School-based swimming education in primary children: a systematic review of teaching approaches, aquatic competence, and water safety outcomes

Educación de natación escolar en niños de primaria: una revisión sistemática de enfoques de enseñanza, competencia acuática y resultados de seguridad en el agua

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Abstract

Introduction: School-based swimming programs represent the primary opportunity for many children to acquire essential aquatic life skills, yet implementation varies significantly.
Objective: The present research analyses existing evidence on school-based swimming (6–12 years) through the "Block 5C Framework" (Context, Content, Conduct, Coaching, and Consequences) to identify effective program configurations.
Methodology: A systematic review was conducted, adhering to PRISMA 2020 guidelines, synthesizing 23 studies (2000–2026) from Scopus and Web of Science, utilizing the 5C framework to code curricular and pedagogical interactions.
Results: Programs integrating water safety knowledge with technical skills, delivered through learner-centered pedagogies, produced superior aquatic competence. Instructor qualification and session frequency were critical determinants.
Discussion: Effectiveness is context-dependent. High-resource settings often over-emphasize technique, while low-resource settings demonstrate that trained community instructors can achieve high survival rates through intensive blocks.
Conclusions: Effective school swimming requires a holistic 5C configuration: supportive policy, safety-integrated content, engaging conduct, and specialized coaching.

Keywords

School swimming; aquatic competence; water safety; Physical Education; primary school; 5C framework.

Resumen

Introducción: Los programas de natación escolar representan la oportunidad principal para que muchos niños adquieran habilidades acuáticas esenciales, aunque su implementación varía significativamente.
Objetivo: La presente investigación analiza la evidencia existente sobre la natación escolar (6–12 años) a través del "Marco Block 5C" (Contexto, Contenido, Conducta, Coaching y Consecuencias) para identificar configuraciones efectivas.
Metodología: Se realizó una revisión sistemática siguiendo las directrices PRISMA 2020, sintetizando 23 estudios (2000–2026) de Scopus y Web of Science, utilizando el marco 5C para codificar interacciones curriculares y pedagógicas.
Resultados: Los programas que integran conocimientos de seguridad acuática con habilidades técnicas, impartidos mediante pedagogías centradas en el alumno, produjeron una competencia acuática superior. La cualificación del instructor y la frecuencia de las sesiones fueron determinantes críticos.
Discusión: La efectividad depende del contexto. Los entornos de altos recursos a menudo enfatizan demasiado la técnica, mientras que los entornos de bajos recursos demuestran que instructores comunitarios capacitados pueden lograr altas tasas de supervivencia.
Conclusiones: La natación escolar efectiva requiere una configuración 5C holística: política de apoyo, contenido integrado de seguridad, conducta atractiva y coaching especializado.

Palabras clave

Natación escolar; competencia acuática; seguridad en el agua; Educación Física; escuela primaria; marco 5C.

Introduction

Swimming occupies a distinct and irreplaceable space in global physical education. Unlike land-based sports, which are often pursued for fitness or competitive glory, swimming represents a fundamental survival skill that serves as the primary defense against the risk of drowning (Criel et al., 2025). This duality of purpose, safety and health, makes swimming unique. On one hand, regular aquatic participation nurtures lifelong cardiovascular resilience (Szuscik-Niewiadomy et al., 2021) and has been shown to improve lung function in specific populations, such as children with asthma (Wu et al., 2020). On the other hand, the aquatic environment itself is not without localized risks. Recent studies indicate that school health protocols must actively manage environmental factors to prevent issues like rhinitis or ear infections in frequent swimmers (Kawabata et al., 2024; Moffa et al., 2022). Negotiating these benefits and risks is the responsibility of educational institutions.

However, a significant disparity exists in who gets to access these benefits. For the vast majority of children in low-to-middle-income countries (LMICs), schools remain the only viable gateway to formal water safety training. Without these institutional interventions, the "aquatic gap" widens dangerously. This is not merely a matter of missing out on sport; it is a matter of life and death in regions with high drowning burdens (Cenderadewi et al., 2025). The urgency of this issue is further amplified by recurrent maritime incidents. For instance, the recent sinking of a tourist boat near Labuan Bajo, Indonesia, which resulted in multiple fatalities, has starkly highlighted the deadly consequences of poor maritime safety standards combined with limited aquatic preparedness among passengers Asia News Network (2 Jan 2026). These events reinforce the critical need for systematic water safety education, particularly for children growing up in archipelagic nations where travel often implies water risks.

The urgency of this issue has been compounded by global disruptions. The COVID-19 pandemic, for instance, created what researchers describe as a "lost generation" of swimmers, where prolonged pool closures led to a measurable regression in motor skills and water confidence across entire cohorts (Tsalis & Mougios, 2022). Policies must now race to recover this lost ground, recognizing that motor skills development serves as the foundation for aquatic competence acquisition, as physical literacy encompasses both terrestrial and aquatic movement patterns (Hidayat et al., 2025). This holistic understanding is critical for designing effective recovery programs.

The specific "context" in which these programs operate varies drastically, creating a fragmented global landscape. In nations with robust welfare models, such as Australia or Scandinavian countries, swimming is deeply embedded in the national curriculum, often supported by state-funded voucher systems designed to lower economic barriers (Macniven et al., 2025; Peden et al., 2025). The success of these systems, however, relies heavily on public awareness. Hanum et al. (2025) note that the availability of funds is useless if parents are unaware of how to redeem them. Conversely, the reality in developing nations is far starker. Programs here are often sporadic, fighting against logistical nightmares such as lack of pools, prohibitive transport costs, and overcrowded curricula (Cenderadewi et al., 2025). Additionally, the physical quality of the water itself is a concern in low-resource settings, where open water training brings risks of bacterial contamination that policymakers must address (French et al., 2021).

