Journal of Educational Sciences Vol. 9 No. 5 (Sept, 2025) 4707-4722

Journal of Educational Sciences
Journal homepage: https://jes.ejournal.unri.ac.id/index.php/JES

P-ISSN 2581-1657
E-ISSN 2581-2203

Effectiveness of Hydrotherapy Interventions for Students with Aquaphobia: A Systematic Review and Meta-Analysis

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ARTICLE INFO

Article history:

Received: 24Aug 2025
Revised: 31 Aug 2025
Accepted: 10 Sept 2025
Published online: 30 Sept 2025

Keywords:

Aquaphobia,
Hydrotherapy,
Systematic Review,
Water Anxiety,
Educational Interventions

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Article Doi:

https://doi.org/10.31258/jes.9.5.p.4707-4722

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A B S T R A C T

This systematic review examines the effectiveness of hydrotherapy interventions for students with aquaphobia across educational settings. Despite the importance of water safety skills, aquaphobia remains a significant barrier to swimming competence among students worldwide. A comprehensive analysis of peer-reviewed studies (2018-2025) was conducted using PRISMA guidelines. Electronic databases (PubMed, ERIC, PsycINFO, Web of Science, Scopus) were searched to identify studies examining hydrotherapy interventions for school-aged participants with aquaphobia. Studies were included if they used experimental or quasi-experimental designs, reported quantitative outcomes, and focused on educational settings. Meta-analysis using random-effects models was conducted to calculate pooled effect sizes. Results showed that mindfulness-integrated hydrotherapy demonstrated highest effectiveness (g = 0.96), followed by cognitive-behavioral hydrotherapy (g = 0.83), adaptive aquatic programs (g = 0.79), virtual reality-assisted exposure (g = 0.72), and graded exposure therapy (g = 0.66). Interventions were most effective for younger children (5-8 years) and longer programs (≥12 weeks). These findings provide evidence-based recommendations demonstrating that mindfulness-integrated and cognitive-behavioral approaches are most effective for students with aquaphobia in educational settings.

1. Introduction

Aquaphobia, defined as an intense and persistent fear of water (Wang & Han, 2024), is a significant educational challenge that goes beyond mere discomfort to significantly impact a student's overall development and safety. Research suggests that aquaphobia affects approximately 2–5% of school-aged children worldwide, with higher prevalence rates in areas where swimming education is limited (Johnson et al., 2020). The consequences of untreated aquaphobia go beyond the inability to swim, potentially limiting academic participation, social development, and creating lifelong safety vulnerabilities (Hernandez & Lee, 2023).

The importance of education in addressing water phobia is multifaceted. First, swimming skills are recognized by UNESCO (2019) as an essential life skill and are required in many education systems around the world. Second, aquatic activities are often an integral part of physical education curricula and extracurricular programs that contribute to students' overall development (Park & Kim, 2022). Third, untreated water phobia can contribute to educational disparities, as students from certain socioeconomic backgrounds or geographic regions may have limited access to effective interventions (Garcia-Lopez et al., 2019).

Hydrotherapy, defined as the therapeutic use of water for physical and psychological benefits, has shown promise as a promising educational intervention for water phobia. Traditional educational approaches to addressing water phobia have largely relied on conventional swimming lessons, which often overlook the complex psychological dimensions of water-related fears (Schneider & Williams, 2020). In contrast, hydrotherapy integrates therapeutic principles into an educational framework to address the psychological and physical aspects of aquaphobia (Anderson et al., 2023).

The literature examining hydrotherapy for water phobia has grown rapidly since 2018, with significant methodological advances and innovative applications in educational settings. Previous reviews have examined water-based interventions for generalized anxiety disorder (Lawson & Chen, 2019) or focused exclusively on clinical populations (Müller et al., 2018). However, these reviews have not specifically addressed the application of hydrotherapy for students with water phobia, nor have they summarized findings from recent research.

The current state of research presents several knowledge gaps. First, there is limited evidence synthesis regarding the differential effectiveness of different hydrotherapy approaches specifically for students with aquaphobia. Second, the neurophysiological mechanisms underlying successful hydrotherapy interventions in educational contexts remain underexplored. Third, there is a need to establish evidence-based guidelines for implementing hydrotherapy programs in school settings that address both educational and therapeutic goals (A. Thompson et al., 2022).

