BENEFITS OF RECREATIONAL SWIMMING ON THE QUALITY OF LIFE OF CHILDREN AND ADOLESCENTS WITH AUTISM SPECTRUM DISORDER: A NARRATIVE REVIEW

BENEFÍCIOS DA NATAÇÃO LÚDICA NA QUALIDADE DE VIDA DE CRIANÇAS E ADOLESCENTES COM TRANSTORNO DO ESPECTRO AUTISTA: UMA REVISÃO NARRATIVA

BENEFICIOS DE LA NATACIÓN RECREATIVA EN LA CALIDAD DE VIDA DE NIÑOS Y ADOLESCENTES CON TRASTORNO DEL ESPECTRO AUTISTA: UNA REVISIÓN NARRATIVA

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ABSTRACT

Autism Spectrum Disorder (ASD) is a developmental condition resulting from variations in brain function, which affects social, behavioral, and communication skills. Regular physical activity, especially aquatic activities, can promote significant developmental progress in children with ASD. Therefore, the objective of this study was to conduct a systematic literature review with a narrative character, elucidating the effects of regular aquatic activities based on swimming on the health and quality of life of children and adolescents with ASD. The PubMed/Medline and Google Scholar databases were consulted using keywords such as “Autism Spectrum Disorder” and “aquatic activities” defined in English and Portuguese, grouped using the Boolean operators “AND” and “OR”. The search for articles from the last 5 years (2019 to 2024) resulted in 1,409 articles, of which only 11 were included in this review. The PEDro Scale was used to measure the internal validity of the articles. The main findings demonstrate original articles that found in their outcomes that the practice of recreational and adapted swimming practiced between 06 and 16 weeks, with a frequency between 01 and 05 times a week, and lasting 45 to 60 minutes, was able to cause an improvement in cognitive and emotional development, with reduced irritability, improvement in motor and physical aspects, especially in body balance, respiratory muscle strength, sleep quality and reduction of inflammatory markers, in addition to improved socialization and social interaction in children and adolescents with ASD. Therefore, it is concluded that the practice of aquatic activities based on swimming can improve and stimulate the cognitive, motor, physical, emotional and social development of children and adolescents with ASD.

Keywords: Autistic Spectrum Disorder. Aquatic activities. Children. Benefits. Narrative review.

RESUMO

O Transtorno do Espectro Autista (TEA) é uma condição de desenvolvimento resultante de variações no funcionamento do encéfalo, que afeta as habilidades sociais, comportamentais e de comunicação. As práticas regulares de atividades físicas, em especial as aquáticas podem promover um grande progresso no desenvolvimento de crianças com TEA. Diante disto, o objetivo deste estudo foi realizar uma revisão de literatura sistematizada com caráter narrativo, elucidando sobre os efeitos das práticas regulares de atividades aquáticas baseadas na natação para a saúde e qualidade de vida das crianças e dos adolescentes com TEA. Foram consultadas as bases de dados PubMed/Medline e Google Acadêmico utilizando palavras-chave como “Transtorno do Espectro Autista” e “atividades aquáticas” definidas nas línguas inglês e português, agrupadas através dos operadores booleanos “AND” e “OR”. A busca de artigos dos últimos 5 anos (2019 a 2024) resultou em 1.409 artigos, dos quais, apenas 11 foram incluídos nesta revisão. Para medir a validade interna dos artigos, foi utilizada a *PEDro Scale.* Os principais achados demonstram artigos originais que encontraram em seus desfechos que a prática da natação lúdica e adaptada praticada entre 06 e 16 semanas, com a frequência entre 01 e 05 vezes na semana, e com duração de 45 a 60 minutos, foi capaz de provocar uma melhora no desenvolvimento cognitivo e emocional, com redução da irritabilidade, melhora nos aspectos motor e físico, em especial no equilíbrio corporal, na força muscular respiratória, na qualidade do sono e na redução de marcadores inflamatórios, além de melhora na sociabilização e na interação social em crianças e adolescentes com TEA. Portanto, conclui-se que a prática de atividades aquáticas baseadas na natação pode melhorar e estimular o desenvolvimento cognitivo, motor, físico, emocional e social de crianças e adolescentes com TEA.

Palavras-chave: Transtorno do Espectro Autista. Atividades aquáticas. Crianças. Benefícios. Revisão narrativa.

RESUMEN

El Trastorno del Espectro Autista (TEA) es un trastorno del desarrollo derivado de variaciones en el funcionamiento del cerebro, que afecta a las habilidades sociales, de comportamiento y de comunicación. La actividad física regular, especialmente la acuática, puede suponer un gran avance en el desarrollo de los niños con TEA. En vista de ello, el objetivo de este estudio fue realizar una revisión sistemática y narrativa de la literatura, dilucidando los efectos de las actividades acuáticas regulares basadas en la natación sobre la salud y la calidad de vida de los niños y adolescentes con TEA. Se consultaron las bases de datos PubMed/Medline y Google Scholar utilizando palabras clave como «Autism Spectrum Disorder» y «aquatic activities» definidas en inglés y portugués, agrupadas mediante los operadores booleanos “AND” y «OR». La búsqueda de artículos de los últimos cinco años (2019 a 2024) dio como resultado 1.409 artículos, de los cuales solo 11 se incluyeron en esta revisión. Se utilizó la Escala PEDro para medir la validez interna de los artículos. Los principales hallazgos incluyen artículos originales que encontraron en sus resultados que la práctica de natación recreativa y adaptada entre 6 y 16 semanas, entre 1 y 5 veces por semana y con una duración de entre 45 y 60 minutos, fue capaz de provocar una mejora en el desarrollo cognitivo y emocional, con una reducción de la irritabilidad, una mejora en los aspectos motores y físicos, especialmente en el equilibrio corporal, la fuerza muscular respiratoria, la calidad del sueño y una reducción de los marcadores inflamatorios, así como una mejora en la socialización y la interacción social en niños y adolescentes con TEA. Por lo tanto, se puede concluir que la práctica de actividades acuáticas basadas en la natación puede mejorar y estimular el desarrollo cognitivo, motor, físico, emocional y social de los niños y adolescentes con TEA.

Palabras clave: Trastorno del espectro autista. Actividades acuáticas. Niños. Beneficios. Revisión narrativa.

