Aquatic Therapy Intervention for Improving Psychomotor Skills in Children with Autism Spectrum Disorder: A Quasi-Experimental Study

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Abstract: This study examines the potential of using Aquatic Therapy Application (ATA) to children with Autism Spectrum Disorder (ASD). Four children, aged 4 to 8 years with ASD, participated in 20 intervention sessions, with one-hour sessions and a student-teacher ratio. This study utilises the Single Case Design method and is carried out using Visual Inspection through the A-B Design approach. The Conatser Adapted Aquatics Swimming Screening Test (CAASST) was used to assess psychomotor skills, and data were collected after every five sessions. Visual analysis revealed consistent improvements across all categories for all participants. Acute and chronic improvements were observed in Psychomotor Skill Adjustment, with acute scores ranging from (m = x1.0 x2.0) and chronic scores from (m = x1.15 x3.0). Similar trends were seen in movement in water, with acute scores ranging from (m = ÷1.25 1.0) and chronic scores from (m = x1.2 x4.0). Moreover, swimming achievement and active movement in water showed acute scores ranging from (m= ÷2.0 x1.5) and chronic scores from (m= x2.0 x4.0). The study supports ATA implementation for enhancing the psychomotor performance of autistic children in learning swimming activities. Aquatic therapy fosters significant improvements in psychomotor skills, psychological and physical adaptation, movement skills in water, and swimming abilities. It may act as an intervention that is valuable for educators, therapists, and parents seeking an effective intervention for children with ASD. The study also discovers that establishing trust among instructors, participants, and parents plays a crucial role in the success of aquatic therapy for children with ASD.

Keywords: Children with Autism Spectrum Disorder, Aquatic Therapy Intervention, Swimming skills, Psychomotor skills, Trust

Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition that impacts various aspects of a child's development, including cognitive, imaginative, language, behavioural, communication, and social interaction skills (Noor et al., 2012). Children with ASD may have well-functioning sensory perceptions but struggle to process sensory stimuli correctly, leading to a tendency to live in their own world. While autism cannot be cured, interventions like aquatic therapy can be used to manage and treat the condition effectively (Koegel et al., 2012). Children with ASD often misinterpret social

relationships due to challenges in maintaining eye contact and communicating with others (Rogers et al., 2013). Autism Spectrum Disorder (ASD) is characterised by a set of neurodevelopmental disorders involving deficits in social and communication skills, repetitive and stereotyped behaviours, and various cognitive impairments (Rogers et al., 2013).

The Malaysian government recognizes the need to involve more people in sports and introduced the policy '1 Student 1 Sport' in 2011, placing importance on sports in the primary and secondary school curricula to nurture holistic and physically, emotionally, and intellectually healthy students (Kementerian Pendidikan Malaysia, 2011). Among the recommended sports activities in Malaysian schools based on the '1 Student 1 Sport' program is swimming (Kementerian Pendidikan Malaysia, 2011).

Aquatic therapy programs can be adapted to make learning enjoyable and significant in contributing to an individual's physical, social, cognitive, and emotional well-being (Noble & Cregeen, 2014). Aquatic skill activities can have positive effects on the cognitive and intellectual aspects of students with autism, leading to improved psychomotor skills, motor movements, and swimming abilities in the pool. Aquatic therapy, as an adapted aquatic program, can engage children with ASD students and help them communicate, stimulate reflex movements, and gradually learn to swim at a specific distance. The aim of this study is to analyse the effects of aquatic therapy on the motor abilities and swimming skills of children with ASD.

Literature Review

Studies indicate that 85% of children with autism exhibit repetitive behavioral traits, and 31-71% of ASD individuals have intellectual impairments (Baio et al., 2018). As such, experts continue to inquire about the true extent of psychomotor challenges among ASD individuals with delayed mental development. Terms like "Autism," "Autism Spectrum Disorder," "Asperger's Syndrome," and "High-Functioning Autism" are associated with psychomotor behavioral traits (Paquet et al., 2014). Factors to consider when teaching ASD children to swim include their tendency to have hypotonia or weak muscles, resulting in hypermobile ligaments. Their walking style may appear stiff and uncoordinated, indicating a lack of motor planning and control over posture, balance, and orientation. Individuals with ASD often struggle to maintain balance and rely on asymmetrical arm movements and less flexible joint movements. When training autistic students to swim, attention should be given to their motor symptoms, including muscle weakness, impaired movement coordination, and difficulty maintaining balance. Tailored approaches and structured exercises can help them overcome these challenges and develop good swimming skills.