Pedagogically, the field is witnessing a tectonic shift in how swimming is taught. For decades, the dominant paradigm was militaristic and linear, focusing almost exclusively on drilling perfect stroke mechanics (Porter & Felstead, 2025). While rigorous, these traditional methods are increasingly scrutinized for their lack of engagement and transferability. Contemporary literature is moving towards more dynamic methodologies, such as Game-Based Approaches (GBA) and Constraints-Led Approaches (CLA) (Signorini et al., 2025).

In line with this trend, research from Retos highlights the importance of foundational physical attributes in developing swimming proficiency among young athletes. A recent biomechanical study by Purnomo et al. (2026) demonstrates that three-dimensional shoulder mobility significantly correlates with freestyle swimming velocity in sub-elite adolescent swimmers, underscoring how fundamental movement capacities must be established before technical refinement can be optimally achieved. These modern frameworks prioritize "physical literacy" or the ability to adapt and move confidently in water, over the aesthetic perfection of a stroke. Crucially, empirical evidence suggests that the manner of instruction (Conduct) is just as important as the content. When lessons are designed to be engaging and intrinsically

motivating, they not only improve skills but also foster a lifelong connection to aquatic activity (Minkels et al., 2023).

This shift is essential for reducing dropout rates and managing aquatic anxiety (Roure & Lentillon-Kaestner, 2022). To dissect this complexity, this study adopts Block's 5C Framework as the primary analytical lens to deconstruct educational programs into five interconnected dimensions: Context (policy and facility background), Content (curriculum substance), Conduct (pedagogical delivery), Coaching (instructor quality), and Consequences (student outcomes).

The conceptual relationship between these dimensions is visualized in Figure 2. As shown in the schematic, Context and Coaching act as systemic inputs that shape the quality of the Process (interaction between Content and Conduct), which ultimately leads to Consequences in the form of student competence. This approach offers a holistic view that student outcomes do not stand alone, but are the product of the configuration of inputs that precede them (Zhang & Jin, 2025).

While recent scoping reviews have mapped general motor learning methods in children (Minkels et al., 2025) or basic skills training (Criel et al., 2025), there remains a lack of systematic synthesis specifically examining the interaction between school-based constraints (Context) and pedagogical choices (Conduct/Coach). Figure 1 summarizes these trends, illustrating how research has increasingly prioritized performance and physiology while leaving school-based pedagogy and water safety outcomes comparatively underexplored.

Figure 1. Conceptual overview of research gaps in children's swimming education.

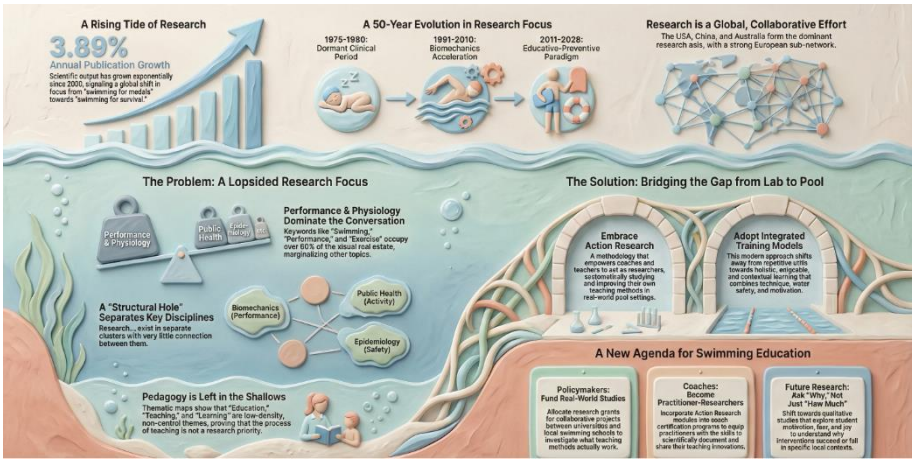


Figure 2 synthesizes these trends, highlighting the structural gap between performance-focused research and school-based educational needs. Most prior research tends to isolate outcomes (Consequences) without examining how input factors like coach quality or teaching methods influence them.

By integrating these five elements, this review aims to address three primary research questions. First, it examines how Context characteristics (resources) and Coaching profiles vary between high- and low-resource settings. Second, it analyses how the Content of curricula and Conduct (pedagogical methods) interact in school-based swimming programs. Finally, it evaluates which program configurations most consistently produce positive Consequences (aquatic competence and safety knowledge) in students.

Method

Study Design

This research was designed as a systematic review adhering to the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) reporting guidelines. The review protocol, registered

on OSF (DOI: 10.17605/OSF.IO/5VFXN), ensured rigorous identification, screening, and inclusion processes, fully documented in the PRISMA checklist (Page et al., 2021). Evaluating the quality of evidence was prioritized to ensure the reliability of findings.

Eligibility Criteria (PICOS)

Inclusion and exclusion criteria were established based on the PICOS framework mapped to the 5C dimensions, as summarized in Table 1.

Table 1. Review eligibility criteria.