INTRODUCTION

Over time, the definition and understanding of autism have changed. This is partly due to the progress of scientific research and partly to changes in the diagnostic criteria for the condition over the years. Currently, it is known that autism is more prevalent than previously believed (Brasil, 2014).

Autism Spectrum Disorder (ASD) is characterized by a group of conditions that have characteristics such as difficulties in social life, communication, and language, as well as specific interests and activities that are repetitive and particular to each individual (WHO, 2023). The symptoms of ASD manifest in childhood and remain throughout adolescence and into adulthood. Generally, the associated conditions become visible in the first five years of life (WHO, 2023).

According to the Diagnostic and Statistical Manual of Mental Disorders version V (DSM-V), there are criteria that diagnose ASD, such as persistent deficits in communication and social interaction, lack of eye contact, problems with body language or limitations in the understanding and use of gestures, restricted and repetitive behavior patterns, as well as fixed interests or actions (APA, 2014). In addition to the criteria, there are also specific characteristics presented by autistic people, among them are increased or decreased sensitivity to sensory stimuli, peculiar interest in sensory aspects of the environment such as apparent indifference to pain and temperature, aversion to certain sounds or textures, excessive sensitivity to smells or touches, visual attraction to lights or movements (APA, 2014).

These individual aspects can impact the quality of life and health of autistic children, as they can delimit behaviors, social interactions, emotional and physical patterns (Assumpção; Bernal, 2018).

According to the Centers for Disease Control and Prevention (CDC), the estimated prevalence of children with ASD in the world in 2023 is 01 in 36 children up to 08 years of age (CDC, 2023). However, in July 2022, a survey published in the journal Jama Pediatrics, involving 12,554 participants and using CDC data for the years 2019 and 2020, pointed out that in the United States, autism is estimated to occur in one in 30 children and adolescents aged between 3 and 17 years (Li et al., 2022). In the Brazilian national scenario, there are no reliable estimates on the number of people with autism, but the data point to between 1 in 160 children in the best estimate and 1 in 32 children in the worst (Freire; Nogueira, 2023).

According to the World Health Organization (WHO), health is defined as a state of complete physical, mental and social well-being, and not just the absence of disease or infirmity (WHO, 1946). Thus, the concept of general health encompasses the balance between the aspects and systems that characterize the human body, encompassing biological, psychological, social, emotional, mental and intellectual characteristics (Bouchard et al., 1990).

One of the parameters that impact the health of autistic children and adolescents are the characteristics resulting from ASD: deficit in interaction, language and social communication; low development and maintenance of relationships; and broad levels of stereotyped behaviors and movements (Assumpção; Bernal, 2018). A strategy to improve the quality of life and health of these individuals is the regular practice of physical activities, which are capable of increasing motor development, reducing stereotyped behaviors,

improving mood and social skills according to the sport modality and methodology applied (Bedim, 2024).

Aquatic activities, specifically swimming practices, are exercises that promote great progress in the development of individuals with ASD (Pereira; Almeida, 2017). In this way, they can help improve motor coordination, spatial orientation, laterality and balance, in addition, it strengthens the muscles, increases cardiovascular capacity and, with the wide movements in the water, facilitates body perception and the surrounding space (Pereira; Almeida, 2017).

Among the various reasons highlighted in the literature to encourage the continuous practice of aquatic activities for autistic individuals is the improvement of aquatic orientation, which can reduce the risk of death in this population by drowning, a rate that is accentuated (Pan et al., 2011). In addition, with the low capacity for ASD care in Brazil together with the epidemic caused by technological advances that plague the world, it becomes increasingly relevant to understand the importance of physical activity as a promising alternative to not only promote body health, but also optimize the overall performance and quality of life of children with ASD. In view of this, this study seeks to analyze the benefits of regular practices of aquatic activities based on playful swimming for the quality of life of children and adolescents with ASD, pointing out the effects of regular swimming practices on the diagnostic criteria of ASD.

METHODOLOGY

The present study is a systematic review of the narrative literature, whose main characteristic is the review of scientific articles that address qualitative aspects used in different methodologies or have different theoretical concepts regarding the same theme or objective of investigation (Galvão; Ricarte, 2020).

"Literature review is a generic term, which comprises all published works that offer an examination of the literature covering specific subjects" (Galvão; Ricarte, 2020, p. 58). Narrative reviews, in turn, are seen as systematized reviews that:

> [...] synthesize the results of individual quantitative studies without reference to the statistical significance of the results. They are a particularly useful means of uniting studies on different topics for reinterpretation or interconnection, in order to develop or evaluate a new theory (Galvão; Ricarte, 2020, p. 59).

Therefore, this review is premised on bringing together scientific research related to the benefits of regular physical activity practices in an aquatic environment, in particular, which use methodologies based on the principles of swimming considering playfulness and

adaptation for individuals with ASD. The objective is to identify the beneficial effects of these practices on the health and quality of life of autistic children and adolescents.

To fulfill this purpose established in the objectives of this study, studies published in journals in the last 5 years that contemplate this theme will be investigated, carefully analyzing the outcome of each intervention applied and whether it is included in the inclusion criteria: a) children and adolescents of both sexes from 2 to 14 years old; b) children and adolescents diagnosed with ASD; c) individuals who were not affected by other neurodevelopmental or severe psychological disorders; d) articles that randomized and controlled their interventions in swimming-based aquatic activities, presenting their results; e) articles published in the last 05 years (2019-2024); f) publications in English and Portuguese; g) articles published in journals and that obtained registration; h) articles that the intervention is only with physical exercises without supplementation, medications or any other adjacent external factor.

The databases consulted were PubMed/Medline and Google Scholar, using the terms inserted in Chart 1. The keywords searched were "Autism Spectrum Disorder" and "aquatic activities" defined in English and Portuguese. The terms were grouped together by constructing a search strategy using the Boolean operator "AND" to sum the distinct expressions and also using the "OR" to group the terms with equal synonyms. The filter was established for studies from the last five years (2019 – 2024), including only original articles.

Chart 1 - Boolean descriptors and operators used in the research and their relationship in each data base.