Swimming activities can provide various benefits in improving psychomotor skills for individuals with autism. Psychomotor skills refer to the relationship between psychological and motor aspects involving physical skills and motor coordination. Children with ASD often face a range of psychomotor challenges, including difficulties in coordinating movements, perceptual deficits, visual-motor integration, and motor efficiency. Swimming can be a beneficial activity for ASD individuals, particularly in increasing Range of Motion (ROM). Swimming is a low-impact activity that places minimal stress on the joints, allowing gentle movements and improving flexibility without excessive strain. Swimming engages various muscle groups throughout the body, encouraging overall strength and flexibility. Swimming strokes can target different muscle groups and help improve ROM. For example, breaststroke can stretch the chest, shoulders, and hips, while freestyle can promote flexibility in the arms and legs. Flexibility and ROM are essential aspects of physical fitness, as good range of motion enables independence in daily activities, prevents injuries, and enhances overall function (Surburg, 1995).

During swimming activities, the Central Nervous System (CNS) directs sufficient impulses from the brain to the muscles to perform motor movements. This process allows the CNS to recognize nerve impulses correctly from functioning organs and create a sufficient body image in the brain. This process can help improve psychomotor challenges faced by children with ASD, leading to increased hand and foot strength and improved body balance. The comfortable water temperature in aquatic therapy also has a calming effect on the CNS. The role of swim instructors is crucial in gradually introducing stimuli and providing support to the CNS. Teaching swimming to individuals with ASD requires a different approach than with typically developing children. A calmer and more adaptive

approach should be employed to create a conducive environment for learning and ensure the success of aquatic therapy interventions.

Methodology

This study adopted a quasi-experimental design to explore the effects of aquatic therapy on psychomotor skills in children with Autism Spectrum Disorder (ASD). The quasi-experimental design allows for the manipulation of an independent variable (aquatic therapy) while controlling for extraneous variables.

Four children diagnosed with Autism Spectrum Disorder (ASD) were recruited from a specialized centre for children with special needs. The participants ranged from 4 to 8 years old, and they were selected based on their availability and the parents' willingness to allow their children to participate in the study. All the participants were assessed and diagnosed by pediatric psychiatrists to confirm their ASD condition.

Instrument

The Conatser Adapted Aquatics Swimming Screening Test (CAASST) was used to assess the participants' psychomotor skills in swimming. The CAASST is a reliable and valid tool designed specifically for individuals with disabilities to evaluate their swimming abilities. The test was conducted at three different time points: before the aquatic therapy intervention (baseline phase), after ten sessions of aquatic therapy intervention (mid-intervention phase), and after twenty sessions of aquatic therapy intervention (full intervention phase). The CAASST consists of various tasks and exercises, and each participant was given scores based on his or her performance in the swimming skills being evaluated.

The study was conducted over a 12-week period, during which the participants underwent a total of 20 aquatic therapy sessions. The sessions were conducted twice a week, with each session lasting approximately 30 minutes. The aquatic therapy intervention was carried out using the Aquatic Therapy Application (ATA) programme. The programme included six stages, each targetting specific psychomotor challenges commonly faced by children with ASD. The stages were: Psychological/Physical Adjustment (3 exercises), Introduction to the Aquatic Environment (13 exercises), Enhancing Postural Body Control (9 exercises), Stretching and Strengthening Muscles (8 exercises), Awareness of Body's Center of Gravity (10 exercises), and Independent Swimming (10 exercises).

The data collected from the CAASST assessments were analysed descriptively using percentages and mean scores for each exercise. The progress of each participant was examined at the baseline phase, mid-intervention phase, and full intervention phase. Participants were given scores based on their performance in each exercise and the achievement of the set objectives. The "Min Performance" approach involves calculating skill performance within each phase by summing data point values and dividing the sum by the total data points. In this study, the "Acceleration Line Slope" is determined through the Split Middle technique, estimating the slope using median values. The "Acceleration Line" is fundamental, requiring data point calculation in each phase, followed by dividing the data points into two equal groups using a vertical line called the "real separation line."

The core of the "Acceleration Line Level" methodology entails executing two primary Split Middle analyses: the "Acceleration Line Level" itself and the "Slope of the Acceleration Line." Another key concept is the "Change of Level," indicating the transition of the Split Middle graph from the final phase A stage to the initial phase B stage, aligned with the flow line direction. The "Slope Calculation Process" starts by identifying points on the "Acceleration Line" intersected by the balanced scale line, factoring corresponding ordinates into calculations. Stability, a vital factor, is assessed by the percentage of values falling within 15% to 25% of the median value in the given phase, with approximately 80% in this range signifying analysis stability. Both quantitative and qualitative analyses were conducted to assess the overall findings of the study and to evaluate the impact of aquatic therapy intervention on the psychomotor skills of children with ASD.

