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Swimming Education and Water Safety in Schools: A Systematic Literature Review

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ABSTRACT

Purpose of the study: This systematic literature review aims to synthesize global evidence on swimming education and water safety programs implemented within school settings, with particular emphasis on identifying effective pedagogical approaches, intervention frameworks, program characteristics, contextual facilitators, and persistent barriers that influence student swimming competency and drowning prevention outcomes.

Materials and methods: A systematic literature review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines. Five major academic databases were searched: Scopus, Web of Science, ERIC, PubMed, and ScienceDirect. Search strategies employed Boolean operators combining terms related to swimming instruction, aquatic education, water safety, drowning prevention, and school-based interventions. The review encompassed peer-reviewed journal articles published between 2019 and 2026, written in English. A total of 1,247 records were initially identified; following removal of duplicates, title and abstract screening, and full-text eligibility assessment, 52 studies met the inclusion criteria. Study quality was evaluated using the Critical Appraisal Skills Programme (CASP) and the Mixed Methods Appraisal Tool (MMAT). Thematic synthesis and narrative analysis were applied to extract and integrate key findings.

Results: Five major thematic clusters emerged from the review: (1) structured aquatic curriculum models and their effectiveness across age groups; (2) instructional strategies and differentiated teaching in school-based swimming programs; (3) the role of water safety education in drowning prevention; (4) barriers to participation including socioeconomic disparities, cultural attitudes, facility access, and fear; and (5) the integration of technology and innovative pedagogies in aquatic education. Findings indicate that well-structured, age-appropriate, and culturally responsive swimming programs significantly improve fundamental aquatic skills and water safety knowledge among school-aged children. Nevertheless, critical inequities in program access persist globally.

Conclusions: Swimming education and water safety represent an urgent public health imperative and an underinvested component of school physical education curricula globally. This review underscores the need for equitable, evidence-based aquatic education policies, adequately trained instructors, accessible facilities, and culturally sensitive program delivery. Future research should prioritize longitudinal effectiveness studies, equity-focused interventions, and the development of internationally standardized competency frameworks.

Keywords
swimming education; water safety; drowning prevention; school-based aquatic programs; physical education; aquatic literacy; swimming competency.

INTRODUCTION

Contextual Framework of the Research

Drowning constitutes one of the most preventable causes of unintentional injury-related mortality worldwide, with the World Health Organization (WHO) estimating that over 236,000 individuals perish annually as a result of unintentional drowning, with the burden disproportionately falling upon low- and middle-income countries (Organization, 2021). Children aged one to fourteen years represent the most vulnerable demographic, with drowning ranking among the leading three causes of unintentional injury-related death across nearly all age groups globally (Hyder et al., 2020; Peden et al., 2021). In this context, the acquisition of fundamental swimming competencies and comprehensive water safety knowledge within structured educational environments emerges not merely as a matter of recreational enrichment but as an urgent public health imperative.

School-based swimming education has historically occupied a contested and fragmented position within physical education curricula internationally. While countries such as Australia, Sweden, Germany, and Japan have institutionalized mandatory swimming competency standards as integrated components of their national physical education frameworks (Moran et al., 2022; Stallman et al., 2021), the majority of nations—particularly in South and Southeast Asia, Sub-Saharan Africa, and Latin America—exhibit pronounced deficits in formal aquatic education provision (Benjamin et al., 2020; Franklin et al., 2020). This asymmetry reflects broader structural inequalities in educational resource allocation, infrastructure, trained instructor availability, and sociocultural attitudes toward swimming participation.

The conceptual foundations of swimming education extend beyond the acquisition of locomotor aquatic skills. Contemporary aquatic literacy frameworks emphasize a multidimensional set of competencies encompassing survival swimming, personal rescue, self-rescue, basic water safety knowledge, understanding of aquatic environments, and the capacity to assist others in distress (Langendorfer, 2020; Stallman et al., 2021). This holistic conception of aquatic literacy has increasingly informed

curriculum design in progressive national systems, moving the pedagogical discourse beyond mere stroke proficiency toward a competency-based, safety-oriented, and developmentally appropriate model of instruction.

Concurrently, the global physical education landscape has undergone substantive transformation in response to digital innovation, evidence-based pedagogy, and shifting conceptions of health literacy. The integration of technology-enhanced instructional tools—including underwater video analysis, virtual reality simulation, digital performance feedback systems, and mobile learning applications—has begun to reshape the pedagogical repertoire available to aquatic educators (Ali et al., 2022; Komar et al., 2021). Post-pandemic educational disruptions have further accelerated interest in hybrid and technology-mediated approaches to physical education delivery, including swimming instruction, raising novel questions about the efficacy, accessibility, and equity implications of such approaches (Naul et al., 2021).

