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Lucía
Peixoto Pino

PhD Thesis

INTEGRATIVE AND
SCIENTIFIC EDUCATIONAL
APPROACH TO CHILD
DROWNING. INNOVATION
FROM PREVENTION TO
INTERVENTION

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Doctoral Programme in Medicine Clinical Research

PhD Thesis

INTEGRATIVE AND SCIENTIFIC EDUCATIONAL APPROACH TO CHILD DROWNING. INNOVATION FROM PREVENTION TO INTERVENTION

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CONFLICT OF INTEREST

Lucía Peixoto Pino has no conflict of interest to declare regarding this thesis.

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ESCOLA DE DOUTORAMENTO
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1. LIST OF PUBLICATIONS

1 LIST OF PUBLICATIONS

Thesis by compendium of publications indexed in the Journal Citation Report and the Scopus index (article 41 of the Regulations for Doctoral Studies - USC). List of publications:

1. **Peixoto-Pino L**, Barcala-Furelos R, Lorenzo-Martínez M, Rodríguez-Núñez A. Prevención del ahogamiento desde la educación para la salud escolar. Evaluación del proyecto piloto SOS 112. [**Drowning prevention through school health education. Evaluation of the SOS 112 pilot project**]. *Rev Esp Salud Publica*. 2023 Jun 30;97:e202306057. Spanish. PMID: 37970869; PMCID: PMC10541291.
2. **Peixoto-Pino L**, Barcala-Furelos R, Paz-García B, Varela-Casal C, Lorenzo-Martínez M, Gómez-Silva A, Rico-Díaz J, Rodríguez-Núñez A. **The "DrownSafe" Project: Assessing the Feasibility of a Puppet Show in Teaching Drowning Prevention to Children and Parents**. *Children (Basel)*. 2023 Dec 23;11(1):19. doi: 10.3390/children11010019. PMID: 38255332; PMCID: PMC10814459.
3. Barcala-Furelos R, **Peixoto-Pino L**, Zanjaño-Ongil J, Martínez-Isasi S. Desafíos en la enseñanza escolar de los primeros auxilios: análisis de la legislación educativa (LOMLOE) y orientación curricular [**Challenges in teaching first aids at schools: analysis of spanish educational legislation (LOMLOE) and curricular guidance**]. *Rev Esp Salud Publica*. 2024 Feb 23;98:e202402013. Spanish. PMID: 38391131.
4. **Peixoto-Pino L**, Martínez-Isasi S, Otero-Agra M, Van Duijn T, Rico-Díaz J, Rodríguez-Núñez A, Barcala-Furelos R. **Assessing the quality of chest compressions with a DIY low-cost manikin (LoCoMan) versus a standard manikin: a quasi-experimental study in primary education**. *Eur J Pediatr*. 2024 Aug;183(8):3337-3346. doi: 10.1007/s00431-024-05601-8. Epub 2024 May 14. PMID: 38740659; PMCID: PMC11263256.
5. **Peixoto-Pino L**, Barcala-Furelos R, Lorenzo-Martínez M, Gómez-Silva A, Rico-Díaz J, Rodríguez-Núñez J. **Training Children for Prehospital Aquatic Interventions: Assessing Throwing Skills Using Traditional and Alternative Materials in a Simulated Water Rescue**. *Prehospital and Disaster Medicine* (Accepted for publication on May 11, 2024).

2. ABSTRACTS

2 ABSTRACTS

2.1 ABSTRACT

Note: this abstract is a condensed version of the Thesis. The references are cited in the English manuscript.

INTRODUCTION

This doctoral thesis comprises a collection of researchs focused on preventing child drowning through an innovative educational approach. Child drowning is a global public health issue, and in this sense the World Health Organization (WHO) recognizes the critical importance of prevention from an early age. One of the knowledge gaps related to effective strategies to reduce drowning worldwide is the creation and dissemination of feasible educational contents and materials, that could be of universal access, especially in low-resource communities. Trying to fill these gaps, the studies conducted in this Doctoral Thesis range from reviewing Spanish educational legislation to designing and implementing interdisciplinary educational programs for drowning prevention, rescue, and resuscitation, integrating different areas of the school curriculum. These programs have been created with considering pedagogical criteria in order to promote meaningful interactive learning, involving students and families in the educational process. Specifically, four interventions are proposed: first and second focused on prevention using a safe water activities children's song and a puppet show, third on water rescue, based on throwing materials to provide flotation to a person at risk of drowning, and fourth focused on teaching basic cardiopulmonary resuscitation (CPR) with innovative do-it-yourself low-cost manikins (LoCoMan).

HYPOTHESES AND OBJECTIVES

The main hypothesis challenges the feasibility and accessibility of low-cost educational materials and programs for drowning prevention and their knowledge generation in various elements related to aquatic incidents. Therefore, the main objective was scientifically evaluate selected educational interventions' effects on the acquisition of concepts and skills for prevention, rescue, and resuscitation in drowning events. These hypothesis and objectives have been broken down into specific hypotheses and objectives related to each of the five studies presented in this research compendium.

METHODOLOGY

The methodology of the thesis is primarily quantitative and descriptive, using pre- and post-intervention tests, as well as cross-group studies. The studies include both quasi-experimental and randomized designs, focusing on evaluating the feasibility and effectiveness of the proposed educational interventions.

RESULTS

The results of the thesis indicate that innovative educational proposals are effective in improving knowledge, attitudes and skills about drowning prevention. The studies show that children can learn fundamental preventive strategies through creative and innovative educational methods, such as specifically composed/created songs and puppet show. Additionally, the research demonstrates that do-it-yourself low-cost materials, such as

paperboards, plastic tubes and recycled plastic bottles for aquatic rescues, are viable and effective for learning effective rescues and developing the needed motor skills. Such activities and trainings can be embedded in the schools Physical Education schedules. An important finding is that teaching basic CPR with the help of low-cost materials does not compromise the quality of learning compared to using conventional commercial manikins. This suggests that it is possible to implement CPR training programs in resource-limited contexts.

DISCUSSION

The discussion of the thesis focuses on the relevance and applicability of specific drowning educational programs in real risk situations and the need for scientific assessment and long-term follow-up to evaluate their effectiveness. It highlights the importance of considering and determining the optimal age for initiation in each educational content and the necessary frequency for retraining rescue skills. Additionally, it addresses the relevance of providing accessible and low-cost and available educational resources in special for disadvantaged communities along the world. Practical education in drowning prevention and bystander initial rescue should be an integral part of the educational curriculum from the early school stages, promoting a long-lasting culture of aquatic safety from a young age.

CONCLUSIONS

School and community education in drowning prevention and activation of the chain-of-survival must be addressed from a global, pedagogical, multidisciplinary, innovative, inclusive, and accessible approach. The proposals developed in this thesis not only improved the knowledge and skills of participating schoolchildren and families but also offer practical and accessible solutions for wide implementation in low-resource contexts, covering the three essential areas: Prevention, Rescue, and initial Resuscitation. Innovative educational proposals, such as the use of children's songs and puppet shows, proved effective in improving children's knowledge of beach signage and promoting safer behavior practices. Additionally, they contributed to the development of initial rescue and basic resuscitation skills, as they can be trained with do-it-yourself low-cost materials, such as recycled plastic bottles for rescue throws and homemade cardboards with plastic tubes and liquid suction pumps for basic CPR.

2.2 RESUMEN

Nota: este resumen es una versión resumida en castellano de la tesis doctoral redactada en inglés. Las referencias bibliográficas fueron citadas en el manuscrito en inglés.

INTRODUCCIÓN

Esta tesis doctoral comprende una colección de investigaciones centradas en prevenir el ahogamiento infantil mediante un enfoque educativo innovador. El ahogamiento infantil es un problema de salud pública global, y en este sentido, la Organización Mundial de la Salud (OMS) reconoce la importancia crítica de la prevención desde una edad temprana. Una de las lagunas de conocimiento relacionadas con las estrategias efectivas para reducir el ahogamiento a nivel mundial es la creación y difusión de contenidos y materiales educativos viables, que puedan ser de acceso universal, especialmente en comunidades con pocos recursos. Intentando llenar estas lagunas, los estudios realizados en esta Tesis Doctoral abarcan desde la revisión de la legislación educativa española hasta el diseño e implementación de programas educativos interdisciplinarios para la prevención del ahogamiento, el rescate y la reanimación, integrando diferentes áreas del currículo escolar. Estos programas han sido creados considerando criterios pedagógicos para promover un aprendizaje significativo e interactivo, involucrando a estudiantes y familias en el proceso educativo. Específicamente, se proponen cuatro intervenciones: primera y segunda centradas en la prevención utilizando una canción infantil sobre actividades seguras en el agua y un espectáculo de títeres, tercera en el rescate acuático, basada en lanzar materiales para proporcionar flotación a una persona en riesgo de ahogamiento y cuarta y última, enfocada en enseñar reanimación cardiopulmonar (RCP) básica con maniqués innovadores de bajo coste y fabricados de forma casera (LoCoMan).

HIPÓTESIS Y OBJETIVOS

La hipótesis principal se centra en la viabilidad y accesibilidad de materiales y programas educativos de bajo coste para la prevención del ahogamiento y su generación de conocimiento en varios elementos relacionados con incidentes acuáticos. Por lo tanto, el objetivo principal de esta tesis fue evaluar científicamente los efectos de las intervenciones educativas seleccionadas sobre la adquisición de conceptos y habilidades para la prevención, el rescate y la reanimación en eventos de ahogamiento. Estas hipótesis y objetivos se han desglosado en hipótesis y objetivos específicos relacionados con cada uno de los cinco estudios presentados en este compendio de investigación.

METODOLOGÍA

La metodología de la tesis es principalmente cuantitativa y descriptiva, utilizando pruebas/test antes y después de las intervenciones, así como estudios entre grupos. Los estudios incluyen tanto diseños cuasi-experimentales como aleatorizados, centrándose en evaluar la viabilidad y efectividad de las intervenciones educativas propuestas.

RESULTADOS

Los resultados de la tesis indican que las propuestas educativas innovadoras son efectivas para mejorar el conocimiento, actitudes y habilidades sobre la prevención del ahogamiento. Los estudios muestran que los niños pueden aprender estrategias preventivas fundamentales a través de métodos educativos creativos e innovadores, como canciones y espectáculos de títeres específicamente diseñados. Además, la investigación demuestra que los materiales de

bajo coste como botellas de plástico recicladas para rescates acuáticos, son viables y efectivos para aprender rescates efectivos y desarrollar las habilidades motrices básicas. Estas actividades y entrenamientos pueden integrarse en los horarios de Educación Física de las escuelas. Un hallazgo importante es que enseñar RCP básica con la ayuda de materiales de bajo coste no disminuye la calidad del aprendizaje en comparación con el uso de maniqués comerciales convencionales. Esto sugiere que es posible implementar programas de entrenamiento en RCP en contextos con recursos limitados.

DISCUSIÓN

La discusión de la tesis se centra en la relevancia y aplicabilidad de programas educativos específicos para el ahogamiento en situaciones de riesgo reales y la necesidad de una evaluación científica y seguimiento a largo plazo para evaluar su efectividad. Se destaca la importancia de considerar y determinar la edad óptima para el inicio de cada contenido educativo y la frecuencia necesaria para el reentrenamiento de habilidades de rescate. Además, se aborda la relevancia de proporcionar recursos educativos accesibles y de bajo coste disponibles especialmente para comunidades desfavorecidas en todo el mundo. La educación práctica en prevención de ahogamientos y rescate inicial por parte de testigos debe ser una parte integral del currículo educativo desde las primeras etapas escolares, promoviendo una cultura duradera de seguridad acuática desde la niñez.

CONCLUSIONES

La educación escolar y comunitaria en la prevención del ahogamiento y la activación de la cadena de supervivencia debe abordarse desde un enfoque global, pedagógico, multidisciplinar, innovador, inclusivo y accesible. Las propuestas desarrolladas en esta tesis no solo mejoraron el conocimiento y las habilidades de los escolares y familias participantes, sino que también ofrecen soluciones prácticas y accesibles para una implementación amplia en cualquier contexto independientemente de sus recursos, cubriendo las tres áreas esenciales: prevención, rescate y reanimación inicial. Las propuestas educativas innovadoras, como el uso de canciones infantiles y espectáculos de títeres demostraron ser efectivas, mejorando el conocimiento de los escolares sobre la señalización en playas, así como promover los comportamientos y prácticas más seguras. Además, contribuyeron al desarrollo de habilidades iniciales de rescate y reanimación básica, ya que pueden ser entrenadas con materiales de bajo coste y auto fabricados, como botellas de plástico recicladas para lanzamientos de rescate y maniqués de cartón con tubos plásticos y bombas de succión de líquidos para RCP básica.

2.3 RESUMO

Nota:

Este resumo é unha versión reducida do documento de tese en inglés. As referencias bibliográficas foron citadas no manuscrito en inglés.

INTRODUCCIÓN

Esta tese doutoral comprende unha colección de investigacións centradas en prever o afogamento infantil mediante un enfoque educativo innovador. O afogamento infantil é un problema de saúde pública global, e neste sentido, a Organización Mundial da Saúde (OMS) reconece a importancia crítica da prevención desde unha idade temperá. Unha das lagoas de coñecemento relacionadas coas estratexias efectivas para reducir o afogamento a nivel mundial é a creación e difusión de contidos e materiais educativos viables, que poidan ser de acceso universal, especialmente en comunidades con poucos recursos. Tentando encher estas lagoas, os estudos realizados nesta Tese Doutoral abranguen desde a revisión da lexislación educativa española ata o deseño e implementación de programas educativos interdisciplinares para a prevención do afogamento, o rescate e a reanimación, integrando diferentes áreas do currículo escolar. Estes programas foron creados considerando criterios pedagóxicos para promover unha aprendizaxe significativa e interactiva, involucrando a estudantes e familias no proceso educativo. Especificamente, proponse catro intervencións: primeira e segunda centradas na prevención utilizando unha canción infantil sobre actividades seguras na auga e un espectáculo de monicreques, terceira no rescate acuático, baseada en lanzar materiais para proporcionar flotación a unha persoa en risco de afogamento e cuarta e última, enfocada en ensinar reanimación cardiopulmonar (RCP) básica con maniquís innovadores de baixo custo fabricados de forma caseira (LoCoMan).

HIPÓTESES E OBXECTIVOS

A hipótese principal céntrase na viabilidade e accesibilidade de materiais e programas educativos de baixo custo para a prevención do afogamento e a súa xeración de coñecemento en varios elementos relacionados con incidentes acuáticos. Polo tanto, o obxectivo principal desta tese foi avaliar cientificamente os efectos das intervencións educativas seleccionadas sobre a adquisición de conceptos e habilidades para a prevención, o rescate e a reanimación en eventos de afogamento. Estas hipóteses e obxectivos desglosáronse en hipóteses e obxectivos específicos relacionados con cada un dos cinco estudos presentados neste compendio de investigación.

METODOLOXÍA

A metodoloxía da tese é principalmente cuantitativa e descritiva, utilizando probas/test antes e despois das intervencións, así como estudos entre grupos. Os estudos inclúen tanto deseños cuasi-experimentais como aleatorizados, centrándose en avaliar a viabilidade e efectividade das intervencións educativas propostas.

Os resultados da tese indican que as propostas educativas innovadoras son efectivas para mellorar o coñecemento, actitudes e habilidades sobre a prevención do afogamento. Os estudos mostran que os nenos poden aprender estratexias preventivas fundamentais a través de métodos educativos creativos e innovadores, como cancións e espectáculos de monicreques especificamente deseñados. Ademais, a investigación demostra que os materiais de baixo custo, como botellas de plástico recicladas para rescates acuáticos, son viables e efectivos para aprender rescates efectivos e desenvolver as habilidades motrices básicas. Estas actividades e adestramentos poden integrarse nos horarios de Educación Física das escolas. Un achado importante é que ensinar RCP básica coa axuda de materiais de baixo custo non diminúe a calidade da aprendizaxe en comparación co uso de maniquís comerciais convencionais. Isto suxire que é posible implementar programas de adestramento en RCP en contextos con recursos limitados.

DISCUSIÓN

A discusión da tese céntrase na relevancia e aplicabilidade de programas educativos específicos para o afogamento en situacións de risco reais e a necesidade dunha avaliación científica e seguimento a longo prazo para avaliar a súa efectividade. Destácase a importancia de considerar e determinar a idade óptima para o inicio de cada contido educativo e a frecuencia necesaria para o reaprendizaxe de habilidades de rescate. Ademais, abórdase a relevancia de proporcionar recursos educativos accesibles e de baixo custo dispoñibles especialmente para comunidades desfavorecidas en todo o mundo. A educación práctica en prevención de afogamentos e rescate inicial por parte de testemuñas debe ser unha parte integral do currículo educativo desde as primeiras etapas escolares, promovendo unha cultura duradeira de seguridade acuática desde a nenez.

CONCLUSIÓNS

A educación escolar e comunitaria na prevención do afogamento e a activación da cadea de supervivencia debe abordarse desde un enfoque global, pedagóxico, multidisciplinar, innovador, inclusivo e accesible. As propostas desenvolvidas nesta tese non só melloraron o coñecemento e as habilidades dos escolares e familias participantes, senón que tamén ofrecen solucións prácticas e accesibles para unha implementación ampla en calquera contexto independentemente dos seus recursos, cubrindo as tres áreas esenciais: prevención, rescate e reanimación inicial. As propostas educativas innovadoras, como o uso de cancións infantís e espectáculos de monicreques demostraron ser efectivas, mellorando o coñecemento dos escolares sobre a sinalización en praias, así como promover os comportamentos e prácticas máis seguras. Ademais, contribuíron ao desenvolvemento de habilidades iniciais de rescate e reanimación básica, xa que poden ser adestradas con materiais de baixo custo e auto-fabricados, como botellas de plástico recicladas para lanzamentos de rescate e maniquís de cartón con tubos plásticos e bombas de succión de líquidos para RCP básica.

2.4 RESUMO AMPLIADO EN GALEGO (>3000 PALABRAS)

Esta versión, redactada en GALEGO, conta con máis de 3000 palabras, de acordo coa normativa da Universidade de Santiago de Compostela. As referencias bibliográficas son citadas no manuscrito en inglés.

INTRODUCCIÓN

Esta tese doutoral comprende unha colección de investigacións centradas en previr o afogamento infantil mediante un enfoque educativo innovador. O afogamento infantil é un problema de saúde pública global, e neste sentido, a OMS reconece a importancia crítica da prevención desde unha idade temperá. reconece a importancia da prevención dende a idade infantil. Un dos baleiros de coñecemento nas estratexias para reducir o afogamento é a creación e difusión de contidos e materiais educativos, así como o acceso universal, especialmente nas comunidades con poucos recursos.

Os estudos realizados nesta tese doutoral abarcan desde a revisión da lexislación educativa española ata a implementación de programas educativos interdisciplinares de prevención, rescate e reanimación, que integran diferentes áreas do currículo escolar. Estes programas están deseñados con criterios pedagóxicos para promover aprendizaxes significativas, nas que o alumnado e as familias son partícipes do proceso educativo. Concretamente, propóñense catro intervencións: dúas centradas na prevención usando unha canción infantil e un teatro de monicreques; unha de rescate, baseada no lanzamento de materiais para prover flotación a unha persoa en risco de afogamento; e a última, centrada no ensino da reanimación cardiopulmonar con maniqués de baixo custo denominados LoCoMan.

A motivación ven da relevancia do afogamento coma unha das principais causas prevenibles de morte non intencional. A OMS considérao un problema maior de saúde pública que afecta a comunidades de todo o mundo. Os datos epidemiolóxicos indican que anualmente unhas 300.000 persoas morren por afogamento, aínda que esta cifra pode estar infravalorada pola dificultade de numerosos países para manter unha estatística actualizada e veraz dos incidentes acuáticos. A mortalidade infantil por afogamento é especialmente relevante, xa que supón a terceira causa de morte global en nenos a partir dos 5 anos e é a primeira en menores de 14 anos, cunha incidencia aproximada de 129.553 mortes en todo o mundo no ano.

Os incidentes infantís no medio acuático teñen diversas causas, como a falta de competencia acuática, a ausencia de supervisión directa e os descoidos por parte dos coidadores, por este motivo, a cadea de supervivencia do afogamento presenta unha secuencia de 5 eslabóns, partindo da prevención como o elemento principal, o rescate seguro (segundo, terceiro e cuarto eslabón) e finalmente a aplicación de coidados e primeiros auxilios da persoa afogada. O afogamento infantil é multifactorial, polo que o seu abordaxe tamén debería selo e involucrar aos pais ou coidadores, xa que reforzan as aprendizaxes e os comportamentos seguros no medio acuático. De cara a conseguir resultados que beneficien á maior cantidade de persoas posible, a creación de recursos accesibles e de baixo custo pode ser unha alternativa accesible para toda a comunidade, en todo o mundo, polo que o seu deseño e estudo é pertinente no eido da investigación en ciencias da saúde e en ciencias da educación, sendo un elemento de transferencia do coñecemento á toda a sociedade.

HIPÓTESES E OBXECTIVOS

Hipótese xeral: os programas educativos para a prevención do afogamento son viables, accesibles e xeran coñecemento práctico nos diferentes elementos relacionados co afogamento (prevención, rescate e reanimación), mesmo sendo de baixo custo.

Obxectivo xeral: avaliar o efecto de diferentes intervencións educativas na adquisición de conceptos e habilidades para a prevención do afogamento, rescate e reanimación.

As hipóteses e obxectivos específicos detállanse a continuación para cada unha das tres seccións (prevención, rescate e reanimación inicial) e para cada unha das cinco publicacións que compoñen o compendio de publicacións da tese.

H1-O1. Análise curricular baseada na lexislación educativa española (Artigo 1)

- H1 - Artigo 1: O currículo educativo español contempla contidos relacionados de forma directa e indirecta coa prevención do afogamento e os primeiros auxilios.
- O1- Artigo 1: Analizar e avaliar a lexislación educativa española relacionada coa prevención de accidentes e primeiros auxilios nos diferentes niveis educativos (educación infantil, educación primaria, educación secundaria e bacharelato).

H2-O2. Prevención do afogamento no ámbito escolar (Artigos 2 e 3)

- H2: A implementación de propostas educativas innovadoras, interdisciplinares e na contorna da comunidade educativa fomentan a comprensión de riscos acuáticos e a aprendizaxe de conceptos relacionados coa prevención do afogamento.
 - o H2.1 - Artigo 2: O uso de cancións e métodos educativos creados especificamente con este obxectivo favorece a aprendizaxe de conceptos e actitudes relacionados coa prevención do afogamento.
 - o H2.2 - Artigo 3: Un espectáculo de monicreques, especificamente deseñado con mensaxes orientadas cara á seguridade dos nenos na contorna acuática, mellorará o coñecemento e as actitudes das familias (fillos e proxenitores) sobre a prevención do afogamento.
- O2: Avaliar a modificación de coñecementos sobre as estratexias preventivas fundamentais para evitar afogamentos.
 - o O2 - Artigo 2: Avaliar a modificación de coñecementos en relación ao significado das bandeiras do mar, o afrontamento dun rescate acuático, o número de emerxencias e as actitudes seguras durante o baño.
 - o O2 - Artigo 3: Avaliar a viabilidade e os efectos inmediatos desta estratexia e ferramenta de ensino innovadora (espectáculo de monicreques).

H3-O3. Habilidades de salvamento –rescate e reanimación cardiopulmonar básica– en caso de afogamento, adquiridas por nenos en idade escolar (Artigos 4 e 5)

- H3: O uso de materiais de baixo custo ou auto fabricados (feitos por eles mesmos), pode ser unha alternativa viable e adaptada para o desenvolvemento de habilidades de rescate e reanimación.
 - o H3 - Artigo 04: Os materiais de rescate convencionais non son axeitados para lanzamentos a longa distancia, mentres que elementos lixeiros e máis pequenos, feitos a man, son mellores para os nenos.
 - o H3 - Artigo 5: O ensino da RCP básica integrada nas actividades escolares con materiais de baixo custo é viable e non supón unha

disminución da calidade en comparación cun maniquí comercial convencional.

- O3: Analizar diferentes habilidades de rescate e reanimación inicial de baixo custo adaptadas a nenos.
 - o O3 - Artigo 4: Analizar a capacidade de lanzamento (distancia e precisión) de dous materiais de rescate específicos (aro salvavidas e tubo de rescate), e comparalos cun material non convencional, a botella de plástico.
 - o O3 - Artigo 5 – Avaliar a aprendizaxe de habilidades de RCP practicando cun maniquí de baixo custo (LoCoMan) con feedback visual cualitativo para as compresións torácicas continuas.

MATERIAIS E MÉTODOS

En xeral, os estudos desta tese son cuantitativos e descriptivos, baseados en probas realizadas en dous momentos (pre e post), e en probas cruzadas entre grupos. Os detalles concretos da metodoloxía en casa estudo son detallados na sección correspondente de cada artigo. A continuación, destacamos os aspectos máis importantes da metodoloxía dos estudos incluídos na tese doutoral.

O artigo 1 baséase nunha revisión, analítica e crítica, da lexislación española actual no eido da educación nas etapas de primaria e secundaria, baseada nun enfoque de análise de consenso por expertos.

O artigo 2 desta tese consistiu nun estudo preliminar de viabilidade, descriptivo e non aleatorizado con avaliación en dous momentos; antes da intervención e despois da intervención.

O artigo 3 foi un estudo quasi-experimental deseñado, que comprende tres fases: creación do espectáculo de monicreques, recrutamento da mostra, e avaliación pre e post-intervención.

O artigo 4 tivo un deseño de estudo cruzado aleatorizado usado para examinar as diferenzas entre equipos de rescate convencionais, como un aro salvavidas e un tubo de rescate, cunha botella de plástico.

Finalmente, o artigo 5 baseouse nun estudo quasi-experimental e transversal realizado usando dous grupos de intervención non aleatorizados; o grupo LoCoMan (LG) adestrado cun maniquí de baixo custo feito a man e un grupo control (CG) practicou cun modelo de maniquí pediátrico convencional, Resusci Junior (Laerdal, Noruega).

O compendio de investigacións nas que participaron humanos (estudos do 2 ao 5) recibiron autorización dun comité de ética da investigación (Apéndice 1) baixo todos os criterios de confidencialidade, protección e autorización previa aos estudos e, desenvolvéronse de acordo cos principios da Declaración de Helsinki.

Cando foi necesaria unha análise cuantitativa (artigos 2, 3, 4 e 5), realizáronse no software IBM SPSS Statistics (v.20 a 25 para Windows, Armonk, NY: IBM Corp). Tódalas análises estatísticas están descritas de forma detallada na sección estatística de cada artigo.

RESULTADOS

Os principais resultados do artigo 1: Na análise dos tres Reales Decretos (RD), identificáronse dez conceptos xerais: prevención de accidentes; protocolo Protexer, Alertar, Socorrer (PAS); protocolo 1-1-2; posición lateral de seguridade (PLS); reanimación cardiopulmonar (RCP); desfibrilador externo automático ou semiautomático (DEA); obstrución das vías aéreas por corpo extraño (OVACE); primeiros auxilios; transporte do

ferido; e ictus. Ao longo de todas as etapas educativas, en vinte e sete ocasións apareceu contido explícitamente relacionado coa prevención de accidentes ou a aprendizaxe de primeiros auxilios.

Os principais resultados do artigo 2: Aproximadamente a metade dos nenos con idades comprendidas entre 8 e 9 anos –terceiro curso de educación primaria- descoñecía o significado das bandeiras de sinalización de risco nas praias. Despois de escoitar a canción composta para o estudo, todos os estudantes identificaron o significado da bandeira vermella, e máis do 90% recoñeceron as bandeiras verde e amarela ($p < 0.001$). Antes da intervención, o 75.3% dos nenos identificaron correctamente os pictogramas de actitudes seguras na auga. Esta percepción de actitudes seguras aumentou significativamente despois da intervención ($p < 0.001$), co recoñecemento do 86.4% dos comportamentos correctos. A puntuación global de seguridade na auga tamén mellorou significativamente nun 22.7% despois da intervención ($p < 0.001$).