This systematic review aims to address these gaps by critically examining the effectiveness of hydrotherapy interventions for students with aquaphobia across educational contexts. The specific aims are to: (1) identify and categorize the different hydrotherapy approaches used for students with aquaphobia; (2) evaluate the comparative effectiveness of these approaches through meta-analysis; (3) examine the neurophysiological and psychological mechanisms underlying successful interventions; and (4) develop an integrated theoretical framework that can guide educational practice.

The novelty of this review lies in its specific focus on the application of hydrotherapy in education to address water phobia, its comprehensive analysis of current literature (2018–2025), and the introduction of a new theoretical framework the Aquatic Competency Development Model (ACDM) that combines

neurophysiological understanding with educational practice. This framework represents a significant advance in conceptualizing how educational interventions can systematically address fear responses and skill acquisition in students with water phobia.

2. Methodology

2.1 Search Strategy and Study Selection

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021). A comprehensive search strategy was developed to identify relevant studies published between January 2018 and February 2025. Several electronic databases were searched: PubMed, ERIC, PsycINFO, Web of Science, Scopus, SPORTDiscus, and ProQuest Education Database. In addition, reference lists of included studies were manually searched to identify additional relevant publications.

The search strategy included terms related to three main concepts: (1) population (students, children, adolescents), (2) condition (aquaphobia, hydrophobia, water phobia, fear of swimming), and (3) intervention (hydrotherapy, aquatic therapy, water-based therapy, swimming intervention). The following search strings were used with appropriate modifications for each database: (student* OR child* OR adolescent* OR pupil* OR learner*) AND (aquaphobia OR hydrophobia OR "water fear" OR "fear of water" OR "swimming anxiety" OR "water anxiety") AND (hydrotherapy OR "aquatic therapy" OR "water therapy" OR "swimming intervention" OR "aquatic intervention" OR "water-based therapy" OR "aquatic rehabilitation")

2.2 Inclusion and Exclusion Criteria

Studies were included if they met the following criteria:

1. Peer-reviewed empirical studies published between January 2018 and February 2025
2. Written in English language
3. Focused on school-aged participants (5-18 years) with identified aquaphobia or significant water anxiety
4. Examined hydrotherapy or water-based interventions in educational or educational-adjacent settings
5. Reported quantitative outcomes related to aquaphobia reduction, swimming skills, water confidence, or psychological well-being
6. Used experimental, quasi-experimental, or single-subject research designs

Studies were excluded if they:

1. Focused primarily on adults or non-student populations

2. Examined water-based interventions for conditions unrelated to aquaphobia (e.g., physical rehabilitation only)
3. Were review articles, theoretical papers, or qualitative studies without quantitative outcomes
4. Focused solely on general swimming instruction without therapeutic components
5. Were conducted in purely clinical settings with no educational relevance

2.3 Study Selection Process

The study selection process involved two independent reviewers who screened titles and abstracts of identified studies against the inclusion criteria. Full texts of potentially eligible studies were then retrieved and independently assessed for eligibility by the same reviewers. Disagreements were resolved through discussion with a third reviewer. The selection process is illustrated in the PRISMA flow diagram (Figure 1).