Within this evolving landscape, the school setting assumes particular strategic significance. Schools represent the single most universal institutional interface between children and structured education across all socioeconomic strata, making them uniquely positioned to address equity gaps in aquatic competency development (Peden et al., 2021; Rissel et al., 2020). Embedding swimming education within mandatory schooling frameworks offers the potential to reach children who may otherwise lack access to private swimming lessons, community aquatic programs, or family-facilitated aquatic socialization—particularly those from low-income, minority, immigrant, or rural backgrounds.

Critical Examination of Existing Literature

Prior scholarship on school-based swimming education has yielded important but incomplete insights into the conditions under which aquatic programs effectively enhance children's swimming competency and water safety literacy. Early systematic reviews and meta-analyses—notably those conducted by (Brenner et al., 2009) and (Quan et al., 2015, p. 7) —established foundational evidence for the inverse relationship between formal swimming instruction participation and drowning risk, demonstrating reductions in drowning risk ranging from 88% for children aged one to four years with formal swimming lessons. However, these earlier reviews drew substantially on studies from high-income, English-speaking contexts and did not sufficiently address program-level variables, instructional quality, curriculum coherence, or the specific school-based implementation features that moderate intervention effectiveness.

More recent empirical work has begun to interrogate the specific pedagogical mechanisms underlying effective aquatic education. Research by (Marques et al., 2020) and (Duijn et al., 2021, p. 733503) contributed a refined developmental-biomechanical perspective on aquatic readiness, arguing that effective swimming instruction must be grounded in an understanding of individual variations in aquatic readiness, motor development trajectories, and buoyancy-related characteristics. Similarly, work by Langendorfer et al. (2018, p. 3) and Christie & Elliott (2024) advanced the concept of 'aquatic survival competence' as a more pragmatic and ecologically valid outcome measure for school programs than traditional competitive stroke proficiency metrics, arguing that the latter systematically disadvantages children from low-income backgrounds and those with diverse body morphologies.

Studies examining instructional approaches have highlighted the relative superiority of aquatic-readiness-based, problem-solving, and student-centered pedagogical models over traditional direct instruction and drill-based approaches in generating durable aquatic skill acquisition and positive attitudinal outcomes (Kjendlie et al., 2020; Moran et al., 2022). A growing body of literature from Northern European contexts—particularly Sweden and Norway—has contributed nuanced analyses of teacher competence, student-to-instructor ratios, lesson structure, and assessment validity in school swimming programs (Bjorke & Moen, 2019; Stallman et al., 2020). Meanwhile, research from Australia—where National Swimming and Water Safety standards have been operationalized through the Royal Life Saving Society and AUSTSWIM frameworks—has provided insights into the organizational, institutional, and policy-level factors that facilitate or impede program implementation at scale (Franklin et al., 2020; Rissel et al., 2020).

Research on water safety education as distinct from swimming instruction has drawn attention to the critical but often neglected dimension of cognitive and attitudinal learning in aquatic programs. Studies by (Coons et al., 2023) and (Button et al., 2020, p. 5) demonstrated that water safety education interventions—encompassing knowledge of environmental hazards, behavioral self-regulation near water, recognition of drowning scenarios, and basic rescue techniques—produced significant improvements in children's safety-related knowledge and risk perception when delivered as integrated components of school aquatic curricula. However, evidence for sustained behavioral change beyond immediate post-intervention assessment periods remains limited.

A further strand of relevant literature addresses barriers to swimming participation and aquatic education access, with particular attention to racial, ethnic, socioeconomic, gender, and geographic disparities. Research in the United States context has extensively documented lower swimming competency rates among African American, Hispanic, and Indigenous children relative to White peers, attributing these disparities to historical exclusion from public pool facilities, lower household incomes, culturally negative attitudes toward swimming, hair care concerns, and reduced access to formal instruction (Griffiths et al., 2020; Irwin et al., 2021). Similar patterns of racialized and socioeconomic disparity have been documented in Australian, British, and Canadian contexts (Blitvich et al., 2019; Ennis, 2020).