N	Database	Search strategy	Identification of studies
1	PubMed/MEDLINE	"aquatic exercise" OR "aquatics exercises modalities" OR "aquagym" OR "aquatic activities" OR "aquatic exercises" OR "swimming" OR "swimming" OR "swimming" OR "swimming" OR "Autism Spectrum Disorder" OR "Autism" OR "Autism" OR "Autism" OR "Autism Spectrum Disorder" All Fields and in the last 5 years.	49 studies
2	Google Scholar	(Aquatic exercise) OR (aquatics exercises modalities) OR (aquagym) OR (aquatic activities) OR (swimming) OR (swimming) AND (Autism Spectrum Disorder) OR (Autism) OR (autism) OR (autism) OR (autism) All terms.	1,360 studies

Image Source: Developed by the authors, 2025.

To make the article selection process more precise, 4 stages were established, identification, screening, eligibility and inclusion. The articles were identified with the search strategies in the databases. Duplicate articles were then removed. Afterwards, the titles of

the articles were read, eliminating those that were not compatible with the objective of this review. Subsequently, in the screening and eligibility period, the abstracts were read, selecting those that were in harmony with the inclusion criteria and excluding the exclusion criteria: a) all parameters that did not meet the inclusion criteria; b) articles that include adolescents over 15 years of age, adults or the elderly, regardless of the diagnosis of ASD; c) studies that involve sports other than swimming, even if they are other aquatic activities such as hydrotherapy, surfing, etc.; d) review articles or gray literature (course completion papers, dissertations, theses); e) articles made with animal model.

And then readings were carried out in reverse mode, as a way to identify future new studies through the references. Finally, in inclusion, the complete readings of the manuscripts took place, following the last elimination.

In order to assess the internal validity of the selected articles, the PEDro Scale (PEDro Scale, 1999) was used. This scale has 11 criteria, counted from 2 to 11 translated into Portuguese: 1. The eligibility criteria were specified; 2. The subjects were randomly assigned to groups (in a crossover study, subjects were randomly placed in groups according to the treatment received); 3. The allocation of subjects was secret; 4. Initially, the groups were similar with respect to the most important prognostic indicators não_ yes; 5. All subjects participated blindly in the study; 6. All therapists who administered the therapy did so blindly; 7. All evaluators who measured at least one key result did so blindly; 8. Measurements of at least one key result were obtained in more than 85% of the subjects initially distributed by the groups; 9. All subjects from whom outcome measurements were presented received the treatment or control condition according to the allocation or, when this was not the case, data analysis was performed for at least one of the key outcomes by "intention to treat"; 10. The results of the inter-group statistical comparisons were described for at least one key outcome; 11. The study presents both measures of precision and measures of variability for at least one key outcome.

For each topic in which the article fits, 1 point is added to the final balance. Therefore, the highest score assigned is given as 10 (when the article presents the 10 topics of the scale) and the lowest is 1 (when the article presents only 1 topic). Thus, articles that obtained at least 60% of the score achieved were included in this review, that is, they had at least 6 topics corresponding to the scale. These scores can be seen in Table 1.

Table 1 – Analysis of the internal validity of the articles selected for review using the PEDro Scale.

	PEDro Scale											
Article Identification	**Criterio n 1**	**Criterio n 2**	**Criterio n 3**	**Criterio n 4**	**Criterio n 5**	**Criterio n 6**	**Criterio n 7**	**Criterio n 8**	**Criterio n 9**	**Criterio n 10**	**Criterio n 11**	***Score***

1 - Jucá *et al.* (2019)	S	Doesn't apply	S	S	Doesn't apply	S	S	S	S	Doesn't apply	S	7*
2 - Benjamin *et al.* (2019)	S	Doesn't apply	S	S	Doesn't apply	S	S	S	S	Doesn't apply	S	7*
3 - Ansari *et al.* (2020)	S	S	S	S	S	S	S	S	S	S	S	10*
4 - Santos *et al.* (2020)	S	Doesn't apply	S	S	Doesn't apply	S	S	S	S	Doesn't apply	S	7*
5 - Johnson *et al.* (2020)	S	Doesn't apply	S	S	Doesn't apply	S	S	S	S	Doesn't apply	S	7*
6 - Oliveira, Santos and Santos (2021)	S	Doesn't apply	S	S	Doesn't apply	S	S	S	S	Doesn't apply	S	7*
7 - Ansari *et al.* (2021)	S	S	S	S	S	S	S	S	S	S	S	10*
8 - Marzouki *et al.* (2022)	S	S	S	S	S	S	S	S	S	S	S	10*
9 - Vodakova *et al.* (2022)	S	Doesn't apply	S	S	Doesn't apply	S	S	S	S	Doesn't apply	S	7*
10 - Adin and Pancar (2023)	S	S	S	S	S	S	S	S	S	S	S	10*
11 - Zhao *et al.* (2024)	S	S	S	S	S	S	S	S	S	S	S	10*

Legend: Identification of the article following Table 1; S = Yes, when the article contemplates the criterion; N = No, when the article does not meet the criterion; Ñ applies = when the criterion is not relevant to the study. Score = total of the sum of the number of criteria met. * = articles that met at least 60% of the criteria and were included in the review.
Image Source: Developed by the authors, 2025.

RESULTS

First, 1,409 articles were identified in the two journals used through search strategies that covered the terms "ASD" and "aquatic activities". In the first screening, all the titles of these 1,409 articles were read, and then 694 studies were separated by identifying the titles that were directly related to the theme and objective of the study.

Subsequently, of the 694, 52 studies were selected for reading the abstracts, the exclusion of the 642 articles occurred because they were not within the determined age group, because they were review articles, had other comorbidities analyzed along with ASD and because they were gray literature studies (TCCs). Of the 52 analyzed, 23 articles were selected for reverse reading and full reading in order to identify the eligibility criteria selected in the inclusion criteria.

Considering the inclusion criteria, 12 articles were excluded due to the study population, where the population was outside the age group of interest (2 to 14 years), or the child did not have only one disorder, as well as articles that did not address only swimming but other aquatic modalities such as surfing, water aerobics, in addition to those that used supplementation along with practical interventions.

In the end, 11 original articles remained that passed the PEDro Scale (Table 1), of which the 11 articles presented in Table 2 were included in this study, demonstrating details about authors, objectives, methodologies, results and conclusion. The entire process of stratification of the selected documents is presented in detail in an illustrative way in the flowchart, called Figure 1.