Results

The participants' achievements were measured using the Conatser Adapted Aquatics Swimming Screening Test (CAASST) after every five sessions completed during the intervention period, specifically at sessions 6, 11, 16, and 21. The research findings are discussed based on CAASST's three main categories: Psychomotor Skills in Psychological and Physical Adjustment, Skills in Movement in the Water, and Swimming Skills.

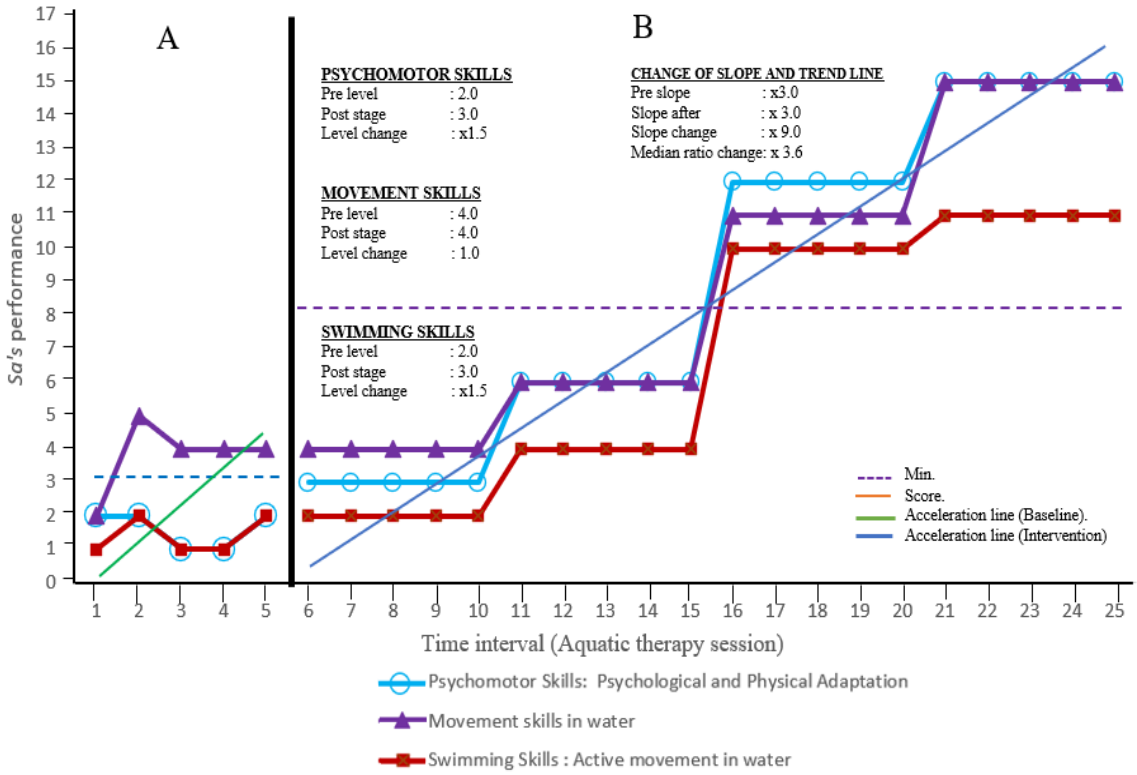

Fig. 1 *Sa's* (Pseudonym) performance on psychomotor, movement and swimming skills after 20 aquatic therapy sessions

Psychomotor skills: Psychological and physical adaptation
Initiated at Level 2.0 at the end of the baseline phase, it increased to Level 3.0 in the first attempt. The acute change rate increased by x 1.5.

Movement skills in water
Initiated at Level 4.0 at the end of the baseline phase, during the intervention phase, it still remained at Level 4.0. There was no acute change, with a score of 1.0.

Swimming skills: Active movement in water
Initiated at Level 2.0 at the end of the baseline phase, during the intervention phase, it increased to 3.0. The acute change rate increased by x 1.5.

Change of slope and trend
The Slope of the Trend Line started at Level x 3.0 at the end of the baseline phase. It showed the same score during the intervention phase at Level x 3.0. The rate of change of the Slope of the Trend Line increased by x 9.0. The rate of change of the Median Ratio increased by x 3.6.