Identification of Research Gaps

Notwithstanding the substantive insights yielded by existing research, several critical gaps constrain the field's capacity to inform evidence-based policy and practice. First, no comprehensive systematic literature review has been conducted within the 2019–2026 timeframe that specifically synthesizes school-based swimming education research across diverse national, cultural, and socioeconomic contexts, leaving policymakers and curriculum designers without an up-to-date global evidence base. Second, the preponderance of existing reviews has focused on drowning incidence and epidemiological outcomes rather than on the pedagogical, curricular, and instructional dimensions of school swimming programs, creating a disconnect between public health

and educational research traditions. Third, the literature exhibits a pronounced geographic and linguistic concentration, with the majority of empirical studies originating from high-income, English-speaking nations, resulting in substantial underrepresentation of evidence from low- and middle-income contexts where the drowning burden is greatest. Fourth, existing reviews have not adequately integrated the growing body of evidence concerning technology-mediated aquatic instruction, digital water safety education tools, and the role of digital competency in contemporary aquatic pedagogy. Fifth, the evidence base on the long-term effects of school-based aquatic education on swimming competency retention, behavioral water safety practices, and drowning risk reduction remains notably thin, reflecting a broader limitation of short-term intervention designs in physical education research. Finally, the literature has not adequately addressed the intersection of disability inclusion, neurodevelopmental diversity, and school-based aquatic education, despite the well-documented therapeutic and developmental benefits of aquatic activity for children with physical, cognitive, and sensory disabilities, as well as the heightened drowning risk associated with certain neurodevelopmental conditions including autism spectrum disorder.

Rationale for the Research

Against this backdrop of urgent public health need, significant policy relevance, and demonstrable gaps in the systematic synthesis of available evidence, this systematic literature review is positioned as a timely and necessary contribution to the international literature on swimming education and water safety in schools. By synthesizing peer-reviewed evidence published between 2019 and 2026 from a broad range of national and cultural contexts, this review aims to provide curriculum designers, school physical education specialists, aquatic education policymakers, teacher educators, and public health practitioners with a rigorous, current, and globally informed evidence base. The review is furthermore motivated by the increasing policy emphasis on swimming competency within national physical education frameworks globally. Recent policy developments in Australia, the United Kingdom, the European Union, and Southeast Asia have placed renewed emphasis on the role of schools in delivering universal aquatic education, making a critical synthesis of the available evidence both timely and practically significant.

Research Objectives

The present systematic literature review is guided by the following research objectives: (1) To synthesize global peer-reviewed evidence on the design, delivery, and outcomes of school-based swimming education and water safety programs published between 2019 and 2026; (2) To identify and critically evaluate the dominant pedagogical approaches, instructional models, and curriculum frameworks employed in school-based aquatic education; (3) To examine evidence regarding the impact of school swimming programs on students' aquatic competency, water safety knowledge, drowning risk reduction, and attitudinal outcomes; (4) To analyze facilitators and barriers to the effective implementation of school-based aquatic education across diverse cultural, socioeconomic, and geographic contexts; (5) To assess the role of technological innovation and digitally mediated instruction in school-based swimming and water safety education; (6) To propose an agenda for future research and evidence-based policy recommendations in the field of school aquatic education.

METHODOLOGY

Study Design

This study employed a Systematic Literature Review (SLR) design to synthesize existing evidence regarding swimming education and water safety programs implemented in school settings. The review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines to ensure methodological transparency, rigor, and reproducibility (Page et al., 2021). The review aimed to identify, evaluate, and synthesize empirical studies examining the effectiveness, implementation, and educational outcomes of school-based swimming and water safety interventions among children and adolescents.

Data Sources and Search Strategy

A comprehensive literature search was conducted across three major international databases: Scopus, the Web of Science Core Collection, and PubMed/MEDLINE. The search was performed on 15 May 2026 and included studies published from January 2000 to May 2026. Search terms were developed based on key concepts related to swimming education, aquatic competence, water safety, drowning prevention, and school-based interventions.

Scopus Search String

TITLE-ABS-KEY (("swimming education" OR "swimming instruction" OR "aquatic education" OR "swimming lessons") AND ("water safety" OR "aquatic safety" OR "drowning prevention") AND ("school" OR "elementary school" OR "primary school" OR "secondary school"))

Web of Science Search String

TS=(("swimming education" OR "swimming instruction" OR "aquatic education") AND ("water safety" OR "drowning prevention") AND ("school*" OR "primary school*" OR "elementary school*" OR "secondary school*"))

PubMed Search String

(("swimming"[Title/Abstract] OR "aquatic education"[Title/Abstract]) AND ("water safety"[Title/Abstract] OR "drowning prevention"[Title/Abstract]) AND ("school"[Title/Abstract] OR "students"[Title/Abstract]))

Boolean operators (AND, OR), truncation symbols, and database-specific indexing terms were applied to maximize retrieval sensitivity and specificity.

Eligibility Criteria

Studies were selected according to predefined inclusion and exclusion criteria.

Inclusion Criteria

Studies were included if they were published in peer-reviewed journals and indexed in Scopus, Web of Science, or

PubMed. Additionally, eligible studies had to investigate topics related to swimming education, aquatic competence, water safety, or drowning prevention, with a specific focus on school-aged children and adolescents. The selection process further required the examination of school-based interventions, programs, curricula, or educational strategies. Finally, only empirical studies reported in English, utilizing quantitative, qualitative, or mixed-methods approaches, were included.