Os principais resultados do artigo 3: Realizáronse probas antes e despois do espectáculo (30 minutos da obra de monicreques en directo – ver o seguinte enlace https://www.youtube.com/watch?v=1Z3gI_dgb9Q&list=PLFQeczn2LeDI4ZZEH5Z5PXqY9v7X7Hbs - para avaliar o

coñecemento e os comportamentos respecto aos ambientes acuáticos. Antes do espectáculo de monicreques, o 78% dos nenos mostraron competencia acuática básica. Só o 33% consideraba arriscado nadar só. Tras a intervención, o 81.6% dos nenos mudaron a súa percepción dos riscos das actividades en solitario na praia, mostrando un mellor coñecemento sobre como contactar co número de emerxencia 112 (do 63.2% ao 98.9%, $p < 0.001$). A intervención aumentou a intención dos pais de visitar praias con socorristas e mellorou o seu coñecemento sobre a RCP en vítimas de afogamento nun 58.8%.

Os principais resultados do artigo 4: Os nenos de todas as idades foron capaces de lanzar a botella de plástico significativamente máis lonxe que o aro salvavidas ($p < 0.001$; $d = 1.19$) ou o tubo de rescate ($p < 0.001$; $d = 0.60$). Non houbo diferenzas significativas ($p = 0.414$) na porcentaxe de nenos que conseguiron lanzar cada obxecto con precisión. Os materiais de rescate convencionais, particularmente o aro salvavidas, poden non ser axeitados para lanzamentos a longa distancia por nenos. En contraste, alternativas máis lixeiras e pequenas, como as botellas de plástico.

Os principais resultados do artigo 5: Os resultados das variables de rendemento da RCP de calidade, foron comparados entre grupos (grupo LoCoMan vs. grupo Control). Os grupos LoCoMan e de control acadaron unha porcentaxe aceptable de calidade (57% e 71%, $p = 0.004$). Entre os estudantes de 6º curso, non houbo diferenzas significativas na calidade da RCP entre LoCoMan 68% e control 71%, $p = 0.66$. O grupo de control acadou mellor profundidade de compresión torácica mentres que o grupo LoCoMan mostrou máis compresións correctas con retroceso torácico adecuado (descompresión de peito).

DISCUSIÓN

A relevancia do problema (afogamento infantil) e a ausencia de literatura científica ao respecto, require do desenvolvemento de estudos baseados no método científico. O obxectivo xeral desta tese foi avaliar o efecto de diferentes intervencións educativas na adquisición de conceptos e habilidades para a prevención do afogamento, rescate e reanimación. Os achados máis importantes foron:

- a) A lexislación educativa española inclúe diferentes elementos curriculares vinculados á prevención de accidentes e ensino dos primeiros auxilios, especialmente da RCP.

- b) As propostas educativas baseadas en cancións infantís contribúen á aprendizaxe de códigos e sinalética relacionada coa prevención de afogamentos, o número europeo de emerxencias, así como a modificación de condutas potencialmente perigosas, como a de intentar facer un rescate sen coñecementos.
- c) Un espectáculo de monicreques pode ser unha estratexia efectiva para fomentar o coñecemento da prevención do afogamento en familia.
- d) A distancia de lanzamento de materiais de rescate (convencionais ou alternativos) increméntase coa idade, pero os materiais lixeiros e alternativos como unha botella de plástico dobran a distancia en comparación co aro salvavidas.
- e) Un maniquí de baixo custo é unha ferramenta válida para o ensino da RCP en escolares.

O afogamento é un problema de saúde pública e a OMS estableceu diversas estratexias para reducir a súa incidencia. Principalmente baséanse en medidas que fomentan a concienciación, o ensino da RCP e o ensino da natación. Non obstante, no entorno educativo formal apenas existen propostas de intervención educativa validadas cientificamente. Está comunmente aceptado que introducir na ensinanza formal e informal a prevención de accidentes é beneficioso para a sociedade. Por este motivo, esta tese ten unha finalidade educativa, e para iso estruturouse en tres bloques de análise. O primeiro, baseado na revisión da lexislación educativa española vinculada aos primeiros auxilios. O segundo bloque de discusión reflicte as consideracións sobre a educación para a prevención discutidas no artigo 2 e 3. Finalmente, o terceiro bloque de discusión céntrase nas intervencións (rescate e reanimación) plantexadas nos estudos 4 e 5.

No primeiro artigo analizáronse os Reais Decretos ao amparo da LOMLOE e puido constatar que a prevención de accidentes e as actuacións básicas de primeiros auxilios deben comezar no segundo ciclo da Educación Primaria. Nos últimos cursos desta etapa incídese en condutas de seguridade e coidados básicos; (PAS) e (PLS). Co inicio da Educación Secundaria, aparece un incremento substancial en contidos relacionados cos primeiros auxilios e é a primeira vez que aparece explicitamente a RCP e o uso do DEA/DESA. Ao finalizar a Educación Secundaria todos os alumnos deben coñecer o SVB. En Bacharelato espérase que o alumnado teña unha análise de riscos, máis aló do entorno escolar e que poida actuar incluso usando os materiais dun botiquín de primeiros auxilios. En consecuencia, pódese apreciar unha tendencia crecente nos contidos curriculares vinculados aos primeiros auxilios, pero aínda moi escasos ou inexistentes en prevención do afogamento. Nos artigos 2 e 3 desta tese buscábase avaliar e mellorar o recoñecemento das bandeiras da praia (vermella, verde e amarela). No segundo estudo (análise do efecto das cancións infantís como método de prevención do afogamento), inicialmente pouco máis da metade dos nenos (55%) coñecía o significado da bandeira vermella, algo que cambiou tras a intervención educativa. Curiosamente, no terceiro estudo (análise do efecto dos monicreques na prevención do afogamento) atopouse unha porcentaxe moi alta de nenos que recoñecían as cores das bandeiras antes da intervención (en torno ao 90%). Quizais a diferenza radica en que a primeira actividade se enmarcaba dentro do ámbito escolar, mentres que a segunda era unha actividade voluntaria, extraescolar e fóra dun canal educativo formal, polo que posiblemente as familias asistentes, en moitos casos tiñan unha predisposición cara á prevención do afogamento. As probas científicas atopadas mostraron que o uso de cancións ou a educación mediante monicreques, ten un potencial educativo moi relevante.

Este enfoque educativo é práctico e rendible, e tamén permite abordar crenzas falsas nun escenario imaxinario. O espectáculo de monicreques enfatiza en numerosos elementos comúns na prevención do afogamento, que a miúdo, son tamén responsabilidade dos proxenitores e coidadores. O principal factor é a falta de supervisión, e por este motivo, na “trama” represéntanse dous afogamentos non mortais, nos que os pais da monicreque protagonista, non se atopaban no lugar do incidente. A estratexia preventiva principal, recoñecida e recomendada, é a supervisión, definida como supervisión directa e de contacto, onde os adultos están ao alcance do neno. A supervisión adecuada comprende tres compoñentes clave: proximidade (dos adultos cos nenos, durante o baño e actividades acuáticas), atención (evitar despistes, por exemplo, co teléfono mobil) e continuidade (non facer interrupcións na vixilancia). Polo tanto, os adultos xogan un papel activo e toman conciencia da importancia da supervisión. Despois da intervención, a metade dos adultos indicaron un aumento no seu coñecemento sobre a prevención do afogamento. Outro resultado positivo do espectáculo de monicreques foi un aumento na intención dos pais e nais de visitar praias supervisadas, recoñecendo que os socorristas proporcionan seguridade adicional.

Os artigos 3 e 4 desta tese céntranse no ensino de habilidades para o rescate por parte das persoas legas que presencien ou sexan testemuñas dun afogamento e a reanimación inicial (activación da cadea de supervivencia). As recomendacións para persoas sen experiencia, inclúen que cando sexan testemuñas dun incidente acuático e perciban a alguén que pode estar afogándose, non deben entrar na auga, xa que se poñerían en risco (existe evidencia de que as persoas non expertas poden afogar ao realizar un rescate acuático), polo que deben intentar o rescate dende fora da auga, lanzando algún obxecto que permita flotar á persoa en risco de afogamento. Un dos principios da OMS é a recomendación de ensinar técnicas de rescate seguras, sen entrar na auga, por este motivo, o concepto de “lanzar, remar e non ir” é comúnmente aceptado pola comunidade científica, xa que se considera un dos paradigmas da prevención. Non obstante, esta recomendación carece de experiencias prácticas que respondan á pregunta de; cal é o material máis axeitado para que unha testemuña (principalmente neno) poida axudar a unha persoa na auga?

Na nosa investigación observouse que o material máis pesado (aro salvavidas) lánzase polos nenos a unha distancia media de 2 metros aos 6 anos e só aumentan a distancia en 2 metros ao longo da educación primaria, alcanzando 4 metros aos 12 anos. En contraste, o material máis lixeiro (botella de plástico) é lanzado ao dobre da distancia polos nenos de 6 anos, practicamente lanzando a mesma distancia (4 metros) que os preadolescentes no último ano de educación primaria ao lanzar o aro salvavidas. Aos 12 anos, usando a botella de plástico, os rapaces poden acadar distancias similares ás que os adultos poden lanzar unha liña de vida (aproximadamente 7 metros).

Dous aspectos fundamentais desta investigación son a elevada aplicación práctica e transferencia do coñecemento a toda a comunidade, así coma o desenvolvemento de estratexias de baixo custo para a ensinanza dos primeiros auxilios. A construción de maniqués de RCP, como LoCoMan, pode contribuír aos principios promovidos desde hai anos por diversas sociedades científicas como o Consello Europeo de Resucitación (European Resuscitation Council (ERC) ou a Asociación Americana do Corazón American Heart Association (AHA), que promoven o ensino escolar da RCP agrupado baixo o concepto KIDS SAVE LIVES (Os nenos salvan vidas), desenvolvendo recursos audiovisuais, cancións educativas, redes sociais, metodoloxías gamificadas ou materiais innovadores que están logrando aprendizaxes significativas e estables ao longo do tempo.

En síntese, esta tese doutoral plantexou catro intervencións de baixo custo, que ademais están dispoñibles en liña para ser usadas por calquera centro educativo, comunidade interesada na prevención do afogamento ou familias que queiran ofrecer unha educación acuática accesible e baseada na evidencia. É dicir, trátase dunha liña de investigación baseada nun problema importante para a sociedade e que fai aportacións baseadas en probas científicas que revirten de forma directa na comunidade, contribuíndo a diminuir mortes e discapacidades evitables, con unha grande repercusión nas persoas e as familias, tanto no momento do evento como ó longo da toda vida restante ós superviventes.

APORTACIÓNS DESTA TESE:

Para profesores, mestres e educadores:

- O artigo 1 analiza a lexislación educativa e dá soporte para a formación nas escolas, ofrecendo aos docentes unha información valiosa sobre que contido ensinar en cada nivel.
- Os artigos 2 e 5 ofrecen propostas educativas interdisciplinares, incluíndo simultaneamente diferentes áreas do currículo baseadas na aprendizaxe significativa.
- O artigo 3 plantexa como dende as obras educativas de monicreques se pode intervir na prevención do afogamento a nivel familiar.
- O artigo 4 desenvolve un contido obrigatorio en Educación Física (lanzamentos), dándolle sentido e funcionalidade, baseado na aprendizaxe significativa (lanzar para salvar unha vida).

Para todas as persoas:

- O artigo 2 e o seu elemento fundamental (a canción) está dispoñible en Youtube. <https://www.youtube.com/watch?v=8qSE8H43rpQ>
- O artigo 3, o espectáculo de monicreques e pílulas adicionais están dispoñibles en Youtube. https://www.youtube.com/watch?v=1Z3gI_dgb9Q&t=868s
- O artigo 4 promove o uso dunha botella de plástico para o rescate sen entrar na auga.
- O artigo 5 ensina a fabricar un maniquí DIY, de baixo custo e con feedback, dispoñible en aberto, na web do European Journal of Pediatrics. <https://link.springer.com/article/10.1007/s00431-024-05601-8#Sec15>

Todo o traballo e propostas desenvolvidas nesta tese de doutoramento baséanse na distribución global e gratuíta (creative commons) a través de internet, polo que a súa accesibilidade é posible para millóns de persoas.

CONCLUSIÓNS

As conclusións desta tese están organizadas en tres seccións, correspondentes ás tres hipóteses desenvolvidas nos diversos artigos deste compendio de publicacións.

- Conclusións da H1 e O1: O currículo actual dota de contido dende a educación primaria especialmente na prevención de accidentes e primeiros auxilios, promovendo a RCP principalmente na educación secundaria e a prevención no medio acuático na etapa de Bacharelato.
- Conclusións da H2 e O2: As propostas educativas innovadoras melloran o coñecemento de conceptos e códigos relacionados coa prevención do afogamento.
 - o H e O 2.1 As cancións infantís con mensaxes preventivas conseguen mellorar o coñecemento sobre a sinalética das praias (bandeiras),

- incrementando a percepción sobre actitudes responsables cara a un baño máis seguro, así como o recoñecemento do número europeo de emerxencias 112.
- o H e O 2.2 Un modelo educativo comunitario baseado nun espectáculo de monicreques é efectivo en promover o coñecemento e comportamentos máis seguros para a prevención do afogamento tanto en nenos pequenos como nos seus proxenitores.
 - Conclusións da H3 e O3: As habilidades de rescate e reanimación poden ser adestradas e desenvolvidas con materiais de baixo custo sen supor unha inferioridade con materiais comerciais convencionais.
 - o H e O 3.1 Os nenos poden lanzar material de rescate con boa precisión, pero a diferentes distancias, non obstante, os materiais máis pesados como o aro salvavidas poden non ser axeitados para longas distancias en contraste con alternativas máis lixeiras e pequenas, como as botellas de plástico.
 - o H e O 3.2 O uso dun maniquí de baixo custo feito a man con feedback visual pode ser unha alternativa para o adestramento e aprendizaxe da RCP básica na escola, e poden integrarse en proxectos educativos comúns desde diversas materias do currículo escolar.

3. INTRODUCTION

3 INTRODUCTION

3.1 DROWNING AS A PUBLIC HEALTH ISSUE

Drowning is a type of preventable incident described as the inability to breathe due to liquid aspiration following immersion or submersion in a fluid(1),. The World Health Organization (WHO) considers it a main public health issue affecting communities worldwide(2–4). Epidemiological data indicate that annually at least 300,000 people die from drowning(5), although this figure may be underestimated due to the difficulty many countries face in maintaining updated and accurate statistics on aquatic incidents. It is estimated that for every person who dies from drowning, between three and five receive care in emergency services for a water-related incident(6). Drowning as a public health problem is particularly relevant in low-resource populations, especially in Southeast Asia(7). Child mortality from drowning is especially significant, as it is the third leading cause of global death in children over 5 years old and the first in those under 14, with an approximate incidence of 129,553 deaths worldwide per year(4). In addition, morbidity of those who survive to a drowning event are not well known and specially in children may impact significantly in terms of long-lasting disabilities and poor quality of life.

Child incidents in aquatic environments have multifactorial causes, such as lack of aquatic competence(8), absence of direct supervision, and caregiver negligence(9–12). For this reason, with the aim of integrate all the steps to prevent, rescue and comprehensive management of victims, the drowning survival chain presents a sequence of 5 links, starting with prevention as the main element, safe rescue (from the second to the fourth link), and finally (fifth link) the application of care and first aid(13). Both the WHO and various organizations fighting against drowning agree and consider as priority that prevention through education and community awareness is the most cost-effective way to reduce incidence and/or improve prognosis in case of drowning. In this sense, the “drowning timeline” (a systematic model defining drowning) describes a systematic model that starts with preparing society through education and promotion of water safety(14).

When all preventive measures fail and an aquatic incident occurs, a person can drown. Traditionally, drowning has been associated as synonymous with death; however, it is now understood as a process with different degrees of severity, and the outcome can be death or survival (with or without short and long-term morbidity) (15). Considering the multiple factors that can concur in a drowning event, the prognosis of the victim will depend, as the most determining factor, on the time of submersion and the first intervention by a witness (rescue and resuscitation) (16).

In developed countries the incidence of drowning in places with lifeguards is very low, so people in general, and children in particular, drown in places without lifeguards (domestic pools or unsupervised natural aquatic spaces) (9,17), hence the importance of witnesses as fundamental elements for activating the first link of the survival chain, as well as their actions for a safe rescue(18) by throwing or approaching a floating object without entering the water (11,13,18), or within the water if they are experts, like surfers(19–21), and finally the application of necessary care such as CPR or other first aid measures(13,14).

The analysis of drowning from a national (Spain) perspective revolves around 400 fatal drownings annually(22), which do not include the deaths of migrants in Spanish waters on their journeys to the Iberian Peninsula, islands, or autonomous cities. Spain is considered a high-resource country, and deaths from drowning are among the leading causes of unintentional death. The explanation possibly has a multifactorial component.

- Firstly, the geographical characteristics; Spain has approximately 8,000 kilometers of coastline and an extensive hydrographic network of more than 186,500 kilometers of rivers and streams. The number of beaches is around 3,500. Of these beaches, 638 have been awarded the blue flag in 2024, keeping Spain as the world leader in this distinction.
- Secondly, the number of tourists and "sun and beach" visitors. In 2024, Spain received approximately 53.4 million international tourists in the first seven months of the year, representing a 12% increase compared to the same period the previous year(23). Generally, the summer months, especially July and August, are the busiest in terms of tourism, as they coincide with summer vacations in many countries, including our State.
- Thirdly, the growing number of aquatic facilities. It is estimated that there are around 1.2 million pools. Of these, approximately 120,000 are for public or collective use, while the rest are private or individual pools(24).
- Fourthly, climate change and its relation to extreme phenomena such as heat waves, natural disasters, or other events that alter the normal course of nature or people(25)
- Fifth, the absence of a national drowning prevention plan that promotes common awareness in the pre-incident phases and establishes proactive legislation for the provision of means and resources for information, surveillance, and rescue in aquatic spaces. (Figure INTRODUCTION-1).

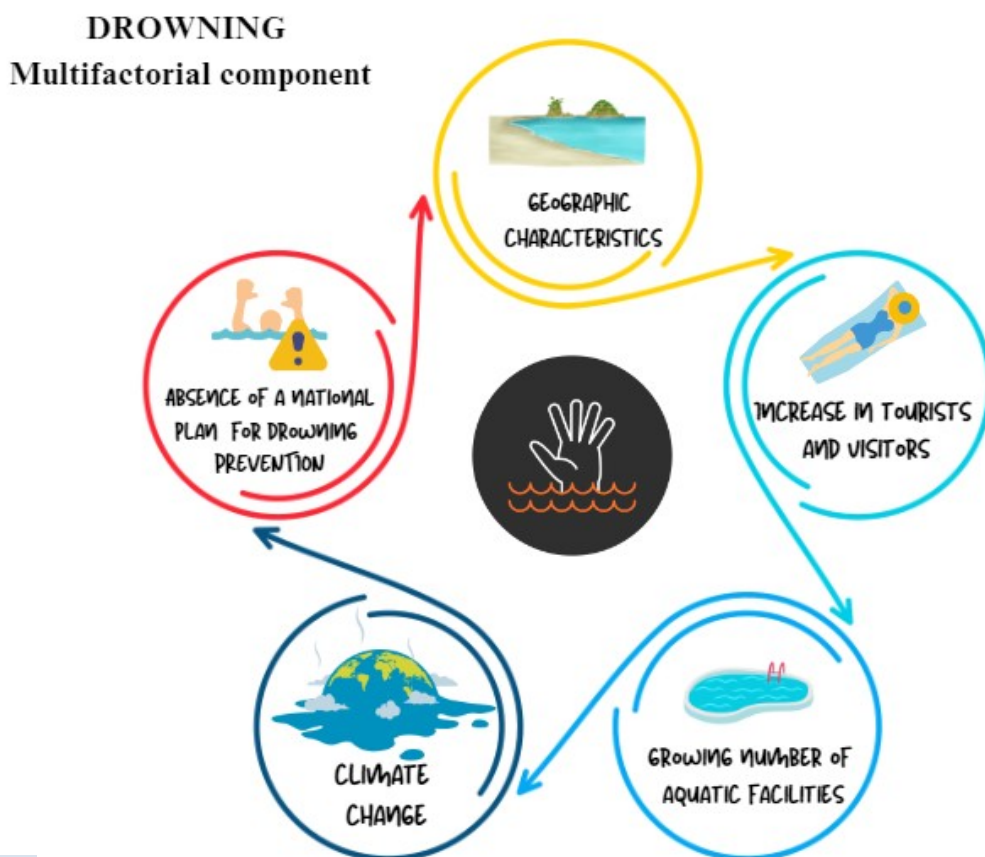


Figure INTRODUCTION-1. Diagram of the five triggers of drowning.
(Author-created figure)

3.2 STRATEGIES FOR THE PREVENTION OF CHILDHOOD DROWNING

The focus on prevention as a preferred tool over mitigation is has not been a very researched field. Initially, the preventive approach was guided by pediatricians; in fact, the American Academy of Pediatrics recommended five basic tips to prevent drownings: Barriers - Supervision - Swim lessons - Life jackets - CPR(10). In recent years, educational programs have expanded to disadvantaged settings, such as the "day-care" program in Bangladesh(26) or school activities framed within official subjects(17,27–29).

Education plays a crucial role in drowning prevention, and various school programs, from early childhood education to secondary education, have demonstrated benefits related to drowning prevention. Childhood drowning is multifactorial, so its approach should also involve parents or caregivers, as they reinforce learning and safe behaviors in aquatic environments. However, there is a knowledge gap regarding which activities or ways to educate younger children could be effective alternatives and how this could be addressed from a family perspective. Additionally, there is a general consensus that community intervention has a beneficial effect on drowning prevention(30).

3.3 EDUCATIONAL LEGISLATION IN THE PREVENTION OF INCIDENTS/ACCIDENTS AND FIRST AID

First aid refers to the set of actions and techniques applied immediately to a person who has suffered an accident or sudden illness, with the aim of preserving their life, preventing complications, and facilitating their recovery until professional medical assistance arrives. The importance of first aid lies in its ability to save lives and minimize the impact of injuries or acute illnesses. In the school context, where children and young people spend a significant amount of their time, training in first aid is crucial to ensure a safe environment prepared to handle emergencies. For this reason, the Spanish Organic Law for the Modification of the Organic Law of Education (LOMLOE) (31) establishes the need to integrate health and safety-related content, including first aid, at all educational levels(32). (Figure INTRODUCTION-1). This regulation aims to ensure that all students acquire basic first aid knowledge during their school education.

Royal Decree 157/2022, of March 1, which establishes the organization and minimum teachings of Primary Education	
3 rd and 4 th Grade. Primary education	<p>Physical Education <i>Specific Competence 1</i></p> <ul style="list-style-type: none"> – Take precautionary and preventive measures against injuries related to the conservation and maintenance of equipment within the framework of various physical-sporting practices, knowing basic protocols for action in the event of accidents that may occur in this context. <p><i>Basic Knowledge</i></p> <ul style="list-style-type: none"> – Accident prevention in motor practices: prevention mechanisms and body control for injury prevention.
5 th and 6 th Grade. Primary	<p>Physical Education <i>Specific Competence 1</i></p> <ul style="list-style-type: none"> – Adopt safety measures before, during, and after physical activity,

education	<p>recognizing risk contexts and acting with caution towards them.</p> <p><i>Basic Knowledge</i></p> <ul style="list-style-type: none"> – Accident prevention in motor practices: general warm-up and cool-down. Importance of respecting safety rules. Commitment to responsibility towards one's own safety and that of others. – Basic actions in the event of accidents during physical activities. Recovery position. PAS conduct (protect, alert, assist). <p>Knowledge of the Natural, Social, and Cultural Environment</p> <p><i>Basic Knowledge</i></p> <ul style="list-style-type: none"> – Guidelines for risk and accident prevention. Knowledge of basic first aid actions.
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Royal Decree 217/2022, of March 29, which establishes the organization and minimum teachings of Compulsory Secondary Education	
1 st and 2 nd Year of Secondary Education	<p>Physical Education</p> <p><i>Specific Competence 1</i></p> <p>1.4 Act according to intervention protocols in accidents derived from physical activity, applying basic first aid measures.</p> <p><i>Specific Competence 5</i></p> <p>5.2 Practice physical-sporting activities in natural and urban environments, applying individual and collective safety rules.</p> <p><i>Basic Knowledge</i></p> <p>B. Organization and management of physical activity</p> <p>Actions in the event of accidents during physical activities. PAS conduct (protect, alert, assist). 112 protocol. BLS.</p>
3 rd and 4 th Year of Secondary Education	<p>Physical Education</p> <p><i>Specific Competence 1</i></p> <p>1.4 Act according to intervention protocols in emergency situations or accidents, applying specific first aid measures.</p> <p><i>Specific Competence 5</i></p> <p>5.2 Design and organize physical-sporting activities in natural and urban environments, assuming responsibilities and applying individual and collective safety rules.</p> <p><i>Basic Knowledge</i></p> <p>B. Organization and management of physical activity</p> <p>Actions in the event of accidents. Resuscitation using AED. CPR protocol (cardiopulmonary resuscitation). Specific techniques and signs of cardiovascular accidents (Heimlich maneuver, stroke signs, and similar).</p>
Royal Decree 243/2022, of April 5, which establishes the organization and minimum teachings of the Baccalaureate.	
Baccalaureate	<p>Physical Education</p> <p><i>Specific Competences. 1</i></p> <p>Internalize the development of an active and healthy lifestyle, responsibly and consciously planning physical activity based on personal self-assessment using scientific and evaluable parameters, to meet demands for active leisure and personal well-being, as well as knowing possible professional opportunities associated with physical activity.</p> <p>The acquisition of this specific competence will materialize when students... critical analysis of situations related to motor skills, up to first aid, prevention, and care of injuries, both in aquatic and terrestrial environments.</p> <p><i>Evaluation Criteria</i></p> <p>1.3 Know and apply specific measures for injury prevention before, during, and after physical activity, as well as for the application of first aid in emergency or accident situations, identifying the possible transfers this knowledge has to the professional and occupational field.</p> <p><i>Basic Knowledge</i></p>

	<ul style="list-style-type: none"> - Critical actions in the event of accidents. PAS conduct: protect, alert, assist. Movement and transport of injured persons. Resuscitation using an AED. CPR protocol (cardiopulmonary resuscitation). Specific techniques and signs of cardiovascular accidents (Heimlich maneuver, stroke signs, and similar). Basic content of an assistance kit (first aid kit). - - Protocols for school alerts.
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Figure INTRODUCTION-2. Injury prevention and first aids topics specified in Spanish educational law (RD 157/2022, 217/2022, 243/2022)

In view of Figure 3.2, the teaching of first aid is a topic that in recent years has been integrated at the school level as a necessary, interdisciplinary content(33). The application of first aid in the school curriculum varies among different Spanish autonomous communities(34), but in general, its inclusion has been promoted especially through the subject of Physical Education, and complementarily, some communities have implemented specific training programs for teachers, to ensure they are equipped to teach these skills to students (such as the *RCP na aula* -basic life support at classroom- or the *ANXOS* program in Galicia – Spain -). The teaching for injury prevention and basic first responder actions in the school environment has gained global interest. Declarations like *KIDs Save Lives*(35) supported by the WHO and various school training projects(36–38) and teacher training(39–41) have given scientific and educational momentum to first aid content in general, and CPR in particular. Although first aid as such is not new in Spanish educational legislation, its curricular weight has been increasing with different educational reforms(34), although almost always focused on injury prevention or BLS, but without addressing the teaching of critical situations that can endanger life. With the new Organic Law 3/2020, of December 29 (LOMLOE) (31), which modifies the Organic Law 2/2006, of May 3, on Education and developed through the RDs: RD 157/2022 of Primary Education(42), RD 217/2022 of Compulsory Secondary Education (ESO) (43), and RD 243/2022 of the Baccalaureate(44), there is a change and evolution of first aid content, expanding the number of mentions in different stages and increasing the topics addressed.

This aligns with the recommendations of the European Resuscitation Council (ERC) – which in its latest update published two novel sections: one on first aid referencing numerous contents explicitly or indirectly cited in the new curriculum (recovery position, optimal position during shock, administration of bronchodilators for asthma, recognition of stroke, anaphylaxis, management of hypoglycemia, rehydration for the treatment of exertional dehydration, control of potentially life-threatening hemorrhages or burns) (45) and an education section intended to be a guide for citizens, educators, and healthcare professionals for the evidence-based implementation of first aid and cardiopulmonary resuscitation (CPR) (46).