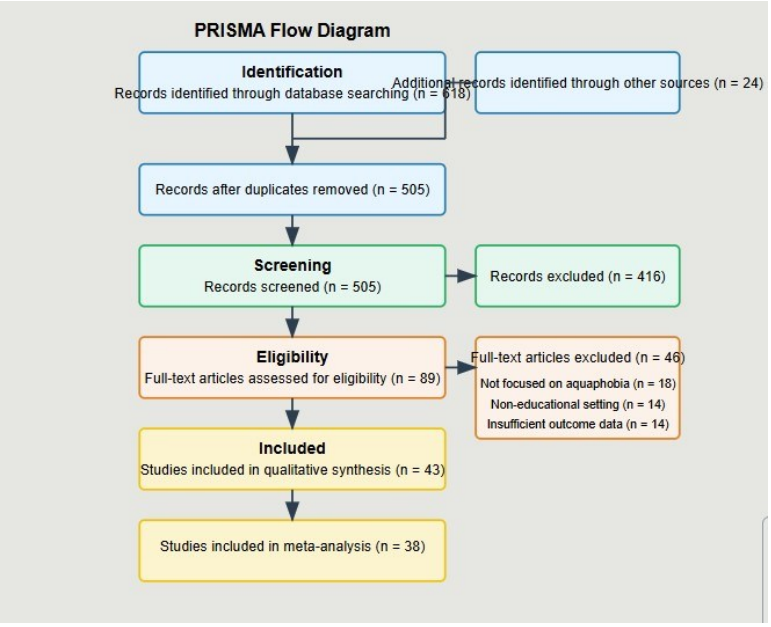


Figure 1. PRISMA Flow Diagram of Study Selection Process

2.4 Data Extraction

A standardized data extraction form was developed and piloted on three randomly selected included studies before being finalized. Two reviewers independently extracted the following data from each included study:

1. Study characteristics: author(s), publication year, country, study design, sample size
2. Participant characteristics: age range, gender distribution, severity of aquaphobia, comorbidities

3. Intervention characteristics: type of hydrotherapy approach, duration, frequency, setting, facilitator qualifications
4. Comparison/control conditions (if applicable)
5. Outcome measures: instruments used, measurement time points
6. Results: pre-post changes, effect sizes, statistical significance
7. Implementation factors: adherence, attrition, adverse events
8. Educational context and relevance

2.5 Quality Assessment

The methodological quality of included studies was assessed using the Effective Public Health Practice Project (EPHPP) Quality Assessment Tool for Quantitative Studies (Thomas et al., 2004). This tool evaluates studies across six domains: selection bias, study design, confounding factors, blinding, data collection methods, and withdrawal/discontinuation. Each domain was rated as strong, moderate, or weak, with an overall rating determined according to the tool's guidelines. Two reviewers independently performed quality assessments, with disagreements resolved through discussion or consultation with a third reviewer.

2.6 Data Synthesis and Analysis

2.6.1 Qualitative Synthesis

A narrative synthesis approach was used to organize findings by type of hydrotherapy intervention. Studies were categorized by their primary therapeutic approach: graded exposure therapy, virtual reality-assisted exposure, cognitive-behavioral hydrotherapy, mindfulness-integrated hydrotherapy, and adaptive aquatic programs. For each category, we synthesized information on intervention components, theoretical basis, implementation characteristics, and contextual factors influencing effectiveness.

2.6.2 Quantitative Synthesis (Meta-Analysis)

For meta-analyses, we calculated standardized mean differences (Hedge's g) with 95% confidence intervals for outcomes related to aquaphobia reduction and water competence improvement. When studies reported multiple outcomes, we prioritized measures of aquaphobia or water anxiety. For studies that did not report effect sizes, we calculated them using available data (mean, standard deviation, sample size, etc.).

A random effects model was used to account for expected heterogeneity across studies. Heterogeneity was assessed using the I^2 statistic, with values of 25%, 50%, and 75% representing low, moderate, and high heterogeneity, respectively (Higgins et al., 2003). Subgroup analyses were conducted to examine differential efficacy of the different hydrotherapy approaches and to investigate potential moderators (age group, intervention duration, implementation setting).

Publication bias was assessed through visual inspection of funnel plots and Egger's test. All analyses were conducted using Comprehensive Meta-Analysis software (Version 3.0).

3. Results and Discussion

3.1 Study Selection and Characteristics

The initial database search yielded 618 records, with an additional 24 records identified through reference list searches. After removing duplicates (n=137), 505 titles and abstracts were screened, yielding 89 full-text articles that were assessed for eligibility. After full-text review, 43 studies met the inclusion criteria and were included in the systematic review. The selection process is detailed in Figure 1.