Based on the objective of this study, which was to analyze the benefits of aquatic activities, especially playful swimming for children with ASD, the main results found are analyzed in detail in Table 2, and then even more detailed in Table 3. It is worth noting that the interventions encompassed methodologies that taught swimming in a playful way for at least 06 weeks and a maximum of 16 weeks, between 01 and 05 times a week, lasting 45 to 60 minutes. The main findings were grouped and discussed according to the physical, cognitive, emotional and social parameters that refer to the diagnostic criteria for ASD.

Table 2 – Main benefits of playful swimming for children and adolescents with ASD related through the articles analyzed.

Benefits	Related Posts	Key findings
Cognitive Benefits	Zhao *et al.* (2024)	Improvement in cognitive development.
Emotional Benefits	Marzouki *et al.* (2022) Johnson *et al.* (2020) Benjamin *et al.* (2019)	Improvement in emotional aspects.
Motor and Physical Benefits	Vodakova *et al.* (2022) Marzouki *et al.* (2022) Santos *et al.* (2020) Jucá *et al.* (2019)	Improvement in general motor aspects such as motor coordination, physical control and autonomy.
	Ansari *et al.* (2020) Jucá *et al.* (2019)	Improvement in body balance.
	Adin and Pancar (2023)	Improvement in respiratory muscle strength.
	Ansari *et al.* (2021)	Improvement in sleep quality and reduction of inflammatory markers.
Social Benefits	Marzouki *et al.* (2022) Jucá *et al.* (2019)	Improved socialization.
	Oliveira, Santos and Santos, (2021) Benjamin *et al.* (2019)	Improved social interaction.

Image Source: Developed by the authors, 2025.

Figure 1 – Flowchart for the presentation of the 4 stages of selection of the documents used in the construction of this review.

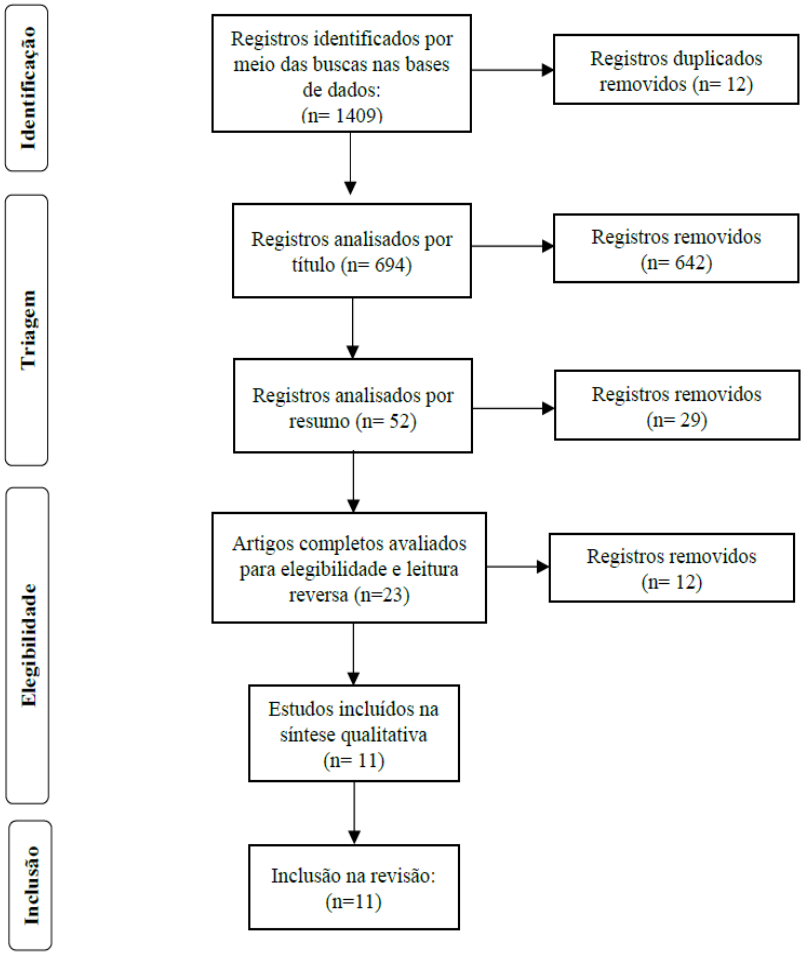

Image Source: Developed by the authors, 2025.

Table 3 – Qualitative evaluation of the articles selected for inclusion in the review, identifying the main benefits of swimming for individuals with ASD.

N	Author/Year	Goal	Methodology	Findings	Conclusion
1	Jucá *et al.* (2019)	To analyze the behavioral and physical changes resulting from the practice of aquatic activities in children with autism.	**Type of intervention:** Children aged 2 to 13 years of both sexes performed aquatic activities 2 times a week for 45 minutes for 01 to 03 months. **Evaluation:** Pimenta questionnaire applied to 10 parents or guardians of children with ASD, where they had to answer about the changes caused by the training given.	80% adapted quickly to the practice of swimming, 20% took a few weeks to adapt swimming. 100% of the children had improvements in social issues. 50% had improvements in balance and motor coordination. 90% of the children improved their relationship with their parents and 10% had no improvement in relation to their parents.	Improvements in adaptation, socialization, balance and motor efficiency of children with ASD.
2	Benjamin *et al.* (2019)	To analyze the effects of a relational psychomotricity program in the aquatic environment on the social behavior of children with ASD.	**Intervention type**: Children aged 5 and 7 years of both sexes participated in a relational psychomotricity program where they performed aquatic activities 02 times a week for 50 minutes that includes 14 sessions. **Assessment:** Two scales to assess behaviours and symptoms, the ATEC (Autism Treatment Assessment Checklist) and the ABC Scale (Atypical Behaviour Scale), before and after the 14 sessions.	When analyzing the ABC scale of the participants before and after the intervention, significant differences in irritability, behavior and inappropriate speech were observed. However, the ATEC scale showed no significant differences in any of its subscales. In the interviews, the parents reported improvements in the children's socialization. The reports, images and videos demonstrated a good interaction between students, objects and teachers during the activities. Only one child showed changes in autonomy in activities of daily living.	Reduced irritability and increased social interaction in children with ASD after aquatic psychomotor training.
3	Ansari *et al.* (2020)	Compare the effect of a land exercise	**Type of intervention**: 30 children distributed in 03 groups	When comparing karate and aquatic training, the results showed no	Both exercises provided significant