In summary, the trend in Europe is towards strengthening the teaching of first aid, which includes concepts and skills, that should start as early as possible as a means of educating future proactive adults in emergencies. In Spain, although belatedly, legislation is moving in that direction, although it requires investment and especially training for teachers who must implement it in school programs. Evidence has shown the effectiveness of teachers in teaching first aid. The Spanish study by Pichel et al. showed how a group of teachers were able to transmit and teach quality CPR, as reflected in the results of their students in the different tests(41).

3.4 CHALLENGES AND OPPORTUNITIES FOR EDUCATION IN DROWNING PREVENTION

The drowning chain of survival(13) indicates the key aspects for prevention, rescue, or mitigation at each phase of drowning; however, most of these elements are based on expert consensus and have low evidence. The latest review by the International Liaison Committee on Resuscitation (ILCOR) (47) reaches the same conclusion regarding the low evidence supporting most interventions in the field of lifesaving.

In the field of training, education, and experiences for the prevention of childhood drowning, there is barely any scientific literature, so it is unknown which materials and methodologies might be best for school teaching of CPR or for performing a safe rescue. It is unclear how children can best learn concepts, attitudes or skills to avoid drowning. Interdisciplinary programs have not been explored, and low-cost materials, which are so necessary in resource-limited places or schools, have not been experimented with.

Despite legislative advances, the effective implementation of first aid teaching in schools faces several challenges. One of the main obstacles is the lack of awareness of the problem, resources and adequate training for teachers, which can limit the intention and quality of teaching.

Therefore, to improve first aid teaching in schools, it is recommended to increase investment in training and resources for teachers, as well as to promote collaboration between educational institutions and organizations specialized in first aid. It is also crucial to foster awareness and commitment from the entire educational community to ensure that first aid training becomes a priority.

In short, there are multiple knowledge gaps that this Doctoral Thesis aims to address through the scientific methods, with the aim to contribute to increasing scientific evidence in the field of drowning prevention.

4. HYPOTHESES AND OBJECTIVES

4 HYPOTHESES AND OBJECTIVES

4.1 GENERAL HYPOTHESES AND OBJECTIVES

4.1.1 General Hypothesis

Educational programs for drowning prevention are viable, accessible, and generate practical knowledge in the different elements related to drowning (prevention, rescue, and resuscitation), even being low-cost. (Figure HYPOTHESES AND OBJECTIVES-3).

4.1.2 General Objective

To evaluate the effect of different educational interventions on the acquisition of concepts and skills for drowning prevention, rescue, and initial resuscitation.

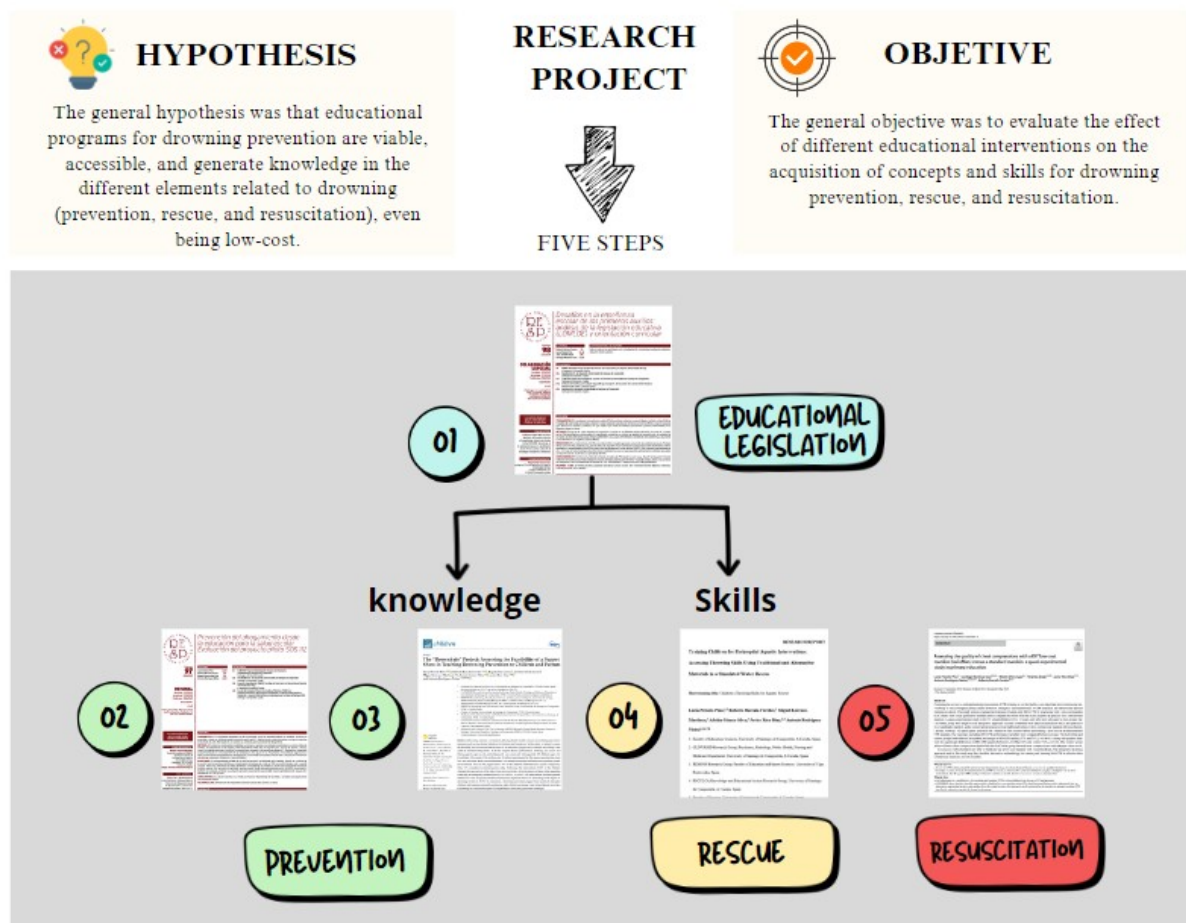


Figure HYPOTHESES AND OBJECTIVES-3. Flow chart of relationship with the hypothesis and general objective, the research steps, the publications and the subject addressed (prevention, rescue and resuscitation). (Author-created figure)

4.2 HYPOTHESES AND SPECIFIC OBJECTIVES BY SECTIONS AND ARTICLES

The specific hypotheses and objectives are detailed below for each of the three section (prevention, rescue and resuscitation) and for each of the five publications that make up the thesis publication compendium.

4.2.1 Curricular Analysis Based on Educational Legislation (Article 1)

- **H1** - Article 1: The Spanish educational curriculum includes content directly and indirectly related to drowning prevention and first aid.
- **O1**- Article 1: To analyze and to assess the Spanish educational legislation related to injury prevention and first aid at different educational levels (early childhood education, primary education, secondary education, and baccalaureate).

4.2.2 H2-O2. School Drowning Prevention (Articles 2 and 3)

- **H2**: The implementation of innovative, interdisciplinary educational proposals within the educational community environment fosters the understanding of aquatic risks and the learning of concepts related to drowning prevention.
 - H2.1 - Article 2: The use of songs and educational methods specifically created for this purpose promotes the learning of concepts and attitudes related to drowning prevention.
 - H2.2 - Article 3: A puppet show, specifically designed with messages aimed at children's safety in aquatic environments will improve the knowledge and attitudes of families (children and parents) about drowning prevention.
- **O2**: To assess the modification of knowledge about fundamental preventive strategies to avoid drownings.
 - O2 - Article 2: To evaluate the modification of knowledge regarding the meaning of sea flags, handling an aquatic rescue, the emergency number, and safe attitudes during swimming.
 - O2 - Article 3: To assess the feasibility and immediate effects of this innovative teaching strategy and tool (puppet show).

4.2.3 H3-O3. Lifesaving Skills – Rescue and Resuscitation – (Articles 4 and 5)

- **H3**: The use of low-cost or self-made materials can be a viable and adapted alternative for the development of rescue and resuscitation skills.
 - H3 - Article 4: Conventional rescue materials are not suitable for long-distance throws, while lighter and smaller elements are better for children.
 - H3 - Article 5: School CPR teaching with low-cost materials is viable and does not imply a decrease in quality compared to a conventional commercial manikin.
- **O3**: To analyze different low-cost rescue and resuscitation skills adapted for children.
 - O3 - Article 4: To analyze the throwing capacity (distance and accuracy) of two specific rescue materials (ring buoy and rescue tube), and compare them with a non-conventional material, the plastic bottle.
 - O3 - Article 5 – To evaluate the learning of CPR skills by practicing with a low-cost manikin (LoCoMan) with qualitative visual feedback for continuous chest compressions.

5. MATERIALS AND METHODS

5 MATERIAL AND METHODS

In general, the studies in this thesis are quantitative and descriptive, based on tests conducted at two steps (pre and post), and on cross-group comparisons. The readers can find the methodology details in each paper. Below, we highlight the most important aspects of the methodology from the studies included in the doctoral thesis.

5.1 DESIGN

The designs of each of the studies in this thesis by article compendium are described below (Figure MATERIAL AND METHODS-4).

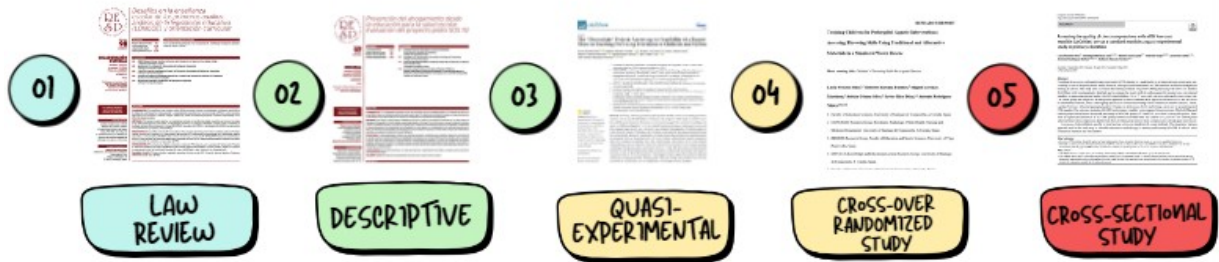


Figure MATERIAL AND METHODS-4. Designs of each study
(Author-created figure)

The first article is based on a review of the current Spanish education law using an expert consensus analysis approach. The second work of this thesis consisted of a preliminary feasibility study, descriptive and non-randomized, with evaluation at two points; before the intervention and after the intervention. The third study was a quasi-experimental study designed, comprising three phases: creation of the puppet show, recruitment of the sample, and pre- and post-intervention evaluation. The fourth article used a randomized crossover study design to examine the differences between conventional rescue equipment, such as a ring buoy and rescue tube, with a PET-bottle. Finally, the fifth article was based on a quasi-experimental, and cross-sectional study carried out using two non-randomized intervention groups; the LoCoMan group (LG) trained with a hand-made Low-Cost Manikin and a control group (CG) practiced with a conventional pediatric manikin model, Resusci Junior (Laerdal, Norway).

5.2 PARTICIPANTS AND ETHICS

In all research involving humans (studies 2 to 5), authorization was obtained from an ethics committee (Appendix 1) under all criteria of confidentiality, protection, and prior authorization to the studies, and were developed in accordance with the principles of the Declaration of Helsinki.

5.3 ASSESMENT TOOLS, VARIABLES AND MATERIALS

This doctoral thesis consists of 5 articles, with different analysis variables and measurement materials or instruments. For the first article, based on the review of educational legislation, the variables were the items related to first aid and injury prevention cited in the Spanish educational legislation for early childhood education, primary education, compulsory secondary education, and baccalaureate. For the second article, the variables referred to different aspects of drowning prevention based on a form (Figure MATERIAL AND METHODS-5), which was the projection on YouTube of an educational song about drowning prevention (<https://www.youtube.com/watch?v=8qSE8H43rpQ>).

Five analysis groups were established according to the evaluation indicators: a) recognition of the meaning of the flags, b) handling of an aquatic rescue, c) recognition of the emergency

number, d) safe attitudes during bathing (score from 0 to 100% calculated based on the formula $(\Sigma \text{correct answers} \times 100)/8$) and e) overall knowledge of water safety calculated based on the formula $(\Sigma \text{correct answers} \times 100)/15$).

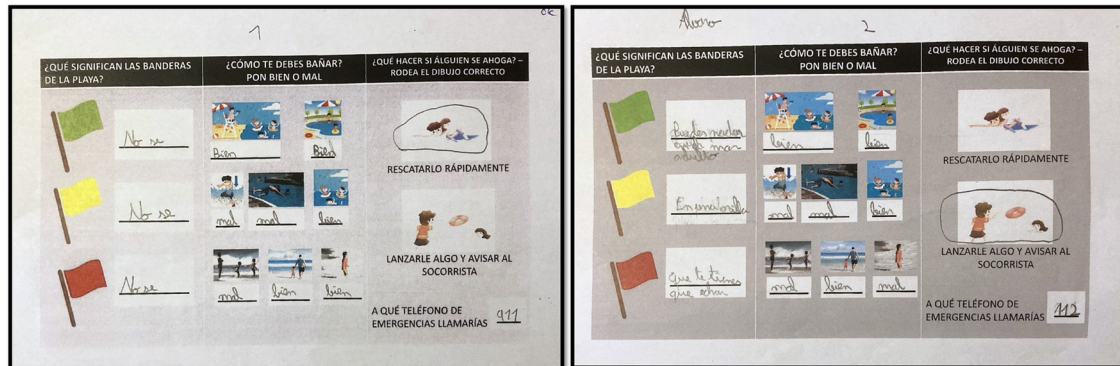


Figure MATERIAL AND METHODS-5. Educational assessment tool of the second article. (Author-created figure)

In the third article, the variables also focus on different aspects of drowning prevention and safe rescue: The variables were grouped into three blocks: 1) the association between flag colors and their corresponding meanings, 2) knowledge of the emergency number, and 3) safe bathing behaviors (being alone, using a float, wearing sleeves and/or being supervised by an adult). After an intervention based on a puppet show, the evaluation was conducted, comparing a pre/post-show test (The recording of the performance is available online at the following link: <https://youtu.be/BSveUwewTyA>). For the evaluation, a dichotomous scale of correctness or error was used for each item, alongside a cumulative variable reflecting the total count of correctly answered items. The evaluation tool was designed in the format of a children's school card, where children were required to answer a series of questions presented in the form of illustrations (Figure MATERIAL AND METHODS-5). The design and iconography of the evaluation sheet were created by two professionals in graphic design and arts, with extensive experience in illustration and creation of children's materials.



Figure MATERIAL AND METHODS-6. Educational assessment tool of the third article. (Author-created figure)

In the fourth article, was evaluated the ability of schoolchildren to throw different objects to approach a person asking for help in the water (at risk of drowning). This was done based on simulation, and two types of variables were analyzed: a) throw distance in meters (m) by

age/material, measured from the throw point to the furthest point of the material after the fall, and b) accuracy, which was defined as the object landing within a maximum of 1 meter to the left or right of the center of the linear projection from the throw point (sufficient for it to be reached by stretching an arm).

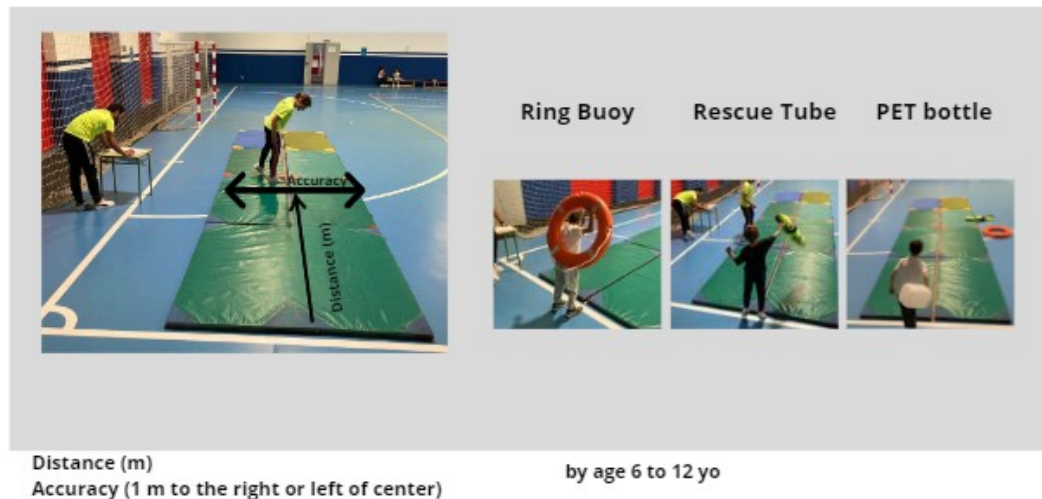


Figure MATERIAL AND METHODS-7. Evaluation of distance and precision, and rescue materials used, in the fourth study.
(Author-created figure)

In the fifth article, the ability of a group of schoolchildren to perform pediatric CPR was analyzed. The assessment was carried out using the Little Junior QCPR manikin (Laerdal, Norway) programmed under the European Resuscitation Council guidelines for resuscitation 2021 (ERC2021): The gold standard describes chest compression (CC) depth of 50 - 60 mm, full chest recoil, and a CC rate between 100 and 120 compressions per minute. Using the QCPR instructor app (Laerdal, Norway), the following variables were obtained: depth, full chest recoil, and CC rate, as well as the global value of the quality of CPR (QCPR) in percentage. The analysis variables were: a) Number of CC in 2 minutes, b) Mean rate (R) of CC per minute during 2 minutes, c) average depth of CC in mm (D). And as percentage variables: d) overall QCPR, e) CC with adequate chest recoil, f) CC with adequate depth, and g) CC with adequate rate.

5.4 DATA ANALYSIS

The statistical analyses are described in each article. When a quantitative analysis was necessary (articles 2, 3, 4, and 5), they were performed in IBM SPSS Statistics software (v.20. to 25 for Windows, Armonk, NY: IBM Corp). All statistical analyses are described in detail in the statistical section of each article. In general, in all studies with people, descriptive statistics based on measures of central tendency (mean or median) and dispersion (standard deviation or interquartile range) were analyzed. When necessary, the normality of the sample was analyzed. The normality of each variable was checked both graphically and using the Kolmogorov-Smirnov test. Comparisons between two groups were made with the Mann-Whitney U test (nonparametric test) or with the Student's T test (parametric test). In statistically significant comparisons, the effect size (ES) was calculated using Rosenthal's r

test (nonparametric test) or Cohen's d test (parametric test). To define the ES, the following classification was used: < 0.2 Trivial; $0.2 - 0.5$ Small; $0.5 - 0.8$ Moderate; $0.8 - 1.3$ Large; ≥ 1.3 Very large. For the description of the percentage variables, absolute frequencies and relative frequencies were used. For the comparison of the groups in the percentage variables, the Chi Square test was used. In statistically significant comparisons, the ES was calculated using Cramer's V test. To define the ES, the following classification was used: $0.1 - 0.3$: Small; $0.3 - 0.5$: Medium; ≥ 0.5 : Large. In the case of multiple comparisons between the groups (Chi Square), a p-value of 0.012 ($0.05/4$) was used for the Bonferroni correction. A significance level of $p = 0.05$ was assigned for all other analyses, with Cohen's d used to calculate the effect sizes. These effects were classified as trivial ($d < 0.2$) small ($0.2 < d < 0.5$), medium ($0.5 < d < 0.8$), and large ($d \geq 0.8$). The differences in accuracy depending on the object thrown were analyzed using Cochran's Q test. For all analysis, the significance value was set at $p \leq 0.05$.

6. RESULTS

LUCÍA PEIXOTO PINO

6 RESULTS

6.1 REVIEW OF SPANISH EDUCATIONAL LEGISLATION IN THE FIELD OF ACCIDENT PREVENTION AND FIRST AID

6.1.1 Article 1 - Title: **Challenges in teaching first aids at schools: analysis of spanish educational legislation (LOMLOE) and curricular guidance.**

The image shows the identification page of an article in the journal 'Revista Española de Salud Pública'. The journal logo is a circular emblem with 'REVISTA ESPAÑOLA DE SALUD PÚBLICA' and 'RESDP' in the center. The article title is 'Desafíos en la enseñanza escolar de los primeros auxilios: análisis de la legislación educativa (LOMLOE) y orientación curricular'. The volume is 98, issue 23/2/2024. The authors listed are Roberto Barcala-Furelos (1), Lucía Peixoto-Pino (2,3), Julio Zanfaño-Ongil (4), and Santiago Martínez-Isasi (3,5). The contributions section states that all authors participated in conceptualization, methodology, investigation, validation, redaction, revision, and editing. The affiliations section lists five institutions: (1) REMOSS Research Group, Facultad de Ciencias de la Educación y el Deporte, Universidade de Vigo, A Xunqueira (Pontevedra), España; (2) Facultade de CC. da Educación, Universidade de Santiago de Compostela, Santiago de Compostela, España; (3) CLINURSID Grupo de Investigación; Escuela de Enfermería, Universidade de Santiago de Compostela, Santiago de Compostela, España; (4) Instituto de Enseñanza Secundaria Augustóbriga, Consejería de Educación de la Junta de Extremadura, Navalmoral de la Mata (Cáceres), España; (5) Facultade de Enfermería, Universidade de Santiago de Compostela, Santiago de Compostela, España. The 'COLABORACIÓN ESPECIAL' section provides submission dates: Recibida: 11/11/2023, Aceptada: 22/1/2024, Publicada: 23/2/2024, and e202402013. The article title is repeated at the bottom: 'Challenges in teaching first aids at schools: analysis of spanish educational legislation (LOMLOE) and curricular guidance'.

Figure RESULTS-8. Screenshot of article 01 identification. Available at <https://pubmed.ncbi.nlm.nih.gov/38391131/>

6.1.1.1 Article abstract

Objective: Teaching first aid (FA) to children and young people is a priority strategy in Public Health. The aim of this paper was to review and analyze new educational legislation within the FA curriculum framework, which is necessary for providing teachers and healthcare professionals with a practical guide that guides teaching to train first responders in different school stages.

Methods: A group of four experts with curricular experience at different educational levels, as well as in the field of FA, participated in this analysis. The methodology involved a consensus analysis approach on the content of the spanish Royal Decrees (RD) for Primary Education (RD 157/2022), Secondary Education (RD 217/2022), and Baccalaureate (RD 243/2022) that develop the curriculum of the Organic Law 3/2020 (LOMLOE).

Results: In the analysis of the three RD, ten general concepts were identified: accident prevention; protocol Protect, Alert, Assist (PAS); 1-1-2 protocol; recovery position (PLS); cardiopulmonary resuscitation (CPR); automated external or semi-automatic defibrillator (AED); foreign body airway obstruction (FBAO); FA; transportation of the injured; and stroke. Throughout all educational stages, in twenty-seven instances appeared content explicitly related to accident prevention or the learning of FA.

Conclusions: The current curriculum provides FA content from the age of eight-nine (3rd year of Primary Education). By the end of compulsory education, all students should be

able to identify cardiac arrest, alert emergency services, initiate resuscitation maneuvers, use the defibrillator, and know how to respond to choking incidents.

Keywords: CPR; Educational legislation; First Aid; Heimlich; School curriculum; School nursing; Stroke; Teacher training; Teachers.

6.1.1.2 Evidence of Quality

This article was published in *REVISTA ESPAÑOLA DE SALUD PÚBLICA* (ISSN: 2173-9110, Publisher: Ministry of Health. Government of Spain). It is cataloged in the Web of Science and Scopus repositories in the field of *Public, Environmental & Occupational Health*, and (1) *Public Health, Environmental and Occupational Health*, (2) *Medicine*, respectively.

Impact factor and quartiles:

Indexing database	Impact Factor	Quartile	Category
Journal Citation Report (JCR)	1.1	Q4	Public, Environmental & Occupational Health
SCImago Journal Rank (SJR)	0.34	Q3	Public Health, Environmental and Occupational Health Medicine

This article has been cited 1 time in Google Scholar

Declaration on Research Assessment (DORA)

[Challenges in teaching first aids at schools: analysis of Spanish educational legislation (LOMLOE) and curricular guidance]. This work analyzes Spanish educational legislation and is published in the Spanish Journal of Public Health (under the Ministry of Health of the Government of Spain), indexed in the JCR and SJR Rank. Recently published, it has already received a citation on Google Scholar and will serve as a reference document for teachers and educators, as well as for training in faculties of Education. It is currently used in first aid courses for physical education teachers, taught by the Illustrious College of Graduates in Physical Education of Galicia.

Full citation of the manuscript:

Barcala-Furelos R, **Peixoto-Pino L**, Zanjaño-Ongil J, Martínez-Isasi S. Desafíos en la enseñanza escolar de los primeros auxilios: análisis de la legislación educativa (LOMLOE) y orientación curricular **[Challenges in teaching first aids at schools: analysis of spanish educational legislation (LOMLOE) and curricular guidance]**. Rev Esp Salud Publica. 2024 Feb 23;98:e202402013. Spanish. PMID: 38391131.

Specific contribution of the PhD candidate to the article:

Conception and design of the study, methodology; drafting of the manuscript and revision after peer-review.

Full text:



Volumen
98
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COLABORACIÓN ESPECIAL

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Challenges in teaching first aids at schools: analysis of spanish educational legislation (LOMLOE) and curricular guidance

Los autores declaran que no existe ningún conflicto de intereses

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<https://ojs.sanidad.gob.es/index.php/resp>

Desafíos en la enseñanza escolar de los primeros auxilios: análisis de la legislación educativa (LOMLOE) y orientación curricular

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CONTRIBUCIONES DE AUTORÍA

Todos los autores han participado en la conceptualización, metodología, investigación, validación, redacción-revisión y edición.

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RESUMEN

FUNDAMENTOS // La enseñanza de los primeros auxilios (PPAA) a escolares y jóvenes es una estrategia prioritaria en Salud Pública. El objetivo de este trabajo fue revisar y analizar la nueva legislación educativa en el marco curricular de PPAA, lo cual es necesario para ofrecer a los docentes y sanitarios una guía práctica que oriente la enseñanza para formar a primeros intervinientes en las diferentes etapas escolares.

MÉTODOS // Un grupo de cuatro expertos con experiencia curricular en los diferentes niveles educativos, así como en el campo de los PPAA, participaron en este análisis. La metodología consistió en un enfoque de análisis de consenso sobre el contenido de los Reales Decretos (RD) de Educación Primaria (RD 157/2022), Secundaria (RD 217/2022) y Bachillerato (RD 243/2022) que desarrollan curricularmente la Ley Orgánica 3/2020 (LOMLOE).

RESULTADOS // En el análisis de los tres RD se encontraron diez conceptos generales: prevención de accidentes; protocolo *Proteger, Alertar, Socorrer* (PAS); protocolo 1-1-2; posición lateral de seguridad (PLS); reanimación cardiopulmonar (RCP); desfibrilador externo automático o semiautomático (DEA/DESA); obstrucción de vía aérea por cuerpo extraño (OVACE); PPAA; traslado de accidentados; e ictus. A lo largo de todas las etapas educativas fueron veintisiete las veces en que aparecían explícitamente contenidos vinculados con la prevención de accidentes o al aprendizaje de PPAA.

CONCLUSIONES // El currículo actual dota de contenido en materia de PPAA desde los ocho-nueve años (3º de Educación Primaria). Al finalizar la Enseñanza Secundaria Obligatoria, todo el alumnado debería saber identificar la parada cardíaca, alertar a los servicios de emergencias, iniciar las maniobras de reanimación, usar el desfibrilador y saber actuar ante un atragantamiento.

PALABRAS CLAVE // Primeros Auxilios; Legislación educativa; Currículo escolar; RCP; Formación docente; Maestros; Profesores; Enfermería escolar; Ictus; Heimlich.

ABSTRACT

BACKGROUND // Teaching first aid (FA) to children and young people is a priority strategy in Public Health. The aim of this paper was to review and analyze new educational legislation within the FA curriculum framework, which is necessary for providing teachers and healthcare professionals with a practical guide that guides teaching to train first responders in different school stages.