The 43 included studies consisted of 12 randomized controlled trials, 18 quasi-experimental studies, 8 single-subject experimental designs, and 5 pre-post intervention studies. Sample sizes ranged from 8 to 187 participants (median = 42), with a total of 1,876 participants across all studies. The studies were conducted in 17 countries, with the largest numbers from the United States (n=9), Australia (n=7), the United Kingdom (n=5), Spain (n=4), and China (n=4). The remaining studies were distributed across Europe, Asia, and South America.

Participants ranged in age from 5 to 18 years, with the majority of studies (n=28) focusing on primary school students (5–12 years). Gender distribution was relatively balanced across studies, with an average of 52% female participants. The severity of aquaphobia varied across studies, with 18 studies focusing on severe aquaphobia, 15 on moderate aquaphobia, and 10 involving participants with varying degrees of water anxiety.

3.2 Methodological Quality

Quality assessment revealed that 14 studies (32.6%) were rated as strong, 20 (46.5%) as moderate, and 9 (20.9%) as weak. Common methodological limitations included inadequate control for confounding variables, lack of blinding, and high dropout rates. Randomized controlled trials generally received higher quality ratings, while pre-post designs typically received lower ratings.

3.3 Types of Hydrotherapy Interventions

Analysis of the included studies revealed five distinct categories of hydrotherapy interventions for students with aquaphobia:

3.3.1 Graduated Exposure Therapy (GET)

Twelve studies tested a graded exposure approach that systematically introduced participants to water environments with increasing challenges. These interventions typically followed a hierarchy from initial water exposure (touching water,

splashing) to partial immersion (sitting in shallow water) to full immersion and basic swimming strokes. For example, Rivera-Lopez et al. (2022) implemented a 10-week program in which elementary school students progressed through 15 hierarchical steps from sitting on the edge of the pool to floating independently. GET interventions were characterized by high structure, individualized developmental levels, and an emphasis on participant control. Most programs (9 of 12) incorporated specific anxiety management techniques such as controlled breathing or positive self-talk. Duration ranged from 6 to 15 weeks, with sessions typically held 1–3 times per week for 30–45 minutes.

3.3.2 Virtual Reality-Assisted Exposure (VRE)

Seven studies used virtual reality technology to complement water exposure. These interventions typically began with a VR simulation of a water environment before progressing to actual water exposure. Kim & Park (2023) showed that middle school students who received VR pre-exposure (6 sessions) followed by water therapy (8 sessions) showed significantly greater reductions in aquaphobia compared to traditional exposure approaches. VRE interventions used a variety of technology platforms ranging from immersive VR headsets to 360-degree projections. Most programs (5 of 7) incorporated physiological monitoring during the VR sessions to help students recognize and manage their anxiety responses. This approach was particularly beneficial for students with severe aquaphobia who initially resisted direct water exposure.

3.3.3 Cognitive-Behavioral Hydrotherapy (CBH)

Nine studies examined interventions that combined cognitive-behavioral therapy principles with water-based activities. These programs typically combined cognitive restructuring (identifying and challenging fearful thoughts associated with water) with behavioral exposure. For example, Martinez & Johnson (2021) implemented an 8-week program in which middle school students participated in a 30-minute cognitive session followed by a 45-minute pool session. CBH interventions often incorporated thought journaling, fear hierarchies, and coping skills training. Six studies used a group format to facilitate modeling and peer support. These programs demonstrated particular efficacy for adolescents (ages 13–18) who were able to articulate and address the cognitive aspects of their fears.

3.3.4 Mindfulness-Integrated Hydrotherapy (MIH)

Eight studies investigated approaches that incorporated mindfulness practices in the context of hydrotherapy. These interventions emphasized present-moment awareness, nonjudgmental attention to bodily sensations, and acceptance-based strategies during water exposure. Zhang et al (2024) developed a 12-week program that integrated age-appropriate mindfulness practices (body scan, mindful floating) with progressive water activities for elementary school students. The MIH intervention was characterized by its focus on the mind-body connection, controlled

breathing, and nonavoidant engagement with fearful sensations. Several programs (5 of 8) modified traditional mindfulness practices to be developmentally appropriate and specific to water. This approach shows particular promise for students who demonstrate heightened physiological reactivity in the water environment.