		program and a swimming exercise program on the balance skills in children with autism.	(control, aquatic training, karate) 02 times a week for 60 minutes which includes 10 weeks. **Assessment:** Static and dynamic balance test before and after the 10-week period.	difference in which exercise was better for children with ASD, but both showed improvements in the static and dynamic balance of the children.	improvements in the balance of children with ASD.
4	Santos *et al.* (2020)	To analyze the results obtained in the scientific literature on swimming and its benefits in the development of children with ASD, and compare them with the results obtained in the work carried out by the author at the Espaço Vida Institute in 2018.	**Intervention type**: Children aged 3 to 11 years performed water activities 1 time a week lasting 45 minutes at the Espaço Vida Institute. **Evaluation:** It was done through two methodologies, behavioral scales and direct observations.	The results showed that both in the methodology of bibliographic review of other articles and in the methodology of practical classes both used showed improvements in children with ASD, both in the physical, motor, cognitive and socio-affective spheres.	Swimming helped increase flexibility, strength, handedness, autonomy and physical development in children with ASD.
5	Johnson *et al.* (2020)	Assess parents' psychological health and children's behaviors before and after a private swimming program for children with ASD.	**Intervention Type**: A private swimming program consisting of 12 sessions was offered to children aged 5-11 years and their primary caregivers. **Evaluation:** were made through a demographic questionnaire, namely: Nisonger Child Behavior Assessment Form (Nisonger CBRF), Positive Thinking Skills Scale (PTSS; Bekhet & Zauszniewski, 2013), Psychological General Well-being Questionnaire Index (PGWBI) (Dupuy, 1984).	Preliminary results point to improved children's physical and psychological behaviors and parents' perception of general health.	Improvement in physical and psychological behavior, parents' perception of children's behaviors, calmer, less hyperactive, less stereotypies, and sensitivity to conduct problems.
6	Oliveira, Santos and Santos (2021)	Keeping up with the change in behavior of the child with autism.	**Intervention Type**: Case study of a 5-year-old swimming child. **Evaluation:** 02 questionnaires with open and closed questions addressed to the mother and the class teacher.	Both the teacher and the mother of the child with ASD said that there were improvements in social interaction and motor cooperation after the training.	Increased social interaction and motor cooperation in children with ASD.
7	Ansari *et al.* (2021)	To assess the effect of aquatic exercise on sleep habits and on two certain sleep-related cytokines of children with autism spectrum disorders (ASD).	**Type of intervention**: 40 children were divided into two groups, 20 in a control group and 20 in an aquatic exercise group aged 6 to 14 years aquatic exercise performed 02 times a week duration of 60 minutes for 10 weeks**.** **Assessment:** Biological measurements before and after 10 weeks to measure interleukin and tumor necrosis levels.	The results showed that there may be improvements in sleep quality and reduction in the levels of interleukin and tumor necrosis in children with ASD.	Increased sleep quality and reduced inflammatory markers in children with ASD.
8	Marzouki *et al.* (2022)	To explore the effects of two 8-week aquatic training programs (Technical *vs.* Aquatic Training). Based on games) on locomotion, stereotypy skills and emotional regulation in children with ASD.	**Type of intervention**: 22 children divided into 03 groups, two experimental groups (aquatic technical program and game-based program) and one control group, and 16 sessions were carried out, 02 times a week lasting 50 minutes. **Assessment:** were assessed before and after the 16 sessions using the gross motor development test**,** emotion regulation checklist, and the stereotypy subscale of the Gilliam Autism Rating Scale.	The results showed that both aquatic training interventions were effective in improving locomotor and control skills in individuals with ASD. However, smaller changes in emotional functioning were observed compared to the control group. These improvements are consistent with previous studies that have shown that exercises in the water promote various aspects of gross motor proficiency and coordination skills in individuals with ASD.	Improvement of motor, social, emotional and functional skills of children with ASD.
9	Vodakova *et al.* (2022)	To evaluate the effect of a seven-week Halliwick method intervention program on the development of aquatic skills, gross motor skills, and mental skills relevant	**Intervention type**: Participants were 7 children who performed swimming 1 time a week after two weeks from baseline using a Halliwick swim program. **Assessment:** Aquatic skills were measured with the Alyn Water Orientation Test 1, and gross motor skills were	There was an improvement in aquatic skills and gross motor skills in seven participants; Two of them did not improve in the mental adjustment oriented to the breath control sections in the water.	Increased aquatic and motor skills of the autistic children assessed.

		to aquatic competencies in children with ASD.	measured with the Gross Motor Function Measure test.		
10	Adin and Pancar (2023)	Examine the Effect of Swimming Exercise on Respiratory Muscle Strength and Functions in children with autism.	**Type of intervention**: 15 children divided into 02 groups, one experimental and one control group, where the experimental group performed aquatic activities 03 times a week for 60 minutes for 06 weeks. **Evaluation**: Two tests were performed, one with the objective of evaluating respiratory muscle strength and the other evaluating pulmonary function before and after a period of 06 weeks.	At the end of 6 weeks, according to the data of the statistical analysis, there was a significant difference in some parameters of the respiratory function of the experimental group, where an improvement in the values of respiratory muscle strength was observed. No significant difference was found in the respiratory functions of the control group as a result of the respiratory muscle strength measurements. As a result, we can say that swimming exercise is effective in improving respiratory muscle strength and respiratory functions in children with ASD.	Advancement in respiratory muscle strength of children with ASD who performed aquatic activities.
11	Zhao *et al.* (2024)	To investigate the effects of aquatic exercise intervention on executive function levels and brain-derived neurotrophic factor in children with ASD.	**Type of intervention:** 30 children were divided into 02 groups: experimental and control, where the control group performed aquatic exercises 4 times a week for 60 minutes for 12 weeks. **Assessment:** Brain-derived neutrotrophic factor levels were determined using the Human Brain-Derived Neurotrophic Factor kit ELISA provided by Rui Xin Biologicals, the task of exchanging dot-triangles to assess cognitive flexibility, tests of cognitive function.	In the results, the experimental group showed significant improvements in inhibition control, cognitive flexibility, and brain-derived neurotrophic factor levels. However, working memory did not improve significantly. The control group showed no significant changes in executive function levels or brain-derived neurotrophic factor concentrations.	Advances in cognitive development and cognitive flexibility have been demonstrated in autistic children who practiced aquatic exercises.