METHODS // A group of four experts with curricular experience at different educational levels, as well as in the field of FA, participated in this analysis. The methodology involved a consensus analysis approach on the content of the Spanish Royal Decrees (RD) for Primary Education (RD 157/2022), Secondary Education (RD 217/2022), and Baccalaureate (RD 243/2022) that develop the curriculum of the Organic Law 3/2020 (LOMLOE).

RESULTS // In the analysis of the three RD, ten general concepts were identified: accident prevention; protocol *Protect, Alert, Assist* (PAS); 1-1-2 protocol; recovery position (PLS); cardiopulmonary resuscitation (CPR); automated external or semi-automatic defibrillator (AED); foreign body airway obstruction (FBAO); FA; transportation of the injured; and stroke. Throughout all educational stages, in twenty-seven instances appeared content explicitly related to accident prevention or the learning of FA.

CONCLUSIONS // The current curriculum provides FA content from the age of eight-nine (3rd year of Primary Education). By the end of compulsory education, all students should be able to identify cardiac arrest, alert emergency services, initiate resuscitation maneuvers, use the defibrillator, and know how to respond to choking incidents.

KEYWORDS // First Aid; Educational legislation; School curriculum; CPR; Teacher training; Teachers; School nursing; Stroke; Heimlich.

INTRODUCCIÓN

LA ENSEÑANZA DE LOS PRIMEROS AUXILIOS (PPAA) es una temática que en los últimos años se ha integrado a nivel escolar como un contenido necesario, interdisciplinar (1), pero hasta el momento poco definido curricularmente. En 2021, el Consejo Europeo de Reanimación (en inglés, *European Resuscitation Council* [ERC]) publicó dos secciones novedosas dentro de las *Guías Europeas de Reanimación*: una de PPAA, en la que se referencian numerosos contenidos citados explícitamente o indirectamente en el nuevo currículo (posición lateral de seguridad, posición óptima durante el shock, la administración de broncodilatadores para asma, el reconocimiento del ictus, la anafilaxia, el manejo de la hipoglucemia, la rehidratación para el tratamiento de la deshidratación por esfuerzo, el control de hemorragias potencialmente mortales o las quemaduras) (2); y una sección de educación que pretende ser una guía para los ciudadanos, educadores y profesionales sanitarios para la implementación, en base a la evidencia, de los PPAA y la reanimación cardiopulmonar (RCP) (3).

La enseñanza para la prevención de accidentes y las actuaciones básicas de primeros intervinientes en el entorno escolar ha experimentado un crecimiento exponencial en los últimos años. Declaraciones como *KIDS Save Lives* (4), apoyada por la Organización Mundial de la Salud, así como diversos proyectos de formación de escolares (5-7) y docentes (8-10) han dado un impulso científico y educativo a los contenidos de PPAA en general, y a la RCP en particular. Si bien los PPAA como tal no son algo nuevo en la legislación educativa española, su peso curricular ha ido aumentando con las diferentes reformas educativas (11), aunque casi siempre focalizado en la prevención de lesiones o las actuaciones básicas de PPAA, pero sin abordar la enseñanza de las situaciones críticas que pueden poner en peligro la vida. Con la nueva *Ley Orgánica 3/2020, de 29 de diciembre (LOMLOE)*, por la que se modifica la *Ley Orgánica 2/2006, de 3 de mayo de Educa-*

ción (12) y desarrollada a través del *RD 157/2022 de Educación Primaria* (13), del *RD 217/2022 de Educación Secundaria Obligatoria (ESO)* (14) y del *RD 243/2022 del Bachillerato* (15), se produce un cambio y evolución de los contenidos de los PPAA, ampliando el número de menciones en las diferentes etapas e incrementando las temáticas abordadas. Por tanto, este artículo tuvo como objetivo revisar y analizar la nueva legislación educativa en el marco curricular de los PPAA para ofrecer a los docentes una visión práctica en cada curso y nivel.

MATERIAL Y MÉTODOS

UN GRUPO DE CUATRO EXPERTOS EN EL ámbito de la educación y la salud, con experiencia curricular en Educación Primaria y Secundaria, así como en el campo de los PPAA, participaron en este análisis. La metodología consistió en un enfoque de análisis de consenso sobre el contenido de los RD de Educación Primaria, Secundaria y Bachillerato que desarrollan curricularmente la LOMLOE. Este grupo analizó la totalidad de referencias a los PPAA que aparecen en los RD [Figura 1].

El grupo de expertos extrajo de cada RD aquellos ítems que mencionaban algún contenido vinculado a la prevención de accidentes y/o los PPAA. En la **Tabla 1** se recogen las competencias y saberes básicos de los diferentes RD desagregados por niveles y etapas.

RESULTADOS

EN EL ANÁLISIS DE LOS TRES RD SE ENCONTRARON diez conceptos generales:

- 1) Prevención de accidentes.
- 2) Protocolo *Proteger, alertar, socorrer* (PAS).
- 3) Protocolo 1-1-2.
- 4) Posición lateral de seguridad (PLS).
- 5) Reanimación cardiopulmonar (RCP).

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Tabla 1

Contenidos relacionados con la prevención de accidentes y los primeros auxilios en Educación Primaria (*Real Decreto 157/2022*), Educación Secundaria (*Real Decreto 217/2022*) y Bachillerato (*Real Decreto 243/2022*).

Real Decreto 157/2022, de 1 de marzo, por el que se establecen la ordenación y las enseñanzas mínimas de la Educación Primaria

3º y 4º de Primaria	<p>Educación Física <u>Competencia específica 1</u></p> <ul style="list-style-type: none"> - Tomar medidas de precaución y prevención de lesiones en relación con la conservación y el mantenimiento del material en el marco de distintas prácticas físicodeportivas, conociendo protocolos básicos de actuación ante accidentes que se puedan producir en este contexto. <p><u>Saberes básicos</u></p> <ul style="list-style-type: none"> - Prevención de accidentes en las prácticas motrices: mecanismos de prevención y control corporal para la prevención de lesiones.
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5º y 6º de Primaria	<p>Educación Física <u>Competencia específica 1</u></p> <ul style="list-style-type: none"> - Adoptar medidas de seguridad antes, durante y después de la práctica de actividad física, reconociendo los contextos de riesgo y actuando con precaución ante ellos. <p><u>Saberes básicos</u></p> <ul style="list-style-type: none"> - Prevención de accidentes en las prácticas motrices: calentamiento general y vuelta a la calma. Importancia de respetar las normas de seguridad. Compromiso de responsabilidad hacia la seguridad propia y de los demás. - Actuaciones básicas ante accidentes durante la práctica de actividades físicas. Posición lateral de seguridad. Conducta PAS (<i>Proteger, Avisar, Socorrer</i>). <p>Conocimiento del Medio Natural, Social y Cultural <u>Saberes básicos</u></p> <ul style="list-style-type: none"> - Pautas para la prevención de riesgos y accidentes. Conocimiento de actuaciones básicas de primeros auxilios.
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Real Decreto 217/2022, de 29 de marzo, por el que se establece la ordenación y las enseñanzas mínimas de la Educación Secundaria Obligatoria

1º Y 2º de ESO	<p>Educación Física Criterios de evaluación <u>Competencia específica 1</u></p> <p>1.4 Actuar de acuerdo a los protocolos de intervención ante accidentes derivados de la práctica de actividad física, aplicando medidas básicas de primeros auxilios.</p> <p><u>Competencia específica 5</u></p> <p>5.2 Practicar actividades físico-deportivas en el medio natural y urbano, aplicando normas de seguridad individuales y colectivas.</p> <p><u>Saberes básicos</u></p> <p>B. Organización y gestión de la actividad física. Actuaciones ante accidentes durante la práctica de actividades físicas. Conducta PAS (<i>Proteger, Avisar, Socorrer</i>). Protocolo 112. Soporte vital básico (SVB).</p>
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Real Decreto 217/2022, de 29 de marzo, por el que se establece la ordenación y las enseñanzas mínimas de la Educación Secundaria Obligatoria

3º Y 4º de ESO	<p>Educación Física Criterios de evaluación Competencia específica 1 1.4 Actuar de acuerdo a los protocolos de intervención ante situaciones de emergencia o accidentes aplicando medidas específicas de primeros auxilios.</p> <p>Competencia específica 5 5.2 Diseñar y organizar actividades físico-deportivas en el medio natural y urbano, asumiendo responsabilidades y aplicando normas de seguridad individuales y colectivas.</p> <p>Saberes básicos B. Organización y gestión de la actividad física. Actuaciones ante accidentes. Reanimación mediante desfibrilador automático (DEA) o semiautomático (DESA). Protocolo RCP (reanimación cardiopulmonar). Técnicas específicas e indicios de accidentes cardiovasculares (maniobra de Heimlich, señales de ictus y similares).</p>
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Real Decreto 243/2022, de 5 de abril, por el que se establecen la ordenación y las enseñanzas mínimas del Bachillerato

Bachillerato	<p>Educación Física Competencias específicas 1 Interiorizar el desarrollo de un estilo de vida activo y saludable, planificando responsable y conscientemente su actividad física a partir de la autoevaluación personal en base a parámetros científicos y evaluables, para satisfacer sus demandas de ocio activo y de bienestar personal, así como conocer posibles salidas profesionales asociadas a la actividad física. La adquisición de esta competencia específica se materializará cuando el alumnado... el análisis crítico de situaciones que tengan que ver con la motricidad, hasta los primeros auxilios, la prevención y el cuidado de lesiones, tanto en medio acuático como terrestre.</p> <p>Criterios de evaluación 1.3 Conocer y aplicar de manera responsable y autónoma medidas específicas para la prevención de lesiones antes, durante y después de la actividad física, así como para la aplicación de primeros auxilios ante situaciones de emergencia o accidente, identificando las posibles transferencias que estos conocimientos tienen al ámbito profesional y ocupacional.</p> <p>Saberes básicos - Actuaciones críticas ante accidentes. Conducta PAS: <i>Proteger, Avisar, Socorrer</i>. Desplazamientos y transporte de accidentados. Reanimación mediante desfibrilador automático (DEA) o semiautomático (DESA). Protocolo RCP (reanimación cardiopulmonar). Técnicas específicas e indicios de accidentes cardiovasculares (maniobra de Heimlich, señales de ictus y similares). Contenido básico de kit de asistencia (botiquín). - Protocolos ante alertas escolares.</p>
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Figura 1
Proceso de la extracción y análisis de contenido de los Reales Decretos educativos.



- 6) Desfibrilador externo automático o semiautomático (DEA/DESA).
- 7) Obstrucción de vía aérea por cuerpo extraño (OVACE).
- 8) PPAA.
- 9) Traslado de accidentados.
- 10) ICTUS.

A lo largo de todas las etapas educativas fueron veintisiete las veces en que aparecían contenidos vinculados con la prevención de accidentes o aprendizaje de PPAA. Además, hasta en trece ocasiones algún ítem curricular que no aparecía explícitamente en una etapa o nivel educativo podría integrarse en contenidos propios del curso al ser parte de un protocolo, técnica o habilidad.

En Educación Primaria se recogieron cuatro contenidos, de los cuales dos eran comunes en segundo y tercer ciclo, relacionados con la prevención de accidentes en prácticas motrices y actuaciones básicas de PPAA, y específicamente de tercer ciclo (5º y 6º) se añadió la conducta PAS y PLS. El quinto contenido (protocolo 112) no era explícito, pero era parte de la conducta PAS, por lo que se consideraría obli-

gatorio. La enseñanza de RCP, DEA y OVACE no se mencionaba, y podría ser incluida a discreción en las actuaciones básicas de PPAA o en la S (socorrer) de la conducta PAS.

En Educación Secundaria se recogieron ocho contenidos, de los cuales seis se correspondían con 1º y 2º de la ESO: prevención; PAS; protocolo 112; RCP; DEA/DESA; y PPAA. De manera no explícita podría añadirse PLS, que está integrada en la S (socorrer) de la conducta PAS. En 3º y 4º de la ESO se añadió el tratamiento de la obstrucción de la vía aérea (OVACE) y el reconocimiento del ICTUS. En la etapa de Bachillerato aparecieron ocho contenidos: prevención en medio terrestre y acuático; PAS; RCP; DESA/DEA; OVACE; PPAA usando botiquín; traslado de accidentados; e ICTUS; y, de manera implícita, el protocolo 112 y PLS como parte de la conducta PAS [TABLA 2].

DISCUSIÓN

ESTE ARTÍCULO ANALIZA LOS RD AL amparo de la LOMLOE en relación con la prevención de accidentes y los PPAA. Los principales hallazgos son los siguientes.

La prevención de accidentes y las actuaciones básicas de PPAA deben empezar en el segundo ciclo de la Educación Primaria. En los

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Tabla 2
Resultados de los contenidos curriculares relacionados con los primeros auxilios por nivel y etapa.

	3º y 4º Primaria	5º y 6º Primaria	1º y 2º ESO	3º y 4º ESO	Bachillerato
Prevención	Prevención en prácticas motrices	Adoptar medidas de seguridad en prácticas motrices (antes/durante/después)	Medio natural y urbano	Medio natural y urbano	Medio terrestre y acuático
PAS	X	Sí	Sí	Sí	Sí
Protocolo 112	X	Implícito de la conducta PAS	Sí	Implícito en PAS/RCP	Implícito en PAS/RCP
PLS	X	Sí	Implícito en PAS	Implícito en PAS	Implícito en PAS
RCP	X	Opcional (dentro de la parte Socorrer de la conducta PAS)	Sí	Sí	Sí
Soporte Vital Básico (SVB)					
DEA/ DESA	X	Opcional (dentro de la parte Socorrer de la conducta PAS)	Sí	Sí	Sí
OVACE	X	Opcional (dentro de la parte Socorrer de la conducta PAS)	Opcional (dentro de la parte Socorrer de la conducta PAS)	Sí	Sí
Primeros Auxilios	Actuaciones básicas	Actuaciones básicas	Actuaciones básicas	Actuaciones básicas	Actuaciones básicas usando el botiquín
Traslado de accidentados	X	Opcional (dentro de la parte Socorrer de la conducta PAS)	Opcional (dentro de la parte Socorrer de la conducta PAS)	Opcional (dentro de la parte Socorrer de la conducta PAS)	Sí
Ictus	X	X	X	Sí	Sí

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últimos cursos de esta se incide en conductas de seguridad y cuidados básicos (PAS y PLS).

Con el inicio de la Educación Secundaria aparece un incremento sustancial en contenidos relacionados con los PPAA, y es la primera vez en que aparecen explícitamente la RCP y el uso del DEA/DESA. Al finalizar la Educación Secundaria todos los alumnos deben conocer el SVB.

En Bachillerato se espera que el alumnado tenga un análisis de riesgos, más allá del entorno escolar, y que pueda actuar incluso usando los materiales de un botiquín de PPAA.

Los RD son muy ambiguos sobre qué contenidos de PPAA se deben enseñar, ya que los refiere como *actuaciones básicas* sin aclarar qué se entiende por básico para un escolar de Primaria, de Secundaria o de Bachillerato, y dejando a la discrecionalidad docente su elección.

En general, existe un consenso en que los niños/as y adolescentes aprendan PPAA y, especialmente, en los centros educativos (2,3,16), y los RD reflejan aquellos saberes y competencias sobre las que existe evidencia de que los jóvenes pueden aprender. Llamar al 112 (17), PLS (18), RCP (5-7,19), OVACE (20) o DEA/DESA (21,22) pueden ser aprendidos y ejecutados desde edades tempranas, incluso antes de lo que los currículos indican. Las tres etapas presentan similitudes y diferencias curriculares en relación a los PPAA. En todas se promueve la prevención de accidentes y el aprendizaje de actuaciones básicas (aunque no se especifican). A partir de la ESO, las habilidades técnicas (RCP/DEA/OVACE) y el reconocimiento de signos y síntomas (ictus) tienen un peso predominante.

Educación Primaria. En la Educación Primaria, en el área de Educación Física, una competencia específica desde segundo ciclo es el conocimiento de protocolos básicos de actuación ante accidentes. Este concepto es muy abierto,

permitiendo al docente crear contenido desde actuaciones básicas de PPAA (por ejemplo, el sangrado de la nariz) hasta actuaciones más especializadas (como la alerta a los servicios de emergencias 112) o el uso de maniobras salvadoras (como PLS). En definitiva, en 3º y 4º no se concretan procedimientos, pero atendiendo a los contenidos de 5º y 6º, en los que sí aparece la conducta PAS (*Proteger, Alertar y Socorrer*), se podría entender que en segundo ciclo de Primaria se busca el conocimiento desde una perspectiva más conceptual, y en el tercer ciclo de Primaria se espera que el alumnado sea capaz de participar activamente, tal y como se deduce del abordaje curricular en el RD 157/2022 (13). Estos saberes básicos y competencias específicas se concretan en que a los nueve y diez años los niños/as deberían ser capaces de prevenir diferentes tipos de accidentes, llamar por teléfono y dar indicaciones adecuadas a los servicios de emergencias. La Educación Primaria es una etapa globalizada, en la que los contenidos de las diferentes materias deben estar interconectados. En el área de Conocimiento del Medio Natural, Social y Cultural para el tercer ciclo se mencionan como saber básico las actuaciones básicas de PPAA, lo que permite el trabajo interdisciplinar y con conexión de contenidos junto al área de Educación Física.

Educación Secundaria. El área de Educación Física en Secundaria tiene un carácter transdisciplinar, en la que se busca el abordaje desde múltiples perspectivas. En tanto que los contenidos de PPAA son más concretos que en Primaria, su aplicabilidad abarca cualquier incidente en la actividad física y también en los contextos sociales próximos (familia, amigos, entorno...).

En primero de la ESO se vuelve a mencionar la conducta *Proteger, Alertar, Socorrer* (PAS) y añade el protocolo 112. Desde una perspectiva de las emergencias, esto supone activar la alerta, con una información precisa, indicando quién llama, qué está pasando, cuántas víctimas necesitan ayuda y qué se está

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haciendo por ellas. El Consejo Europeo de Reanimación promueve tres pasos para activar la alerta (23):

- 1) Llamar de inmediato a los servicios médicos de emergencia (112) si una persona está inconsciente con ausencia de respiración o respiración anormal.
- 2) Un testigo que está solo con un teléfono móvil, debe marcar el número 112, activar el altavoz u otra opción manos libres.
- 3) Comenzar inmediatamente la RCP asistido por el operador de emergencias.

Un aspecto novedoso es la aparición del Soporte Vital Básico (SVB), que se define como el conjunto de maniobras que permiten reconocer el paro cardiorrespiratorio, la alerta a los servicios de emergencias y el conocimiento de las maniobras de PPAA. Estas maniobras incluyen la evaluación de la conciencia, la apertura de las vías respiratorias (y desobstrucción si es necesario), la respiración artificial (si es posible) y las compresiones torácicas de calidad. En resumen, el SVB incluye la RCP, el DEA/DESA y OVACE y cómo evaluar su necesidad mediante la valoración primaria: A (aire); B (respiración); C (circulación). Esto supone el conocimiento de las maniobras de apertura de vía aérea (maniobra frente/mentón), la reanimación cardiopulmonar, la posición lateral de seguridad y las maniobras de desobstrucción de vía aérea ante atragantamiento (palmas inter-escapulares y maniobra de Heimlich).

En tercero y cuarto de la ESO se establece como saber básico *actuaciones ante accidentes*, pero no derivado exclusivamente de la práctica de actividad física, por lo que deja en manos de la programación docente la inclusión de actuaciones, por ejemplo, ante incidentes acuáticos mediante formación en salvamento y socorrista, incidentes en montaña, en accidentes de tráfico u otras actuaciones de emergencias como el control activo de hemorragias, traslado de accidentados, etc.

Aunque en cursos anteriores se introdujo al alumnado en los conceptos de SVB, en tercero y cuarto se menciona específicamente el uso del Desfibrilador Externo Automático o Semiautomático (DEA/DESA). Es destacable que este contenido puede ser aprendido en etapas previas, ya que técnicamente es muy sencillo, y la evidencia ha mostrado que escolares más pequeños ya son capaces de aprender su uso (22). Posiblemente, el énfasis que el Decreto (14) realiza en este nivel se justifique en la búsqueda de una cardioprotección activa, y que el alumnado no sea ya sólo un mero receptor de conocimiento, sino ejercer una ciudadanía proactiva que actúe en caso de parada cardiorrespiratoria, pudiendo incluso identificar signos y síntomas de alarma de diferentes patologías (por ejemplo, el ictus).

Bachillerato. Del análisis de las competencias específicas, los criterios de evaluación y los saberes básicos que menciona el Real Decreto (15) para esta etapa, se deduce que el alumnado debe no ser sólo un mero receptor de conocimiento y dominar también habilidades básicas. Deben regular su propia seguridad, tomar conciencia de los riesgos y asumir decisiones en situaciones críticas de una forma autónoma.

Un aspecto relevante es la mención de la prevención de lesiones e incidentes no sólo en el medio terrestre, también en el medio acuático. Este matiz tiene más importancia de la que aparentemente se pueda pensar, pues el ahogamiento infantil y adolescente se sitúa entre las tres primeras causas de muerte no intencional. Además, en la etapa adolescente hay un cambio de tendencia, pasando de ahogarse principalmente en piscinas, provocado por la falta de supervisión de sus cuidadores, al ahogamiento en espacios naturales (playas marítimas, ríos y pantanos), en ausencia de adultos y en presencia de grupos de amigos (24). Por lo que un contenido fundamental en esta etapa es la prevención activa y la educación en la seguridad activa en cualquier entorno acuático o deporte náutico (25).

En relación a los saberes básicos, en esta etapa se continúan reforzando las técnicas de SVB, que incluyen la RCP, el uso de desfibrilador (DEA/DESA) y las maniobras de desobstrucción de la vía aérea (OVACE), si bien sólo indica la maniobra de Heimlich (una parte de las técnicas de desobstrucción de vía aérea), que además la clasifica erróneamente como accidente cardiovascular, al igual que el ictus, que es un accidente cerebrovascular. Su inclusión es pertinente porque en España supone la segunda causa de muerte y la primera de discapacidad adquirida, por lo que a nivel curricular englobaría la prevención que tiene que ver con el estilo de vida saludable, eliminando condiciones y/o hábitos nocivos como la dislipemia, el tabaquismo, el alcoholismo, la obesidad y el sedentarismo, así como la identificación precoz de los signos y síntomas de alarma por parte de la población en general, ya que el tratamiento precoz reduce la mortalidad y atenúa las secuelas (26).

También como saber básico se incluye el kit de un botiquín y su uso, que por lo general se utiliza para aquellos incidentes menores, normalmente para el tratamiento de heridas y contusiones leves. Por lo que en esta etapa el alumnado debería identificar los tipos de heridas, cómo tratarlas y las medidas de asepsia para estos procedimientos (lavado de manos, uso de guantes, evitar fuentes contaminantes, etc.)

Otra novedad que se incorpora a la educación obligatoria es el conocimiento de los protocolos de alerta escolar, que son el conjunto de acciones coordinadas para ofrecer una respuesta inmediata y eficaz al alumnado que padece una patología crónica susceptible de descompensación e, incluso, de compromiso vital. Habitualmente se refieren a crisis alérgicas (anafilaxia), crisis comiciales (epilepsia), crisis diabéticas (hipoglucemias), crisis asmáticas graves y cardiopatías congénitas. En estos casos debe haber un protocolo de actuación que va desde la identificación hasta la alerta inmediata, según el plan diseñado a tal efecto, así como una serie de pro-

cedimientos que deberían estar previamente fijados y en los que puede participar el alumnado. Por ejemplo, identificar una reacción anafiláctica grave durante el recreo y alertar al profesorado, o colaborar en un ataque epiléptico, separando mesas, sillas u objetos potencialmente dañinos para la persona que está sufriendo la crisis.

En segundo de Bachillerato se ofertan optativas que pueden venir marcadas por las diferentes comunidades como, por ejemplo, *Actividad física y salud*, o bien pueden ser de oferta propia del centro, que llegan a tener nombres tan específicos como PPAA. En estos casos, el contenido curricular vinculado con la prevención de accidentes y los PPAA puede verse ampliado o reforzado.

Fortalezas y debilidades de los RD en materia de PPAA. La incorporación de los PPAA en los nuevos RD supera las leyes educativas anteriores, ofreciendo a los estudiantes una formación más completa para prevenir riesgos y adquirir habilidades que les permitan actuar en situaciones de emergencia. Sin embargo, llama la atención que muchas de las acciones no están detalladas, especialmente en los primeros años escolares. Es importante señalar que ninguno de los planes de estudios de Educación Primaria, ya sea en los currículos anteriores o actuales, menciona explícitamente la enseñanza de la RCP, aunque el concepto de socorrer en el protocolo PAS incluye la aplicación de medidas para auxiliar a alguien en una emergencia crítica, como un paro cardíaco. Quizá lo más sorprendente es que el protocolo 1-1-2 no aparezca ya desde el primer año de Primaria, cuando precisamente fue diseñado para que los niños/as más pequeños puedan activar la cadena de supervivencia con un número fácil de recordar.

También cabría preguntarse por qué se introduce el concepto de SVB en los primeros dos años de Secundaria pero no se menciona en los dos años siguientes, mientras que la RCP, el DEA/DESA y OVACE se abordan en 3º

RD
&D

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y 4º de forma independiente cuando lo lógico es que fuese en 1º y 2º de ESO, para finalizar la etapa educativa integrando las tres habilidades del SVB en un enfoque global.

Por otro lado, llama la atención que el RD de Secundaria y Bachillerato incluye dentro de accidentes cardiovasculares la maniobra de Heimlich o el ictus, lo que claramente es una clasificación errónea y que debería ser corregida, ya que puede dar lugar a errores de interpretación (un atragantamiento no tiene nada que ver con una patología cardiovascular). En síntesis, se ha producido un avance notable en el desarrollo curricular, pero sería necesario más concreción en los diferentes cursos académicos y más precisión en la redacción de la legislación educativa vinculada a los PPAA.

El currículo actual dota de contenido en materia de PPAA a las diferentes etapas educativas, no sólo desde una vertiente de la prevención sino también del aprendizaje de técnicas y protocolos para aplicar en situaciones críticas. Los diferentes contenidos se estruc-

turan en una secuencia desde lo más simple (conducta PAS desde Educación Primaria) hasta situaciones más complejas en Bachillerato, como la identificación de accidentes cerebrovasculares y la integración del alumnado dentro de la cadena asistencial, bien como testigo que alerta o como primer interviniente que participa activamente de la emergencia. La prevención de accidentes es el contenido más repetido en los diferentes cursos y tiene su inicio a los ocho-nueve años. Al finalizar la etapa educativa obligatoria (ESO), todo el alumnado debería saber identificar la parada cardíaca, alertar a los servicios de emergencias, iniciar las maniobras de reanimación, usar el desfibrilador y saber actuar ante un atragantamiento. Por este motivo, este artículo puede ser de ayuda para la comunidad educativa (docentes) así como para profesionales sanitarios vinculados al ámbito educativo (enfermería escolar, pediatría y Atención Primaria) de cara a identificar qué, cómo y cuándo enseñar cada uno de los procedimientos, técnicas y protocolos en las diferentes etapas escolares. ●

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6.2 DROWNING PREVENTION THROUGH INNOVATIVE EDUCATIONAL INTERVENTIONS.

Article 2 - Title: Drowning prevention through school health education. Evaluation of the SOS 112 pilot project.

Article 3 - Title: The "DrownSafe" Project: Assessing the Feasibility of a Puppet Show in Teaching Drowning Prevention to Children and Parents.

6.2.1 Article 2 - Title: Drowning prevention through school health education. Evaluation of the SOS 112 pilot project.

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RESESP

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Drowning prevention through school health education. Evaluation of the SOS 112 pilot project

Prevención del ahogamiento desde la educación para la salud escolar. Evaluación del proyecto piloto SOS 112

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Figure RESULTS-9. Screenshot of article 02 identification. Available at <https://pubmed.ncbi.nlm.nih.gov/37970869/>

6.2.1.1 Article abstract

Background // Drowning represents one of the main causes of child mortality. Water-related incidents are preventable and should be addressed through health education. The aim of this study was to evaluate an educational program for eight-year-old students based on a song with content on drowning prevention.