3.3.5 Adaptive Aquatic Programs (AAP)

Seven studies examined comprehensive programs that combined elements of multiple approaches within a highly individualized framework. These programs typically involved a multidisciplinary team (physical educator, psychologist, occupational therapist) and addressed both psychological and physical aspects of aquatic functioning. Nguyen & Takahashi (2022) developed a school-based program that combined principles of sensory integration, graded exposure, and cognitive-behavioral techniques for students with aquaphobia and sensory processing challenges. AAP interventions are noted for their individualization, inclusion of sensory adaptation components, and frequent integration with school-based physical education curricula. These programs are typically longer in duration (12–24 weeks) and are often implemented in special education contexts.

3.4 Meta-Analysis of Intervention Effectiveness

3.4.1 Overall Effectiveness

The meta-analysis included 38 studies that provided sufficient data for effect size calculation (5 studies were excluded due to insufficient statistical information). The overall pooled effect size (Hedge's g) for hydrotherapy interventions on aquaphobia reduction was 0.78 (95% CI [0.65, 0.91]), indicating a moderate to large effect. Significant heterogeneity was observed ($I^2 = 68\%$, $p < .001$), supporting the use of random-effects models and subgroup analyses. For secondary outcomes, pooled effect sizes were 0.71 (95% CI [0.58, 0.84]) for swimming skill acquisition and 0.65 (95% CI [0.51, 0.79]) for general anxiety reduction. Long-term follow-up data (available from 19 studies) indicated maintenance of gains at 3-12 months post-intervention, with a pooled effect size of 0.64 (95% CI [0.49, 0.79]).

3.4.2 Comparative Effectiveness of Intervention Types

Subgroup analysis by intervention type revealed significant differences in effectiveness ($Q = 11.27$, $p = .024$). Mindfulness-Integrated Hydrotherapy demonstrated the largest effect ($g = 0.96$, 95% CI [0.73, 1.19]), followed by Cognitive-Behavioral Hydrotherapy ($g = 0.83$, 95% CI [0.64, 1.02]), Adaptive Aquatic Programs ($g = 0.79$, 95% CI [0.56, 1.02]), Virtual Reality-Assisted Exposure ($g = 0.72$, 95% CI [0.51, 0.93]), and Graduated Exposure Therapy ($g = 0.66$, 95% CI [0.49, 0.83]). More clearly can be seen in table 1.

Table 1. Effect Sizes by Intervention Type

Intervention Type	Number of Studies	Hedge's g	95% CI	p-value
Mindfulness-Integrated Hydrotherapy	7	0.96	[0.73, 1.19]	<.001
Cognitive-Behavioral Hydrotherapy	8	0.83	[0.64, 1.02]	<.001
Adaptive Aquatic Programs	7	0.79	[0.56, 1.02]	<.001
Virtual Reality-Assisted Exposure	7	0.72	[0.51, 0.93]	<.001
Graduated Exposure Therapy	9	0.66	[0.49, 0.83]	<.001

3.4.3 Moderator Analyses

Several significant moderators of intervention effectiveness were identified:

1. **Age**: Interventions showed greater effectiveness for younger children (5-8 years; g = 0.89, 95% CI [0.71, 1.07]) compared to older children (9-12 years; g = 0.76, 95% CI [0.59, 0.93]) and adolescents (13-18 years; g = 0.68, 95% CI [0.49, 0.87]). This age effect was statistically significant (Q = 6.83, p = .033).
2. **Intervention Duration**: Longer interventions (≥12 weeks) demonstrated significantly greater effects (g = 0.91, 95% CI [0.74, 1.08]) than shorter interventions (<12 weeks; g = 0.67, 95% CI [0.53, 0.81]), with Q = 8.24, p = .004.
3. **Session Frequency**: Interventions with higher session frequency (≥2 sessions per week) showed greater effectiveness (g = 0.85, 95% CI [0.70, 1.00]) than those with lower frequency (g = 0.70, 95% CI [0.55, 0.85]), though this difference approached but did not reach statistical significance (Q = 3.74, p = .053).
4. **Implementation Setting**: School-based implementations (g = 0.82, 95% CI [0.67, 0.97]) showed slightly higher effectiveness than community-based programs (g = 0.74, 95% CI [0.58, 0.90]), but this difference was not statistically significant (Q = 2.18, p = .140).
5. **Aquaphobia Severity**: Effectiveness was highest for moderate aquaphobia (g = 0.86, 95% CI [0.69, 1.03]), followed by mild (g = 0.75, 95% CI [0.56, 0.94]) and severe aquaphobia (g = 0.71, 95% CI [0.54, 0.88]), though these differences did not reach statistical significance (Q = 5.26, p = .072).