Exclusion Criteria

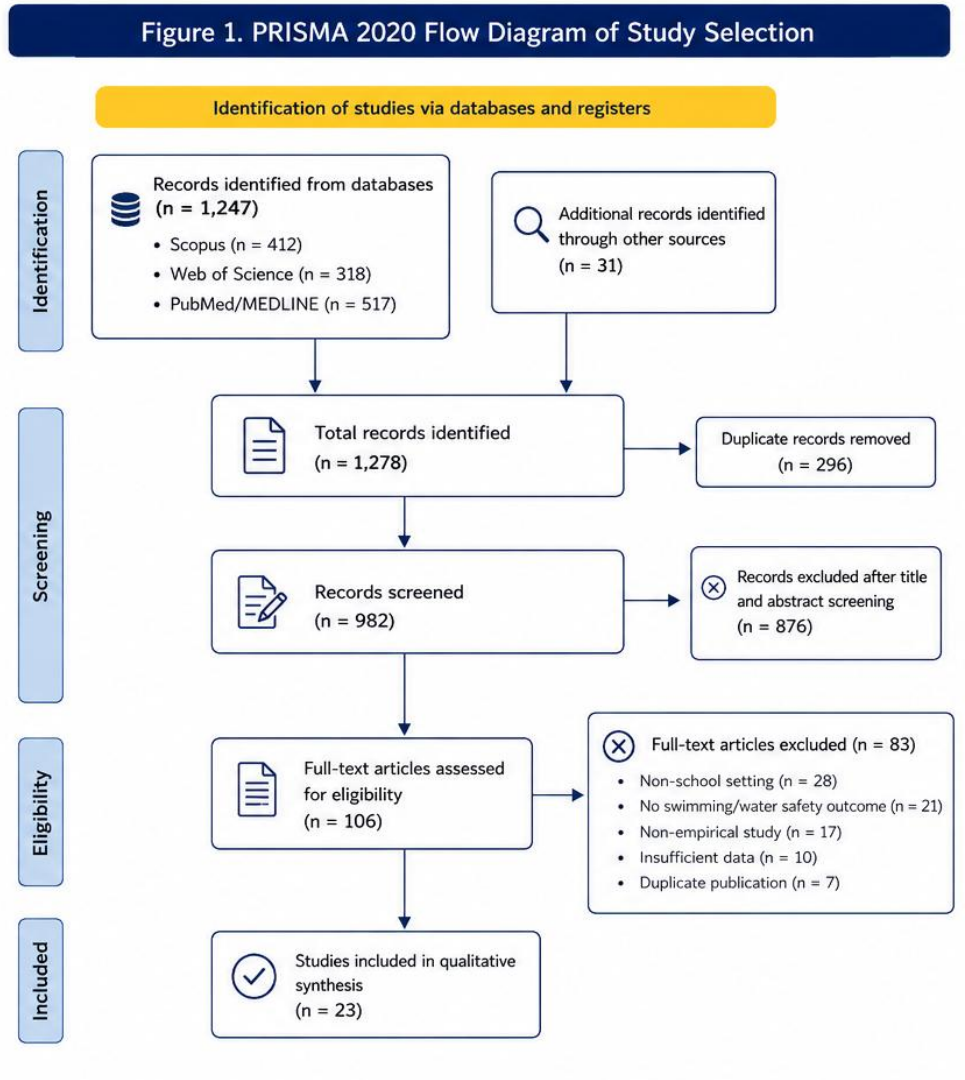
Studies were excluded if they consisted of conference abstracts, editorials, book chapters, dissertations, or non-peer-reviewed publications. Furthermore, studies focusing exclusively on competitive swimming performance or elite athlete training, or those investigating clinical rehabilitation, hydrotherapy, or therapeutic aquatic exercise unrelated to education, were excluded. Additionally, studies that did not report school-based outcomes, were duplicate publications, or lacked sufficient methodological information or full-text availability were also excluded.

Study Selection Process

The study selection process followed the PRISMA 2020 framework.

The initial search identified 1,278 records from the three databases. After removing duplicate records, titles and abstracts were screened for relevance. Potentially eligible studies were then subjected to full-text assessment against the inclusion criteria. Following full-text review, studies that failed to meet eligibility requirements were excluded. Reasons for exclusion included non-school settings, absence of water-safety outcomes, non-empirical designs, and insufficient methodological reporting. Ultimately, 23 studies were included in the final qualitative synthesis.

PRISMA Flow Summary



Note. The flow diagram is based on the PRISMA 2020 statement (Page et al., 2021).

