

Evaluating aquatic competence in children with autism spectrum disorder (ASD) and intellectual disabilities (ID): A comparative analysis of the WOTA, HAAR, and A-SEAS Scales

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Abstract

Adapted aquatic programs offer children with Autism Spectrum Disorder (ASD) and Intellectual Disability (ID) important physical, social, and psychological benefits. Specialized tools instruments, including WOTA 1, HAAR, and the newer A-SEAS, are used to evaluate the effectiveness of these programs. Comparing WOTA 1, HAAR, and A-SEAS within the same population and intervention context is essential for determining whether they assess similar or complementary aspects of aquatic competence. Thus, this study examined the concurrent validity of WOTA 1, HAAR, and A-SEAS in evaluating aquatic competence among 30 children aged 6–15 with ASD or ID. Participants completed pre- and post-intervention assessments following a 14-week adapted swimming program using visual prompts. Significant improvements were observed in the experiment group across WOTA 1, HAAR, A-SEAS aquatic skills and A-SEAS emotional adjustment. Strong, positive and statistically significant correlations were found among WOTA 1, HAAR, and A-SEAS at both pre- and post-intervention assessments, with stronger correlations observed after the intervention, indicating that improvements in aquatic competence were reflected more consistently across the different assessment perspectives. Overall, the findings demonstrated that the three instruments assess related aspects of a common underlying construct while providing complementary information. Specifically, WOTA 1 assesses functional aquatic performance, HAAR evaluates aquatic readiness, while A-SEAS evaluates aquatic skills and emotional adjustment during participation. The results support the view that aquatic competence in children with ASD and ID should not be understood exclusively as the acquisition of swimming skills, but as a multidimensional construct involving functional performance, motor adaptation, emotional adjustment and participation in aquatic settings.

Keywords: Concurrent validity, Aquatic motor performance, Developmental disabilities, Emotional adjustment.

Introduction

Participation in adapted aquatic programs provides significant physical, social, and psychological benefits for children with Autism Spectrum Disorder (ASD) and Intellectual Disability (ID) (Alecú & Onea, 2025; Ansari et al., 2021; Tsolaki et al., 2023). However, the acquisition of aquatic competence in these populations is often hindered by motor difficulties, sensory processing differences, and difficulties with emotional regulation. Consequently, a comprehensive and accurate assessment of aquatic competence is essential to ensure safe participation, guide individualized instruction and monitor progress within adapted aquatic interventions (Kemp et al., 2024; Kokaridas et al., 2025; Tsolaki et al., 2023). An important consideration in aquatic assessment is whether available instruments capture overlapping aspects of aquatic competence or provide complementary information about different dimensions of performance and adjustment (Güeita-Rodríguez et al., 2019; Kokaridas et al., 2025). Understanding the relationships among these assessment perspectives may help practitioners interpret children's progress more comprehensively and select assessment tools according to their specific evaluation needs (Kemp et al., 2024; Tsolaki et al., 2023).

A range of assessment tools have been developed to evaluate aquatic competence in children with developmental disabilities, each reflecting different theoretical perspectives and assessment priorities. The Water Orientation Test Alyn 1 (WOTA 1), grounded in the Halliwick method, assesses water orientation, mental adjustment, breath control, and functional motor performance in the aquatic environment (Tirosh et al., 2008). Similarly, the Humphries Assessment of Aquatic Readiness (HAAR), also based on the Halliwick approach, focuses on aquatic readiness and the progressive development of foundational aquatic skills (Humphries, 2008). Previous studies have used these instruments to assess aquatic functioning and skill development in children with developmental disabilities, including children with autism spectrum disorder (ASD) and intellectual disability (ID) (Caputo et al., 2018; Chu & Pan, 2012; Tsolaki et al., 2023; Vodakova et al., 2022; Zanolini & Solari,

2019). Although both instruments are informed by the Halliwick approach, they emphasize different aspects of aquatic assessment, that is, WOTA 1 focuses on mental adjustment and functional performance in water (Tirosh et al., 2008), whereas HAAR focuses on children's readiness to participate in aquatic activities and their transition from land to water (Humphries, 2008). Understanding how these assessment approaches relate to one another may help clarify whether they provide similar or distinct information about children's aquatic competence.