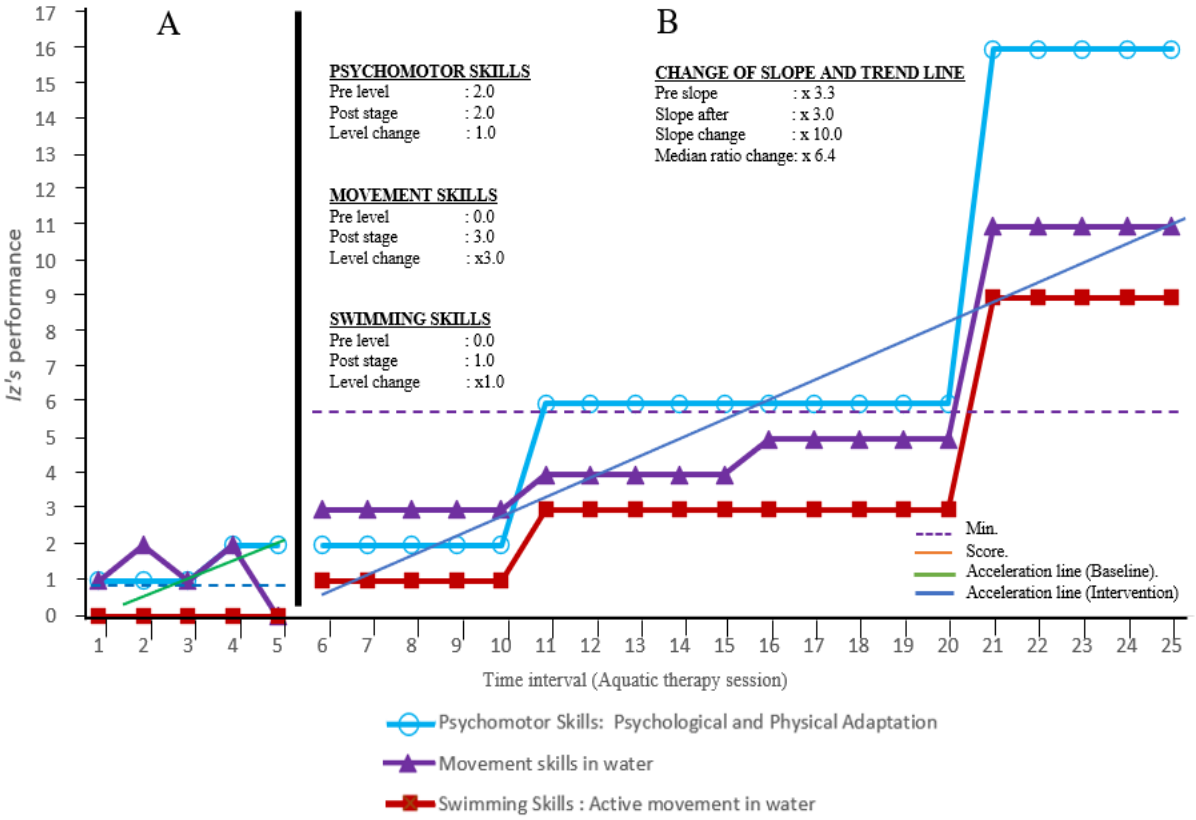

Fig. 2 *Iz's* (Pseudonym) performance on psychomotor, movement and swimming skills after 20 aquatic therapy sessions

Psychomotor skills: Psychological and physical adaptation

Initiated at Level 2.0 at the end of the baseline phase, it increased to Level 3.0 in the first attempt. The acute change rate showed no increase, with a score of 1.0.

Movement skills in water

Initiated at Level 0.0 at the end of the baseline phase, during the intervention phase, it increased to Level 3.0. The acute change rate increased to a score of x 3.0.

Swimming skills: Active movement in water

Initiated at Level 0.0 at the end of the baseline phase, during the intervention phase, it increased to 1.0. The acute change rate increased to a score of x 1.0.

Change of slope and trend

The Slope of the Trend Line started at Level x 3.3 at the end of the baseline phase. It showed the score of the intervention phase at Level x 3.0. The rate of change of the Slope of the Trend Line increased by x 10.0. The rate of change of the Median Ratio increased by x 6.4.