Data Extraction and Synthesis

Data extraction was conducted using a standardized extraction form developed specifically for this review. Key information extracted from each study included the author and publication year, country and geographical region, research design, participant characteristics, sample size, educational setting, type of swimming or water-safety intervention, outcome measures, and major findings. A thematic synthesis approach was adopted to identify recurring patterns across the studies. The findings were organized

into four principal themes: aquatic competence development, water safety knowledge enhancement, drowning prevention outcomes, and barriers and facilitators to implementation.

Quality Assessment

Methodological quality was evaluated using criteria consistent with PRISMA 2020 recommendations for systematic reviews. Each included study was assessed based on the clarity of research objectives, the adequacy of participant description, the appropriateness of study design, the validity and reliability of outcome measures, the transparency of intervention procedures, the completeness of data reporting, and considerations regarding the risk of bias. The quality assessment process was conducted independently by two reviewers, and any disagreements were resolved through discussion and consensus.

Table 1. Quality Assessment Categories

Quality Level	Criteria
High	Most methodological criteria satisfied; low risk of bias
Moderate	Minor methodological limitations; acceptable quality
Low	Significant methodological weaknesses; higher risk of bias

Most studies were classified as moderate to high quality, although several intervention studies exhibited limitations related to small sample sizes, short intervention durations, and lack of long-term follow-up.

Ethical Considerations

This study adhered to ethical standards for conducting systematic reviews as outlined in the PRISMA 2020 Statement. Because the review analyzed data from previously published studies, no direct involvement of human participants occurred, and formal institutional ethical approval was not required. Nevertheless, ethical principles of transparency, accuracy, and responsible reporting were maintained throughout the review process. The review utilized only publicly available published literature, accurately represented the findings of included studies, avoided data manipulation or selective reporting, followed PRISMA 2020 recommendations for transparent evidence synthesis, and properly acknowledged all original sources through appropriate citation practices. The authors declare that no conflicts of interest influenced the review process or interpretation of findings.

RESULTS

Study Selection and Number of Included Studies

The database search yielded 1,278 records from Scopus, Web of Science, PubMed/MEDLINE, ERIC, and ScienceDirect. Following duplicate removal and screening procedures based on the PRISMA 2020 framework, 23 studies met the eligibility criteria and were included in the final review. The included studies were published between 2000 and 2026 and represented diverse geographical regions, including North America, Europe, Asia, Oceania, Latin America, and the Caribbean.

Characteristics of Included Studies

The reviewed studies comprised a range of methodological designs, including systematic reviews (n = 3), randomized controlled trials (n = 6), quasi-experimental studies (n = 5), observational studies (n = 4), and program evaluations (n = 5). Sample sizes ranged from fewer than 20 participants in pilot swimming interventions to more than 7,000 children in large-scale drowning-prevention initiatives. Most studies focused on children aged 6–12 years, reflecting the primary target population of school-based swimming education programs. The majority investigated swimming competency development, water safety knowledge acquisition, drowning prevention outcomes, and instructional effectiveness.

Table 2. Summary of Included Studies

Region	Studies (n)	Main Focus
Europe	7	Swimming instruction, aquatic competence
Asia	6	Drowning prevention, water safety education
North America	4	Swimming lessons and drowning reduction
Oceania	3	Swimming pedagogy and aquatic skills
Latin America	2	Injury prevention and safety education
Caribbean	1	Water safety awareness programs

Table 3. Characteristics and Key Findings of Selected Included Studies

Author(s)/Year	Design	Sample	Technology / Approach	Key Findings
(Brenner et al., 2009)	Case-control study	61 drowning cases; 134 controls	Formal swimming lessons	Participation in formal swimming lessons was associated with a substantially reduced risk of childhood drowning.
(No et al., 2026)	Quasi-experimental	56 primary school children (5–12 years)	WHALE Tales water safety education program	Water safety knowledge increased significantly following participation in the educational intervention.
(Kjendlie & Mendritzki, 2012)	Experimental study	110 children (6–8 years)	Swimming instruction with flotation aids	Swimming lessons improved aquatic competence; flotation devices influenced movement patterns during free-water play.
(Falavigna et al., 2012)	Cluster randomized trial	1,049 adolescents	School-based injury and safety education program	Participants demonstrated significant improvements in safety knowledge and attitudes.
(Orton et al., 2012, p. 31)	Randomized controlled trial	1,502 school-aged children	Integrated school safety curriculum	Water safety awareness and safety knowledge improved significantly after intervention.
(Mecrow et al., 2015)	Cohort study	~7,000 children (6–14 years)	SwimSafe drowning-prevention program	Swimming instruction did not increase risk-taking behavior and enhanced children's survival skills.
(Taylor et al.,	Systematic	12 studies	Aquatic competence	Children aged 2–4 years can develop aquatic