Legend: ASD = Autism Spectrum Disorder.
Image Source: Developed by the authors, 2025.

DISCUSSION

The studies analyzed in this article show a wide range of benefits promoted by psychomotor experiences in the integral development of children and adolescents. In the cognitive field, Zhao et al. (2024) highlight significant advances in the development of higher mental functions. Regarding emotional aspects, the investigations by Marzouki et al. (2022), Johnson et al. (2020) and Benjamin et al. (2019) point to improvements in emotional balance and the expression of feelings. With regard to motor and physical gains, the results indicate relevant progress in motor coordination, body control, and autonomy (Vodakova et al., 2022; Marzouki et al., 2022; Santos et al., 2020; Jucá et al., 2019), in addition to improvements in balance (Ansari et al., 2020; Jucá et al., 2019), respiratory muscle strength (Adin; Pancar, 2023), sleep quality, and the reduction of inflammatory markers (Ansari et al., 2021). Finally, in the social field, the work of Marzouki et al. (2022), Jucá et al. (2019), Oliveira, Santos and Santos (2021) and Benjamin et al. (2019) reveals an increase in sociability and the quality of interpersonal interactions. These findings support the relevance of psychomotor practices as a tool to promote integral health and well-being.

COGNITIVE BENEFITS

In the study by Zhao et al. (2024), boys were selected into two groups: experimental (n=16) and control (n=14). The research was conducted in a swimming training center and only the experimental group participated in the intervention, which lasted 12 weeks, with practices 4 times a week lasting 60 to 70 minutes using the Halliwick method. In this study, several tests were used to assess executive function, inhibitory control, cognitive flexibility, and Brain-Derived Neurotrophic Factor (BDNF). After the tests, they identified improvements in cognitive development and cognitive flexibility. Therefore, it seems that the practice of adapted swimming following the principles of the Halliwick Method for 04 months for boys with ASD can positively impact cognition.

The literature also indicates that regular swimming offers several additional benefits. Shariat et al., (2024) point out that the Halliwick Method, originally created to teach swimming to people with physical disabilities, also facilitates swimming learning for children with autism. This is because the method contributes to the improvement of self-esteem, the development of motor skills and physical capacities, in addition to reducing tension and stress levels, thanks to the muscle relaxation provided by the aquatic environment (Holdefer; Costa, 2023). Water activities aimed at children with neurodevelopmental disorders are effective in improving cognitive and motor skills, especially in improving executive function, due to greater use of attention, impairment and memory (Craig et al., 2016). Also, the practice of aquatic activities such as swimming involves several commands, this can improve cognitive flexibility through changing focus and adapting to new exercises in children and adolescents with ASD (Alaniz et al., 2018).

Another finding related to the cognitive benefits for children and adolescents with ASD concerns the improvement of concentrated attention with swimming practices, making these individuals able to improve their cognitive aspects of focus (Geamonond, 2019).

MOTOR AND PHYSICAL BENEFITS

Motor and physical benefits were the most reported and presented in the studies included in this review. In the study by Marzouki et al. (2022), 22 children were selected, divided into 03 groups (a control, a technical aquatic activities program, a game-based aquatic activities program). Two sets of tests were performed, namely the Gross Motor Development Test, the stereotypy subscale of the Gilliam Autism Rating Scale, and the Emotion Regulation Checklist. The intervention was done using the Halliwick method. This method was divided into four phases: adaptation to the water, rotations, movement and control of movement in the water, where they took swimming lessons 02 times a week

lasting 50 minutes in an indoor pool. The class had established criteria such as: a 5-minute general warm-up (e.g., walking, jogging, jumping jacks, and arm and leg movement), followed by a 7-minute warm-up in the pool (e.g., breathing technique, movement of hands and feet under water), 30 minutes of the selected program, and finally 8 minutes of cooling down to return to the resting state. After this intervention, the authors identified improvements in the children's motor and functional skills.

In the research by Santos et al. (2020), practical swimming classes were used, being held on Monday with a duration of 45 minutes, where the teacher subjectively evaluated the child's confidence, sociability, social interaction, cooperativity, self-esteem and objectively the flexibility, balance, motor coordination, spatial orientation, laterality and the maintenance of posture through the kick test, stroke, flotation. The tests showed that, through playful classes, there were improvements in quality of life, promoting a more active life, in addition to benefits such as flexibility, strength, agility, which can directly impact ASD deficits, leaving the child with more autonomy, confidence and making the practice fun and pleasurable.

Vodakova et al. (2022) sought to investigate the effect of the Halliwick method on aquatic skills in three different sections: mental adjustment, respiratory control and functional capacity, and gross motor function of children with ASD. The children's aquatic abilities were measured with the Alyn 1 aquatic orientation test (WOTA-1), while their gross motor skills were measured with the gross motor function test (GMFM). The intervention took place with 07 children, 01 time a week lasting 60 minutes for 09 weeks, where the class followed the following criteria: 10-minute warm-up, including breathing exercises, diving exercises, jumps and other similar exercises, 30-minute swimming training, which consisted of kicks with a plank, crawling arms, backstroke and breaststroke, and a 10-minute session of relaxation and play, including diving and breathing activities. Like Marzouki et al. (2022), the authors also identified improvements in motor and functional skills in children with little experience in the water.

Thus, observing the three studies included in this review that identified general motor and physical aspects, it seems that 01 to 02 times a week with classes of 50 to 60 minutes in duration are enough to promote acute improvements in the physical and motor control of individuals with ASD.

From a motor and physical point of view, swimming stands out for providing resistance and movement in a low-impact environment, benefiting skills such as coordination and balance, as evidenced by Ansari et al. (2020). This motor development contributes to greater autonomy in daily activities, which also strengthens children's self-esteem. In addition, Pereira and Almeida (2017) observed that swimming, by favoring the

learning of aspects such as laterality and spatial orientation, contributes significantly to motor progress, being one of the most complete exercises for physical development.