However, while the WOTA 1 accommodates individuals with limited functional and cognitive profiles, it addresses cognitive difficulties as an overarching, generic category rather than capturing the unique cognitive and behavioral characteristics of ID and ASD. Moreover, traditional aquatic assessments have systematically overlooked the real-time emotional adjustment of the participant within each specific task, focusing almost exclusively on isolated motor performance. For instance, the WOTA 1 includes only a single, generalized item that provides a broad description of water adjustment, leaving the precise interaction between emotional state and swimming skills unmeasured (Kokaridas et al., 2025). This distinction is essential because in children with ASD and ID, observable behaviors such as hesitation, freezing, or task refusal may reflect not only motor difficulties, but also heightened anxiety and sensory over-responsiveness (Fernandes et al., 2024; Odeh et al., 2022; Tsolaki & Kokaridas, 2026).

This limitation has triggered a paradigm shift toward multidimensional assessment contexts. Emerging neurodevelopmental research indicates a distinct developmental pathway leading from gross motor skills to emotional regulation in children, a mechanism that is directly mediated by the refinement of executive functions (Li et al., 2022). Indeed, Tsolaki et al. (2026) study showed that an adapted swimming program incorporating visual prompts resulted in improvements in executive functioning, visual processing, and motor efficiency in children with ASD and ID. More recently, Tsolaki and Kokaridas (2026) demonstrated that aquatic skill development and emotional regulation are not parallel, isolated developmental pathways, but rather deeply interconnected dimensions of growth that can be advanced concurrently through structured interventions.

Consequently, considering aquatic skill acquisition as a purely physical performance ignores the behavioral and emotional factors that can set limitations on motor skills improvement in children with ID and ASD (Fernandes et al., 2024; Odeh et al., 2022). Thus, evaluating emotional adjustment, task satisfaction, and the intrinsic joy derived from swimming exercises becomes of equal diagnostic importance to assessing objective aquatic performance. To address this limitation and bridge the gap between motor execution and affective processing, Kokaridas et al. (2025) introduced the Adapted Swimming and Emotional Adjustment Scale (A-SEAS). Recognizing that motor development barriers in ASD and ID are deeply intertwined with executive and emotional functioning, this specialized instrument incorporates emotional adjustment alongside fundamental aquatic skills, evaluating both motor performance and observable emotional adjustment concurrently across standardized aquatic activities (Kokaridas et al., 2025). Rather than serving as a replacement for traditional tools, examining the A-SEAS alongside the WOTA 1 and HAAR allows researchers to clarify how functional motor execution, aquatic readiness and emotional adjustment relate to one another within adapted swimming programs (Kokaridas et al., 2025; Tsolaki & Kokaridas, 2026; Tsolaki et al., 2023).

Despite the individual strengths of these instruments, no studies yet have directly compared WOTA 1, HAAR, and A-SEAS within the same population and intervention context. A direct comparison of these assessment tools may help determine whether they evaluate similar or complementary aspects of aquatic competence, thereby supporting evidence-based selection in adapted aquatic practice. The present study aims to provide a direct comparison of the WOTA 1, HAAR, and A-SEAS scales within the same group of children with ASD and ID. Specifically, it examines the concurrent validity of these assessment tools and evaluates the extent to which they assess aquatic competence in children with developmental disabilities. The findings are expected to provide educators and aquatic professionals with robust evidence to support the selection of appropriate assessment instruments for adapted swimming programs tailored to children with ASD and ID.

Materials and Methods

Participants

Thirty children (n=30) aged 6 to 15 years (21 boys, 9 girls) with developmental diagnoses of either intellectual disability (ID; n=10, 6 boys/4 girls) or autism spectrum disorder (ASD; n=20, 15 boys/5 girls) participated in the study. All diagnoses were officially established by the Centers for Interdisciplinary Assessment, Counseling and Support. Participants were randomly assigned either to an experimental group (EG; n=17; 11 ASD, 6 ID) and a control group (CG; n=13; 9 ASD, 4 ID). Recruitment was conducted following official permission from the Directorate of Primary Education to contact parents in inclusive or special education settings. The main researcher informed the parents, who subsequently reviewed-independently or via dictation-and signed the informed consent form. The study protocol and procedures were approved by the Bioethics Committee of the University of Thessaly (protocol number 2366-3/4-2024).