Methods // A feasibility pilot study was conducted, including forty-six children enrolled in a public school in Santiago de Compostela (A Coruña, Spain). The study was developed in three phases. In the first step, a group of experts and musicians created the educational content and the song. Secondly, the evaluation tool was developed, and finally, the program was implemented based on flag recognition, how to help in a drowning situation, safe swimming attitudes, and information about the emergency phone number 112.

The percentage of correct responses by children before and after the educational intervention were compared using the McNemar test.

Results // Approximately half of the children were unaware of the meaning of the flags. After listening to the song, all students identified the meaning of the red flag, and over 90% recognized the green and yellow flags ($p < 0.001$). Before the intervention, children correctly identified, on average, 75.3% of the safe water attitude pictograms. This perception of safe attitudes significantly increased post-intervention ($p < 0.001$), with recognition of 86.4% of the correct behaviours. The overall water safety score also significantly improved by 22.7% after the intervention ($p < 0.001$).

Conclusions // The educational song is a resource to promote the learning of signals and concepts related to child drowning prevention.

Keywords // Drowning prevention; Health education; Song; Schoolchildren.

6.2.1.2 Evidence of Quality

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Declaration on Research Assessment (DORA)

[Drowning prevention through school health education. Evaluation of the SOS 112 pilot project]. This research was conducted in a public educational center and its results have been published in the Spanish Journal of Public Health, edited by the Ministry of Health of the Government of Spain. It offers an online resource available to the entire educational community (<https://www.youtube.com/watch?v=8qSE8H43rpQ>). It currently has a citation on Google Scholar.

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Specific contribution of the PhD candidate to the article:

Leadership in writing the manuscript (first author). Conception and design of the study, methodology; drafting of the manuscript and revision after peer-review.

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Prevención del ahogamiento desde la educación para la salud escolar. Evaluación del proyecto piloto SOS 112

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RESUMEN

FUNDAMENTOS // El ahogamiento representa una de las principales causas de mortalidad infantil. Los incidentes acuáticos son prevenibles y deben ser abordados desde la educación para la salud. El objetivo de este estudio fue evaluar un programa educativo en alumnado de ocho años basado en una canción con contenido para la prevención del ahogamiento.

MÉTODOS // Se realizó un estudio piloto de viabilidad que incluyó a cuarenta y seis niños/as escolarizados en un centro público de Santiago de Compostela (A Coruña, España), siendo desarrollado en tres fases. En el primer paso, un grupo de expertos y músicos crearon el contenido educativo y la canción. En segundo lugar, se elaboró la herramienta de evaluación y, finalmente, se implementó el programa basado en el reconocimiento de las banderas, en cómo ayudar en un ahogamiento, en las actitudes seguras para el baño y en información sobre el teléfono de emergencias 112. El porcentaje de respuestas correctas antes y después de la intervención educativa se compararon utilizando la prueba de McNemar.

RESULTADOS // Aproximadamente la mitad de los niños/as desconocía el significado de las banderas. Después de la audición de la canción, todos los escolares identificaron el significado de la bandera roja y más del 90% reconoció la bandera verde y amarilla ($p < 0.001$). Antes de la intervención, los niños identificaron correctamente, en promedio, el 75.3% de los pictogramas de actitudes acuáticas seguras. Esta percepción de actitudes seguras aumentó significativamente postintervención ($p < 0.001$), reconociendo el 86.4% de las conductas correctas. La puntuación general de seguridad del agua también mejoró significativamente después de la intervención un 22.7% ($p < 0.001$).

CONCLUSIONES // La canción educativa es un medio para favorecer el aprendizaje de las señales y conceptos sobre la prevención del ahogamiento infantil.

PALABRAS CLAVE // Prevención del ahogamiento; Educación para la salud; Canción; Escolares.

ABSTRACT

BACKGROUND // Drowning represents one of the main causes of child mortality. Water-related incidents are preventable and should be addressed through health education. The aim of this study was to evaluate an educational program for eight-year-old students based on a song with content on drowning prevention.

METHODS // A feasibility pilot study was conducted, including forty-six children enrolled in a public school in Santiago de Compostela (A Coruña, Spain). The study was developed in three phases. In the first step, a group of experts and musicians created the educational content and the song. Secondly, the evaluation tool was developed, and finally, the program was implemented based on flag recognition, how to help in a drowning situation, safe swimming attitudes, and information about the emergency phone number 112. The percentage of correct responses by children before and after the educational intervention were compared using the McNemar test.

RESULTS // Approximately half of the children were unaware of the meaning of the flags. After listening to the song, all students identified the meaning of the red flag, and over 90% recognized the green and yellow flags ($p < 0.001$). Before the intervention, children correctly identified, on average, 75.3% of the safe water attitude pictograms. This perception of safe attitudes significantly increased post-intervention ($p < 0.001$), with recognition of 86.4% of the correct behaviours. The overall water safety score also significantly improved by 22.7% after the intervention ($p < 0.001$).

CONCLUSIONS // The educational song is a resource to promote the learning of signals and concepts related to child drowning prevention.

KEYWORDS // Drowning prevention; Health education; Song; Schoolchildren.

INTRODUCCIÓN

EL AHOGAMIENTO ES UN EVENTO PREVENIBLE que contribuye de manera significativa a la mortalidad y morbilidad infantiles (1,2), provocando anualmente la muerte de 175.000 menores (3), por lo que existe un llamamiento internacional a detener esta *epidemia* (2). Aunque se han propuesto diversas estrategias preventivas (2,4-7), la mayor parte de las acciones se han basado en la enseñanza de la natación a los mayores de cuatro años (8), las recomendaciones a los adultos para que supervisen de forma directa a los niños/as, el uso de chalecos salvavidas o campañas para la enseñanza de la reanimación cardiopulmonar (RCP); sin embargo, se dispone de pocas evidencias científicas acerca del efecto de los programas educativos sobre la identificación de riesgos y la adquisición de conocimientos y actitudes hacia la prevención del ahogamiento infantil.

La educación para la salud tiene entre sus finalidades identificar y evitar riesgos para evitar el incidente acuático (9). La prevención del ahogamiento pretende anticiparse a sus desencadenantes desde un enfoque proactivo y educativo. La educación acuática, especialmente en los jóvenes, puede prevenir ahogamientos sin poner en riesgo la propia vida (10,11).

Los materiales educativos son una parte fundamental en las herramientas de los docentes para la enseñanza, y en la prevención del ahogamiento ya se han usado los cuentos en educación infantil (12), conmemoraciones como el *day care* (4) o los vídeos educativos (13). En el ámbito de la educación existe la evidencia de que las canciones pueden ser un método efectivo para transmitir mensajes de Salud Pública a bajo coste y promover cambios de comportamiento (14), además de ser un recurso educativo habitual en los primeros años escolares.

Por tanto, este estudio piloto tuvo como objetivo analizar el efecto de un programa

educativo creado en torno a una canción infantil para promover conocimientos y actitudes seguras en el medio acuático en escolares de ocho años.

MATERIAL Y MÉTODOS

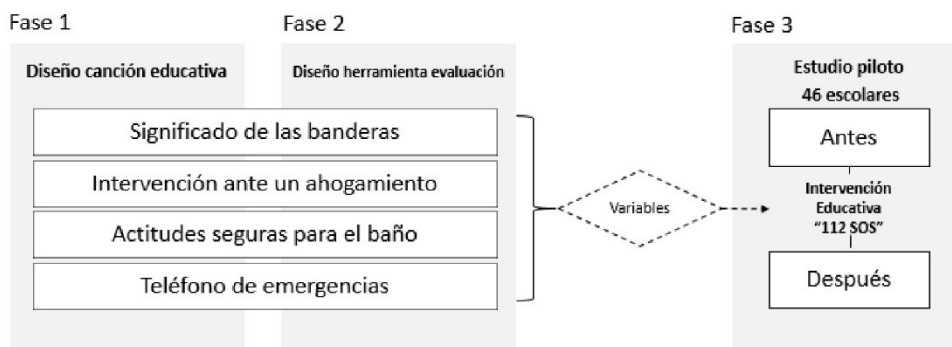
SE REALIZÓ UN ESTUDIO PRELIMINAR DE viabilidad, descriptivo y no aleatorizado con evaluación de dos momentos: antes de la intervención y después de la intervención.

Diseño y muestra. El estudio se desarrolló en tres fases [Figura 1]:

- 1) Creación de una canción infantil que abordara el contenido de prevención del ahogamiento, adaptada a los niños/as de ocho años de edad.
- 2) Elaboración de una herramienta de evaluación (ficha de actividades escolares) para cuantificar los conocimientos teóricos en relación con la seguridad acuática.
- 3) Aplicación de los materiales en un estudio de viabilidad con un grupo de cuarenta y seis escolares (veinticuatro niñas y veintidós niños) de ocho años de edad. El criterio de inclusión fue que no presentasen ninguna incapacidad física o psíquica que limitase su capacidad de comprensión y que se contase con la autorización a efectos de investigación de los tutores legales. Los escolares pertenecían a un centro educativo público de Santiago de Compostela (A Coruña). La realización de este estudio fue aprobada por el comité de ética de la Facultad de Ciencias de la Educación y el Deporte (*Universidade de Vigo*) con el código 08-0721 y el estudio se desarrolló en mayo de 2022.

Creación de la canción educativa. Un grupo de expertos formado por seis profesionales expertos en seguridad y educación acuática participaron en el diseño del proyecto educativo basado en una canción con contenidos

Figura 1
Diseño del estudio.



de prevención en ahogamiento. Los expertos procedían de los ámbitos de la pediatría, el socorrismo, la educación y/o la investigación. Los expertos elaboraron un listado de ítems que debían ser incluidos en el texto de la canción, estableciéndose cuatro conceptos fundamentales:

- 1) Significado del color de las banderas.
- 2) Intervención ante un ahogamiento.
- 3) Conocimiento del teléfono europeo de emergencias 112.
- 4) Consejos para un baño seguro.

Dos músicos profesionales, especialistas en canciones infantiles, elaboraron la primera versión de la letra, que fue modificándose en tres diferentes versiones a sugerencia de los expertos. Una vez llegado al consenso sobre el contenido de la letra, la canción fue grabada, estando disponible en el siguiente enlace: <https://www.youtube.com/watch?v=8qSE8H43rpQ>

Intervención educativa y evaluación del Proyecto. Intervención educativa. El proyecto se implementó en un centro educativo público de educación primaria de la ciudad de Santiago de Compostela (España). La canción titulada *112 SOS* se proyectó (audio y vídeo) en una pizarra digital una única vez. Al finalizar la proyección los alumnos podían hacer preguntas al docente sobre el contenido audiovisual. El video completo alojado en *YouTube* dura 6 minutos y 11 segundos, en el que se incluyen consejos de prevención del ahogamiento y la canción, cuya duración es de 2 minutos y 27 segundos. Finalmente, tras la proyección del vídeo, se generó un debate con el alumnado de diez minutos de duración.

Para analizar la viabilidad del proyecto educativo y poder cuantificar la modificación de los conocimientos se elaboró una ficha escolar que se aplicaría antes de la intervención educativa y después.

Evaluación *Báñate con seguridad*: canción del 112 SOS. La herramienta de evaluación se presentaba en una ficha estructurada en tres blo-

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ques con pictogramas e imáxenes en las que los escolares debían indicar el significado (en el caso de las banderas), el número de los servicios de Emergencias, rodear la actitud correcta ante un ahogamiento e indicar cuál de las situaciones acuáticas era segura o insegura **[FIGURA 2]**.

Variables de análisis. Se establecieron cinco grupos de análisis de acuerdo a los indicadores de evaluación:

- a) Reconocimiento del significado de las banderas.
- b) Afrontamiento de un rescate acuático.
- c) Reconocimiento del número de Emergencias.
- d) Actitudes seguras en el baño (puntuación de 0 a 100% calculado en base a la fórmula $(\Sigma \text{ciertos} \times 100)/8$).
- e) Conocimiento global de la seguridad acuática calculado en base a la fórmula $(\Sigma \text{ciertos} \times 100)/15$.

Análisis estadístico. Todos los análisis se realizaron con SPSS para Windows (versión 25.0, Armonk, NY: IBM Corp). La normalidad de las variables se evaluó mediante la prueba de Shapiro-Wilk. Los resultados descriptivos se presentan como frecuencia absoluta (F) y porcentaje relativo (%) de respuestas para variables dicotómicas o media; desviación estándar (DE), mediana y rango intercuartílico (CI) para variables continuas. Se utilizó la prueba de McNemar para comparar el porcentaje de respuestas correctas antes y después de la intervención. Las diferencias entre las variables puntuación antes y después se analizaron según la prueba de Wilcoxon. Para todos los análisis, el valor de significación se fijó en $p < 0,05$.

RESULTADOS

Conocimiento de seguridad acuática. La **Tabla 1** muestra las diferencias en el conocimiento de los niños sobre la seguridad en el agua antes y después de la intervención educativa. Aproximadamente la mitad de los niños desconocía el significado de las banderas antes

Figura 2
Fichas de evaluación: antes (izquierda) y después de la intervención (derecha).



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Tabla 1
Diferencias en el conocimiento de los niños sobre seguridad en el agua antes y después de la intervención educativa (F y porcentaje de respuestas correctas)^(a). Puntuaciones de seguridad en el agua obtenidas por los niños antes y después de la intervención^(b).

Conocimientos de seguridad acuática ^(a)	Antes	Después	McNemar (p-valor)	
Significado de las banderas	Roja	25 (55,6%)	45 (100%)	18,050 (<0,001)
	Amarilla	21 (46,7%)	41 (91,1%)	18,050 (<0,001)
	Verde	24 (53,3%)	42 (93,3%)	14,450 (<0,001)
Intervención ante un ahogamiento	19 (42,2%)	44 (97,8%)	23,040 (<0,001)	
Número de emergencias	34 (75,6%)	44 (97,8%)	8,100 (0,002)	

Escala de seguridad acuática ^(b)	Antes			Después		
	Media ± DT	Mediana	Rango IQ	Media ± DT	Mediana	Rango IQ
Acciones seguras	75,3 ± 17,6	75,0	62,5-87,5	86,4 ± 16,4	87,5	75,0-100
Seguridad global acuática	67,4 ± 15,5	69,2	53,8-76,9	90,1 ± 11,3	92,3	84,6-100

de la intervención, especialmente la bandera amarilla. Después de escuchar la canción, este conocimiento mejoró significativamente ($p < 0,001$), ya que todos los estudiantes identificaron el significado de la bandera roja y más del 90% reconoció la bandera verde y amarilla. En cuanto a la intervención teórica en caso de ahogamiento, inicialmente el 57,8% de los escolares optaría por intentar un rescate acuático, frente a la opción correcta de lanzar un objeto flotante y avisar al socorrista o pedir ayuda (42,2%). Tras la intervención educativa, la mayoría de los sujetos elegirían la opción correcta (97,8%). Además, antes de la intervención, el 24,4% de los escolares no conocían el número de emergencia 112, dejando en blanco la respuesta o indicando otro número no operativo en la zona (por ejemplo, 911). Después de escuchar la can-

ción, el conocimiento del número 112 se incrementó al 97,8%.

Escala de seguridad acuática. Las diferencias entre las puntuaciones de seguridad en el agua obtenidas por los niños antes y después de la intervención se muestran en la **TABLA 1**. Antes de la intervención, los niños/as identificaron correctamente, en promedio, el 75,3% de los pictogramas de actitudes acuáticas seguras. Esta percepción de actitudes seguras aumentó significativamente tras escuchar la canción ($Z=4,319$; $p < 0,001$), reconociendo el 86,4% de las conductas correctas. La puntuación general de seguridad del agua también mejoró significativamente después de la intervención ($Z=5,670$; $p < 0,001$). En concreto, el porcentaje medio de aciertos aumentó un 22,7% (del 67,4% al 90,1%).

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DISCUSIÓN

ESTE ESTUDIO, AUNQUE PRELIMINAR, ES el primero que analiza efecto a corto plazo de una canción educativa sobre los conocimientos relacionados con la prevención del ahogamiento. Los principales hallazgos son:

- a) Incremento significativo sobre el significado de la bandera roja hasta alcanzar el 100% de la muestra.
- b) Modificar la idea primaria del intento de rescate con contacto directo por el rescate desde fuera del agua.
- c) Mejora el conocimiento del número europeo de Emergencias.

En el campo de la prevención del ahogamiento infantil, las recomendaciones se han centrado principalmente en medidas tales como fomentar las clases de natación, el uso de chalecos salvavidas, el cierre perimetral de piscinas, la educación en reanimación y una conciencia del riesgo, especialmente en los cuidadores de los niños (6,7); sin embargo, apenas existen proyectos escolares que fomenten conocimiento del riesgo, de las normas y que promuevan comportamientos seguros. Lo cierto es que los directores de las escuelas acuáticas australianas recomiendan que los niños/as de once años deberían tener conocimientos específicos sobre seguridad acuática y prevención del ahogamiento (15), por lo que se deben promover esfuerzos educativos para incrementar el conocimiento en seguridad (16), desarrollando programas con objetivos adecuados, ya que su efectividad dependerá del correcto diseño (17).

Un aspecto nuclear de nuestro estudio se basa en el reconocimiento de las banderas de la playa (roja, verde y amarilla). Inicialmente poco más de la mitad de los niños conocía el significado de la bandera roja, algo que cambia tras la intervención educativa. A pesar de lo simple que puede parecer, esta circunstan-

cia también fue encontrada por Wilks *et al.* en un estudio en Australia (15). Lo cierto es que niños y adolescentes tienen bajos conocimientos sobre la prevención acuática (13,18). La falta de atención de los bañistas en la señalización de la playa es un hecho constatado (19), lo que puede suponer un riesgo añadido por falta de conocimiento, y es inevitable sugerir que podría resolverse con consejos básicos de prevención desde la Escuela Primaria. La escuela puede ser un entorno adecuado para la implementación de programas de seguridad (20), ya que se puede acceder a la mayoría de los jóvenes, que suelen ser muy receptivos a los mensajes preventivos. La información debe ser progresiva y adaptada a la edad de los niños/as.

La prevención del ahogamiento puede integrarse de manera significativa con otros contenidos escolares (como Educación Física o Ciencias). En la escuela infantil se puede partir de conceptos muy básicos como conocer el significado las banderas o a quién llamar en caso de emergencia (12) hasta contenidos y habilidades más complejas en la Educación Primaria, incluyendo las habilidades acuáticas de natación y autosalvamento, la prevención activa y reactiva, lanzar objetos flotantes a quien parece estar ahogándose y conocer que el frío puede matar, así como pensar y mirar antes de saltar (7,15,17,21). En la Educación Secundaria (adolescencia) debe enfocarse hacia una adquisición de actitudes (17) y el desarrollo de habilidades más complejas como reconocer las corrientes de retorno o la identificación de otros riesgos acuáticos (13). La continua evolución de la educación hacia modelos más integradores y significativos no es ajena a la educación en seguridad acuática, en la que el reto para su comprensión y asimilación requiere innovación y trabajo en equipo (5). Turgut *et al.* (16) desarrollaron un programa educativo en la escuela secundaria y, tras su implementación, se incrementaron un 32% los niveles de conocimiento sobre la seguridad del agua; la evaluación consistía en señalar en pictogramas cuáles situaciones eran seguras y cuáles no. Nuestro estu-

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dio encuentra también un incremento del 21% sobre el conocimiento acerca de la seguridad en el agua tras la audición de la canción. En este sentido, el uso de canciones como herramienta educativa o para promover conductas relacionadas con la prevención o emergencias ya ha sido analizada en la literatura (22,23).

Desde hace años, diversas sociedades científicas como el *European Resuscitation Council* (ERC) o la *American Heart Association* (AHA) promueven la enseñanza escolar de la Reanimación Cardiopulmonar (RCP), que se ha agrupado bajo el concepto *KIDS SAVE LIVES* (24), desarrollándose recursos audiovisuales (25), canciones educativas (26), contenidos específicos en redes sociales (27), metodologías ludificadas (28,29) o materiales innovadores (30,31) que están logrando aprendizajes significativos y estables a lo largo del tiempo. Siguiendo esta idea, urge la creación de contenidos educativos infantiles que promuevan actitudes seguras para prevenir el ahogamiento. El uso de recursos educativos de fácil distribución y mínimo coste puede ser una alternativa para una formación masiva de la población infantil. El ahogamiento es un problema global, pero los medios para evitarlo no son iguales en todos los países, por lo que la Organización Mundial para la Salud (OMS) en la *Practical guidance for the provision of daycare, basic swimming and water safety skills, and safe rescue and resuscitation training* (6) recomienda la adaptación de materiales para entornos con bajos recursos, y nuestra propuesta se basa en la distribución global y gra-

tuita a través de *YouTube* en lengua española, por lo que su accesibilidad es posible para millones de hispanohablantes.

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Limitaciones de este estudio. En primer lugar, al tratarse de un estudio piloto la muestra es pequeña y local y unicéntrica. Se abordan algunos de los aspectos más relevantes de la seguridad acuática pero no están todos, no se puede atribuir un mejor resultado en el test final a una mayor seguridad efectiva en el medio acuático ni a un cambio de actitudes hacia los riesgos acuáticos. Futuros estudios deben abordar la incidencia del ahogamiento entre niños con formación específica y niños que no la han recibido.

A modo de conclusiones, señalar que una canción infantil con mensajes preventivos consigue transmitir a los niños y mejora su conocimiento sobre la señalética de las playas (banderas), incrementa la percepción sobre las actitudes de cara a un baño seguro, disminuye la idea de intentar un rescate acuático dentro del agua con contacto, optando teóricamente por la alternativa de lanzar un objeto desde fuera del agua y alertar a los servicios de Emergencias.

Las canciones infantiles compuestas de forma específica para transmitir los mensajes claves de prevención en el medio acuático pueden ser instrumentos educativos efectivos y factibles que deberían ser conocidos y utilizados por los docentes dentro de los contenidos de educación para la salud. ©

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6.2.2 Article 03 - Title: The "DrownSafe" Project: Assessing the Feasibility of a Puppet Show in Teaching Drowning Prevention to Children and Parents.



Article

The "DrownSafe" Project: Assessing the Feasibility of a Puppet Show in Teaching Drowning Prevention to Children and Parents

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Figure RESULTS- 10. Screenshot of article 03 identification.

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6.2.2.1 Article abstract

Drowning remains a prominent global pediatric health concern, necessitating preventive measures such as educational initiatives for children and caregivers. In this study, we aimed to assess the feasibility and educational effectiveness of an interactive puppet show centered on teaching water safety to children and parents. A 30 min original theater performance, featuring two actors and three puppets (a girl, a crab, and a lifeguard), was conducted. Subsequently, 185 children (aged 4 to 8) and their 160 parents (134 mothers and 26 fathers) participated in this quasi-experimental study. Pre- and post-show tests were administered to evaluate knowledge and behaviors regarding aquatic environments. Prior to the puppet show, 78% of the children exhibited basic aquatic competency. Only 33% considered swimming alone risky. Following the intervention, 81.6% of the children changed their perception of the risks of solo beach activities, showing improved knowledge regarding contacting an emergency number (from 63.2% to 98.9%, $p < 0.001$). The intervention increased parents' intention to visit lifeguard-patrolled beaches and improved their CPR knowledge with regard to drowning victims by 58.8%. In conclusion, a drowning prevention puppet show positively impacted children and parents, potentially enhancing safety behaviors during water-related leisure activities, warranting its consideration part of comprehensive drowning prevention strategies.

Keywords: drowning prevention; learning; training; schoolchildren; parents; puppets show; lifeguard; low-cost intervention; basic life support

6.2.2.2 Evidence of Quality

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It is cataloged in the Web of Science and Scopus repositories in the field of *Pediatrics*, and *Pediatrics, Perinatology and Child Health*.

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[The "DrownSafe" Project: Assessing the Feasibility of a Puppet Show in Teaching Drowning Prevention to Children and Parents]. This research is part of a community action called "Corresponsables" and is funded by the Government of Spain, Xunta de Galicia, and the University of Vigo. It has reached over 500 people (children and adults) in different municipalities in the provinces of Pontevedra and Ourense (Galicia, Spain). It currently has a citation on Google Scholar. This publication is indexed in the JCR and SJR Rank.

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Article

The “DrownSafe” Project: Assessing the Feasibility of a Puppet Show in Teaching Drowning Prevention to Children and Parents

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Abstract: Drowning remains a prominent global pediatric health concern, necessitating preventive measures such as educational initiatives for children and caregivers. In this study, we aimed to assess the feasibility and educational effectiveness of an interactive puppet show centered on teaching water safety to children and parents. A 30 min original theater performance, featuring two actors and three puppets (a girl, a crab, and a lifeguard), was conducted. Subsequently, 185 children (aged 4 to 8) and their 160 parents (134 mothers and 26 fathers) participated in this quasi-experimental study. Pre- and post-show tests were administered to evaluate knowledge and behaviors regarding aquatic environments. Prior to the puppet show, 78% of the children exhibited basic aquatic competency. Only 33% considered swimming alone risky. Following the intervention, 81.6% of the children changed their perception of the risks of solo beach activities, showing improved knowledge regarding contacting an emergency number (from 63.2% to 98.9%, $p < 0.001$). The intervention increased parents’ intention to visit lifeguard-patrolled beaches and improved their CPR knowledge with regard to drowning victims by 58.8%. In conclusion, a drowning prevention puppet show positively impacted children and parents, potentially enhancing safety behaviors during water-related leisure activities, warranting its consideration part of comprehensive drowning prevention strategies.

Keywords: drowning prevention; learning; training; schoolchildren; parents; puppets show; lifeguard; low-cost intervention; basic life support

1. Introduction

Childhood drowning is a concerning public health problem that affects communities worldwide [1,2], being the third leading cause of global child mortality among children aged 5 and older [3]. Incidents involving children in aquatic environments have multifactorial causes, including lack of aquatic competence, absence of direct supervision, and caregivers’ negligence [4–6].

Education must play a crucial role in drowning prevention, and different school programs, from preschool to secondary education, have demonstrated benefits related to drowning prevention [7–11]. Childhood drowning incidents are multifactorial, so the approach to their prevention should also involve parents or caregivers, as they reinforce learning and safe behaviors in the aquatic environment [12–15]. However, there is a gap in the knowledge regarding which activities or educational approaches could be effective alternatives for younger children as well as regarding how to address them from a family perspective. Furthermore, there is general agreement that community intervention has a beneficial effect on preventing drowning [16].

A primary purpose of drowning research should be to provide low-cost, wide-ranging, and easily replicable educational resources and strategies to mitigate cultural or economic gaps, particularly focusing on low-income countries where children are more vulnerable [3]. In the quest for effective strategies, scientific evidence has shown that theatrical performances, especially those involving puppets, have great potential for teaching content related to injury prevention and health education due to their incorporation of fantasy elements and imagination, allowing recipients to actively engage in the teaching–learning process [17].

The use of puppets has a long tradition in Early Childhood Education and Care (ECEC) [18]. A recent review of puppet use for children aged 1 to 9 identified up to four theoretical perspectives (constructivism, psychology, sociology, and arts) that support the constructs of communication, fantasy, storytelling, and friendship among young children [19]. However, the use of puppets in ECEC has been declining in recent years [19]. Nevertheless, evidence has shown how interactive simulation with puppets can be particularly effective in children’s healthcare [20]. The pedagogical use of puppets is supported by theories that emphasize the importance of imaginative experiences in learning [19], encouraging the fantastic transition from children’s imagination to key elements in early scientific research and science education [21]. Puppets offer a unique and effective educational approach, providing opportunities for imaginative play, communication, and engagement that may not be as easily achieved through traditional methodologies, especially in the field of health, where content can elicit rejection or phobias. Puppets can overcome these barriers and facilitate effective communication and expression among young children [18]. In the healthcare field, puppets have been used to detect strokes or seek medical assistance, demonstrating their potential in intervention programs and health education [22]. In the field of water safety, to the best of the authors’ knowledge, no research has been conducted on drowning prevention using puppets.

Therefore, based on the hypothesis that a puppet show, specifically written with messages geared towards safety in aquatic environments, would improve the knowledge and attitudes of both children and their parents regarding drowning prevention and the activation of the chain of survival, we aimed to assess the feasibility and immediate effects of this innovative teaching strategy and tool.