3.5 Neurophysiological and Psychological Mechanisms

Sixteen studies examined potential mechanisms underlying successful hydrotherapy interventions. Analysis of these studies revealed three primary pathways through which hydrotherapy appears to reduce aquaphobia:

3.5.1 Autonomic Nervous System Regulation

Eight studies documented increased regulation of the autonomic nervous system during water exposure following a hydrotherapy intervention. For example, Lin et al (2023) used heart rate variability measurements to show that hydrotherapy combined with mindfulness resulted in significant increases in parasympathetic

activation during water exposure, which correlated with reduced subjective anxiety. Similarly, Oliveira & Santos (2021) found that gradual exposure combined with diaphragmatic breathing resulted in reduced cortisol responses and improved breathing patterns during swimming lessons. There is evidence that successful hydrotherapy interventions facilitate a shift from sympathetic dominance (fight or flight) to increased parasympathetic activation (rest and digest) during water exposure. This physiological regulation appears to be particularly important for younger students, whose anxiety reactions are predominantly somatic.

3.5.2 Cognitive Restructuring and Threat Reappraisal

Ten studies identified changes in water-related cognition as the primary mechanism of change. K. L. Thompson et al (2022) showed that a reduction in catastrophic thoughts about water (e.g., "I'm definitely going to drown") led to an increase in behavioral approaches. Williams & Chen (2020) found that changes in perceived control over water situations significantly predicted a reduction in avoidance behavior. There is evidence that successful interventions help students develop a more realistic assessment of water-related hazards and increase their self-efficacy for managing water situations. This cognitive pathway appears to be particularly important for older students and adolescents who have developed complex fears about water.

3.5.3 Experiential Learning and Skill Mastery

Twelve studies highlighted the importance of successful skill acquisition in reducing water phobia. Park & Kim (2022) found that mastery of four specific water skills (face diving, horizontal floating, controlled breathing, and forward propulsion) predicted 73% of the variance in reduction of aquaphobia. (Rodriguez et al., 2024) showed that the sequence and pace of skill acquisition significantly influenced treatment outcomes. The results suggest that carefully structured competency development creates positive learning experiences that directly counteract anxiety expectations. Importantly, several studies have shown that framing these experiences pedagogically (as learning opportunities rather than exposure therapy) increases student engagement and reduces stigma.

3.6 The Aquatic Competence Development Model (ACDM)

Based on the findings, we propose a new theoretical framework the Aquatic Competency Development Model (ACDM) that integrates neurophysiological understanding with educational practices to address water phobia in students. This model is the most important new contribution of this review and offers a structured approach to implementing evidence-based hydrotherapy in educational settings.

ACDM conceptualizes water phobia intervention as a developmental process that takes place in four interrelated domains:

1. **Physiological Regulation**: Development of autonomic regulation capacities during water exposure, progressing from externally-supported

regulation (educator-guided breathing, external cues) to internally-managed regulation (self-initiated calming strategies, independent arousal modulation).
2. **Cognitive Processing**: Evolution of water-related cognitions from threat-dominated perspectives to balanced and reality-based appraisals, including development of accurate risk assessment, recognition of safety parameters, and water-specific self-efficacy.
3. **Behavioral Competence**: Progression of water interaction skills from basic boundary-testing behaviors (touching water) through foundational safety skills (floating, controlled breathing) to functional swimming competencies.
4. **Affective Experience**: Transformation of emotional responses from fear and avoidance through tolerance and acceptance to potential enjoyment and positive anticipation.