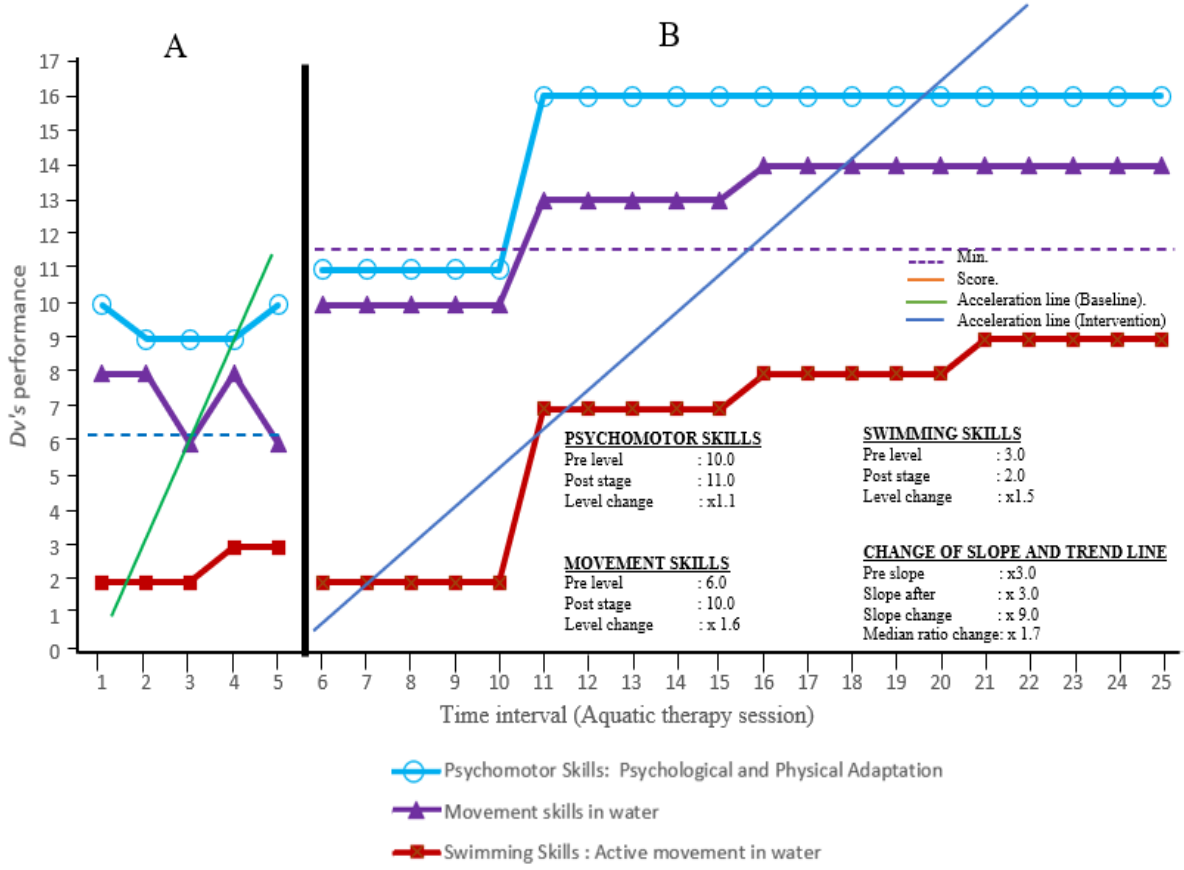

Fig.3. *Dv's* (Pseudonym) performance on psychomotor, movement and swimming skills after 20 aquatic therapy sessions

Psychomotor skills: Psychological and physical adaptation

Initiated at Level 10.0 at the end of the baseline phase, it increased to Level 11.0 in the first attempt. The acute change rate showed no increase, with a score of 1.0.

Movement skills in water

Initiated at Level 6.0 at the end of the baseline phase, during the intervention phase, it increased to Level 10.0. The acute change rate increased to a score of x 1.6.

Swimming skills: Active movement in water

Initiated at Level 3.0 at the end of the baseline phase, during the intervention phase, it increased to Level 2.0. The acute change rate increased to a score of x 1.5.

Change of slope and trend

The Slope of the Trend Line started at Level x 3.0 at the end of the baseline phase. It showed the same score during the intervention phase at Level x 3.0. The rate of change of the Slope of the Trend Line increased by x 9.0. The rate of change of the Median Ratio increased by x 1.7.