In addition to the reasons mentioned, the literature shows that swimming helps in children's learning, stimulating adequate breathing, the development of laterality and motor progression, as it involves different muscle groups, as well as promoting socialization (Souza, 2014). Another factor that should be mentioned is that in swimming, children have the ability to use their skills, aiming to develop their physical and intellectual capacities to the maximum. The earlier a child with ASD starts swimming, the better his performance and development in social life, becoming a more active child (Pereira; Almeida, 2017).

Benefit on body balance

Another physical aspect identified in this review was regarding body balance. The study by Jucá et al. (2019) used a questionnaire containing 30 closed questions that addressed sociodemographic, cognitive, behavioral and physical aspects for the 10 parents or guardians of children with ASD who participate in swimming 02 times a week lasting 45 minutes where playful activities were used and not only repetitive and fundamental exercises. Improved motor efficiency and balance were found as an outcome. Another study, developed by Ansari et al. (2020), selected 30 children, equally distributed in 03 groups, one being a control group, another training group with aquatic exercises and another group training with kata techniques. Two evaluations were performed before and after interventions to assess dynamic and static balance of the participants through the stork and walking test. The aquatic exercise training group was used a swimming program 02 times a week lasting 60 minutes for 10 weeks. He used the Halliwick method with pediatric aquatic exercises where the class was planned: 5-minute warm-up (walking, running, jumping jacks and movement of arms and legs), 15 minutes of orientation training (sagittal, transverse and longitudinal rotation), 20 minutes of basic swimming skills (breathing, floating and stroke skills), 15 minutes of free swimming (group activities and playing with pool toys) and a 5-minute cool-down. Improvements in the static and dynamic balance of the children were identified, highlighted as a good alternative to be used in schools and institutions.

Therefore, swimming in a playful way with practices 02 times a week between 45 and 60 minutes for 10 weeks or more, seems to be indicative of improved body balance in children with ASD.

The study by Caputo et al. (2018) that involved 26 children with an average age of 8.3 years, found that the water activity program had significant effects on the participants' balance, going far beyond just balance, but improving quality of life.

Benefit on Respiratory Muscle Strength

Another physical component highlighted in the studies analyzed in this review was the improvement of respiratory muscle strength with the practice of swimming. In the study by Adin and Pancar (2023), 15 children participated and were divided into two groups, one experimental (n=8) and one control (n=7), where they were subjected to 02 tests, one measuring the forced vital capacity and the other calculating the respiratory inspiratory flow and the peak expiratory flow, in addition to the measurement of vital capacity. Only the experimental group underwent the intervention in the swimming class held 03 times a week lasting 1 hour for 06 weeks, where the class occurred as follows: warm-up and stretching were applied for 10 minutes, and the training was applied according to the exercise program ready for the remaining 50 minutes. At the end of every 20 minutes of training, 5 minutes of free play were given. After this intervention, they identified improvements in the respiratory muscle strength and respiratory functions of children with ASD.

In addition, the regular practice of aquatic activities contributes to the strengthening of the respiratory muscles of children with ASD, the resistance of the water during the exercises makes the respiratory muscles work more intensely, which results in more efficient breathing and the strengthening of the muscles involved in this process (Adin; Pancar, 2023). Aquatic activities are also used and show the efficiency and improvement of the respiratory muscles in other groups affected by deficit disorders, especially with regard to the expansion of respiratory functional responses (Vural, Özdal; Pancar, 2019).

Benefit on sleep quality and reduction of inflammatory markers

Other aspects found were demonstrated in the study by Ansari et al. (2021). 40 children were selected and divided into two groups, one aquatic and the other control. Two evaluations were performed before and after the intervention, in addition to a Children's Sleep Habits Questionnaire and laboratory measurements before and after the intervention to analyze serum IL-1 and TNF-α. This study concluded, after this intervention, that the practice of adapted swimming for children and adolescents with ASD can improve sleep quality and reduce inflammatory markers.

IL-1 and TNF-α are inflammatory markers that signal a high rate of inflammation, which may indicate changes in neurological, cognitive, and social functioning (Adibsaber et

al., 2023). When associated with vitamin D supplementation, swimming can reduce levels of inflammatory markers and improve social and communication skills in autistic children (Adibsaber et al., 2023).

Sleep quality, in turn, can impact the physical and mental health of the general population, as well as poor sleep quality can increase levels of sadness, anxiety, and nervousness (Bedim et al., 2024). In the autistic population, there is the same relationship between poor sleep quality and emotional aspects (Pinato et al., 2019).

In turn, as presented by Ansari et al. (2021), the swimming intervention in relation to sleep quality in children with ASD can be beneficial, enabling children to sleep better the night after class, in addition, other benefits are also cited in the literature such as improved social and physical skills (Jia et al., 2024).

EMOTIONAL BENEFITS

Authors Johnson et al. (2020) conducted a swimming program for 10 children with ASD and their caregivers. The class took place in two parts, the first class for caregivers lasting 60 minutes and the other part for the children, which included 12 sessions in the pool over three weeks, with 05 classes in the first week, 05 classes in the second week and 02 classes in the third week. Each day of the program, 10 children received a 30-minute private swimming lesson where the children had steps to complete such as entering the pool, blowing bubbles and diving their faces in the water. The evaluation was through a demographic questionnaire that included questions about the children's challenging behaviors and was also evaluated, by specific instruments, the positive thinking of the parents in relation to the children and the psychological well-being of both, as well as the parents' perception of the children's general health. The study concluded that swimming practice improved physical and psychological behavior, in relation to parents' perception of children's behaviors, reporting that children became calmer, less hyperactive, had lower stereotypies and sensitivity to conduct problems.

Another study analyzed also noticed emotional improvements in children. Marzouki et al. (2022), after 16 swimming sessions focused on playful aspects, noticed improvements in the children's emotional skills.

The research by Benjamin et al. (2019), used 02 questionnaires, being ATEC (scale developed to assess the effectiveness of autism treatment where it evaluates speech, sociability, sensory and cognitive perception, physical and behavioral aspects) and ABC instrument where parents or guardians answered 58 items related to behavioral issues. The class was taught to 06 children on Tuesdays and Thursdays with a duration of 60 minutes

during 14 sessions, in which they advocate working with relational psychomotricity (the children freely built their games with noodles, balls, boards, etc.). As an outcome, a reduction in irritability was identified. Therefore, between 12 and 16 sessions of adapted swimming with a minimum of 02 and a maximum of 05 sessions per week, there were reports of emotional improvements in individuals with ASD.