Procedure

The adapted aquatic intervention lasted 14 weeks, consisting of two 60-minute sessions per week conducted in a small pool of the municipal swimming facilities. All participants in the experiment group (EG) and the control group (CG) completed pre- and post-intervention assessments conducted by the main researcher

using three assessment instruments designed to measure aquatic competence. While the control group did not participate in the program during the study period, these participants were offered the opportunity to join it following the completion of the post-intervention assessments. The adapted swimming program using visual prompts followed a progressive structure including preparation activities, breathing exercises, balance and body control tasks, individual movement games, swimming skill exercises, cooperation and independence activities, and cool-down routines. All assessment procedures were video-recorded for subsequent evaluation by the research team.

Instruments

Three assessment instruments were selected to provide a comprehensive evaluation of aquatic skills. These tools represent established approaches to aquatic assessment and have been previously used in relevant studies involving children with ASD and ID. Examining all three following instruments within the same intervention enables a direct comparison of their measurement characteristics and their responsiveness to changes following an adapted swimming program.

- The Water Orientation Test Alyn 1 (WOTA 1) was developed to assess aquatic competence in individuals aged 3 years and older with limited functional and cognitive abilities (Tirosh et al., 2008). Based on the Halliwick concept, this instrument evaluates mental adjustment to the aquatic environment, breath control, and functional performance in the water. The assessment consists of 13 items scored on a 4-point ordinal scale, with higher scores indicating greater aquatic competence. The WOTA 1 has been widely used to assess aquatic performance in children with developmental disabilities, including ASD and cerebral palsy. Previous research has demonstrated satisfactory reliability and validity for this tool, supporting its use as a standardized measure of aquatic competence in these populations (Tsolaki et al., 2023; Vodakova et al., 2022).
- The Humphries' Assessment of Aquatic Readiness (HAAR) was developed to evaluate aquatic readiness according to the Halliwick Concept. Rather than focusing on conventional swimming performance, it emphasizes adaptation to the aquatic environment and the progressive development of movement skills. The assessment comprises 32 items distributed across five domains: mental adjustment, introduction to the aquatic environment, rotations, balance and movement control, and independent movement in water. Each item is scored dichotomously (successful/unsuccessful), and scores for each domain are expressed as percentages (Humphries, 2008). HAAR has been used in studies involving children with disabilities, including ASD and ID, and has been recognized as an appropriate instrument for evaluating aquatic readiness and progress in adapted swimming programs within the Halliwick framework (Caputo et al., 2018; Chu & Pan, 2012; Tsolaki et al., 2023; Zanolini & Solari, 2019).
- The Adapted Swimming and Emotional Adjustment Scale (A-SEAS; Kokaridas et al., 2025) was specifically developed for children aged 6 years and older with ASD and ID. Unlike traditional aquatic assessment tools, the A-SEAS simultaneously evaluates swimming performance and emotional adjustment during each activity. The scale consists of 14 items, with Items 1–6 and 14 assessing mental adjustment, and Items 7–13 evaluating balance, rotations, and independent movement in the water. Swimming performance is rated on a 5-point scale, whereas emotional adjustment is assessed on a 4-point scale ranging from fear or refusal to relaxed and happy participation. This dual-rating approach provides a comprehensive evaluation of both motor execution and emotional engagement during aquatic activities. Although the A-SEAS is a recently developed instrument and empirical evidence regarding its application remains growing, initial validation findings indicate strong correlations with established aquatic competence measures. These findings support its potential as a reliable tool for capturing both swimming skills and emotional regulation in children with ASD and ID (Tsolaki & Kokaridas, 2026).

The three instruments provide a comprehensive evaluation of aquatic skills in children with ASD and ID. Since each instrument evaluates distinct dimensions of aquatic competence, their combined use enables a comprehensive comparison of their measurement characteristics and responsiveness to change following the intervention.

Statistical Analysis

Data were analyzed using non-parametric statistical procedures. Within each group, the Wilcoxon signed-rank test evaluated differences between pre- and post-intervention measurements. The Mann–Whitney *U* test compared independent groups (experiment vs. control) and disability categories (ASD vs. ID). Spearman's rank-order correlation coefficients examined the relationships among WOTA-1, A-SEAS (aquatic skills), and HAAR scores. The strength of significant correlations was interpreted using guidelines by Portney (2020). Statistical significance was set at $p < .05$. All analyses were conducted using IBM SPSS Statistics (Version 31).

Results

The Mann–Whitney *U* test results revealed statistically significant differences between the EG ($n=17$) and CG ($n=13$) in post-intervention measures, favoring the EG participants. Specifically, significant differences were found in WOTA 1 ($U = .00, p = .001$), A-SEAS aquatic skills ($U = 9.00, p = .001$), A-SEAS Emotional Adjustment ($U = .50, p = .001$), HAAR ($U = .00, p = .001$). No statistically significant differences were observed between the two groups across all pre-intervention measurements (Table I).