Criterion	Description
Population (P)	Primary school-aged children (estimated 6–12 years). Studies involving preschool or early adolescents were included if the program was school-based or education policy-driven.
Intervention (I)	Swimming or water safety education programs coordinated by schools, conducted either in school pools or through partnerships. Interventions covered various content (Content) and teaching methods (Conduct).
Comparator (C)	Control groups receiving standard PE lessons, traditional teaching methods (drills), or pre-test data.
Outcomes (O)	Must report at least one quantitative measure related to Consequences: aquatic competence (motor skills), water safety knowledge, or psychological outcomes (confidence, affection).
Study Design (S)	Randomized Controlled Trials (RCTs), quasi-experiments, cohort studies, and pre-post evaluations.

Information Sources and Search Strategy

A comprehensive literature search was conducted on two major databases: Scopus and Web of Science. The search period was restricted, ranging from January 2000 to January 2026 to capture recent pedagogical trends and the latest evidence. Keywords combined concepts of "swimming" (swimming, aquatic), "school education" (school, physical education, curriculum), and "intervention/program".

Data Extraction and Analysis (5C Coding)

Data from selected studies were extracted into a standard template and coded based on 5C categories to facilitate pattern analysis, as detailed in Table 2:

Table 2. 5C coding categories

Dimension	Code & Definition
Context (Cx)	Cx1 (High-Resource): Developed nations, onsite pools/easy access, strong mandatory policy (e.g., Australia, NZ).
	Cx2 (Medium): Mixed, rented pools, varied access.
	Cx3 (Low-Resource): Developing nations, difficult/natural access, cost barriers (e.g., Indonesia, Bangladesh).
Content (Ct)	Ct1 (Skill Only): Dominant focus on stroke technique.
	Ct2 (Skill + Safety): Combination of swimming technique and water safety knowledge.
	Ct3 (Integrated/PL): Holistic (Skill + Safety + Physical Literacy/Resilience).
Conduct (Cd)	Cd1 (Weekly Drills): Traditional linear weekly model.
	Cd2 (Block/Intensive): Intensive model (daily for 1-2 weeks).
	Cd3 (Game-Based/Integrated): Game-based, CLA, VR, Experiential.
Coaching (Ch)	Ch1 (Nonspecialist): Parents, volunteers, general classroom teachers.
	Ch2 (Trained Generalist): Physical Education (PE) teachers with additional swimming training.
	Ch3 (Specialist): Specialized certified swimming coaches.

Consequences (Cs):

- Cs+: Significant/consistent improvement in outcomes.
- Cs±: Partial/low/mixed improvement.
- Cs0: Unclear/no effect/barrier studies.

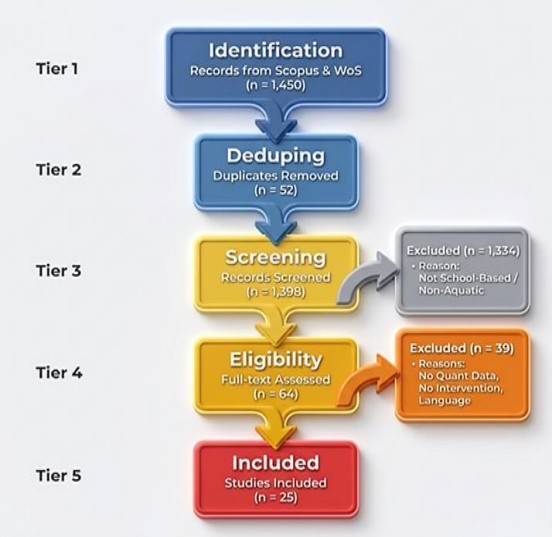
The authors declare that the use of artificial intelligence (AI) in this study was limited to the initial data extraction process and sentence paraphrasing to improve readability. The entire process of data analysis, synthesis, and interpretation was conducted manually by the authors to ensure accuracy and scientific context.

Results

Study Selection and Context

The systematic search yielded 23 unique studies relevant to school-based swimming and aquatic education. The selection process (see Figure 2) followed a rigorous PRISMA flow: initial identification from Scopus and Web of Science produced a total of 548 records. After removing duplicates and screening titles/abstracts for relevance, 56 full-text articles were assessed for eligibility. Reasons for exclusion at this stage included lack of school-based intervention, absence of quantitative outcomes, or non-primary school populations. Ultimately, 23 studies meeting all inclusion criteria were included in the final synthesis as the primary data source. All 23 studies were presented in three core analysis tables: Table 3 (Context & Coaching characteristics), Table 4 (Content & Conduct features), and Table 5 (Consequences/Outcomes).

Figure 2. PRISMA Flow Extraction Diagram



Geographically, the "Context" (Cx) of these studies varied significantly. The majority were conducted in high-resource settings (Cx1), including Australia, New Zealand, and Norway, where swimming is often a compulsory, state-mandated component of the curriculum (Lundhaug, 2025; Petrass et al., 2025). Fewer studies represented low-to-medium resource contexts (Cx3), such as Indonesia and Bangladesh but highlighted critical adaptations to infrastructure barriers (Cenderadewi et al., 2025; Rahman et al., 2025). This disparity highlights a global gap in specific research on school swimming implementation in lower-middle income countries (LMICs).

Study Characteristics by 5C (Context & Coaching)

The Context and Coaching dimensions analyzed the characteristics of the studies, which included the demographic characteristics, country settings, and instructor profiles of the key studies (see Table 3).