2. Materials and Methods

A quasi-experimental study was designed, comprising three phases: creation of the puppet show, recruitment of the sample, and pre- and post-intervention evaluation. The research team consisted of 8 experts, including 1 pediatrician, 1 puppeteer, 2 lifeguards, 2 university professors specializing in the arts, and 2 university professors who were experts in drowning prevention. This research was approved by the Ethics Committee of the Faculty of Education and Sports Sciences of the University of Vigo under the code 06-170123 and was conducted in accordance with the ethical principles of the Helsinki Convention.

2.1. Creation of the Puppet Show

The play was an adaptation of the children’s book “The rat who wanted to learn to swim” (“O rato con as que quería aprender a nadar”) [23]. This book pedagogically

addresses the most frequent incidents reported in scientific literature to be known causes of child drowning [4,5,10,24] and covers the following topics: the meaning of safety flags on beaches, how to activate emergency services in case of witnessing a drowning, and basic tips for safe bathing (such as the importance of never bathing alone, even when using floating devices). The group of experts adapted the book's messages and scripted the puppet play. This play depicted the aquatic adventures of the protagonist puppet, designed in the likeness of an approximately five-year-old girl. Throughout the performance, this puppet experienced two drowning incidents: one at the beach and another in a pool. The plot of the play is summarized below:

"A girl (the puppet) was at the beach and decided to swim in the sea without adult supervision, despite the warning of the red flag. This led her to aspirate water and cough (non-fatal drowning—grade 1). Subsequently, the same girl re-entered the water equipped with a ring-shaped float. Due to the wind, she was carried farther out to sea, requiring a rescue by the lifeguard and the incident only resulted in a warning (water rescue). After this incident, upon returning home, she attempted to retrieve a ball from her pool but slipped and fell, initiating the drowning process. Her mother promptly called the emergency number 112, and a lifeguard (another character) performed cardio-pulmonary resuscitation (CPR), explaining the steps to the public. The protagonist puppet was revived in the scene (non-fatal drowning—grade 6). The story concludes with a moral emphasizing prevention, the importance of respecting sea warning flags, always bathing under adult supervision, remembering the emergency number 112, and the steps of CPR".

Therefore, the cast of the play (Figure 1) included (a) the main character, a 5-year-old girl named Lis (puppet) who served as the protagonist around whom the story revolves; (b) a crab (puppet), who was her friend and reinforced the educational messages; (c) the mother (actress), who alternated between offering educational advice and displaying confusion and a lack of attention during drowning; (d) a lifeguard (puppet), who performed the sea rescue; and (e) another lifeguard (actor), who taught the drowning CPR protocol (5 rescue ventilations followed by a sequence of 30 chest compressions and 2 ventilations) and saved the main character (Lis). The recording of the performance is available online via the following link: https://www.youtube.com/watch?v=1Z3gI_dgb9Q, accessed on 19 December 2023.

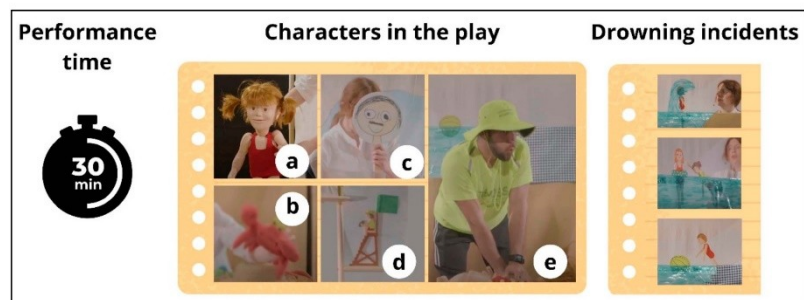


Figure 1. Performance time, characters, and drowning incidents in the show. Legend: (a) main character, the puppet Lis; (b) puppet crab; (c) the mother, an actress; (d) the puppet lifeguard; (e) the real lifeguard, an actor.

2.2. Sample

A total of 345 subjects participated in this study, comprising 185 children (85 boys and 100 girls) aged between 4 and 8 years (mean age: 6.2 ± 1.1 years) and 160 parents (134 mothers and 26 fathers) aged between 29 and 56, with an average age of 41.7 ± 4.8 years. The study involved 11 theatrical performances conducted in different cities and towns in Galicia (northwest Spain). Each performance accommodated between 20 and 40 people and was advertised in the local press and on the institutional website of the University of

Vigo. The inclusion criteria for the child participants encompassed an age range of 4 to 8 years of age, parental authorization, and voluntary participation. For adults, inclusion required a parental (father or mother) relationship with the child attending the puppet show. Participants did not receive any form of compensation for their involvement, and attendance at the puppet show was free. The children’s legal guardians provided informed consent for the use of their data in this research.

2.3. Intervention, Variables, and Evaluation

The puppet show was scheduled to last 30 min and was consistently performed by the same actress and characters, as well as under optimal conditions of light, sound, and space. The research design focused on two aspects: (a) the pre- and post-intervention knowledge of the children and (b) the attitudes and knowledge regarding drowning prevention among the parents (Figure 2).

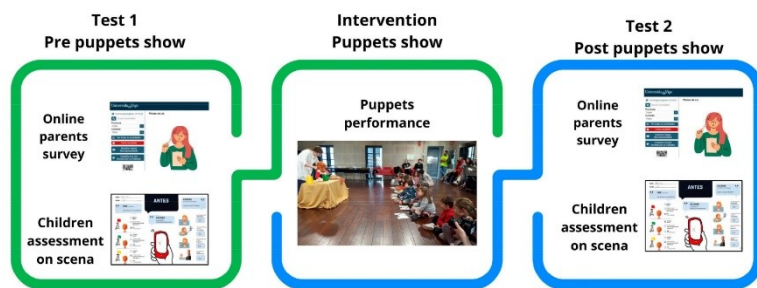


Figure 2. Intervention design and evaluation.

2.3.1. Children’s Knowledge of Drowning Prevention (Pre- and Post-Intervention)

The evaluation tool was designed in the format of a children’s school card, wherein children were required to answer a series of questions presented in the form of illustrations (Figure 3). This evaluation system was employed based on a previous pilot study that demonstrated its methodological feasibility for similar age groups [10]. The design and iconography of the evaluation sheet were developed by two professionals in graphic design and arts, with extensive experience in the illustration and creation of children’s materials.

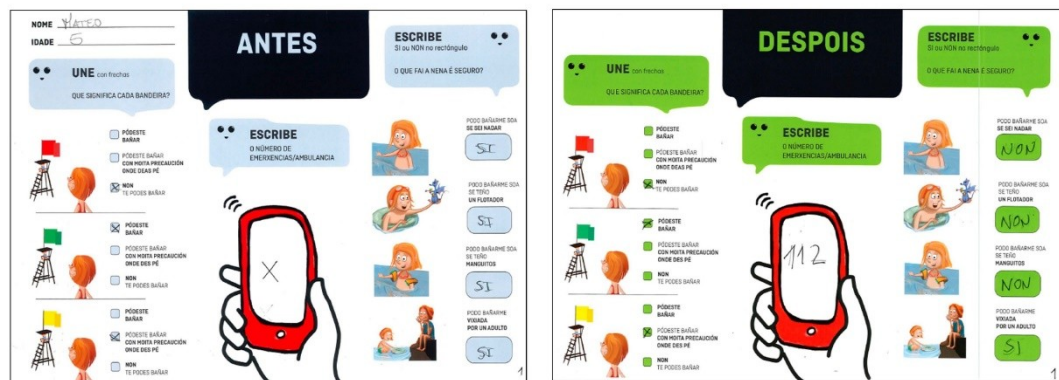


Figure 3. Design of the children’s evaluation tool for drowning prevention.

Before the puppet show, the children individually filled out the evaluation form (Test 1). During the 30 min period following the performance, they, once again, individually com-

pleted the reverse side of the evaluation form, which displayed the same set of questions (Test 2).

The variables were grouped into three blocks: (1) the association between flag colors and their corresponding meanings, (2) knowledge of the emergency number, and (3) safe bathing behaviors (being alone, using a float, wearing sleeves, and/or being supervised by an adult). For evaluation, a dichotomous scale of correctness or error was used for each item, alongside a cumulative variable reflecting the total number of correctly answered items.

2.3.2. Parents' Behaviors and Knowledge Regarding Drowning Prevention

For the parents, the research team designed a questionnaire consisting of 10 questions. Following a discussion process based on the focus group technique, 3 questions were eliminated, resulting in a consensus-derived total of 7 questions. Questions Q1 and Q2 were administered before the puppet show to assess the children's aquatic skills according to the classification of Szpilman et al. [4] and determine whether the parents' exhibited any significant distractions or lapses in attention during their child's bath at any point. Questions Q3–Q6 were presented both before and after the performance. The purpose of these questions was to assess whether the puppet show had influenced parents' preferences regarding the choice of beaches with the presence of lifeguards, exploring the use of flotation devices as a measure for drowning prevention, investigating comprehension of the meanings of sea state flags, and analyzing knowledge of CPR. Finally, Q7 was intended to determine if the puppet show induced any changes in knowledge regarding drowning prevention (Table 1). Parents completed this survey electronically through an email invitation sent during the registration process for the puppet show and during the week following their attendance at the event.

Table 1. Questionnaire for parents distributed before and after the puppet show.

Information Pre-Intervention	Comparison between Pre- and Post-Intervention	Information Post-Intervention
<p>Q1. What aquatic competence does my child have?</p> <ol style="list-style-type: none"> 1. My child does not have swimming or flotation skills. 2. My child has basic floating skills. 3. My child is able to swim using more than one stroke and has advanced floating skills. 4. My child is able to swim in all 4 strokes. Crawl, backstroke, breaststroke, and butterfly. 5. My child is a swimmer with risk analysis and rescue knowledge. 	<p>Q3. With family, we go to beaches or pools with lifeguard supervision.</p> <ol style="list-style-type: none"> 1. It is not a criterion that we consider when choosing a beach. 2. Somewhat agree. If you have a lifeguard, better, but it is not a selection criterion. 3. Strongly agree. Preferably we look for supervised beaches. 4. Totally agree. It is one of the beach selection criteria. <p>Q4. My child uses armbands and flotation devices as a preventative measure against drowning.</p> <ol style="list-style-type: none"> 1. Never 2. Almost never 3. Sometimes 4. Always 	<p>Q7. Did the puppet show "Drown-Safe" lead to any kind of change in your idea of drowning prevention?</p> <ol style="list-style-type: none"> 1. It did not entail any change. I was already very aware. I respected and knew all the behaviors and recommendations shown in the work. 2. It improved a bit. Only in some aspects or behaviors not too relevant. 3. It improved somewhat. Now I feel that I will be more aware when my children are in the water. 4. It improved a lot. I am going to change my behaviors towards preventing the drowning of my children.
<p>Q2. Have you ever been distracted while your child was near water or bathing alone without supervision?</p> <ol style="list-style-type: none"> 1. Yes, but it is not an oversight, my child already bathes or swims alone. 2. Yes, more than once. 3. Yes, once. 4. Never. 	<p>Q5. As a parent, do you know the meaning of the three state sea flags (green, yellow, and red)?</p> <ol style="list-style-type: none"> 1. I have doubts about the meaning of the three. 2. I have doubts about the meaning of two. 3. I have doubts about the meaning of one. 4. Yes, about the three. <p>Q6. Do you know how to perform CPR adapted for a drowning victim?</p> <ol style="list-style-type: none"> 1. No 2. Yes 	

2.4. Statistical Analyses

All analyses were conducted using the statistical package IBM SPSS for Windows (version 25.0. Armonk, NY, USA: IBM Corp). The descriptive results for qualitative variables are presented as absolute and relative (%) frequencies of responses, while means and standard deviations (SD) are provided for continuous variables. The McNemar test was used to analyze the differences in the children's responses before and after the intervention. The differences between the number of correct responses provided by the children before and after the intervention were analyzed using the Wilcoxon test. For all analyses, the significance value was set at $p < 0.05$.

3. Results

3.1. Children's Knowledge of Drowning Prevention

Table 2 shows the differences in the children's knowledge regarding water safety before and after the intervention. Overall, the children answered an average of 5.5 ± 1.5 out of 8 questions correctly before the intervention, whereas after the intervention, the number of correct answers increased to 7.6 ± 0.9 . Thus, there was a significant improvement in the children's overall knowledge of water safety following the intervention (Wilcoxon $Z = 10.746$; $p < 0.001$). More specifically, the percentage of correct responses significantly increased ($p < 0.05$) for all items for which the children were questioned, except for bathing under adult supervision, where there was little room for improvement as a high number of correct responses had already been obtained in the initial test. In the third block, there was an approximate 50% increase in the percentage of correct responses for the variables bathing alone, using a flotation device, and using armbands.

Table 2. Differences in children's knowledge of water safety before and after the intervention (n and % of correct responses).

		Before	After	McNemar χ^2 (p -Value)
Block 1. Knowledge of flag colors	Red Flag	173 (93.5%)	184 (99.5%)	7.692 (0.003)
	Yellow Flag	174 (94.1%)	183 (98.9%)	7.111 (0.004)
	Green Flag	161 (87.0%)	184 (99.5%)	21.043 (<0.001)
Block 2. Emergency number	Number: 112	117 (63.2%)	183 (98.9%)	64.015 (<0.001)
Block 3. Safe bathing behaviors	Bathing alone	61 (33.0%)	151 (81.6%)	80.827 (<0.001)
	Using a flotation device	78 (42.2%)	170 (91.9%)	86.260 (<0.001)
	Using armbands	73 (39.5%)	163 (88.1%)	82.510 (<0.001)
	Adult supervision	177 (95.7%)	180 (97.3%)	0.364 (0.549)

3.2. Parents' Behaviors and Knowledge Regarding Drowning Prevention

Table 3 displays the information on parental behaviors and knowledge with respect to water safety before and after the intervention. Around 80% of the children lacked the ability to swim or had only basic flotation skills. Moreover, 17.5% of the parents acknowledged that they had inadvertently left their children unsupervised near water or allowed them to bathe without supervision at some point.

The majority of parents (42.5%) indicated that they did not consider the presence of lifeguards to be a determining factor when selecting a beach or pool, while 21.9% stated that they did not take it into account at all. In contrast, 21.3% expressed a preference for beaches with lifeguards, and 14.4% considered it a crucial factor. However, there was a significant shift in the perception of lifeguards' importance following the intervention. Most parents (31.3%) stated a preference for beaches with lifeguards, and 27.5% considered their presence a determining factor. Regarding the use of armbands and floaters as a preventive measure against drowning, the majority of parents reported that their children used them sometimes (29.4%) or always (29.4%), while others indicated that they never (25.0%) or almost never (16.3%) used such devices. After the intervention, parents expressed a greater inclination

toward their children using these devices. Specifically, 28.8% of parents stated their children would use them sometimes, and 40.0% indicated they would use them always.

Table 3. Differences in parents' behaviors and knowledge regarding water safety before and after the intervention (*n* and % of correct responses).

		Before	After
Q1. What aquatic competence does my child have?	1. My child does not have swimming or flotation skills.	32 (20.0%)	
	2. My child has basic floating skills.	94 (58.8%)	
	3. My child is able to swim using more than one stroke and has advanced floating skills.	32 (20.0%)	
	4. My child is able to swim in all 4 strokes: crawl, backstroke, breaststroke, and butterfly.	1 (0.6%)	
	5. My child is a swimmer with risk analysis and rescue knowledge.	1 (0.6%)	
Q2. Have you ever been distracted while your child was near water or bathing alone without supervision?	1. Yes, but it was not an oversight; my child already bathes or swims alone.	3 (1.9%)	
	2. Yes, more than once.	5 (3.1%)	
	3. Yes, once.	20 (12.5%)	
	4. Never.	132 (82.5%)	
Q3. With family, we go to beaches or pools with lifeguard supervision.	1. It is not a criterion that we consider when choosing a beach.	35 (21.9%)	3 (3.8%)
	2. Somewhat agree. If you have a lifeguard, that is better, but it is not a selection criterion.	68 (42.5%)	30 (37.5%)
	3. Strongly agree. Preferably, we look for supervised beaches.	34 (21.3%)	25 (31.3%)
	4. Totally agree. It is one of the beach selection criteria.	23 (14.4%)	22 (27.5%)
Q4. My child uses armbands and flotation devices as a preventative measure against drowning.	1. Never	40 (25.0%)	21 (26.3%)
	2. Almost never	26, 16.3%	4 (5.0%)
	3. Sometimes	47 (29.4%)	23 (28.8%)
	4. Always	47 (29.4%)	32 (40.0%)
Q5. As a parent, do you know the meaning of the three state sea flags (green, yellow, and red)?	1. I have doubts about the meaning of the three.	4 (2.5%)	0 (0.0%)
	2. I have doubts about the meaning of two.	2 (2.0%)	0 (0.0%)
	3. I have doubts about the meaning of one	7 (4.4%)	0 (0.0%)
	4. Yes, about the three.	147 (91.9%)	80 (100%)
Q6. Do you know how to perform CPR adapted for a drowning victim?	1. No	116 (72.5%)	11 (13.8%)
	2. Yes	44 (27.5%)	69 (86.3%)
Q7. Did the puppet show "Drown-Safe" lead to any kind of change in your idea of drowning prevention?"	1. It did not entail any change. I was already very aware. I respected and knew all the behaviors and recommendations shown in the work.		34 (42.5%)
	2. It improved a bit. Only in some aspects or behaviors not too relevant.		11 (13.8%)
	3. It improved somewhat. Now I feel that I will be more aware when my children are in the water.		21 (26.3%)
	4. It improved a lot. I am going to change my behaviors towards preventing the drowning of my children.		14 (17.5%)

With respect to the knowledge of the meaning of the three flags denoting sea conditions (green, yellow, and red), before the intervention, 91.9% of the parents were familiar with

their meaning. After the intervention, all parents reported being aware of their meanings. Furthermore, there was a significant increase in the percentage of parents who considered themselves knowledgeable with regard to performing pediatric CPR, rising from 27.5% to 86.3% following the intervention.

Overall, although most parents (42.5%) already perceived themselves to be highly aware of the behaviors and recommendations presented in the performance, others reported a slight (13.8%), moderate (26.3%), or substantial (17.5%) increase in their understanding of child drowning prevention. Furthermore, the parents' overall evaluation of the theatrical performance averaged 3.8 ± 0.4 on a 4-point Likert scale.

4. Discussion

This study was designed to analyze the knowledge and perceptions of children and their parents regarding aquatic safety. It was also intended to promote a more proactive awareness of drowning prevention through attendance at a puppet show. The main findings are as follows: (a) The children demonstrated a high level of knowledge about the meaning of flags but had limited awareness of the relevant emergency number. A high percentage of children believed they could bathe without adult supervision. Some adults acknowledged failures in supervision while their children were in the water. (b) The parents' choice of aquatic spaces did not correspond to safety criteria, such as the presence of a lifeguard, even though the majority of children possessed only basic aquatic competence or did not know how to swim. (c) After the puppet show, the children exhibited increased confidence in their preference for bathing supervised by adults. Among the parents, half of them considered that the performance would lead to changes (to a greater or lesser extent) amounting to safer and more preventive behaviors in aquatic environments while also enhancing their knowledge of CPR.

In the battle against drowning, the World Health Organization (WHO) advocates for community-based educational initiatives that focus on enhancing public awareness and education regarding the use of aquatic spaces and training children and bystanders in safe bathing, safe rescue procedures, and CPR [3]. Accessibility is also promoted, so the creation of educational materials and resources must be a priority strategy. In addition, various previous efforts using comics and stories [10] have proven effective in enhancing children's understanding of water safety. In this regard, puppet plays have been implemented in diverse health areas for educational purposes [25,26]. However, to the best of our knowledge, their effect on preventing drowning has never been studied.

The use of puppets in the shape of children serves a pedagogical purpose since they can be perceived as peers by other children. This educational approach is practical and cost-effective, and it also allows for addressing false beliefs within an imaginary scenario [27]. However, children's knowledge gained from puppets may not necessarily align with their knowledge gained from real-world social agents, such as adults [28]. To mitigate potential discrepancies between the imaginary and the real, a collective activity involving parents and children was promoted. In this activity, puppet representations were used to impart new knowledge and encourage safer behaviors related to drowning prevention at the family level.

In the first phase, the primary aim was to identify the baseline. It became apparent that the children participating in this study had basic aquatic competence, as reported by their parents. Aquatic competence is defined as the set of skills essential for surviving common drowning situations and even includes the ability to identify a swimmer in distress, call for help, or perform a safe rescue [29]. However, young children often lack developed aquatic skills, consequently heightening their vulnerability in water [3]. Moreover, the current findings revealed that a significant proportion of the children did not recognize bathing alone as a potentially dangerous behavior, and approximately 20% of the parents admitted to instances of providing inadequate supervision during their children's aquatic activities, even on more than one occasion. This situation is not coincidental, as other studies have also

identified that between 15% and 30% of caregivers have left young children unsupervised for periods ranging from 1 to 5 min during bathing [5].

The puppet show emphasized this key concept, highlighting unsupervised access to water as the primary trigger for drowning among young children [4,5,30,31]. Throughout the storyline, the puppet experienced two non-fatal drownings, both of which could have been prevented if parents had been present. While some may believe that children carrying floating devices or knowing how to swim might relax their attention, it is crucial to note that knowing how to swim does not render them “drown-proof” [12]. The American Academy of Pediatrics emphasizes that parents and caregivers should never—even for a moment—leave children alone or in the care of another child in bathtubs, swimming pools, or open water [4]. The primary preventive strategy is supervision [5,11], defined as direct, hands-on supervision, where adults are within arm’s reach of a child [4]. Adequate supervision comprises three key components: proximity, attention, and continuity [32]. By following this approach, parents play an active role and become aware of the importance of supervision. After the intervention, half of the parents indicated that their knowledge about preventing drowning increased after attending the puppet show. Moreover, over 80% of the children stated that bathing alone was an incorrect behavior. Another positive outcome from the puppet show was an increase in parents’ intention to visit supervised beaches, recognizing that lifeguards provide additional security [4,33].

In the puppet show, the recognition of sea state flags was promoted, as it is directly related to drowning prevention. Prior to the intervention, the parents and children already possessed a high level of knowledge regarding their meanings. Following attendance at the puppet show, flag recognition reached nearly 100%. These findings suggest that using simple visual elements is an effective strategy. However, there is still no universal consensus regarding this symbology. In various regions worldwide, such as Spain, the flags represent traffic light colors, but in other areas, up to six or seven flags coexist, differing in color and even shape, potentially hindering comprehension, especially among children. This raises the question of why there is an almost unanimous global consensus on most danger symbols or road signs, while the same does not hold true for symbols and signs used in aquatic environments.

In the drowning survival chain, the first step is prevention, while the second is recognizing aquatic distress and asking for help [34]. Therefore, this puppet show was also intended to teach the audience how to ask for help. Contacting emergency services not only activates the chain but also serves as a preventive measure against further rescue attempts by laypeople, which can potentially result in the drowning of both the victim and the rescuer [35,36]. Overall, over half of the children in this study were already aware of the European emergency telephone number (112). However, after the intervention, nearly 100% of them indicated they would know who to call in the event of an emergency occurring in an aquatic setting.

The final step in the chain of survival for drowning is to provide necessary care [34]. Our puppet show addressed this aspect by incorporating recommended adaptations for managing cardiac arrest resulting from drowning (rescue ventilations and 30 chest compressions plus two ventilations). Tobin et al. [37] observed neurologically favorable survival rates among children who received bystander compressions and ventilations. Therefore, it is imperative to train parents in the application of conventional CPR and encourage its use within this demographic. The aim of this intervention was to move from the standard recommendation for laypeople of “just compress” towards the recommendation of “compress and ventilate”, specifically in cases involving children and/or individuals experiencing cardiorespiratory arrest due to drowning. In the theatrical performance, an actor (lifeguard) successfully resuscitated the puppet (the main protagonist), and during the CPR demonstration, the actor interacted with the audience, explaining key guidelines according to the European Resuscitation Council’s recommendations for specific circumstances (drowning) [38]. Upon completion of the intervention, 86% of the parents reported knowledge of the CPR techniques indicated for drowning. This dissemination led to the majority of

the adults being theoretically aware of the peculiarities of performing cardiopulmonary resuscitation in cases of asphyxia.

4.1. Practical Implications

Young children represent a particularly vulnerable group due to their limited ability to assess risks effectively and insufficiently developed swimming skills, which impede their autonomy in aquatic environments [16]. Preventing aquatic incidents requires a multifaceted approach, with education playing a pivotal role. Evidence has shown that educational activities involving children, parents, or communities have a positive impact on drowning prevention. The challenge, however, lies in providing cost-effective interventions (for greater accessibility) that are pedagogically efficient and replicable. An example of such an intervention is the “Kim na escola” project promoted by the Brazilian Aquatic Rescue Society (SOBRASA) [39], in which, through an interactive show involving puppets, lifeguards, and children, emphasis is placed on drowning prevention. Puppets can serve as an alternative satisfying all these criteria and can be integrated into various programs implemented in different countries, both in live performances and in online versions (YouTube, Instagram, and TikTok).

4.2. Limitations of This Study

This research has some limitations that must be pointed out. This study was confined to a specific Spanish region with a strong connection to the sea; hence, it is plausible that different answers might have been observed in other locations or among individuals with distinct cultural profiles. This puppet show may have an impact on locations with conditions similar to those in this study. Not all places around the world have children drowning in the same spaces and under the same circumstances. Puppets can serve as an educational medium, but adaptation to different communities and differences in circumstances leading to drowning is necessary.

An important limitation is the absence of a control group with which to unequivocally attribute the acquired knowledge to the intervention (the puppet show). Some initial responses revealed elevated values (e.g., the significance of sea state flags), which could be explained by the attending families having a pre-existing interest in water safety. This could introduce a recruitment bias. Additionally, there was a bias that was challenging to control concerning certain responses, as a correct answer does not necessarily correlate with correct behavior. This research did not assess the retention of learning over the long term. Future studies should aim to evaluate the retention of learning and its relationship with drowning prevention in real-life situations.

Therefore, future research should aim to investigate the effects of parental and child behaviors on actual aquatic incidents.

5. Conclusions

A community educational model based on a puppet show is effective in promoting knowledge and safer behavioral practices for the prevention of drowning, targeting both young children and their parents. The use of puppets can be an engaging, interactive method for enhancing connections with both children and adults, effectively conveying essential messages that contribute to reducing the incidence of drowning. Through the puppet-based approach, parents can shift their mindsets towards adopting safer and more proactive behaviors in drowning prevention while gaining new knowledge. Hence, encouraging and facilitating parental participation in educational activities tailored for children is highly recommended.

Author Contributions: Conceptualization, R.B.-F., L.P.-P., B.P.-G. and A.R.-N.; methodology, R.B.-F., L.P.-P., B.P.-G. and A.R.-N.; formal analysis, M.L.-M.; investigation, R.B.-F., L.P.-P. and B.P.-G.; resources, B.P.-G., A.G.-S. and C.V.-C.; data curation, M.L.-M.; writing—original draft preparation, L.P.-P., R.B.-F. and A.R.-N.; writing—review and editing, M.L.-M.; visualization, B.P.-G.; supervision,

L.P.-P., B.P.-G., A.G.-S. and A.R.-N.; project administration, A.G.-S., C.V.-C. and J.R.-D.; funding acquisition, J.R.-D. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: This research was approved by the Ethics Committee of the Faculty of Education and Sports Sciences of the University of Vigo, with the code 06-170123 (approval date: 17 January 2023), in accordance with the ethical principles of the Helsinki Convention.

Informed Consent Statement: Written informed consent was obtained from all children and parents involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to containing information protected by the Spanish Organic Law on Personal Data Protection and Digital Rights Guarantee.

Conflicts of Interest: The authors declare no conflicts of interest.