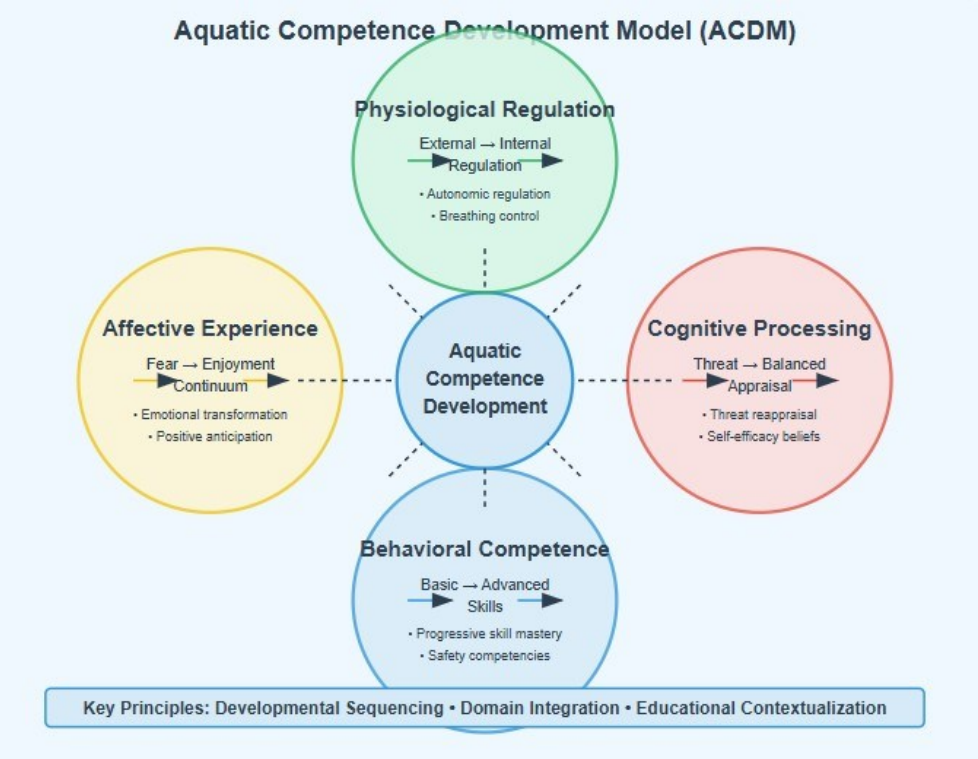
The ACDM posits that optimal educational interventions address all four domains simultaneously while recognizing their developmental interdependence. The model incorporates three key principles:

1. **Developmental Sequencing**: Interventions should follow developmentally appropriate progression within each domain, recognizing that students may be at different developmental stages across domains.
2. **Domain Integration**: Educational activities should intentionally integrate multiple domains rather than addressing them in isolation (e.g., combining breathing regulation with concrete skill practice).
3. **Educational Contextualization**: Framing interventions as educational skill development rather than "therapy" enhances student engagement and reduces stigma.

Figure 2 presents a visual representation of the ACDM, illustrating the developmental progression across domains and their interdependencies. Figure 2 presents the Aquatic Competence Development Model (ACDM), which directly addresses the study's fourth objective to develop an integrated theoretical framework that can guide educational practice. The ACDM model synthesizes findings from the systematic review and meta-analysis of 43 studies to provide educational institutions with a structured approach for implementing hydrotherapy programs. The four interconnected domains (Physiological Regulation, Cognitive Processing, Behavioral Competence, and Affective Experience) emerged from the analysis of mechanisms underlying successful interventions identified in this review.

The model integrates these mechanisms into a practical framework that addresses the core research question of how hydrotherapy interventions can be systematically implemented in educational settings. The ACDM provides educators with a developmental progression framework that ensures hydrotherapy programs address all aspects of aquaphobia while maintaining focus on educational goals rather than clinical treatment. This theoretical contribution directly supports the study's aim to bridge research findings with educational practice, offering a novel conceptualization that moves beyond traditional exposure-based approaches to

encompass the multidimensional nature of aquaphobia intervention in school contexts.