A key pattern emerged regarding instructor qualification: programs in Cx1 settings typically utilized specialized external instructors (Ch3) or PE teachers with specific aquatic certifications (Ch2). In Cx3 settings, reliance on generalist teachers or volunteers (Ch1) was more common, although targeted training interventions (e.g., the SwimSafe program) demonstrated that trained community instructors could effectively deliver high-quality outcomes.

Table 3. Study characteristics overview (Context & Coaching)

Author (Year)	Country (Setting)	Context Code (Cx)	Instructor Profile (Ch Code)
Peden et al. (2025)	New Zealand	Cx1	Verified Instructors/Community (Ch3)
Rahman et al. (2025)	Bangladesh	Cx3	Trained Community Volunteers (Ch2)
Cenderadewi et al. (2025)	Indonesia	Cx3	Parents/Generalists (Ch1)

Petrass et al. (2026)	Australia	Cx1	Certified Swim Teachers (Ch3)
Kurniati (2017)	Indonesia	Cx2	Class Teachers (Ch1/2)
Signorini et al. (2025)	Italy	Cx1	Federal Club Instructors (Ch3)
Lundhaug (2025)	Norway	Cx1	PE Teachers with swim experience (Ch2)

Program Content and Delivery (Content & Conduct)

Analysis of Content (Ct) and Conduct (Cd) revealed a pedagogical shift. Traditional programs (Cd1) focusing solely on stroke mechanics (Ct1) were increasingly supplemented or replaced by integrated approaches (Ct2/Ct3) that combine technical skills with water safety knowledge and survival competence.

These variations in delivery models and curriculum focus are summarized in Table 4. The table compares game-based or integrated approaches with traditional models, highlighting differences in intervention duration and intensity.

Table 4. Program features (Content & Conduct)

Study	Teaching Approach (Cd Code)	Curriculum Focus (Ct Code)	Duration/Model
Santiago et al. (2026)	Cd3 (VR Gaming)	Ct2 (Beach Safety)	Single Session (45 min)
Kurniati (T.T.)	Cd3 (Water Games)	Ct3 (Fund. Movement)	Block (5 Sessions)
Signorini et al. (2025)	Cd3 (Multiteaching)	Ct1 (Technique)	Weekly (36 weeks)
Lundhaug (2025)	Cd3 (Experiential)	Ct3 (Resilience)	1 Week Block
Rahman et al. (2025)	Cd2 (Intensive Block)	Ct2 (Survival)	Daily (2 weeks)
Petrass et al. (2026)	Cd1 (Weekly/Periodic)	Ct2 (Skill + Theory)	Varied (Curriculum)
Willcox-Pidgeon (2025)	Cd1 (Technical Drills)	Ct1 (Swim Strokes)	Weekly (10 weeks)

Effects on Outcomes (Consequences)

The "Consequences" (Cs) of these programs were categorized into skill acquisition, safety knowledge, and psychological factors. The impact of these various program configurations on student outcomes is summarized in Table 4.

Table 5. Consequences and outcomes (Consequences)

Study	Primary Outcome (Domain)	Result (Cs Code)	Key Finding
Rahman (2025)	Survival Skills Retention	Cs+	84.2% skill retention after 10 years in the block program graduates.
Santiago (2026)	Beach Safety Knowledge	Cs+	The VR group showed equal knowledge gain to Desktop but higher engagement.
Signorini (2025)	Swim Stroke Efficiency	Cs+	The multi-teaching style improved stroke length more than the Command style.
Petrass (2026)	Water Safety Knowledge	Cs±	Knowledge low despite lessons; theory is often neglected in pools.
Cenderadewi (2025)	Program Barriers	Cs0	Lack of pools and fear of water are primary barriers to enactment.

As shown in Table 5, the combination of interventions (Context, Content, Conduct) yields different outcomes, ranging from improved physical competence to changes in affective perception.

Discussion

The findings of this review confirm that the success of school-based swimming education is not solely determined by the availability of luxury pools (Context), but heavily relies on the applied 5C configuration. The discussion is grouped into three main thematic areas: (1) the structural impact of delivery models (Block vs. Weekly), (2) equity and contextual barriers, and (3) the pedagogical evolution towards ecological dynamics.

Conduct Quality and Coaching emerge as decisive variables that can overcome facility limitations. This aligns with findings by Ordonhes et al. (2021) in Retos, who identified that structural intervening factors, specifically the organization of teaching and human resources, are critical determinants in the development of swimming programs, often more so than physical infrastructure alone. The dynamics between effective and ineffective configurations are visualized in Figure 3.

Figure 3. The Key to Swimming Success

Panel a Figure 3 demonstrates how the synergy between trained instructors and dense pedagogy (block/game-based) can produce positive outcomes (Cs+) even within constraints. Conversely, Panel B illustrates that without a strong design, weekly programs led by generalists tend to fail in achieving safety competence targets.

The Block vs. Weekly Debate

Evidence strongly supports that "Block" delivery (Cd2) is effective, particularly for skill retention. Rahman et al. (2025) demonstrated that 84.2% of graduates from an intensive block program in Bangladesh retained functional swimming and floating skills even 10 years post-intervention. This suggests that for motor skill acquisition, especially in children with limited water exposure, concentrated practice allows for better consolidation of motor memory compared to weekly models, which are often disrupted by forgetfulness and absenteeism (Minkels et al, 2025).