It is important to note that a study such as that of Aguiar et al. (2017) has been pointing out that the practices of physical activities and aquatic activities improve self-control, communicative capacity and reduce behaviors and attitudes that show aggressiveness. However, the results underline the importance of swimming lessons as a vital skill for survival, highlighting the motivation of parents to involve their children in this activity. Zanobini and Solari (2019) highlighted the importance of effective communication in water activities, demonstrating improvements in interpersonal skills and a reduction in stereotyped behaviors. However, parents face barriers when seeking these classes, such as teachers' lack of knowledge about ASD. This highlights the need for greater training and awareness among professionals, ensuring that swimming lessons are safe and inclusive for all (Carter; Koch, 2023). In contrast, in the study by Mische Lawson et al. (2019), families' perception of safety increased as children's swimming skills improved. This suggests that swimming is relevant not only as a physical activity, but also as a tool to promote self-confidence in children with ASD.

SOCIAL BENEFITS

According to the findings of this study, the regular practice of swimming proved to be advantageous for the improvement and cognitive and emotional development of children, favoring social interaction and promoting psychological well-being (Johnson et al., 2020; Olive tree; Saints; Santos, 2021). In the study carried out by Benjamin et al. (2019), an improvement in the social behavior and speech of children and adolescents with Autism Spectrum Disorder (ASD) was observed through playful aquatic activities based on swimming. Likewise, Oliveira, Santos, and Santos (2021) applied two questionnaires, with open and closed questions, aimed at mothers and swimming teachers to assess a child with ASD level 2, considering aspects such as motor coordination, speech, and social interaction. The classes took place twice a week, lasting 45 minutes each, for three months, always with a playful focus. Improvements in motor coordination, social interaction and sociability with family members and other people were identified.

Thus, we can say that playful swimming twice a week, over a period of 12 to 14 weeks, seems to favor the social interaction of children with Autism Spectrum Disorder

(ASD). Other aspects highlighted in the literature refer to the ability of these children to meet their basic needs independently, in addition to advances in communication, eye contact, and interaction with peers when exercises are proposed together, according to Santos et al. (2021).

Additionally, it is important to mention that children and adolescents with ASD face significant difficulties in socialization and expression. Thus, the practice of swimming can act as a facilitator of social skills through group classes (Ferreira; Peace; Tenório, 2020). The study carried out by Jucá et al. (2019) evidenced as a result the improvement in social and behavioral relationships in a broader context. In the work of Marzouki et al. (2022), the intervention resulted in advances in social and emotional competencies. The practice of swimming is often highlighted in the literature as advantageous for both physical and mental health, especially with regard to the integration, sociability, and creativity of children with specific disorders (Oliveira et al., 2021).

Several studies mentioned in the literature show that swimming can help socialization through playful activities in swimming classes, generating joy in children and adolescents and promoting interaction between them. This process contributes to psychosocial development and increased communication among young people (Santos et al., 2013). In addition, swimming favors neurological development, helping children to understand and socialize, improving their reactions and attitudes in the face of challenging situations (Pan et al., 2011). According to Ennis et al. (2011), the results obtained showed a significant advance in social relationships, communication and, especially, in body self-knowledge. The research focused on aquatic activities as a way to work on sociability and nonverbal communication in autistic children, involving children from 3 to 6 years old, over a program that lasted 10 weeks, with sessions of approximately 60 minutes each.

This study addressed a topic of great relevance, investigating the benefits of aquatic activities practiced through playful swimming for children and adolescents with ASD, an area with significant potential to improve the quality of life of these children. The studies used robust methodologies, with validated questionnaires and behavioral assessments ensuring the reliability of the data collected. However, most studies were carried out with small and specific samples, limiting the understanding of the investigation of interventions with children and adolescents with ASD. Thus, the surveys carried out in this study require cautious interpretations.

More research is needed to include diverse and larger samples, in order to increase the validity of the results. In addition, controlled and randomized research is necessary to understand if the result is being positive over time. It is also essential to investigate new

variables such as family or school environment to see if these factors interfere with the results of aquatic activities. In addition, the difficulty in locating specific protocols and articles related to swimming was linked to the use of the term "aquatic activities", due to the lack of standardization in the documents and literature on this specific theme

This study showed that body dissatisfaction was manifested in the discourse in relation to physical appearance in almost half of the number (44.9%) of adolescents living in rural cities. Excess weight and the accumulation of fat in the abdominal region were the main reasons for this feeling of rejection with the physical shape. To contain this negative feeling about the body, attitudes were taken by the adolescents to feel good about their appearance, with physical activity and control of food being the most declared. These results highlight that the phenomenon of body image needs to be analyzed from a qualitative perspective, since the instruments currently applied present standardized results, which makes it difficult to deepen and understand the results obtained (Tort-Nasarre et al., 2023; Conti et al, 2009).

CONCLUSION

Based on the results obtained and the objectives of the study, it is possible to affirm that the regular practice of aquatic activities, especially swimming, brings significant benefits to children and adolescents with Autism Spectrum Disorder (ASD). The analysis of the literature reveals that this practice positively impacts multiple aspects of development, including cognitive, emotional, motor and physical.

The results indicate that the study's initial hypothesis – that regular swimming would provide physical, emotional and psychological benefits for children and adolescents with ASD, especially in the areas of cognitive and motor development, communication, social interaction and reduction of stereotyped movements – has been confirmed.

Thus, regular aquatic practice, when well structured, can be considered a beneficial and viable intervention to promote health and quality of life in children and adolescents with ASD.

Finally, while this study has provided important insights into the potential benefits of swimming for children with ASD, it is important to recognize its limitations. It is necessary for the academic and scientific community to develop more research in this crucial area. Future studies may deepen the understanding of the mechanisms underlying the benefits of swimming for children with ASD, as well as explore other therapeutic and physiological aspects of this activity. This ongoing research is critical to developing more effective interventions and improving the quality of life for children with ASD.

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