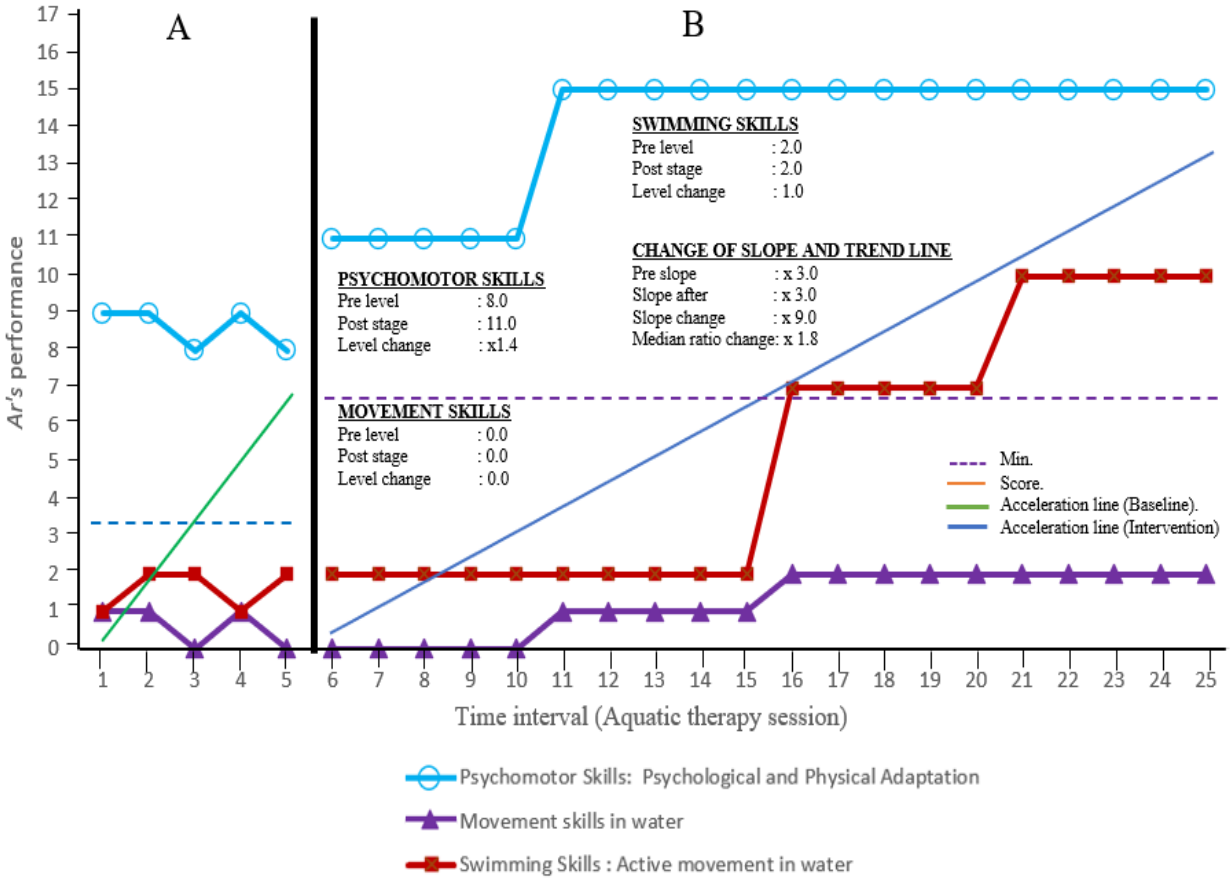

Fig.4 *Ar's* (Pseudonym) performance on psychomotor, movement and swimming skills after 20 aquatic therapy sessions

Psychomotor skills: Psychological and physical adaptation

Initiated at Level 8.0 at the end of the baseline phase, it increased to Level 11.0 in the first attempt. The acute change rate showed no increase, with a score of x 1.4.

Movement skills in water

Initiated at Level 0.0 at the end of the baseline phase, and there was no improvement during the intervention phase, remaining at Level 0.0. There was no acute change rate, with a score of 0.0.

Swimming skills: Active movement in water

Initiated at Level 2.0 at the end of the baseline phase, and there was no improvement during the intervention phase, remaining at Level 2.0. The acute change rate was at a score of 1.0.

Change of slope and trend

The Slope of the Trend Line started at Level x 3.0 at the end of the baseline phase. It showed the same score during the intervention phase at Level x 3.0. The rate of change of the Slope of the Trend Line increased by x 9.0. The rate of change of the Median Ratio increased by x 1.8.