Context and Equity: Bridging the Global Gap

One of the most profound findings of this review is the stark inequality inherent in the Context of global swimming education. In high-resource nations (Cx1), the academic discourse has moved beyond basic survival; it now focuses on "optimization", integrating resilience training, outdoor experiences, and even virtual reality simulations (Lundhaug, 2025; Santiago et al, 2026). This is a luxury of infrastructure. In contrast, for low-to-middle-income countries (Cx3) like Indonesia, qualitative studies have documented both a high burden of child drowning and an absence of consistent school-based swimming provision (Cenderadewi et al., 2025). This gap is critical. Recent high-profile incidents, such as the Labuan Bajo tragedy, underscore how limited swimming skills intersect with weak regulatory enforcement to create fatal outcomes. Therefore, embedding aquatic competence and risk awareness within the basic education curriculum is not simply a pedagogical choice but a vital strategy aligned with WHO drowning prevention recommendations.

This exclusion is not solely financial but also psychological and structural. Fundamental motor competence development serves as the foundation for successful aquatic skill acquisition, as physical literacy encompasses both terrestrial and aquatic movement domains that must be systematically cultivated (Hidayat et al., 2025). Hamilton et al. (2025) suggest that parental beliefs about safety are often a hidden gatekeeper that prevents children from even approaching the water. When the home environment lacks a water culture, such as portable pools or play, the child starts school with a deficit in aquatic familiarity. Therefore, school-based programs are essential equity mechanisms, not just educational add-ons. Furthermore, true inclusion requires addressing specific vulnerabilities. Migrant populations often lack the cultural touchpoints for water safety in their host nations (Willcox-Pidgeon et al., 2025). Similarly, children with Autism Spectrum Disorder (ASD) require tailored pedagogical interventions that standard curricula fail to provide, yet research shows they can achieve remarkable safety outcomes with the right structural support (Marzouki et al., 2022).

Pedagogical Evolution: From Drills to Ecological Dynamics

The era of teaching competitive swim strokes (Ct1) as the sole objective of school swimming is fading. The contemporary shift towards Game-Based Approaches (Cd3) is not a trend but a theoretical alignment with Ecological Dynamics. Specifically, the Constraints-Led Approach (CLA) argues that learning happens best when students self-organize in response to problems, rather than mimicking a teacher's rigid demonstration (Signorini et al, 2025). Contemporary physical education pedagogy increasingly emphasizes learner-centered approaches that integrate motor skill development with social competencies, as evidenced in recent primary school interventions (Wibowo et al., 2025). This broader pedagogical shift reinforces the validity of applying game-based methods specifically to aquatic contexts.

This adaptability is the core of Water Competency. Real-world drowning situations are chaotic and unpredictable; a student trained only in sterile, lane-based swimming may struggle to adapt to the currents or obstacles of open water. This supports Ecological Dynamics theory, which suggests that aquatic behavior emerges from the interaction between the individual, the environment, and the task. Conversely, Petrass et al. (2026) found that even in high-resource settings (Cx1), if instruction is weekly but disjointed and lacks theoretical integration, student understanding of water safety remains low.

Therefore, the definition of "education" must expand. Findings from Petrass et al. (2025) and Santiago et al. (2026) emphasize that cognitive knowledge, understanding currents, depth, and rescue protocols is just as vital as motor skills. This is where technology offers a bridge. Virtual Reality (VR) and land-based simulations provide cost-effective ways to teach these cognitive aspects without consuming scarce pool time. Adopting this holistic view helps prevent the phenomenon of "failure" in swimming classes, which is often less about physical inability and more about unaddressed anxiety or a lack of motor richness in the curriculum design (Ostrowski et al., 2022).

The Critical Role of Coaching and Teacher Training

In Indonesia (Cenderadewi et al., 2025) and similar settings, the lack of competent teachers is a primary barrier. This review suggests that the pragmatic solution for developing nations is not to wait for specialist sports teachers in every school, but to adopt the Train-the-Trainer model: training community volunteers or generalist teachers with a specific, focused water safety curriculum (Byun et al., 2025; Rahman et al., 2025). Trust in the instructor is paramount for overcoming a child's initial fear (aquatic anxiety), which acts as a massive constraint on learning (Lundhaug, 2025). Moreover, recognizing distinct talent profiles early can help coaches tailor instruction to varying potential, ensuring no child is left behind (Ochs et al., 2025).

Implications for Policy and Practice

Based on the 5C synthesis, several key recommendations for national curricula emerge. 1. Mandate Minimum Dosage: Policy should specify not just "swimming" but a minimum number of hours or sessions. The data suggest that intensive blocks (e.g., 10 consecutive days) or camp-based models (Bielec et al., 2025) may be more cost-effective and skill-retentive than spread-out yearly sessions. 2. Redefine "Competence": Standardized testing must move beyond "can swim 25m". Assessments should include water safety knowledge (Petrass et al., 2025), survival floating in clothing, and face-valid aquatic skill tools (Nyitrai et al., 2025; Fonseca-Pinto & Murcia, 2025). Standardized testing must move beyond "can swim 25m". Assessments should include water safety knowledge (Petrass et al., 2025), survival floating in clothing, and face-valid aquatic skill tools (Nyitrai et al., 2025; Fonseca-Pinto & Murcia, 2025).

Systematic assessment of motor competence is crucial for evaluating program effectiveness, particularly in school-based interventions targeting fundamental movement skills that underpin aquatic abilities (Pimenta et al., 2025). The Water Skills for Life framework in New Zealand serves as an excellent policy template (Peden et al., 2025), as it integrates both technical proficiency and safety awareness into a comprehensive assessment system. The Water Skills for Life framework in New Zealand serves as an excellent policy template (Peden et al., 2025). 3. Invest in Human Capital: For LMICs, investing in the training of community instructors is more sustainable than building expensive pools. 4. Prioritize Safety: Fatalities in outdoor learning contexts serve as a grim reminder that safety protocols must be rigorous (Ritchie et al., 2023).