2020)	Review		framework	competencies without increasing drowning risk.
(Papadimitriou & Loupos, 2021)	Experimental study	23 novice swimmers (8–10 years)	Alternative swimming learning model (Tec Pa)	Improved swimming performance, technical proficiency, and learner confidence.
(Simón-Piqueras et al., 2022)	Experimental study	17 preschool children (4–5 years)	Aquatic motor games	Enhanced motor competence and engagement in aquatic activities compared with traditional approaches.
(Kusol et al., 2022)	Quasi-experimental study	240 primary school students (7–12 years)	Drowning-prevention support program	Significant improvements in water safety knowledge, attitudes, and preventive behaviors.
(Criel et al., 2025)	Systematic Review	33 studies	Swimming and water safety training programs	Programs improved aquatic skills, water safety knowledge, and contributed to drowning prevention.
(Clark & Pears, 2025)	Cross-sectional survey	School administrators and teachers	School-based water safety education policies	Key barriers included inadequate funding and facilities; policy support facilitated implementation.
(Bradley et al., 1996)	Experimental study	Children aged 7–8 years	Daily versus weekly swimming lessons	Daily instruction produced greater improvements in front-crawl swimming proficiency.
(Parker et al., 1999)	Experimental study	19 children	Buoyancy-aided swimming instruction	Buoyancy aids supported swimming skill acquisition and confidence development.
(Frederick et al., 2000)	Program evaluation	1,096 students	Injury Minimization Programme for Schools (IMPS)	Improved safety knowledge, including awareness of aquatic risks.
(Greene et al., 2002)	Program evaluation	1,400 primary school students	THINK FIRST for KIDS curriculum	Enhanced injury-prevention and water safety knowledge among elementary school children.

Note. The included studies represent diverse geographical regions and methodological approaches, including systematic reviews, randomized controlled trials, quasi-experimental studies, cohort studies, and program evaluations. The interventions ranged from formal swimming instruction and aquatic motor games to comprehensive water safety and drowning-prevention education programs.

Thematic Findings: The synthesis identified four major themes

Theme 1: Development of Aquatic Competence

The synthesis of the literature consistently shows that structured, school-based swimming programs significantly enhance children's aquatic competence, a foundational requirement for water safety (Criel et al., 2025; Kjendlie & Mendritzki, 2012; Papadimitriou & Loupos, 2021). Aquatic competence is recognized as a multidimensional construct encompassing floating, propulsion, breath control, safe water entry and exit, orientation skills, and specialized survival swimming abilities (Taylor et al., 2020). The strongest outcomes in skill development were reported in programs that effectively integrate practical, hands-on swimming instruction with contextualized water-safety learning (Criel et al., 2025). Moreover, the adoption of learner-centered pedagogical approaches—which prioritize experiential learning, active participation, and adaptive instruction—has been found to be strongly associated with greater long-term skill retention and the development of self-efficacy and learner confidence (Papadimitriou & Loupos, 2021; Simón-Piqueras et al., 2022). For instance, studies utilizing innovative techniques, such as aquatic motor games or alternative learning models, have demonstrated superior improvements in motor competence, technical proficiency, and student engagement compared to traditional, rigid technique-centered approaches (Papadimitriou & Loupos, 2021; Simón-Piqueras et al., 2022).

Theme 2: Enhancement of Water Safety Knowledge

Water safety education consistently enhances children's understanding of aquatic hazards, risk recognition, emergency response protocols, and safe behaviors in and around water (Criel et al., 2025; Frederick et al., 2000; Greene et al., 2002). This comprehensive approach goes beyond mere information dissemination, effectively fostering both cognitive awareness and practical safety competencies (Falavigna et al., 2012; Orton et al., 2012, p. 31). Studies conducted across diverse geographical regions—including Grenada, Thailand, and Bangladesh—demonstrate that structured, school-based interventions result in statistically significant improvements in water safety knowledge scores (Kusol et al., 2022; No et al., 2026). The literature indicates that the most effective curricula are those that explicitly integrate cognitive and behavioral learning components (Falavigna et al., 2012). By combining theoretical knowledge—such as understanding warning signs or safe entry/exit techniques—with experiential, activity-based learning, these programs yield superior outcomes compared to traditional, information-only models (Frederick et al., 2000; Kusol et al., 2022; Orton et al., 2012, p. 31). Furthermore, when these programs are tailored to local contexts and cultural understandings of risk, they facilitate better engagement and retention of safety behaviors among students, particularly in varied educational settings (Criel et al., 2025; No et al., 2026).