Discussions

Achievement in Psychomotor Skills, Psychological, and Physical Adaptation

Participants demonstrated improvement in Psychomotor Skills, Psychological, and Physical Adaptation (items 1-16) using the Conatser Adapted Aquatics Swimming Screening Test (CAASST) (Conatser et al., 2009). All four participants showed enhancement after undergoing 20 ATA training sessions during the intervention phase. Participants displayed acute scores ranging from (m = 2.0 to 10.0) and chronic scores ranging from (m = 3.0 to 11.0) with an increase in the score ratio ranging from (x1.1 to x1.5). By session 6 (the first session of the intervention phase), all participants were able to wear swim caps and goggles provided by the instructor, which they continued to do until the intervention sessions concluded. Findings indicated that all participants began showing collaborative responses to the instructor starting from session 11. By session 21, participants Sa and Iz (pseudonyms) successfully mastered nearly all exercises in the Psychological and Physical Adaptation Skills checklist, while Dv (pseudonym) achieved this by session 11, and Ar by session 6. These results suggest that a participant's mastery level in this category depends on how quickly he or she began to trust the swimming instructor in the pool environment. This supports the claim by Bakar and Bakar (2021) that children with autism can be taught to swim when instructors play a role in instilling trust among them. Trust can manifest in various forms, including trust in the swimming instructor, swimming float, pool deck, and trust in oneself. Since all participants were young, they displayed somewhat excessive dependence, which initially delayed the process of building self-confidence in the instructor. Baron-Cohen et al. (2000) suggested that a deficit in the Amygdala size in the brains of individuals with autism might lead to abnormal fear responses in these children (either showing too little or too much fear compared to non-autistic controls). This could explain why the calming process for the students was somewhat slow until session 11.

Achievement in Movement Skills in Water

The Movement Skills in Water category consists of four sub-categories: Entry and Exit from the Pool (items 17-18), Range of Movement (ROM) in Water (items 19-21), Breathing Control Skills (items 22-27), and Balance and Floatation (items 28-33) (Conatser et al., 2009) in CAASST. Findings revealed that participants were able to master Movement Skills in Water when provided with repetitive training and sufficient time to adapt. Participants in this study exhibited acute scores ranging from (m = 0.0 to 6.0) and chronic scores ranging from (m = 0.0 to x10.0) with an increase in the score ratio ranging from (0.0 to x3.0). However, due to the young age of the participants (mental maturity level), none of them could communicate verbally with the instructor. Nevertheless, they understood brief physical instructions from the instructor (such as hand signals) and could comprehend concise verbal instructions. Consequently, three participants were not taught breathing exercises throughout the intervention period. Instead, they could hold their breath, which allowed them to float naturally and swim short distances but not long distances due to fatigue. In contrast, Dv, who was eight years old (higher mental maturity level), could blow bubbles in the water while swimming, remain calm, and swim 50 meters with ease. Additionally, her weak muscle tone (hypotonia) enabled her to easily adjust her movements with the water pressure in the swimming pool. The results also indicated that all participants needed repetitive training to reeducate muscles to achieve balanced upper-body strength, particularly in the cervical region, so that these flexible muscles could stabilize the head position above the shoulders and improve torso flexibility. However, Movement Skills in Water were disrupted at the initial intervention stage due to the participants' clingy behavior, which required them to be held by the instructor throughout the session.

Achievement in Swimming Skills: Active Movement in Water

Swimming Skills: Active Movement in Water includes items 34 to 44 in the Conatser Adapted Aquatics Swimming Screening Test (CAASST) (Conatser et al., 2009). The results in this category indicated improvement in all four participants' Swimming Skills: Active Movement in Water. Participants in this study exhibited acute scores ranging from (m = 1.0 to 3.0) and chronic scores

ranging from (m = 0.0 to 2.0) with an increase in the score ratio ranging from (÷1.5 to x1.0). The findings showed differences in participants' mastery levels, with three participants reaching this level as early as session 11, and one participant reaching it by session 16. The researcher observed that an individual's speed in mastering Swimming Skills depended on physical factors such as muscle strength and the ability to maintain body postural control, as well as psychological factors such as self-confidence to perform movements independently. By the end of the intervention phase, all participants were able to master almost all the skills in the CAASST checklist. They displayed improved body alignment, erect side body posture, and increased upper-body muscle tone. The study also found that arm strokes and leg kicks on the water's surface increased participants' muscle tone. This finding aligns with Cole & Becker (2004), who discovered that warm aquatic environments and splashes from leg kicks increased muscle tone to a normal level and enabled more efficient movements. The improved erect posture was attributed to increased core muscle strength. Consequently, their coordination during swimming was more organized, consistent with Cole & Becker's (2004) view that aquatic activities involve the entire body without exerting excessive pressure or tension on specific body parts. However, by the end of the intervention phase, no participant was able to demonstrate standard swimming coordination but was proficient in moving in the water, which is in line with Burkhardt & Escobar's (1985) view that swimming is an individual's ability to maintain and move oneself in the water without touching the bottom, in other words, in a free manner.

Conclusion

With the increasing population of autism in the world, this study was conducted to make swimming activities beneficial to this group by improving physical strength and mastering swimming skills. Swimming ability can reduce the risk of drowning, which may be a frightening concern for parents. Researchers often received initial responses from parents of autistic children such as "my child loves playing with water," "my child can play in the pool for hours and doesn't want to leave," and "my child spends hours playing with water in the bathroom." These observations indicate the joy experienced by autistic children due to sensory stimulation, but at the same time, they illustrate the "Theory of Mind Blindness" as proposed by Baron-Cohen (2009), where these children might have difficulty assessing risks and appear to be in their own world.