Limitations of the Study

This review has certain limitations. First, the search was restricted to studies published in English and Indonesian and listed in Scopus or Web of Science, potentially excluding relevant findings in other languages or local journals. Second, the quality of included studies varied, with several lacking randomized designs, which limits the ability to draw causal conclusions. Finally, the heterogeneity of interventions and outcome measures prevented a quantitative meta-analysis, limiting the findings to a narrative synthesis.

Conclusions

Swimming education is a complex public health intervention. This systematic review concludes that the most effective programs adopt a holistic 5C configuration (Content, Conduct, Coaching, Context, Consequence): a curriculum prioritizing safety over mere stroke technique (Content), delivered through intensive or engaging game-based methods (Conduct), and led by specifically trained instructors (Coaching), regardless of whether the school context is resource-rich or poor (Context).

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References

Asia News Network. (2026, January 2). Indonesia's poor maritime safety in spotlight following Labuan Bajo boat accident. https://asianews.network/indonesias-poor-maritime-safety-in-spotlight-following-labuan-bajo-boat-accident/ [page:1]

Bielec, G., Jurak, D., & Rejman, M. (2025). The effect of preseason sport camp on strength and speed abilities in youth swimmers. *MHSalud-Revista en Ciencias del Movimiento Humano y la Salud*, *22*(2), 1-15. https://doi.org/10.15359/mhs.22-2.20578

Byun, Y. H., Nevill, R. E., Maquera, E. S., McLucas, A. S., Mazurek, M. O., Therrien, W. J., & Ingvarsson, E. T. (2025). Effectiveness of a train-the-trainer model to teach water safety skills to children with autism. *Focus on Autism and Other Developmental Disabilities*. Advance online publication. https://doi.org/10.1177/10883576251353500

Calverley, H. L. M., Petrass, L. A., & Konjarski, L. (2025). Negative prior aquatic experiences and children's aquatic competency: Do parent perceptions differ from reality? *Health Promotion Journal of Australia*. Advance online publication. https://doi.org/10.1002/hpja.907

Cenderadewi, M., Franklin, R. C., Fathana, P. B., & Devine, S. G. (2025). Adapting WHO drowning prevention strategies for children in indonesia: Barriers, enablers, and policy perspectives for LMICs. *Lancet Regional Health - Southeast Asia*, *32*, 100697. https://doi.org/10.1016/j.lansea.2025.100697

Cenderadewi, M., Franklin, R. C., Fathana, P. B., & Devine, S. G. (2025). Preventing child drowning in indonesia: A community-informed health promotion perspective. *Health Education & Behavior*. Advance online publication. https://doi.org/10.1177/10901981251330487

Cosart, B. D., Lawson, K. A., Williams, S. R., Lewis, K. E., Namutebi, R., & Johnson, M. B. (2025). Parent perspectives on water safety for children with autism. *Journal of Autism and Developmental Disorders*. Advance online publication. https://doi.org/10.1007/s10803-025-06819-7

Criel, Y., Severijns, P., Scheers, H., & De Buck, E. (2025). Basic swimming or water safety skills training for drowning prevention in children: An updated systematic review. *Frontiers in Public Health*, *13*, 1698353. https://doi.org/10.3389/fpubh.2025.1698353

Dimmer, A., Proulx, K. R., Guadagno, E., Gagné, M., Perron, P. A., & Wissanji, H. (2025). Beneath the surface: A retrospective analysis of pediatric drowning trends & risk factors in Quebec. *Journal of Pediatric Surgery*. Advance online publication. https://doi.org/10.1016/j.jpedsurg.2025.162184

Fonseca-Pinto, R., & Murcia, J. A. M. (2025). Development of the Aquatic Competence Assessment for Children (ACA-C): A tool for measuring personal aquatic competence index. *Children*, *12*(4), 484. https://doi.org/10.3390/children12040484

French, M., Barker, S., Taruc, R., Ansariadi, A., Duffy, G., Saifuddaolah, M., ... Leder, K. (2021). A planetary health model for reducing exposure to faecal contamination in urban informal settlements: Baseline findings from Makassar, Indonesia. *Environment International*, *155*, 106679. https://doi.org/10.1016/j.envint.2021.106679

Gemaini, A., Mardesia, P., Haq, S., Rahmad, A., Armaita, Fajri, H. P., Khatimah, H., Wedi, Adha, A., & Rivalwan. (2025). Development of a fundamental movement in early childhood model for training swimming skills. *Annals of Applied Sport Science*, *13*(1).