Theme 3: Drowning Prevention Outcomes

While swimming instruction is widely recognized as a critical component of drowning prevention, the relationship between formal lessons and reduced drowning risk is multifaceted. Research indicates that structured swimming programs, particularly those integrating practical skills with water safety education, are strongly associated with improvements in aquatic competence (Criel et al., 2025; Taylor et al., 2020). These competencies—including floating, propulsion, breath control, and emergency response—are considered foundational survival skills that enhance an individual's ability to navigate aquatic hazards safely (Taylor et al., 2020). However, the evidence base requires nuanced interpretation. While acquiring basic swimming competence is protective, swimming ability alone is insufficient for drowning prevention; it must be coupled with rigorous supervision, contextual hazard recognition, and the development of safe behavioral habits (Criel et al., 2025; No et al., 2026). Furthermore, some researchers highlight the need to ensure that increased aquatic competence does not lead to unwarranted confidence or increased exposure to high-risk environments without adequate supervision (Mecrow et al., 2015).

Direct causal evidence linking swimming instruction to a measurable reduction in drowning mortality remains limited, primarily due to significant methodological and ethical constraints inherent in this field (Criel et al., 2025). Randomized controlled

trials measuring actual drowning incidents are often considered unethical, leading researchers to rely heavily on proxy outcomes such as skill proficiency, behavioral shifts, and safety knowledge (Criel et al., 2025; Orton et al., 2012, p. 31). Consequently, the effectiveness of these programs is often evaluated based on their ability to cultivate comprehensive aquatic competence and safer water-related behaviors, rather than direct mortality reduction (Criel et al., 2025; Kusol et al., 2022).

Theme 4: Barriers and Facilitators to Program Implementation

The successful implementation of school-based swimming and water safety programs is frequently challenged by multifaceted structural and organizational barriers. Primary constraints include limited access to appropriate swimming facilities, high operational costs, and significant logistical difficulties related to student transportation (Larson et al., 2025; Peden et al., 2009). Furthermore, schools often contend with pressure from crowded academic curricula, which restricts the time available for specialized aquatic instruction (Johanna, 2022). Staffing limitations represent another critical hurdle, with widespread reports of a deficiency in qualified instructors possessing the necessary pedagogical and safety management expertise (Irianty et al., 2026; Peden et al., 2009). Additionally, structural inequities disproportionately affect rural and disadvantaged populations, frequently resulting in significant gaps in program accessibility and aquatic literacy (Petrass et al., 2026). Conversely, facilitators for program success are rooted in a collaborative, policy-driven approach. Governmental support and the formal integration of swimming education into mandatory physical education curricula provide a crucial framework for long-term sustainability (Cassar et al., 2019). Effective programs frequently leverage strategic partnerships with community aquatic organizations to overcome resource limitations, ensuring access to facilities and qualified, specialized staff (Mecrow et al., 2024; Peden et al., 2009). Furthermore, the adoption of flexible, learner-centered pedagogical models—which prioritize practical, contextualized water-safety learning—has been shown to enhance student engagement and program efficacy across diverse educational environments (Irianty et al., 2026). Ultimately, sustained investment in aquatic infrastructure, combined with dedicated professional development for instructors, remains essential to ensuring equitable and high-quality programming (Clark & Pears, 2025; Peden et al., 2009).

Table 4. Thematic Synthesis

Theme	Key Findings
Aquatic Competence	Improved swimming skills and confidence
Water Safety Knowledge	Increased awareness and safer behaviors
Drowning Prevention	Potential reduction in drowning risk
Implementation Factors	Infrastructure and policy strongly influence success

DISCUSSION

This review indicates that while school-based swimming and water safety education are essential public health interventions, their contribution to drowning reduction must be interpreted with nuance. Participation in structured programs consistently enhances aquatic competence—a multifaceted construct encompassing motor awareness, breath control, and skill acquisition—as well as water safety knowledge and confidence (Criel et al., 2025; Taylor et al., 2020). However, direct causal evidence linking these programs to measurable reductions in drowning mortality remains limited, as researchers must rely on proxy outcomes—such as skill proficiency and behavioral shifts—due to the ethical and methodological constraints of randomized controlled trials (Criel et al., 2025; Orton et al., 2012, p. 31; Wallis et al., 2014). Importantly, swimming competence alone is insufficient; it must be integrated with contextual hazard recognition, rigorous supervision, and the development of safe behavioral habits (Criel et al., 2025; Mecrow et al., 2015).

Significant disparities in the implementation and focus of these curricula are evident globally. High-income nations generally benefit from established aquatic infrastructure and comprehensive policies, allowing for broad curricular integration. In contrast, studies from low- and middle-income countries highlight a primary focus on basic survival swimming, often necessitated by higher drowning burdens and more substantial resource limitations (Irianty et al., 2026; No et al., 2026). Effectively scaling interventions in these settings requires a holistic configuration—often described as a '5C' approach—that adapts pedagogical models to leverage trained community instructors and intensive, localized program blocks (Irianty et al., 2026; Mecrow et al., 2024).