Table I. Mann-Whitney results.

Factors	Group	Mean Rank	Mann-Whitney U	Asymp. Sig
WOTA-1 pre	EG	16.18	99.000	.629
	CG	14.62		
WOTA-1 post	EG	22	0	.001
	CG	7		
ASEAS aquatic skills pre	EG	15.94	103.000	.751
	CG	14.92		
ASEAS aquatic skills post	EG	21.47	9.000	.001
	CG	7.69		
ASEAS Emotional Adjustment pre	EG	14.74	97.500	.583
	CG	16.50		
ASEAS Emotional Adjustment post	EG	21.97	.500	.001
	CG	7.04		
HAAR pre	EG	15.94	103.000	.751
	CG	14.92		
HAAR post	EG	22	0	.001
	CG	7		

On the total sample of all participants with ID and ASD, non-parametric Wilcoxon signed-rank analysis demonstrated statistically significant improvements between pre- and post- measurements across all subscales (WOTA 1, A-SEAS aquatic skills, A-SEAS Emotional Adjustment, HAAR) exclusively for the EG (Table II).

Table II. Wilcoxon pre and post results.

Factors	Group	N	Measures	Median	IQR	Z	p
WOTA1	EG	17	pre	28	8	-3.627	.001
			post	47	6.5		
	CG	13	pre	26	9.5	-1.342	.180
			post	26	10		
ASEAS aquatic skills	EG	17	pre	17	19	-3.625	.001
			post	45	10		
	CG	13	pre	17	18	0	1
			post	17	18		
ASEAS Emotional Adjustment	EG	17	pre	26	7.5	-3.626	.001
			post	37	5		
	CG	13	pre	27	7.5	0	1
			post	27	7.5		
HAAR	EG	17	pre	29.5	10.75	-3.622	.001
			post	77.4	13.95		
	CG	13	pre	27	8.25	0	1
			post	27	8.25		

A Spearman's rank-order correlation was conducted to examine the relationships among WOTA-1, A-SEAS Aquatic Skills, and HAAR scores at pre-test in 30 participants ($n=30$). Results indicated strong, positive, and statistically significant correlations among the assessed variables. Specifically, WOTA-1 scores showed a strong positive correlation with A-SEAS scores ($r_s = .907, p < .01$), while strong positive correlations were also observed between WOTA-1 and HAAR scores ($r_s = .883, p < .01$) and between A-SEAS and HAAR scores ($r_s = .878, p < .01$) (Table III).

Table III. Spearman's rank correlations among WOTA, A-SEAS, and HAAR at pre-test.

	WOTA1	A-SEAS	HAAR
WOTA1	-	.907**	.883**
A-SEAS	.907**	-	.878**
HAAR	.883**	.878**	-

Note. $N = 30$. Spearman's rho coefficients are reported. ** $p < .01$ (two-tailed).

A Spearman's rank-order correlation was conducted to examine the relationships among WOTA-1, A-SEAS Aquatic Skills, and HAAR scores at post-test in 30 participants ($n=30$). Results indicated strong, positive, and statistically significant correlations among the assessed variables. Specifically, WOTA-1 scores showed a strong positive correlation with A-SEAS scores ($r_s = .948, p < .01$), while strong positive correlations were also observed between WOTA-1 and HAAR scores ($r_s = .942, p < .01$) and between A-SEAS and HAAR scores ($r_s = .929, p < .01$) (Table IV).

Table IV. Spearman's rank correlations among WOTA, A-SEAS, and HAAR at post-test.

	WOTA1	A-SEAS	HAAR
WOTA1	-	.948**	.942
A-SEAS	.948**	-	.929
HAAR	.942	.929	-

Note. $N = 30$. Spearman's rho coefficients are reported. ** $p < .01$ (two-tailed).

Discussion

The purpose of this study was to compare the WOTA 1, HAAR, and A-SEAS assessment tools, evaluate their ability to measure aquatic competence following an adapted swimming program and analyze their relationships in children with ASD and ID. Overall, the findings demonstrated the high sensitivity of all three assessment instruments in detecting and tracking changes of aquatic competence as well as the significant positive correlations among the WOTA 1, HAAR, and A-SEAS scores. These findings suggest that while the three instruments capture a common underlying dimension of aquatic competence, they simultaneously provide complementary information based on their different conceptual and assessment frameworks. In broader terms, the results support the view that aquatic competence in children with ASD and ID should not be understood exclusively as the acquisition of swimming skills, but rather as a multidimensional construct involving functional performance, motor adaptation, emotional adjustment and participation in aquatic settings.