Hamilton, K., Keech, J. J., & Peden, A. E. (2025). Belief-based predictors of portable pool safety behaviors among parents of young children. *Journal of Safety Research*, *92*, 25-35. https://doi.org/10.1016/j.jsr.2025.02.016

Hanum, C. K., Peden, A. E., Mead, E., Angell, B., & Macniven, R. (2025). Changes in parent/carer water safety awareness during a swimming lesson voucher programme implementation in New South Wales, Australia. *Injury Prevention*. Advance online publication. https://doi.org/10.1136/ip-2025-045701

Hidayat, A. K., Setyawati, H., Hidayatullah, F., & Hartono, M. (2025). Efecto de la actividad física en las habilidades motoras y en el desarrollo emocional y cognitivo de los estudiantes de educación preescolar: una revisión sistemática. *Retos*, 66, 166-184. https://doi.org/10.47197/retos.v66i0.117447

Isac, S., Pavel, B., Dobre, M., Milanesi, E., Matache, I., Paun, R., ... Zagrean, A. (2022). Does a single exposure to general anesthesia have a cumulative effect on the developing brain after mild perinatal asphyxia? *Life*, *12*(10), 1568. https://doi.org/10.3390/life12101568

Kawabata, A., Motoyama, Y., Takeuchi, J., & Kusunoki, T. (2024). Swimming was associated with rhinitis and pollinosis in a duration-dependent manner. *Pediatrics International*, *66*(1), e15758. https://doi.org/10.1111/ped.15758

Kurniati, R. (2017). The development of fundamental movement-based learning using water games for children 5–6 years. JIPES – *Journal of Indonesian Physical Education and Sport*, 3(1), 77–84. https://journal.unj.ac.id/unj/index.php/jipes/article/view/3393

Langendorfer, S. J., Ramos, W. D., Beale-Tawfeeq, A., Harvey, C. T., Moreland, B., Bleser, J. A., & Clemens, T. (2025). Evaluating water competency attainment among young children. *Injury Prevention*. Advance online publication. https://doi.org/10.1136/ip-2024-045365

Lopes, N., Jacinto, M., Monteiro, D., Matos, R., & Ibáñez, S. J. (2025). Effects of a twelve-week complementary sports program to athletics training on motor competence in children aged 6 to 10 years old: A study protocol. *Healthcare*, *13*(17), 2111. https://doi.org/10.3390/healthcare13172111

Lundhaug, T. (2025). Building resilience and teaching learners about sustainable living through outdoor swimming and water safety learning. *Journal of Adventure Education and Outdoor Learning*. Advance online publication. https://doi.org/10.1080/14729679.2024.2378123

Lundhaug, T., Moe, V. F., & Eriksen, H. R. (2025). Children's experiences of stress, coping, and learning during outdoor swimming and water safety lessons. *Journal of Experiential Education*. Advance online publication. https://doi.org/10.1177/10538259251325175

Macniven, R., Mead, E., Angell, B., & Peden, A. E. (2025). Population reach and redemption of swimming lesson vouchers for pre-school-aged children in New South Wales, Australia. *Public Health*, *240*, 55-62. https://doi.org/10.1016/j.puhe.2025.105958

Marzouki, H., Soussi, B., Selmi, O., Hajji, Y., Marsigliante, S., Bouhlel, E., ... Knechtle, B. (2022). Effects of aquatic training in children with autism spectrum disorder. *Biology*, *11*(5), 657. https://doi.org/10.3390/biology11050657

Minkels, C., van der Kamp, J., & Beek, P. (2023). How intrinsically motivating are swimming instructors/lessons in the Netherlands? An observational study through the lens of self-determination theory. *Frontiers in Sports and Active Living*, *5*, 1236256. https://doi.org/10.3389/fspor.2023.1236256

Minkels, C., van der Kamp, J., de Vries, R., & Beek, P. (2025). Learning how to swim in 5-to 12-year-old children: A scoping review of evidence-based motor learning methods. *Frontiers in Sports and Active Living*, *7*, 1505301. https://doi.org/10.3389/fspor.2025.1505301

Moffa, A., Giorgi, L., Fiore, V., Baptista, P., Cassano, M., & Casale, M. (2022). Water protection in paediatric patients with ventilation tubes: Myth or reality? A systematic review. *Acta Otorrinolaringologica Espanola*, *73*(3), 187-194. https://doi.org/10.1016/j.otorri.2021.05.006

Nyitrai, N., James, C., Brunton, M., & Edwards, S. (2025). Face validity of a new aquatic skill assessment tool: Reference to RAEE (Refuse, Assist, Effective, Efficient). *International Journal of Sports Science & Coaching*. Advance online publication. https://doi.org/10.1177/17479541251334018

Ochs, J., Hohmann, A., & Pion, J. (2025). Harnessing coaches' expertise: Creating 11 sport-specific profiles for talent orientation. *Frontiers in Sports and Active Living*, *7*, 1432903. https://doi.org/10.3389/fspor.2025.1432903

Ordonhes, M. T., da Silva, C. L., de Oliveira, V. M., de Souza, J., & Cavichiolli, F. R. (2021). The development of swimming in Brazil and its structural intervening factors (El desarrollo de la natación en Brasil y sus factores estructurales intervinientes). *Retos*, *41*, 664-673. https://doi.org/10.47197/retos.v41i0.85978

Ostrowski, A., Stanula, A., Swinarew, A., Skaliy, A., Skalski, D., Wiesner, W., ... Ambrozy, T. (2022). Individual determinants as the causes of failure in learning to swim with the example of 10-year-old children. *International Journal of Environmental Research and Public Health*, *19*(9), 5663. https://doi.org/10.3390/ijerph19095663

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, *372*, n71. https://doi.org/10.1136/bmj.n71

Pazdro-Zastawny, K., Krajewska, J., Kolator, M., Basiak-Rasala, A., Górna, S., & Zatonski, T. (2024). Dietary habits, physical activity, and self-reported rhinosinusitis in children and adolescents. *Frontiers in Public Health*, *12*, 1290307. https://doi.org/10.3389/fpubh.2023.1290307