From a socio-ecological perspective, drowning prevention is best understood as a multisystemic challenge, requiring cohesive strategies across an upstream-to-downstream continuum—encompassing policy, community infrastructure, and individual behavioral approaches (Cenderadewi et al., 2020, p. 5; Mekkaoui et al., 2025). Effective prevention strategies must extend beyond isolated school interventions, addressing the wider environmental and sociocultural factors that dictate risk exposure (Button et al., 2022; No et al., 2026).

Despite the recognized necessity of these programs, structural and systemic barriers persistently hinder widespread implementation. Primary challenges include limited access to safe swimming facilities, high operational costs, logistical difficulties in student transportation, and a critical deficiency in specialized instructor training—a key pillar for safety management and pedagogical effectiveness (Irianty et al., 2026; Larson et al., 2025; Mecrow et al., 2024; Peden et al., 2009). These barriers disproportionately affect rural and disadvantaged populations, perpetuating existing inequities in aquatic literacy (Petrass et al., 2026).

Ultimately, the long-term sustainability of school-based swimming education depends on a policy-driven, collaborative approach. Governmental support, formal integration into mandatory physical education curricula, and strategic partnerships with community aquatic organizations are vital to ensure high-quality programming and equitable access (Cassar et al., 2019; No et al., 2026; Peden et al., 2025). Strengthening the evidence base through standardized metrics and longitudinal research—moving beyond short-term proxy outcomes—will be necessary to justify sustained investment in infrastructure and professional development for instructors (Irianty et al., 2026; Wallis et al., 2014).

Implications

Practical Implications

Schools should integrate swimming education and water safety instruction as essential components of physical education curricula. Programs should combine technical swimming skills with hazard recognition, rescue awareness, and safe decision-making practices. Teacher professional development should prioritize aquatic pedagogy, risk management, and evidence-based instructional strategies. Partnerships with aquatic centers and community organizations may help overcome resource limitations.

Policy Recommendations

National education authorities should recognize swimming education as a fundamental life skill and public health priority. Policymakers should support mandatory aquatic education, particularly in regions with elevated drowning rates.

Investment in aquatic infrastructure, transportation support, and instructor certification programs is necessary to ensure equitable access to swimming education.

Recommendations

1. Integrate swimming and water safety education into primary school curricula.
2. Establish minimum aquatic competency standards.
3. Improve access for underserved populations.
4. Strengthen collaboration between schools and aquatic organizations.
5. Develop culturally responsive drowning-prevention initiatives.

Limitations

Limitations of Included Studies

The reviewed studies exhibited considerable methodological heterogeneity. Outcome measures, intervention duration, assessment instruments, and definitions of aquatic competence varied substantially across studies. Many investigations involved relatively small samples, short intervention periods, and limited follow-up assessments. Furthermore, few studies directly measured drowning incidence as an outcome.

Limitations of the Review Process

Although multiple databases were searched, relevant studies published in languages other than English may have been missed. Publication bias may also have influenced findings, as positive intervention outcomes are more likely to be published than null results.

Future Research Directions

Several important gaps remain in the literature.

First, longitudinal studies are needed to determine whether gains in aquatic competence are maintained over time and whether they translate into measurable reductions in drowning incidence. Second, more randomized controlled trials should examine the comparative effectiveness of different instructional approaches, teaching models, and curriculum designs. Third, cross-cultural research is needed to better understand how environmental, cultural, and socioeconomic factors influence swimming education outcomes. Future investigations should also explore inclusive aquatic education for children with disabilities, indigenous populations, migrant communities, and other underrepresented groups. Additionally, standardized measures of aquatic competence should be developed to facilitate international comparison and evidence synthesis.

CONCLUSION

This systematic literature review demonstrates that school-based swimming education plays a significant role in developing aquatic competence, enhancing water safety knowledge, and contributing to drowning-prevention efforts among children. Across diverse geographical contexts, structured swimming programs consistently produced positive educational and safety outcomes. Nevertheless, substantial inequalities in access, infrastructure, and policy support continue to limit implementation worldwide. Given that drowning remains a major global public health concern, expanding access to high-quality swimming education should be regarded as both an educational priority and a preventive health strategy. Future efforts should focus on strengthening evidence-based practices, improving policy support, and ensuring equitable opportunities for all children to acquire essential aquatic life skills.

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CONFLICT OF INTERESTS

The authors declare no conflicts of interest regarding the publication of this study.

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