The WOTA 1, HAAR, and A-SEAS effectively documented the improvements generated by the adapted aquatic intervention, demonstrating their capacity to measure diverse aspects of aquatic competence. These findings are consistent with previous research showing that adapted swimming programs not only improve aquatic skills, balance, and motor control in children with developmental disabilities (Ennis, 2011; Güeita-Rodríguez et al., 2021; Tsolaki et al., 2023; Tsolaki & Kokaridas, 2026; Vodakova et al., 2022), but also offer broader physical, social, and psychological benefits for individuals with ASD and ID (Alecú & Onea, 2025; Ansari et al., 2021; Tsolaki et al., 2023). Consequently, the significant post-intervention differences demonstrate the high sensitivity of all three assessment instruments in detecting and measuring targeted aquatic skills and behavioral changes.

Within this context, the WOTA 1 findings provide an important starting point for its applicability across different populations and its responsiveness in interpreting changes in aquatic competence of children with disabilities (Huguet-Rodríguez et al., 2020; Ogonowska-Słodownik et al., 2025). Previous studies have reported significant improvements in swimming skills following intervention programs, supporting the current findings (Ennis, 2011; Güeita-Rodríguez et al., 2021; Tsolaki & Kokaridas, 2026; Vodakova et al., 2022). Therefore, the findings further support the role of WOTA 1 as a practical instrument for monitoring functional progress in adapted aquatic interventions.

When considering these findings, it is helpful to note WOTA's conceptual framework. While the instrument can accommodate individuals with limited functional and cognitive abilities (Tirosh et al., 2008), it views cognitive difficulties broadly and therefore does not necessarily reflect the specific cognitive, behavioral, sensory, and emotional characteristics associated with ASD and ID (Kokaridas et al., 2025). Furthermore, its focus on functional aquatic performance offers limited insight into a child's real-time emotional adjustment in individual tasks. Because a child might improve technically while still facing anxiety, sensory discomfort, or emotional regulation challenges (Tsolaki & Kokaridas, 2026), functional performance alone may not fully represent the child's overall adaptation to the swimming environment.

The HAAR provides a complementary perspective by focusing specifically on aquatic readiness and motor adaptation. Previous research has demonstrated that HAAR can effectively capture progression in aquatic readiness, particularly in areas such as rotational control, balance, and independent movement in children with ASD (Chu & Pan, 2012; Pan, 2010, 2011). Similar improvements in HAAR scores have been reported by Caputo et al. (2018) and Zanobini and Solari (2019), while Tsolaki et al. (2023) highlighted the usefulness of HAAR for documenting readiness and motor progression during aquatic interventions. The present findings therefore reinforce the role of HAAR in identifying changes in the foundational swimming skills that enable children to adapt progressively to the aquatic environment.

The distinction between WOTA 1 and HAAR is particularly relevant when considering the developmental process of aquatic competence. Whereas WOTA 1 offers insights into functional aquatic performance and adaptation, HAAR emphasizes the readiness and motor prerequisites that allow a child to perform aquatic movements effectively. In this sense, HAAR captures the underlying motor progression that supports functional aquatic performance. Nevertheless, neither instrument was specifically designed to provide a detailed assessment of the child's emotional response during each aquatic task.

This is particularly important in children with ASD and ID, for whom motor performance may be influenced by sensory processing differences, behavioral characteristics and difficulties with emotional regulation. Emerging research suggests that gross motor development and emotional regulation may follow interconnected developmental pathways that are mediated, at least in part, by executive functions (Li et al., 2022). Within aquatic settings, this relationship may be especially relevant because successful participation requires children to simultaneously process sensory information, regulate emotional responses, understand task demands and execute motor actions.