In Malaysia, most swimming instructors do not organize swimming programs for children with autism due to a lack of understanding of their behaviours. Bakar et al. (2022) reported that swimming instructors are worried about teaching autistic students as they lack sufficient knowledge and skills to handle this group. The challenges faced by instructors in this study include two-way oral communication problems and the risk of physical control loss of the participants in and around the pool.

To address these challenges, the researchers, in collaboration with instructors from a swimming academy, contacted parents to explain certain requirements before starting the study. One of the conditions was that parents needed to bring their children to the edge of the pool and leave them with the waiting instructors. Parents were advised not to make eye contact or talk to their children during the session and to wait in a designated area. This strategy aimed to establish trust, an affective element considered focal in all aspects of life (Aboo Bakar & Jaafar, 2017) between parents and instructors.

During the first intervention session, all participants showed similar denial attitudes by screaming, crying, and resisting throughout the session. The swimming instructors maintained a professional approach by remaining calm and not giving verbal instructions to the students. They also avoided eye contact with the participants to prevent adding fear to the children's experience (Baron-Cohen et al., 2000). This approach was consistently applied for 3 to 6 intervention sessions, depending on the mental maturity of the participants. Three participants took longer to calm down due to their young age and strong attachment to their parents, while another quickly adapted and focused on learning due to being older.

The swimming instructors allowed all participants to adjust to the pool environment, gradually shifting their "first beliefs" (Baron-Cohen, 2009) of the pool being a "playful and free" place to viewing it as a "place to learn discipline and danger lures". Regular conversations between

the instructors and parents were used to build a trusting relationship, fostering cooperation both inside and outside the swimming classes. This positive relationship had a significant impact on the success of the swimming program, as indicated by punctuality and attendance adherence to schedules, mutual respect between both parties, and continuous discussions about the children's health.
Furthermore, all participants were members of a created WhatsApp support group which provided emotional support and information exchange among parents. This group played a vital role in associating positive experiences of parents with their autistic children during the aquatic therapy programme (Bakar & Bakar, 2019), contributing to mutual support and tranquillity throughout the program.

The 1-hour duration of the Aquatic Therapy Application (ATA) training for each session was deemed efficient and adequate. The researchers believed that shorter or longer durations would not be suitable since each session required around 5 minutes for parents to bring their children to the poolside, time for participants to calm down and put on swimming caps and goggles, and all the class preparations. The remaining 50 minutes consisted of stretching, muscle, and cardiovascular exercises, including short and long-distance swimming. The final 5 minutes were allocated for preparations before leaving the pool and heading home with the parents. Apart from participant readiness, consideration was also given to the convenience and worthiness of parents' time, especially for those who travelled from far or had other therapies to attend.

The researchers recorded video footage of the participants during 20 intervention sessions for analysis and progress tracking. This method greatly assisted the analysis process by observing the participants' adjustments before and after several ATA sessions at each of the six stages. Notably, performance improvements were observed after the 16th intervention session, during the "Body Gravity Awareness" stage. The exercises enabled participants to balance and float comfortably, eventually leading to independent swimming in the next stage. The findings from the 20 training sessions during the intervention phase showed that ATA was successful in helping autistic participants learn to swim systematically, albeit not necessarily using standard swimming techniques. The researchers used the CAASST (Comprehensive Aquatic Ability Scale for Swimming with Autism Spectrum Disorder) to analyse the participants' swimming skill progress, which they found to be appropriate for measuring the learning-to-swim ability of autistic individuals systematically.

Limitations and Suggestions for Future Studies

This study focused on observing the psychomotor development of participants during the intervention period. Data collection for this study took place during the Recovery Movement Control Order (PKP) in early 2021, during which the government of Malaysia enforced strict Standard Operating Procedures (SOPs) for pool usage. The researchers were able to observe clear emotional development along with increased cognitive abilities among participants throughout the study, although these aspects were not measured. Future research could explore new scopes, such as how swimming or physical activities can contribute to the development of Mind Theory in autistic individuals. Investigating how these activities may challenge autistic individuals to engage in logical thinking and overcome their comfort zones could be explored. Early stages of swimming activities may initially trigger fears that are disproportionate to the situation, but with proper encouragement from instructors, individuals with autism can establish connections with others, which is one of the biggest challenges they face. Experienced coaches or swimmers should be present to ensure participants feel confident and comfortable while being supervised to prevent potential drowning incidents (Vaahtera, 2012).

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