### Gross and Fine Motor Impairment

Motor impairment is a common, co-occurring challenge for children with ASD. Deficits in gross motor skills may manifest as difficulty with higher level balance and coordination skills necessary for participation in life situations [20]. Delays in development of strength and endurance can negatively affect social interactions and self-perception [13]. Aquatic therapy has been shown to improve gross and fine motor skills.

Gross and fine motor skill delays may impact the ability of children to engage in recommended amounts of daily exercise and activity [11]. The positive effects of physical activity on health parameters, specifically among children with ASD (physical and mental health) are known, however, children with ASD may not engage in physical activities with adequate intensity to optimize positive effects [21]. Reasons for limited engagement in physical activity include lack of family support, challenges with motor control, and self-perception [22]. Children with ASD may engage in less peer-based recreational activities because of social and communication deficits [22] and decreased motor skills [23]. These impairments may become more obvious in group activities and could lead to decreased participation in social interactions with peers and self-perception [22]. Additionally, medical interventions, such as medication, are commonly used to address impairments experienced by children with ASD. While these treatments may have been found to be safe and effective [24], they are passive and may amplify sedentary behavior. Such sedentary behavior experienced by children with ASD may place them at increased risk for obesity, movement disorders, and cognitive function impairment [25]

### Fine motor skill in ASD

Challenges with fine motor skills, such as manipulation of objects with the hands, grasping toys, and handwriting, can also present activity and participation level difficulties for children with ASD [26] Up to 83% of children with ASD experience difficulty in executing age appropriate fine motor skills. [27]. Differences in the fine motor abilities of children with ASD and their typically developing peers increase as they age [28]. Managing deficits in fine motor control early is important as expectations for exploration and, eventually, schoolwork increase rapidly across the early lifespan. Significant motor coordination deficits have been found specifically in precision grip tasks for children with ASD [29].

It has been shown that, the specific characteristics of exercise training, including water-based exercises, could affect the fine motor skills among children with ASD. Those that have shown promise include task and process-oriented interventions, which are easily adaptable to an aquatic environment. Further, aquatic exercise is feasible and adverse effects are minimal, but appropriate parameters for aquatic exercise have not been established [30].

### Social and Cognitive function in ASD

Challenges with social communication are common for individuals with ASD. Physical exercise has been shown to improve long-term memory, brain versatility, and cognitive capacity. Physical work can enhance long-term memory and increase cognitive capacity [31]. Research supports that it may also address

difficulties associated with emotional and executive function and increasing social skills in individuals with a diagnosis of ASD [32].

Empathising with others and demonstration of compassion can be especially challenging for individuals with ASD. Other terms used to describe “empathising” include: “theory of mind” and taking the “intentional stance”. Compassion includes two major components: (1) the capacity to link mental states to oneself and others, as a characteristic way to create sense of agency, and (2) having an emotional response that is fitting to the other person’s mental state (such as sympathy) [33]. Difficulties with empathizing are thought to underlie the challenges in social communication experienced by individuals with ASD. The inclusion of aquatic therapy may provide opportunities for social interaction and the practice of communication skills [34]. Research supports that many interventions, including water therapy, can help facilitate play and increase social interaction [35].

### General Exercise in ASD

Despite evidence for the positive impact of exercise training among the children with ASD, practical suggestions for application, specifically with regard to aquatic therapy, are lacking [36,37]. Some previous studies reported positive effects of general exercise training on the motor, cognitive, and behavioral function of children with ASD [25, 38]. A meta-analysis of the effects of group and individual physical exercise in ASD by Sowa and Meulenbroek (2012) reported increased adherence to exercise and improvements in strength [39 38] [Erratum: corrected 15 Dec 2022 by request of the Authors]. Translating these exercises to an aquatic environment, leveraging the key properties of water: Hydrostatic pressure, buoyancy, warmth, and increased opportunities for play and socialization, may increase the benefits of these exercises.

Supervised, water-based therapies may offer safe and effective opportunities to address the physical exercise needs of the population with ASD. Fragala Pinkham et al. (2011) determined the positive effects of different patterns of exercises, including endurance and resistance training in water, for the children with ASD [40 39] [Erratum: corrected 15 Dec 2022 by request of the Authors]. Even the act of maintaining a floating position on the surface of water was found to be effective in improving the physical performance of children with ASD [19].

### Author’s opinion

The main aim of this study was to present suggestions for the incorporation of water-based exercises in rehabilitation for the children with ASD. The literature supports that the use of aquatic therapy as an intervention for individuals with ASD is worth both the time and money. Even though many challenges experienced by individuals with ASD could be addressed through water-based therapies, this intervention is currently underutilized.

The characteristics of water, including buoyancy, resistance, compression, and warmth, provide opportunities to enhance exercise training in this population. These properties provide opportunities for children with ASD to experience movement and improve balance in a gravity lessened environment and to work on strength using the water as resistance. Consistent temperature and pressure can provide calming and relaxation to help ready the individual for engagement in the therapeutic process.

Because aquatic therapy can positively affect gross and fine motor, emotional and social skills, a practical program would include three foci: motor adaptation; emotional adaptation; and social interaction. Leveraging the calming effect of the pressure and warmth of the water, may help ready the child for the practice of advancing motor skills or engagement in social interactions with other children. Social engagement in water play is common activity in childhood. Enhancing opportunities for practice of activities that are social and generalizable are a hallmark of interventions for children with ASD. Aquatic therapy provides such opportunities.

Including an aquatic exercise program in the treatment of children with ASD could be useful in enhancing the known effects of exercise on fine and gross motor control and social emotional skills. The use of aquatic therapy should be an early consideration in the treatment of children with ASD.

#### Conflict of interest

The authors declare that they have no conflict of interest.

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The correction does not change the study's findings of significance or overall interpretation of the study's results or the scientific conclusions of the article in any way.

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