Recent intervention evidence supports this broader perspective. Tsolaki et al. (2026) reported that an adapted swimming program incorporating visual prompts was associated with improvements in executive functioning, visual processing, and motor efficiency in children with ASD and ID. Similarly, Tsolaki and Kokaridas (2026) provided evidence that aquatic skill development and emotional regulation may represent interconnected rather than isolated dimensions of development. Their work also established the high reliability of the A-SEAS and its strong associations with the WOTA 1, highlighting its value in providing critical information regarding a child's emotional adjustment and active participation. These findings are consistent with the argument that evaluating aquatic competence exclusively through physical performance may overlook behavioral and emotional factors that influence children's ability to acquire and demonstrate swimming skills (Fernandes et al., 2024; Odeh et al., 2022). Therefore, A-SEAS complements existing assessment approaches by contributing a broader understanding of aquatic competence in children with ASD and ID.

In this regard, the significant improvement observed in the A-SEAS scores is particularly meaningful. A-SEAS was developed to address the need for a more comprehensive assessment of aquatic competence by incorporating emotional adjustment alongside fundamental swimming skills (Kokaridas et al., 2025). Recent evidence has demonstrated high reliability of the A-SEAS and strong associations with WOTA 1 in children with ASD and ID (Tsolaki & Kokaridas, 2026). Hence, unlike assessments that primarily focus on aquatic skill acquisition and motor progression, A-SEAS provides additional information concerning emotional adjustment and participation during swimming activities. The present findings therefore extend previous evidence by demonstrating that changes in emotional aspects of aquatic experience can occur concurrently with improvements in functional and motor aquatic competence.

The strongest evidence aligning with this multidimensional interpretation comes from the significant positive correlations observed among WOTA 1, HAAR, and A-SEAS at both pre- and post-intervention assessments. These associations indicate that, despite their conceptual differences, the three instruments assess related aspects of a common underlying construct. This finding is particularly important because it provides direct evidence from the same population and intervention context that swimming performance, aquatic readiness and emotional regulation are meaningfully related. The stronger correlations observed after the intervention may further indicate that improvements in aquatic competence were reflected more consistently across the different assessment perspectives following participation in the adapted swimming program.

The strong positive correlations suggest that, although the three instruments capture related dimensions of aquatic competence, each contributes unique information. WOTA 1 primarily reflects functional aquatic performance and mental adjustment, whereas HAAR emphasizes aquatic readiness and motor progression. Additionally, A-SEAS incorporates emotional adjustment as an essential component of aquatic participation, providing additional insight into the affective dimensions of aquatic competence in children with ASD and ID.

However, these strong correlations should not be interpreted as the three instruments being overlapping or interchangeable. Rather, their conceptual differences suggest that they capture different manifestations of a shared construct. These dimensions are closely related but are not identical. WOTA 1 primarily reflects functional aquatic performance, water orientation, postural control and independence, whereas HAAR emphasizes aquatic readiness and motor progression, including rotational control and balance and A-SEAS adds the dimension of emotional adjustment and regulation of the child with ASD and ID while performing swimming tasks. Consequently, the high correlation among the three measures provides evidence of concurrent validity in the assessment of aquatic competence while their different perspectives support their complementary use, thereby providing a more comprehensive representation of individual progress.

Overall, the present findings across WOTA 1, HAAR, and A-SEAS demonstrate that adapted swimming interventions can influence functional, motor, and emotional dimensions of aquatic participation, representing a closely associated multidimensional construct. Nevertheless, certain limitations including a small sample size and a short intervention period, warrant a careful interpretation of the current results. Thus, future studies should use larger samples alongside extended intervention periods and follow-ups.

Conclusions

In conclusion, the findings of this study confirm that while the WOTA 1, HAAR, and A-SEAS share a common core in evaluating aquatic progress, they capture distinct and complementary aspects of a child's improvement. Specifically, the WOTA 1 provides a reliable measure of functional aquatic performance, the HAAR effectively maps the underlying aquatic readiness, and the A-SEAS addresses the critical gap of emotional adjustment and real-time regulation during swimming tasks. Together, the concurrent positive changes across all three instruments validate the overall effectiveness of the adapted aquatic program and its capacity to simultaneously enhance physical, motor, and psychological domains.

More broadly, this study reinforces the argument that aquatic competence in children with developmental disabilities should not be viewed solely through swimming skill acquisition. Rather, adaptation to the pool environment requires a child with ASD and ID to successfully manage sensory processing, regulate emotions, understand task demands and execute motor actions. Consequently, evaluating aquatic progress requires a comprehensive and holistic representation of individual advancement, ensuring that adapted swimming interventions are both physically effective and emotionally supportive.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors didn't use of AI in the writing of the article.

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Conflicts of interest The authors declare no conflict of interest.

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