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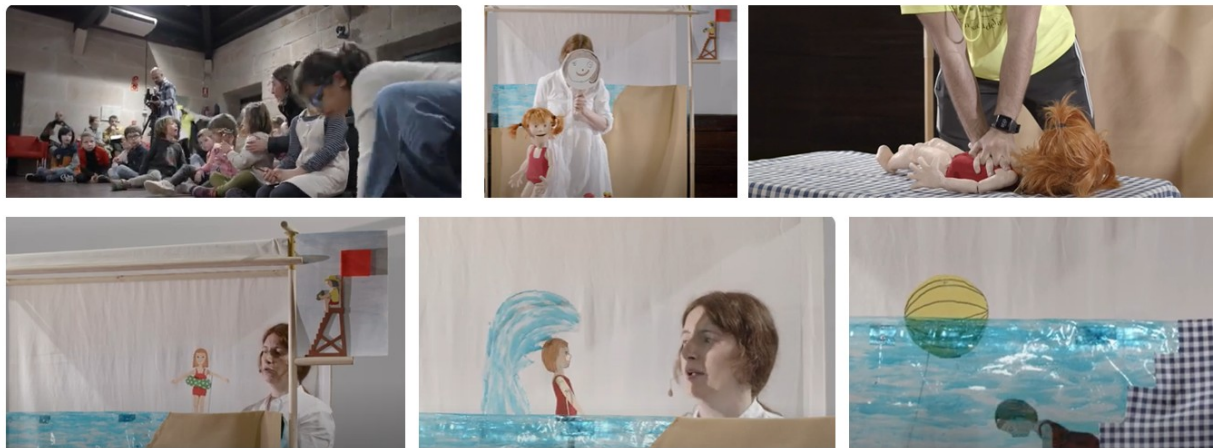
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Supplementary materials:

The video of the puppet show can be downloaded at:
https://www.youtube.com/watch?v=1Z3gI_dgb9Q

Video S1: Puppet show



*Figure RESULTS-11. Sequence of the puppet show: participating children, main puppet, cardiopulmonary resuscitation, aquatic incidents in the sea and in the pool.
(Author-created figure)*

6.3 SKILLS FOR SAFE RESCUE AND RESUSCITATION

Article 4 - Title: Training Children for Prehospital Aquatic Interventions: Assessing Throwing Skills Using Traditional and Alternative Materials in a Simulated Water Rescue.

Article 5 - Title: Assessing the quality of chest compressions with a DIY low-cost manikin (LoCoMan) versus a standard manikin: a quasi-experimental study in primary education.

6.3.1 Article 04 – Title: Training Children for Prehospital Aquatic Interventions: Assessing Throwing Skills Using Traditional and Alternative Materials in a Simulated Water Rescue

[accepted for publication 11-05-2024]

PREHOSPITAL and
DISASTER MEDICINE



**Training Kids for Prehospital Aquatic Interventions:
Assessing Throwing Skills Using Traditional and Alternative
Materials in a Simulated Water Rescue**

Journal:	<i>Prehospital and Disaster Medicine</i>
Manuscript ID	Draft
Manuscript Type:	Research Report
Keywords:	Drowning, Lifesaving, Pet bottle, Do-it-yourself, Safe rescue
Abstract:	<p>Background: Drowning remains a significant cause of mortality among children worldwide, making prevention strategies crucial. The World Health Organization (WHO) recommends training children in safe rescue techniques, including the use of basic skills such as throwing floating objects. This study aims to address a knowledge gap regarding the throwing capabilities of children aged 6 to 12 using conventional and alternative water rescue materials. Method: A total of 374 children aged 6 to 12 years participated in the study, including both males and females. A randomized crossover approach was used to compare throws with conventional rescue material (ring buoy and rescue tube) to an alternative material (PET-bottle). Throwing distance and accuracy were assessed based on age, sex, and the type of rescue tools used. Results: Children of all ages were able to throw the PET-bottle significantly farther than both the ring buoy ($p<0.001$; $d=1.19$) and the rescue tube ($p<0.001$; $d=0.60$). There were no significant differences ($p=0.414$) in the percentage of children who managed to throw each object accurately. Conclusion: Conventional rescue materials, particularly the ring buoy, may not be well-suited for long-distance throws by children. In contrast, lighter and smaller alternatives, such as PET-bottles, prove to be more adaptable to children's characteristics, enabling them to achieve greater throwing distances. The emphasis on cost-effective and easily accessible alternatives should be implementation in drowning prevention programs or lifesaving courses delivered to children.</p>

Figure RESULTS- 12. Screenshot of article 04 (peer review draft) identification.

6.3.1.1 Article abstract

Drowning remains a significant cause of mortality among children worldwide, making prevention strategies crucial. The World Health Organization (WHO) recommends training children in safe rescue techniques, including the use of basic skills such as throwing floating objects. This study aims to address a knowledge gap regarding the throwing capabilities of children using conventional and alternative water rescue materials. A total of 374 children aged 6 to 12 years participated in the study, including both males and females. A randomized crossover approach was used to compare throws with conventional rescue material (ring buoy and rescue tube) to an alternative material (PET-bottle). Throwing distance and accuracy were assessed based on age, sex, and the type of rescue tools used. Children of all ages were able to throw the PET-bottle significantly farther than both the ring buoy ($p<0.001$; $d=1.19$) and the rescue tube ($p<0.001$; $d=0.60$). There were no significant differences ($p=0.414$) in the percentage of children who managed to throw each object accurately. Conventional rescue materials, particularly the ring buoy, may not be well-suited for long-distance throws by children. In contrast, lighter and smaller alternatives, such as PET-bottles, prove to be more adaptable to children's characteristics, enabling them to

achieve greater throwing distances. The emphasis on cost-effective and easily accessible alternatives should be implementation in drowning prevention programs or lifesaving courses delivered to children.

6.3.1.2 Evidence of Quality

This article was accepted for published in *Prehospital and Disaster Medicine* (ISSN: 1945-1938, Publisher: *Cambridge University Press*). It is cataloged in the Web of Science and Scopus repositories in the field of *Emergency Medicine*, (1) *Emergency Medicine* (2) *Emergency Nursing*.

Impact factor and quartiles:

Indexing database	Impact Factor	Quartile	Category
Journal Citation Report (JCR)	2.1	Q2	Emergency medicine
SCImago Journal Rank (SJR)	0.525	Q2	Emergency medicine Emergency Nursing.

Declaration on Research Assessment (DORA)

Training Children for Prehospital Aquatic Interventions: Assessing Throwing Skills Using Traditional and Alternative Materials in a Simulated Water Rescue. *Prehospital and Disaster Medicine*. This research, accepted for publication in *Prehospital and Disaster Medicine*, addresses one of the main knowledge gaps for safe rescue identified by the International Life-Saving Organization and WHO. This work may be referenced in future updates related to drowning prevention and may possibly be implemented as an activity in aquatic safety (swimming) and school physical education classes.

Full citation of the manuscript:

Peixoto-Pino L, Barcala-Furelos R, Lorenzo-Martínez M, Gómez-Silva A, Rico-Díaz J, Rodríguez-Núñez J. Training Children for Prehospital Aquatic Interventions: Assessing Throwing Skills Using Traditional and Alternative Materials in a Simulated Water Rescue. *Prehospital and disaster medicine* [Accepted for publication] (Figure 6-5).

De: Prehospital and Disaster Medicine <onbehalf@manuscriptcentral.com>

Enviado: sábado, 11 de maio de 2024 19:25

Para: LORENZO MARTINEZ MIGUEL <miguel.lorenzo.martinez@usc.es>

Asunto: Prehospital and Disaster Medicine - Decision on Manuscript ID PDM-2024-0086.R1

11-May-2024

Dear Dr. Lorenzo-Martínez:

Thank you for submitting the revised version of the manuscript entitled "Training Children for Prehospital Aquatic Interventions: Assessing Throwing Skills Using Traditional and Alternative Materials in a Simulated Water Rescue", which is acceptable for publication in *Prehospital and Disaster Medicine* in its current form.

We will now initiate the Production process and when typesetting is complete, you will receive electronic proof copies of the manuscript for review and final approval. Due to the number of accepted manuscripts, this process can take 2-3 months to begin.

From time to time, WADEM/PDM and Cambridge University Press undertake marketing efforts to highlight papers published in PDM. If you would like your manuscript to be considered for this type of publicity, please fill out the publicity survey at:

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With best regards,

Samuel Stratton
Editor-in-Chief, *Prehospital and Disaster Medicine*
pdm@wadem.org



Figure RESULTS-13. Screenshot of article acceptance.

Specific contribution of the PhD candidate to the article:

Leadership in writing the manuscript (first author). Conception and design of the idea of the letter to the editor, drafting of the manuscript and revision after peer-review.

Full text:

Training Kids for Prehospital Aquatic Interventions: Assessing Throwing Skills Using Traditional and Alternative Materials in a Simulated Water Rescue

1. INTRODUCTION

Children are over-represented in fatal and non-fatal drowning incidents [1], and drowning is one of the top five causes of death in over 40 countries up to the age of 14 (1). In order to reduce worldwide fatal drowning, the World Health Organization (WHO) recommends teaching children safe rescue without entering the water (2,3) by learning and practicing elementary techniques such as throwing floating objects (3). For this reason, the concept of “throw, row and don’t go” has become popular (4,5), as it is considered one of the paradigms of prevention (6).

Although there is a lack of empirical research regarding the most effective type of water rescue equipment for a lay-responder when assisting a drowning victim, for this reason, in 2019, Beale-Tawfeeq et al posed the key question: What are the most effective types of aquatic rescue equipment for a layperson/bystander to use to rescue a drowning person? [7]

When a person witnesses a drowning, they may feel the instinct or duty to help (7). However, this can have fatal consequences (8). This phenomenon is referred to as the Aquatic Victim-Instead-of-Rescuer Syndrome (AVIR) (9), which can occur in both adults (8) and children (10,11). To prevent AVIR syndrome, teaching throwing skills could contribute to reducing the burden of drowning [2,4,12]. However, there is a knowledge gap that has not yet been addressed regarding the most effective type of water rescue equipment for a lay-responder [13]: How far individuals are able to reach with a throw? Would the throw be accurate? Are conventional rescue materials adapted to the

characteristics of children? In the scientific literature, rescue materials such as ring buoys [14], rescue tubes [15], or do-it-yourself (DIY) materials like PET-bottles [16] can be found.

The hypothesis of this study is that conventional rescue materials are not suitable for long-distance throws, while lightweight and smaller elements are better suited for children's characteristics, allowing for greater distances to be reached. Therefore, the aim of this research was to analyze the throwing capacity (distance and accuracy) of two specific rescue materials (ring buoy and rescue tube), and compare them with a non-conventional material, the PET-bottle.

2. METHODS

2.1. Sample

A total of 374 children (181 males and 193 females) aged 6-12 years (age: 8.8 ± 1.8 years; height: 138.0 ± 11.7 cm; weight: 33.0 ± 8.4 kg) participated in this study. The sample size for each age cohort was as follows: 6 years: $n=45$, 7 years: $n=60$, 8 years: $n=62$, 9 years: $n=68$, 10 years: $n=53$, 11 years: $n=60$, and 12 years: $n=26$. The inclusion criteria required that participants did not have any physical or mental handicaps that would limit their ability to perform the tests. Children who did not meet the inclusion criteria but wished to collaborate were invited to participate in the study, although their data were excluded from the final results. All guardians of participants provided authorization for the use of their data through informed consent. The study received approval from the Ethics Committee of the Faculty of Education and Sports Sciences (University of Vigo, Spain) with the code 07-170123.

2.2. Study design

A randomized crossover study design was used to examine the differences between conventional rescue equipment, such as a ring buoy and rescue tube, with a PET-bottle. The children participating in the study were presented with the following scenario:

In a pool, you observe someone drowning. Since you cannot enter the water to avoid endangering your own life, you must throw a floating object to help. Throw it as far and as centered as you can!

The test dynamics were as follows: Randomly, each child was required to throw the material from a space simulating a poolside in a dry land scenario, which was previously used in an Australian study [5]. To ensure the throw was as realistic as possible, no prior familiarization with the weight or dimensions of the material was allowed. To prevent learning biases, each test was conducted individually and supervised by two members of the research team.

<<FIGURE 1>>

Figure 1. Flow chart design

2.3. Variables

Two types of variables were analyzed: a) throw distance in meters (m) by age/material, measured from the throw point to the furthest point of the material after the fall, and b) accuracy, which was defined as the object landing within a maximum of 1 meter to the left or right of the center of the linear projection from the throw point (sufficient for it to be reached by stretching an arm). The assessment was recorded by two members of the research team at the end of each test using a tape measure. After the throw, one researcher positioned themselves at the point of initial contact with the material, while the other measured the distance from the throw point to the position indicated by the first.

2.4. Rescue equipment characteristics

The ring buoy had an outer diameter of 75 cm, an inner diameter of 43.6 cm, and weighted of 2.5 kg. The rescue tube had dimensions of 100 x 16 x 9 cm and weighted 0.76 kg. A 10 liters PET-bottle was used, with dimensions of 19.3 cm in diameter, 22.8 cm in width, 30.8 cm in height, and a weight of 0.48 kg (Figure 2).

<<FIGURE 2>>

Figure 2. Material characteristics

2.5. Statistical analyses

All analyses were conducted using the statistical package SPSS for Windows (version 25.0. Armonk, NY: IBM Corp). The normality of each variable was checked both graphically and using the Kolmogorov-Smirnov test. Descriptive statistics for these variables are presented as mean \pm standard deviation (SD). A repeated-measures analysis of variance (ANOVA) was used to analyze the throwing distance of the subjects according to the equipment used (ring buoy, rescue tube, or PET-bottle). Age and sex of participants were also included in the analysis as inter-subject factors. Partial eta-squared (η^2_p) effect sizes were calculated for this analysis. A value $\eta^2_p \geq 0.01$ indicates a small effect, ≥ 0.059 a medium, and ≥ 0.138 a large effect. Pairwise comparisons were conducted using the Bonferroni post-hoc test, with Cohen's d used to calculate the effect sizes. These effects were classified as trivial ($d < 0.2$) small ($0.2 < d < 0.5$), medium ($0.5 < d < 0.8$), and large ($d \geq 0.8$). The differences in accuracy depending on the object thrown were analyzed using Cochran's Q test. For all analysis, the significance value was set at $p \leq 0.05$.

3. RESULTS

Table 1 shows the differences in throwing distance and accuracy according to the equipment used and sex. Overall, the results of the repeated-measures ANOVA indicated significant differences by equipment ($F=308.803$; $p<0.001$; $\eta^2_p=0.462$). Children were able to throw the PET-bottle significantly farther than the ring buoy ($p<0.001$; $d=1.19$) and the rescue tube ($p<0.001$; $d=0.60$). Children's throwing distance using the rescue tube was also significantly greater than with the ring buoy ($p<0.001$; $d=0.83$).

In terms of the interaction between the equipment and sex, small effects were observed ($F=10.380$; $p<0.001$; $\eta^2_p=0.028$). The differences in throwing distance when using the PET-bottle compared to the ring buoy were similar between males ($p<0.001$; $d=1.26$) and females ($p<0.001$; $d=1.22$). However, males obtained greater benefits ($p<0.001$; $d=0.76$) than females ($p<0.001$; $d=0.46$) from throwing the bottle compared to the rescue tube, while the difference in throwing distance with the ring buoy compared to the rescue tube was greater in females ($p<0.001$; $d=0.91$) than in males ($p<0.001$; $d=0.79$).

Regarding throwing accuracy, no significant differences were found in the percentage of subjects who managed to throw each object accurately ($Q=1.763$; $p=0.414$). These results were consistent for both males ($Q=2.118$; $p=0.357$) and females ($Q=1.762$; $p=0.414$).

<< TABLE 1 >>

Table 2 and Figure 3 show the differences in throwing distance depending on equipment and children's age. The results showed no significant interactions between equipment and age ($F=1.464$; $p=0.132$; $\eta^2_p=0.024$), nor for the interaction between equipment, age, and sex ($F=0.765$; $p=0.687$; $\eta^2_p=0.013$). Regardless of the age, throwing distance with the PET-bottle was always significantly greater than with the ring buoy ($p<0.001$; $d=1.14$ – 1.70) and the rescue tube ($p<0.01$; $d=0.53$ – 1.07). Similarly, throwing distance with the rescue tube was also significantly greater than with the ring buoy for all ages ($p<0.001$;

$d=0.65-1.16$). Furthermore, throwing distance with all objects tended to increase with age. The largest increases in throwing distance occurred between 10 and 11 years old for the ring buoy ($p=0.002$; $d=0.63$) and the PET-bottle ($p=0.050$; $d=0.52$), while for the rescue tube, the largest change occurred between ages 8 and 9 ($p=0.044$; $d=0.63$).

<< TABLE 2 >>

<< FIGURE 3 >>

Figure 3: Chart of the results (distance/age)

4. DISCUSSION

The aim of this study was to evaluate the distance and accuracy of throws using different materials, including those specifically designed for aquatic rescue and those that are not, with the purpose of aiding a person involved in a simulated drowning scenario. The main findings were as follows: a) the PET-bottle was thrown accurately and at a greater distance, ranging from 4 meters at 6 years old to 7 meters at 12 years old; b) a 6-year-old child reached the same distance with a PET-bottle as a 12-year-old with a ring buoy; c) there is a relationship between the weight of the material and the distance it is thrown, with the ring buoy being the material that reaches the shortest distance.

The emphasis on teaching children in safety skills is motivated by their vulnerability to drowning [17,18], particularly in middle and low-resource countries [1,2,19], where kids are often untrained in aquatic rescues [20]. Consequently, “non-expert” witnesses should use non-contact rescue techniques without entering the water [5,6,21]. It is necessary for water safety programs to address two concurrent circumstances in aquatic incidents: the

impulse to rescue without analyzing risks [7] and the fact that when a witness throws an object to save a drowning person, it is often their first time doing so [5].

To prepare for such scenarios, some institutions advocate achieving a minimum level of competence in throwing aid tools. For instance, the Australian Water Safety Council (AWSC) recommends that children should be capable of throwing a rescue flotation aid to a partner at a distance of 5 meters before completing primary school (11-12 years old). However, the AWSC report revealed that only a small percentage of children achieved this rescue skill [22]. For this reason, the current study aimed to identify the age and distance at which children could potentially achieve a life-saving throw.

It was observed that the heavier material (ring buoy) reaches an average distance of 2 meters at 6 years old and only increases by an additional 2 meters throughout primary education, reaching 4 meters by age 12. In contrast, the lighter material (PET-bottle) doubles the distance achieved by 6-year-olds, practically reaching the same distance (4 meters) as preadolescents in the last year of primary education when throwing the ring buoy. At the age of 12, using the PET-bottle, children can achieve distances similar to those adults throw a lifeline (approximately 7 meters) [5].

To achieve an effective throw, two components are needed: strength and coordination. These must be acquired progressively through biological maturation and motor stimulation. Specifically, motor stimulation, as provided in physical education lessons, allows trained children to reach greater distances than adults. Research has shown that individuals under the age of 14 can achieve distances of up to 10 meters when throwing a lifeline [5].

One fundamental aspect of this research, which is highly practical, is the development of low-cost strategies that can be implemented globally. Modified buoyancy aids can be

inexpensive, such as empty plastic containers, bodyboards, or driftwood can serve as alternatives to water rescue tools [15]. The plastic bottle, being the object thrown the farthest, is undoubtedly the most accessible and could be easily adopted by all children as their Rescue-Pet, with an appearance acceptable for rescue equipment [15]. The creation of DIY materials is itself an efficient pedagogical strategy [23,24], and in drowning prevention, teachers in schools form a powerful core for promoting life skills [25]. The combination of school education with community-wide programs, especially involving parents, can effectively reduce drowning incidents [26].

5. LIMITATIONS

This study has limitations that should be noted. Firstly, it involves a local sample without cultural, racial, or socio-cultural diversity. A more diverse sample could yield different results. Additionally, the major limitation is that it is a simulation in which children must imagine being in an aquatic environment and throwing an object to someone who is drowning. Similar to the challenges faced in teaching school-based CPR [27], further research should analyze the transfer of simulation learning in school to interventions in real-life situations.

6. CONCLUSIONS

Children can throw any rescue equipment with good accuracy, but at different distances. Conventional rescue materials, particularly the ring buoy, may not be well-suited for long-distance throws by children. In contrast, lighter and smaller alternatives, such as PET-bottles, prove to be more adaptable to children's characteristics, allowing them to achieve greater throwing distances. The emphasis on cost-effective and easily accessible alternatives underscores the potential for widespread implementation in drowning prevention programs.

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For Peer Review

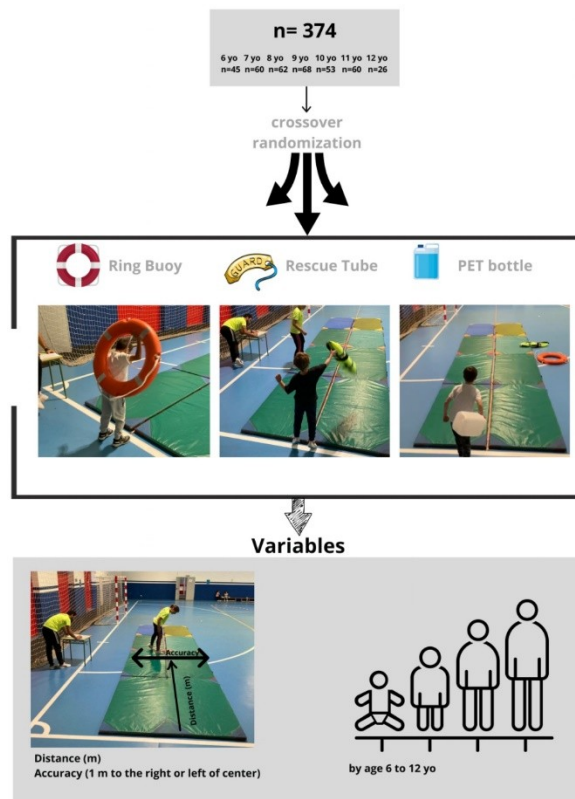


Figure 1

1067x1510mm (118 x 118 DPI)

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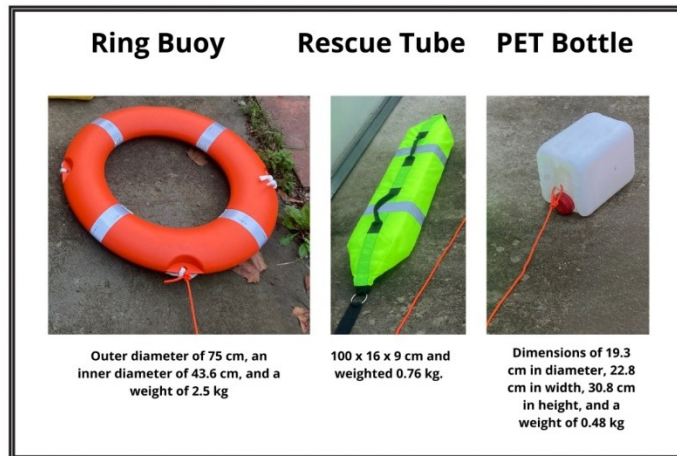


Figure 2

1510x1067mm (118 x 118 DPI)

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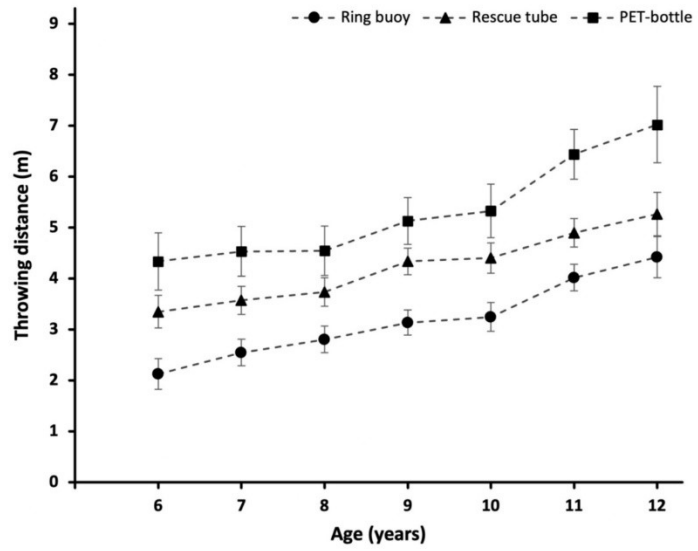


Figure 3

153x127mm (300 x 300 DPI)

Cambridge University Press

Table 1. Differences in throwing distance and accuracy according to the object used and sex.

	Throwing distance (M ± SD)			Accuracy (%)		
	Ring buoy	Rescue tube	PET-bottle	Ring buoy	Rescue tube	PET-bottle
Males	3.4 ± 1.3 ^{#‡}	4.4 ± 1.2 ^{*‡}	5.8 ± 2.4 ^{*#}	95.0	91.7	91.7
Females	2.8 ± 1.1 ^{#‡}	3.9 ± 1.3 ^{*‡}	4.6 ± 1.7 ^{*#}	90.2	88.6	92.2
Total	3.1 ± 1.2 ^{#‡}	4.1 ± 1.3 ^{*‡}	5.2 ± 2.2 ^{*#}	92.5	90.1	92.0

*Significant difference ($p < 0.05$) with ring buoy; [#]Significant difference ($p < 0.05$) with rescue tube; [‡]Significant difference ($p < 0.05$) with PET-bottle.

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Table 2. Differences in throwing distance (M \pm SD) according to age.

	Age (years)						
	6 [n=45]	7 [n=60]	8 [n=62]	9 [n=68]	10 [n=53]	11 [n=60]	12 [n=26]
Ring buoy	2.1 \pm 0.8 ^{#†}	2.6 \pm 0.9 ^{#†}	2.8 \pm 1.0 ^{#†}	3.2 \pm 1.1 ^{#†}	3.2 \pm 1.1 ^{#†}	4.0 \pm 1.4 ^{#†}	4.4 \pm 1.0 ^{#†}
Rescue tube	3.3 \pm 1.2* [‡]	3.6 \pm 0.9* [‡]	3.7 \pm 1.0* [‡]	4.4 \pm 1.2* [‡]	4.4 \pm 1.0* [‡]	4.9 \pm 1.3* [‡]	5.3 \pm 1.1* [‡]
PET-Bottle	4.3 \pm 1.9* [#]	4.6 \pm 1.8* [#]	4.5 \pm 1.7* [#]	5.2 \pm 1.9* [#]	5.3 \pm 1.9* [#]	6.5 \pm 2.7* [#]	6.9 \pm 1.9* [#]

*Significant difference ($p < 0.05$) with Ring buoy; #Significant difference ($p < 0.05$) with Rescue tube; ‡Significant difference ($p < 0.05$) with PET-bottle.

For Peer Review

6.3.2 Article 5 – Title: **Assessing the quality of chest compressions with a DIY low-cost manikin (LoCoMan) versus a standard manikin: a quasi-experimental study in primary education.**

European Journal of Pediatrics
<https://doi.org/10.1007/s00431-024-05601-8>

RESEARCH



Assessing the quality of chest compressions with a DIY low-cost manikin (LoCoMan) versus a standard manikin: a quasi-experimental study in primary education

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Figure RESULTS- 14. Screenshot of article 05 identification.

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6.3.2.1 Article abstract

Extending the access to cardiopulmonary resuscitation (CPR) training to a wider public is an important step in increasing survivability of out-of-hospital cardiac arrest. However, often price and maintenance of CPR manikins are barriers that prevent training at schools. This study aims to evaluate the learning of hands-only (HO) CPR by practicing with a low-cost manikin (LoCoMan) with visual qualitative feedback and to compare the results with the skills acquired by practice on a conventional manikin. A quasi-experimental study with 193 schoolchildren (10 to 12 years old) who were allocated to two groups: the LoCoMan group was taught via an integrative approach (science combined with physical education (PE)) and practiced on a handmade manikin, and a control group practiced in a traditional setting with a commercial manikin (Resusci Junior, Laerdal, Norway). All participants practiced for 1 hands-on skill session before performing a post-test on an instrumented CPR manikin. The outcomes including HO-CPR performance variables were compared between groups. The LoCoMan and control groups both achieved acceptable percentage of HO-CPR quality (57% and 71%, $p = 0.004$). Among 6th-graders, there were no significant differences in HO-CPR quality between LoCoMan 68% and control 71%, $p = 0.66$. The control group achieved better chest compression depth while the LoCoMan group showed more compressions with adequate chest recoil. Conclusion: Schoolchildren are able to build and use a low-cost manikin with visual feedback. The integrative learning approach used in this study may be a feasible alternative methodology for training and learning HO-CPR in schools when commercial manikins are not available.