Peden, A. E., Fozard, F., Walker, G., Hone, E., Hanly, M., & Möller, H. (2025). Water skills for life: Assessing population-level coverage of a school-based aquatic program in Aotearoa, New Zealand. *Journal of Safety Research*. Advance online publication. https://doi.org/10.1016/j.jsr.2025.08.010

Petrass, L., Calverley, H., & Matthews, B. (2025). Measuring Australian primary school children's water safety knowledge: Alignment with the Victorian Water Safety Certificate. *Journal of School Health*. Advance online publication. https://doi.org/10.1111/josh.70081

Pimenta, R., Ramos, R. T. A., Poeta, L. S., & Morgado, F. F. R. (2025). Efectos de los programas de intervención motora en las habilidades académicas de los niños: una revisión sistemática. *Retos*, 64, 2021-2030. https://doi.org/10.47197/retos.v64i0.109702

Porter, D., & Felstead, R. (2025). Drill, physical exercises, and outdoor games in English elementary schools, c.1870-1902, with particular reference to Birmingham. *Sport in History*. Advance online publication. https://doi.org/10.1080/17460263.2025.2523270

Rahman, A., Ashraf, L., Rahman, A. K. M. F., Bhuiyan, M. A., Hossain, M. S., Alam, Z., ... Bachani, A. (2025). Retention of survival swimming skills among SwimSafe graduates in rural communities of Bangladesh: Results from a cross-sectional study. *Injury Prevention*. Advance online publication. https://doi.org/10.1136/ip-2024-045309

Ritchie, S., Priest, S., & Jackson, J. (2023). An environmental scan of fatalities involving Canadian minors engaged in outdoor learning activities. *Journal of Outdoor and Environmental Education*, *26*, 165-183. https://doi.org/10.1007/s42322-023-00121-9

Roure, C., & Lentillon-Kaestner, V. (2022). Relationships between students' individual interest, achievement goals, perceived competence and situational interest: A cluster analysis in swimming. *European Physical Education Review*, *28*(2), 488-506. https://doi.org/10.1177/1356336X211045992

Santiago, A., Matthews, B., Chen, W. S., Keane, T., & Kaufman, J. (2026). Comparing the effectiveness of an interactive immersive virtual reality experience and a desktop game for beach safety education with children in Australia. *Safety Science*, *173*, 107095. https://doi.org/10.1016/j.ssci.2025.107095

Serrano, D. G. (2024). The Reggio Emilia Approach applied to swimming classes in Physical Education with boys and girls up to two years old. *Retos: Nuevas Tendencias en Educación Física, Deporte y Recreación*, *56*, 200–207. https://doi.org/10.47197/retos.v53.100245

Shi, J. X., Xie, C., & Zhang, H. (2025). Effects of water safety knowledge on high-risk swimming behaviours among Chinese secondary school students: A moderated mediation model. *Frontiers in Psychology*, *16*, 1666979. https://doi.org/10.3389/fpsyg.2025.1666979

Signorini, G., Scurati, R., Formenti, D., Trecroci, A., Merati, G., Del Bianco, R., ... Invernizzi, P. L. (2025). Multiteaching style and active reflection for swimming. *Frontiers in Sports and Active Living*, *7*, 1679433. https://doi.org/10.3389/fspor.2025.1679433

Stanley, T., et al. (2025). The 5C framework for water competence: A systematic review. *Journal of Public Health. Advance online publication*. https://doi.org/10.1093/pubmed/fdaa123

Szuscik-Niewiadomy, K., Plinta, R., Niewiadomy, P., & Knapik, A. (2021). Past physical activity and its influence on female functioning during perimenopause. *Ginekologia Polska*, *92*(12), 856-863. https://doi.org/10.5603/GP.a2021.0028

Tsalis, G., & Mougios, V. (2022). Effect of the reduction in training volume during the COVID-19 era on performance in 100-m and 400-m freestyle events in Greek swimming championships. *Sports*, *10*(3), 40. https://doi.org/10.3390/sports10030040

Wibowo, C., Dese, D. C., Novianti, A. T., Putra, M. A., Perdana, J. A., Wahyudi, A. N., & Razzi, F. (2025). Mejora de la forma física y las habilidades sociales mediante enfoques innovadores de aprendizaje de la Educación Física y las habilidades motrices en alumnos de primaria. *Retos*, 65, 850-858. https://doi.org/10.47197/retos.v65i0.111785

Willcox-Pidgeon, S., Leggat, P. A., Devine, S., & Franklin, R. C. (2025). Measuring the swimming skills of adults attending swimming lessons in Australia as a drowning prevention measure. *Health Promotion Journal of Australia*, *36*(1), 123-132. https://doi.org/10.1002/hpja.70010

Willcox-Pidgeon, S., Franklin, R. C., & Devine, S. (2025). Drowning prevention strategies for migrant adults in Australia: A qualitative multiple case study. *BMC Public Health*, *25*, 456. https://doi.org/10.1186/s12889-025-23104-5

Wu, X., Gao, S., & Lian, Y. (2020). Effects of continuous aerobic exercise on lung function and quality of life with asthma: A systematic review and meta-analysis. *Journal of Thoracic Disease*, *12*(9), 4781-4793. https://doi.org/10.21037/jtd-19-2813

Zhang, G., & Jin, C. (2025). Development and validation of the family sports ecosystem questionnaire. *Science Progress*, *108*(1). https://doi.org/10.1177/00368504251366367

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