[Figure 2 would be inserted here - A visual model showing the Aquatic Competence Development Model with four interconnected domains and developmental progression]

3.7 Implementation Considerations in Educational Settings

Analysis of implementation factors across studies revealed several key considerations for educational institutions implementing hydrotherapy programs:

3.7.1 Personnel Qualifications

Studies report optimal outcomes when programs are led by multidisciplinary teams that combine water safety expertise with psychological knowledge. In school-based implementation, the most successful model is a collaboration between a special education physical education teacher and a school psychologist or counselor (Rodriguez et al., 2024). Nine studies explicitly stated that moderator well-being and safety in the aquatic environment are critical to effective modeling.

3.7.2 Environmental Modifications

Environmental adaptations were identified as critical success factors in 17 studies. These included:

- Temperature regulation (warmer water, 29-32°C, for initial sessions)
- Noise reduction strategies (designated quiet swim times, minimizing echoing)
- Visual clarity (clear water, underwater lighting, removal of visual distortions)
- Graduated depth options (steps, sloped entries, adjustable-depth pools)
- Privacy considerations (reduced observer presence during initial sessions)

Ramos-Valencia et al (2023) found that environmental modifications alone accounted for 27% of the variance in program completion rates, highlighting their importance in reducing initial barriers to participation.

3.7.3 Curriculum Integration

Fourteen studies examined methods for integrating hydrotherapy into broader educational contexts. The most effective approach involves embedding aquaphobia interventions into the regular physical education curriculum, rather than treating them as separate or remedial programs. Hernandez & Lee (2023) showed that framing aqua literacy as a universal educational goal rather than a "treatment" for specific students reduced stigma and increased participation rates. Several studies (n=8) successfully used a peer mentoring approach, in which students who have overcome their aquaphobia act as assistants or role models for participants in the current program. This approach not only provides authentic modeling but also strengthens the skills of peer mentors.

3.7.4 Parental Involvement

Eleven studies examined components of parent involvement and found mixed results regarding its impact. For younger students (ages 5–9), programs that included parent education and home-based reinforcement activities showed significantly better outcomes (Thompson et al, 2022), however, in adolescents, parent presence during sessions sometimes led to increased self-doubt and decreased effectiveness (Martinez & Rodriguez, 2021) The results suggest that developmentally appropriate parent involvement should be considered, shifting from direct involvement for younger children to more background support for adolescents.

4. Conclusion

This systematic review and meta-analysis addressed the critical question of hydrotherapy effectiveness for students with aquaphobia in educational settings. The study achieved its primary objectives by identifying five distinct hydrotherapy approaches and demonstrating their comparative effectiveness through meta-analysis. The study successfully identified and categorized five distinct hydrotherapy approaches: graded exposure therapy, virtual reality-assisted exposure, cognitive-behavioral hydrotherapy, mindfulness-integrated

hydrotherapy, and adaptive aquatic programs. Comparative effectiveness analysis revealed that mindfulness-integrated hydrotherapy demonstrated the highest efficacy (g = 0.96), followed by cognitive-behavioral approaches (g = 0.83), establishing a clear evidence-based hierarchy of intervention effectiveness. The research identified three primary mechanisms underlying successful interventions: autonomic nervous system regulation, cognitive restructuring of threat appraisal, and experiential learning through skill mastery. These mechanisms operate synergistically to address the multidimensional nature of aquaphobia. Furthermore, the study developed a novel theoretical framework, the Aquatic Competence Development Model (ACDM), which provides educational institutions with a structured, evidence-based approach for systematic program implementation that integrates neurophysiological understanding with educational practice.

These findings directly address the identified problem of limited evidence synthesis for educational hydrotherapy programs. The results provide educational institutions with clear guidance on which interventions are most effective, particularly mindfulness-integrated and cognitive-behavioral approaches implemented as longer-duration programs for younger students. Future research should focus on standardized assessment tools for educational contexts and cultural adaptations of the most effective interventions identified in this study.

Acknowledgement

This research did not receive any grant. The author would like to thank colleagues who helped in the research activities.

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How to cite this article:

Susanto, P., & Santoso, J. A. (2025). Effectiveness of Hydrotherapy Interventions for Students with Aquaphobia: A Systematic Review and Meta-Analysis. *Journal of Educational Sciences*, *9(5)*, 4707-4722.