Keywords Hands-only cardiopulmonary resuscitation · Low-cost · Schoolchildren · Chest compressions · Educational program

6.3.2.2 Evidence of Quality

This article was published in **European Journal of Pediatrics** (ISSN: 1432-1076, Publisher: Springer). It is cataloged in the Web of Science and Scopus repositories in the field of *Pediatrics, Pediatrics, Perinatology and Child Health*.

Impact factor and quartiles:

Indexing database	Impact Factor	Quartile	Category
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SCImago Journal Rank (SJR)	0.984	Q1	Pediatrics, Perinatology and Child Health

Declaration on Research Assessment (DORA)

Assessing the quality of chest compressions with a DIY low-cost manikin (LoCoMan) versus a standard manikin: a quasi-experimental study in primary education. This work published in the European Journal of Pediatrics is indexed in JCR and SJR and fulfills an important role as it is the first DIY prototype with qualitative feedback for chest compressions. It addresses knowledge gaps identified by ILCOR and has already been referenced in numerous CPR blogs, in addition to being a finalist in various awards and competitions.

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Specific contribution of the PhD candidate to the article:

Leadership in writing the manuscript (first author). Conception and design of the study, methodology, intervention, drafting of the manuscript and revision after peer-review.

Full text:



Assessing the quality of chest compressions with a DIY low-cost manikin (LoCoMan) versus a standard manikin: a quasi-experimental study in primary education

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Abstract

Extending the access to cardiopulmonary resuscitation (CPR) training to a wider public is an important step in increasing survivability of out-of-hospital cardiac arrest. However, often price and maintenance of CPR manikins are barriers that prevent training at schools. This study aims to evaluate the learning of hands-only (HO) CPR by practicing with a low-cost manikin (LoCoMan) with visual qualitative feedback and to compare the results with the skills acquired by practice on a conventional manikin. A quasi-experimental study with 193 schoolchildren (10 to 12 years old) who were allocated to two groups: the LoCoMan group was taught via an integrative approach (science combined with physical education (PE)) and practiced on a handmade manikin, and a control group practiced in a traditional setting with a commercial manikin (Resusci Junior, Laerdal, Norway). All participants practiced for 1 hands-on skill session before performing a post-test on an instrumented CPR manikin. The outcomes including HO-CPR performance variables were compared between groups. The LoCoMan and control groups both achieved acceptable percentage of HO-CPR quality (57% and 71%, $p=0.004$). Among 6th-graders, there were no significant differences in HO-CPR quality between LoCoMan 68% and control 71%, $p=0.66$. The control group achieved better chest compression depth while the LoCoMan group showed more compressions with adequate chest recoil.

Conclusion: Schoolchildren are able to build and use a low-cost manikin with visual feedback. The integrative learning approach used in this study may be a feasible alternative methodology for training and learning HO-CPR in schools when commercial manikins are not available.

What is Known:

- Access to CPR training should be universal and independent of age, location, financial means, or access to qualified instructors.
- Scientific societies promote the implementation of CPR in schools, so that teachers and schoolchildren can play a multiplier role in their environment, but the gap in CPR learning is related to cultural, economic factors or access to resources and materials.

What is New:

- LoCoMan may be a useful device for teaching and learning CPR in schoolchildren from the age of 10 and upwards.
- LOCOMAN shows that it is feasible and possible to build a low-cost manikin (about €5 in the European Region) and to integrate it into an integrative educational project, and outlines how this could be done. this approach can be an incentive for teachers to attempt teaching CPR, but also for education outside the formal environment.

Keywords Hands-only cardiopulmonary resuscitation · Low-cost · Schoolchildren · Chest compressions · Educational program

Abbreviations

AHA American Heart Association
CC Chest compressions
CPR Cardiopulmonary resuscitation

CG Control group
DIY Do-it-yourself
ERC European Resuscitation Council
ES Effect size
HO-CPR Hands-only CPR (continuous chest compression)
IQR Interquartile range
LoCoMan Low-cost manikins

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Extended author information available on the last page of the article

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LG	LoCoMan group
OHCA	Outcomes of out-of-hospital cardiac arrest
PE	Physical education
QHO-CPR	Quality of HO-CPR in percentage (0–100%)

Introduction

It is commonly accepted that early training in cardiopulmonary resuscitation (CPR) increases the likelihood that bystanders can intervene in an emergency and eventually improve the outcomes of out-of-hospital cardiac arrest (OHCA) [1, 2]. Access to CPR training should be universal and independent of age, location, financial means, or access to qualified instructors. To expand the reach of CPR training, the European Resuscitation Council (ERC) and the American Heart Association (AHA) encourage widespread CPR education [3, 4] and the declaration “KIDS SAVE LIVES,” supported by the World Health Organization (WHO), promotes the implementation of CPR at schools so that teachers and schoolchildren can play a multiplying role in their environment [5]. However, there is still a gap in CPR learning related to several factors, due to cultural and economic factors or access to resources and materials. To try to overcome these barriers, low-cost manikins can be an option for mass CPR teaching and training [6]. Currently, there are various low-cost devices that may be used as an alternative to conventional manikins; some low-cost devices are prefabricated, such as for example an auditory feedback heart made of plastic (5), a natural rubber manikin (6), or a children’s pillow [7–9].

More recently, a do-it-yourself (DIY) movement has emerged [10, 11] which is based on the construction and self-development of devices that can simulate a human torso or be useful for teaching resuscitation maneuvers, in order to promote mass training at low cost. Most DIY models we are aware of are either made with conventional materials, such as toilet paper, T-shirts, or towels [10, 12, 13], or based on recycled material, especially plastic bottles [6, 14]. However, there is still a lack of knowledge on the usability of such manikins in the school. Studies on the acquisition of CPR

skills via DIY manikin compared to commercial manikins are scarce. The development of DIY manikins must evolve and diversify to include models that are suitable for different contexts, learning outcomes, and target groups. In a pedagogically ideal case, a DIY manikin may be able to replace with ingenuity those elements that have been shown to be effective in teaching resuscitation—such as feedback [15, 16], motivation [17], cognitive involvement [7], or gamification [18]—and evaluate their effect on the acquisition of skills.

Traditionally, conventional and unconventional manikins have focused on achieving the proper depth or rate of compressions, but it is well known that a key factor in resuscitation is its continuity, i.e., avoiding interruption of chest compressions (CC) [19], especially when performing the hands-only CPR (HO-CPR) technique [20]. However, to our knowledge, there is no low-cost manikin for lay people that helps to train and understand this physiological concept.

Therefore, this study aims to evaluate the learning of CC skills by practicing with a low-cost manikin (LoCoMan) with visual qualitative feedback for continuous CC and to compare the results with the skills acquired by practice on a conventional manikin.

Material and method

Participants

A convenience sample of 193 schoolchildren from Spain participated in this research, aged between 10 and 12 years, corresponding to two academic years (5th and 6th year of primary school). The data broken down by groups and sex are shown in Table 1. Exclusion criteria were any physical or mental impairments and any previous experience (theoretical or practical) in cardiopulmonary resuscitation.

The research was approved by the Ethics Committee of the Faculty of Education and Sport Sciences–University of Vigo (Spain) that supported (Code: 03–250322). The study was authorized by the educational department of the participating schools and the parents (via written informed consent).

Table 1 Characteristics of the sample

Variables	Total <i>n</i> = 193	LoCoMan group <i>n</i> = 91	Control group <i>n</i> = 102	<i>p</i> value
Academic year	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	
5 th PE [10–11 years]	106 (55%)	45 (50%)	61 (60%)	<i>p</i> = 0.15
6 th PE [11–12 years]	87 (45%)	46 (51%)	41 (40%)	
Sex	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	
Female	106 (55%)	56 (61%)	50 (49%)	<i>p</i> = 0.08
Male	87 (45%)	35 (39%)	52 (51%)	

PE primary education

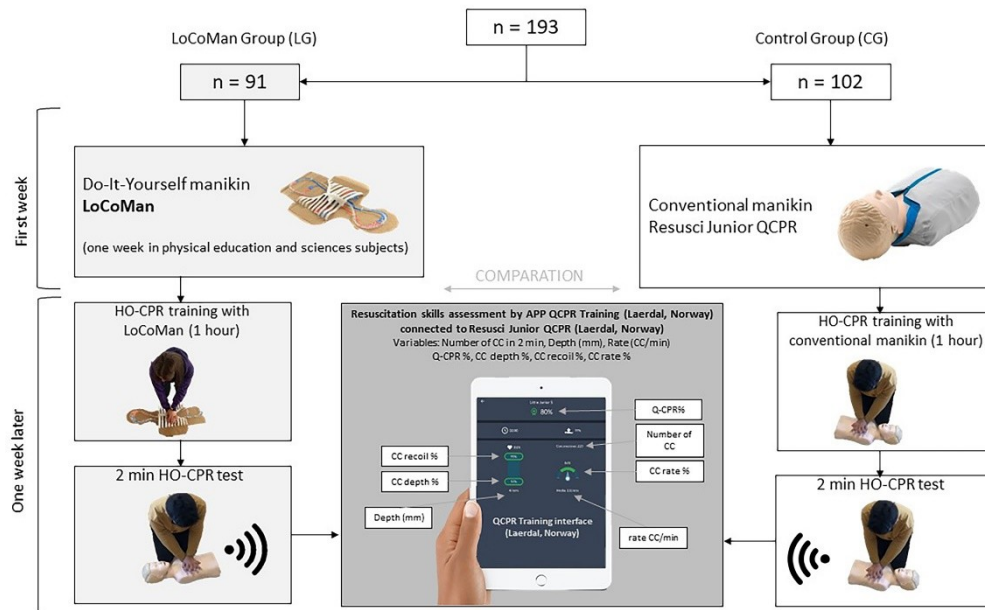


Fig. 1 Flowchart design

Study design

A quasi-experimental and cross-sectional study was carried out using two nonrandomized intervention groups; the LoCoMan group (LG) trained with a hand-made low-cost manikin and a control group (CG) practiced with a conventional pediatric manikin model, Resusci Junior (Laerdal, Norway) (Fig. 1).

LoCoMan: educational project principles

This project was based on the principles of significant, transversal, and integrative learning [21, 22], focused on understanding the process by which continuous chest compressions achieve continuous circulation and cerebral perfusion. The LG built their manikins during one academic week in the physical education subject (2 sessions), in a coordinated manner with the subject of science (2 sessions), during which cardiocirculatory functions were learned (Fig. 2). Children in the CG received the same science lesson, but without a comprehensive approach (no connection between contents).

- Science subject: participants were introduced to the cardiocirculatory system and the effect of HO-CPR on circulation. At the same time, they studied the functions of blood and the beating of the heart, the cardiac

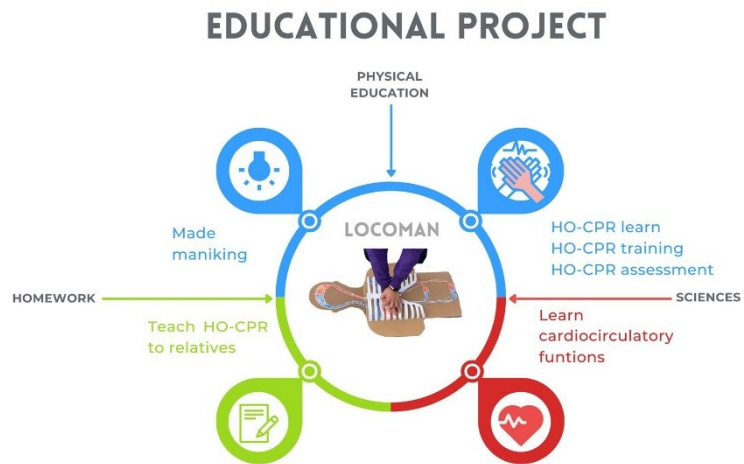
cycle, the transport of blood, and the need for oxygen in different organs such as the brain.

- Physical education subject: participants built their manikin under guidance from a teacher. In small groups, they helped each other in the different phases of the build, which provoked collaboration and reflection. The materials and instructions for the build of LoCoMan are described in Fig. 3; more detailed instructions are available in an online supplementary video and assembly manual.
- Homework: in a first step before building LoCoMan, inspired by the flipped or inverted classroom theory [23, 24], the schoolchildren introduced the project to their families, and together they had to get some of the materials, such as cardboard to draw the human silhouette. In this way, the students began to integrate human anatomy, cardiac physiology, and cardiopulmonary resuscitation. In a second step, at the end of the learning unit, schoolchildren had to take LoCoMan to their homes and teach HO-CPR to their relatives.

LoCoMan's feedback mechanism (Fig. 3)

LoCoMan's blood circuit is made up of transparent plastic tubes, into which water (and some bubbles) had previously been introduced with a simple syringe. Once the

Fig. 2 Integrative educational project learn-by-doing LoCoMan



“circulation tubes” are sealed, the water and numerous air bubbles are visible. This visually simulates the transport of oxygen by the blood. Visual feedback is based on visualizing the flow of fluid that is percussed (simulating the volume of systolic ejection) with each CC. The movement of the fluid, its circulation and the irrigation of the brain, is easily perceptible during the maneuvers, as well as the immediate blood flow interruption when CC are interrupted (see supplementary video).

CPR training (LG and CG)

CPR training was guided by a physical education teacher, who had previously been trained by accredited instructors [25]. During a 1 h-long physical education class, the following phases were carried out:

1. An explanation of the chain of survival was provided, including the sequence: recognizing cardiac arrest,

Fig. 3 How to make a LoCoMan (step by step) and in a supplementary video online



calling 112, performing HO-CPR, and following the demonstration of chest compressions: depth, rate, and correct position of execution. In the LG, feedback was provided by the movement of air bubbles through the “blood circuit” during compression, which should not stop. In the CG, feedback was provided by a tablet connected to the Resusci Junior (Laerdal, Norway) through the APP QCPR Training for IOS (Laerdal, Norway). The students in this group were instructed how to interpret the feedback from the tablet regarding three indicators: depth, full chest recoil, and rhythm (rate).

2. Practical demonstration of how to perform CPR on the manikin (the same for LG and CG).
3. The students performed CC guided by the teacher (the same for LG and CG).
4. Schoolchildren performed HO-CPR to the rate of the “La Macarena” song [26] (the same for LG and CG).
5. Schoolchildren performed HO-CPR without any kind of teacher feedback (the same for LG and CG).

Assessment of skills and analysis variables

HO-CPR performance was analyzed during a separate testing session after the last practice session. Each student performed an individual test of 2 min. The assessment was carried out using the Little Junior QCPR manikin (Laerdal, Norway) programmed under the European Resuscitation Council guidelines for resuscitation 2021 (ERC2021): The gold standard describes chest compression (CC) depth of 50–60 mm, full chest recoil, and a CC rate between 100 and 120 compressions per minute. Using the QCPR instructor app (Laerdal, Norway), the following variables were obtained: depth, full chest recoil, and CC rate, as well as the global value of the quality of HO-CPR (QHO-CPR) in percentage. This device is widely used in the scientific literature for the evaluation of skills during resuscitation in simulation studies [18, 27, 28].

Manikin, interface, and variables can be seen in Fig. 1. The analysis variables were (a) number of CC in 2 min, (b) mean rate (*R*) of CC per minute during 2 min, (c) average depth of CC in mm (*D*) and as percentage variables (d) overall QHO-CPR, (e) CC with adequate chest recoil, (f) CC with adequate depth, and (g) CC with adequate rate.

The percentage of students who reached different percentages of QHO-CPR was analyzed for 4 intervals: 0–24%, 25–49%, 50–69% and $\geq 70\%$. A result equal to or greater than 70% has been established as the highest standard [29].

Statistical analysis

Based on our hypothesis, CG and LG were compared in each dependent variable. An additional round of analyses was conducted within each school year (5th graders and 6th

graders). All analyses were performed with the IBM SPSS Statistics Software version 20 for Windows. To describe the quantitative variables, measures of central tendency (median) and dispersion (interquartile range, IQR) were used. After checking the normality of the distributions with the Kolmogorov–Smirnov test, group (CG vs. LG) comparisons of the continuous variables were made with the Mann–Whitney *U* test (nonparametric test) or with Student’s *t* test (parametric test). In statistically significant comparisons, the effect size (ES) was calculated using Rosenthal’s *r* test (nonparametric test) or Cohen’s *d* test (parametric test). To define the ES, the following classification was used: < 0.2 trivial; 0.2–0.5 small; 0.5–0.8 moderate; 0.8–1.3 large; ≥ 1.3 very large. For the description of the percentage variables, absolute frequencies and relative frequencies were used. For the comparison of the groups in the percentage variables, the chi square test was used. In statistically significant comparisons, the ES was calculated using Cramer’s *V* test. To define the ES, the following classification was used: 0.1–0.3 small; 0.3–0.5 medium; ≥ 0.5 large. In the case of multiple comparisons between the groups (chi square), a *p* value of 0.012 (0.05/4) was used for the Bonferroni correction. A significance level of $p = 0.05$ was assigned for all other analyses.

Results

Table 2 shows the dependent variables. The median number of CC performed during 2 min by the LG was 196 [161–221] while in the CG it was 217 [195–235], $p = 0.001$. In the disaggregated analysis of continuous variables, mean rate and mean depth also present significant differences, rate: LG 99 [87–109] vs. CG 109 [100–122], $p < 0.001$ y, depth: LG 43 mm [38–49] vs. CG 49 mm [43–55], $p < 0.001$, in the latter case with a large effect size (0.70).

In the analysis of the percentage of quality, LG performed at 57% [18–84] vs. CG 71% [42–86], $p = 0.04$, with a small effect size (0.15). The chest recoil rate was LG 100% [92–100] vs. CG 98% [74–100], $p = 0.01$; the percentage of adequate depth was LG 3% [0–47] vs. CG 40% [5–82], $p < 0.001$; and the percentage of CC at an adequate rate was not significantly different between groups: LG 31% [13–64] vs. CG 38% [21–62], $p = 0.24$.

In the analysis of the percentage of QHO-CPR in the 5 sectors [0–24%, 25–49%, 50–69%, and $\geq 70\%$], at a global level, no significant differences are found in the group of children who reach the highest sector of $\geq 70\%$.

In the 5th grade, the best percentages are obtained by the control group, but in the 6th grade, the values of the CG and LG groups are similar, without significant differences in any sector (Fig. 4).

In the analysis by school grades (supplementary Table 1), in the cohort of 5th grade of primary education, all the

Table 2 CPR variables

Variable	LoCoMan group No. = 91		Control group No. = 102		<i>p</i> values (<i>p</i>) and effect size (ES)
	Median	IQR	Median	IQR	
Number of CC	196	(161–221)	217	(195–235)	<i>p</i> = 0.001 (ES 0.26)
Mean rate (CC/min)	99	(87–109)	109	(100–122)	<i>p</i> < 0.001 (ES 0.34)
Mean depth (mm)*	43	(38–49)	49	(43–55)	<i>p</i> < 0.001 (ES 0.70)
QHO-CPR (%)	57	(18–84)	71	(42–86)	<i>p</i> = 0.04 (ES 0.15)
CC with full chest recoil (%)	100	(92–100)	98	(74–100)	<i>p</i> = 0.01 (ES 0.18)
CC with adequate depth (%)	3	(0–47)	40	(5–82)	<i>p</i> < 0.001 (ES 0.33)
CC with adequate rate (%)	31	(13–64)	38	(21–62)	<i>p</i> = 0.30

IQR interquartile range, *N* absolute frequency, (%) relative frequency

For quantitative variables: Mann–Whitney's *U* test with Rosenthal's test for effect size

For effect size classification: < 0.2: trivial; 0.2–0.5: small; 0.5–0.8: moderate; 0.8–1.3: large; > 1.3: very large

For qualitative variables: chi square test with Cramer's *V* test for effect size

For effect size (ES) classification: 0.1–0.3: small; 0.3–0.5: medium; ≥ 0.5: large

*For quantitative variables: Student's *t* test with Cohen's *d* test for effect size

variables showed significant differences in favor of the CG except in CC with adequate chest recoil. In the global analysis of quality (QHO-CPR variable), the CG (71 [72–89]) performed better than the LG (39 [4–82], *p* < 0.02). Analyzing the data from the 6th grade cohort of primary education, there were significant differences between groups in the percentage variables, but no significant differences in the QHO-CPR.

Discussion

The aim of this study was to evaluate the learning of CC skills by practicing with a DIY manikin for continuous CC and to compare the results with the skills acquired by practice on a conventional manikin. Our findings corroborate the hypothesis that LoCoMan may be a useful device for teaching and learning HO-CPR in schoolchildren from the age of 10 and upwards.

We decided to work with 10-year-old schoolchildren, since chest compressions can be learned at this age with adequate training [30]. However, neither the group trained with LoCoMan nor the group that used the conventional manikin reached the recommended depth of compression (50–60 mm) [31]. These findings may be related to the relatively low body mass at this age: the relationship of body mass and achieved depth of compressions is a limiting factor for children's success at learning this skill [32, 33]. It should also be noted that the LoCoMan model cannot be compressed to the full depth of 50 mm (maximal depth is 35 mm). This is a probable explanation for the finding that the control group obtained better results in depth variable in this study. Part of the purpose of building LoCoMan was

to provide feedback on the continuity of compressions for continuous cerebral perfusion, a fundamental concept in HO-CPR. Based on the results obtained from number of CC, rate, and mean rate percentage, we were able to verify that there was no interruption, neither in the control group using electronic feedback, nor in the LoCoMan group.

In the cohort analysis (i.e., separated by school year), LoCoMan led to better CPR quality in 6th graders (aged 11 and 12). Indeed, they performed practically equal to the control group, approaching the gold standard of 70% [29]. In other CPR variables such as full chest recoil or CC rate, significant variations were found between the two models, but these differences would not have clinical relevance because their values are close or very close to the gold standard of the resuscitation guidelines [34] (i.e., rate with LoCoMan was 104 CC/min vs. Laerdal Manikin 118 CC/min, gold standard 100–120 CC/min).

Hand-made manikins may contribute to the improvement of individual CPR and can make mass collective teaching possible, especially in low-resource settings [6] when there is no industry or government support. We consider that this project may be relevant because it could help promote the teaching of basic life support in schools or in informal contexts [6–10, 14, 35], which might have a significant impact on bystanders who perform CPR [4], for example, by increasing confidence and readiness to act in an emergency [17, 36].

A relevant feature of LoCoMan is the qualitative feedback that allows the schoolchild to observe how the simulated blood circuit flows during chest compressions. To our knowledge, this is the only model that has visual feedback and integrates knowledge of circulatory physiology. Feedback during practice has been associated with better CPR

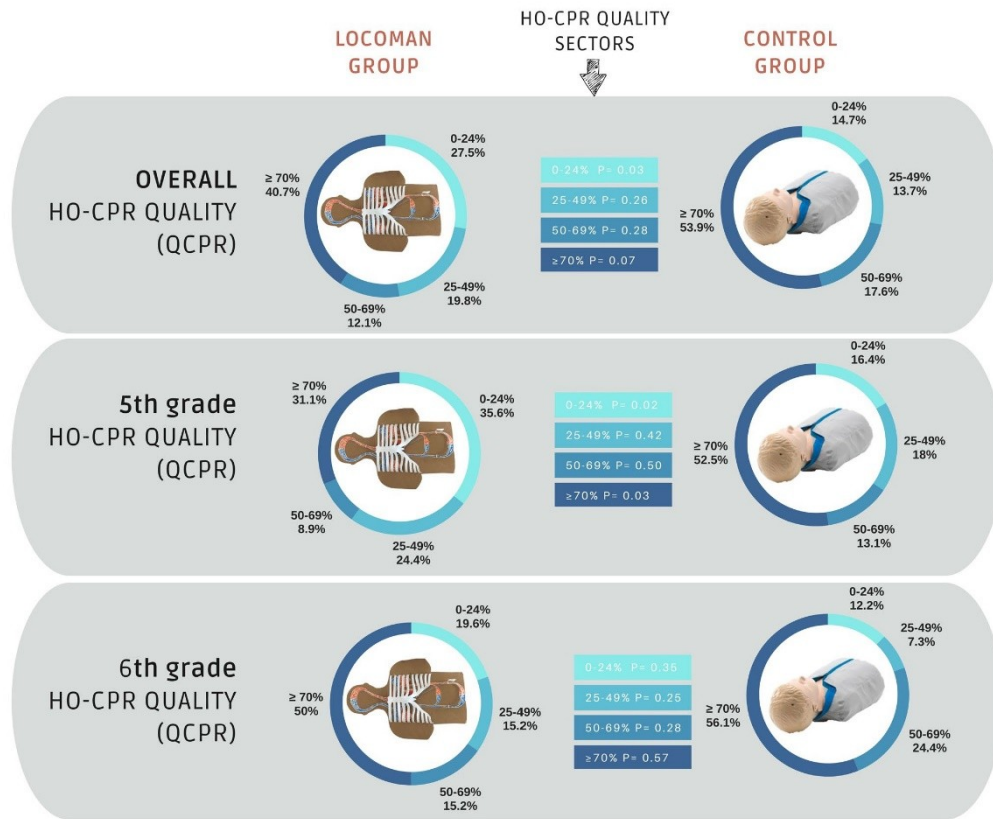


Fig. 4 Quality CPR sectors and percentage of schoolchildren by group and grade

quality and more effective learning [15], helping students achieve mastery of skills and shortening demonstration time [10]. Another noteworthy aspect is that throughout the training process, no manikin suffered significant deterioration, so this pilot tool is potentially sustainable for training or learning, and although it is not commercialized, it can be locally manufactured since its components are readily available.

Most OHCAs occur at home (26). One additional aim of this educational project was to enable families to practice CPR at their homes. For this reason, the intervention included several “at-home steps”: Before building their manikin, learners involved their care-takers and relatives in the collection of recyclable materials to bring to school, and after the manikin was finished, the schoolchildren had to teach the skills acquired to their relatives. This process was not analyzed as part of this paper, but it is also a mission of the project that should be evaluated in the future.

The presented project conforms to the main principles of KIDS SAVE LIVES: the dissemination of knowledge and training, encouraging fun and excitement during CPR (3). From an educational perspective, learning is stronger and more durable when it is based on connection of content, rather than analytical, isolated, or mechanical learning. New learning methodologies and materials emerge and promote learning-by-doing (5). LoCoMan is a project that combines the subject of science (knowledge of the human body) and physical education (first aid), all the while keeping the learner at the center, as the protagonist promoting their own learning progress [21, 22].

This work has important practical implications: it shows that it is feasible and possible to build a low-cost manikin (about €5 in the European Region) and to integrate it into an integrative educational project and outlines how this could be done. As a general reference, the cost of

100 LoCoMan units is less than 2 commercial manikins with feedback (i.e., as used in this study), and the learning outcomes are comparable. These and other evidence-based alternatives to expensive manikin training may be an incentive for teachers to attempt teaching CPR, but also for education outside the formal environment.

Study limitations

We acknowledge that this study has a few limitations. The sample was located in a specific region, so it is not representative of all children worldwide. As the classes were grouped by academic years, there was a slight age overlap around the age of 11 years. A distribution by biological age (10, 11, and 12 years) could be more appropriate, but due to the educational dynamics of the school system, this has not been possible. Another factor that is necessary to note is that the LoCoMan is part of a multidisciplinary educational project, and this circumstance might improve the motivation of schoolchildren and relatives to perform well. A relevant and limiting aspect of the study is that a portion of the learning in the LoCoMan group may possibly be influenced by the overall project rather than exclusive training in HO-CPR. This methodological limitation also serves as a strength of this project, which extends beyond the building of a manikin. Another limitation is that, as each student made their own LoCoMan, there may have been small variations between manikins as it is not a standardized model. The LoCoMan structure allows a maximum compression depth of 35 mm (based on measurements with a CPR meter) (Laerdal, Norway, see supplementary video online) which may be the most plausible justification for achieving 3% of compressions at the indicated depth compared to the 40% achieved by the children who trained on the commercial manikin. Future versions of LoCoMan will address this issue.

Conclusion

The use of a low-cost, hand-made manikin with visual feedback might be an alternative for training and learning CPR in schools, especially when commercial manikins are not available. Low-cost manikins can be integrated into an educational project that promotes learning of CPR.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s00431-024-05601-8>.

Authors' contributions Concept and design: P.P, B.F and R.N; Acquisition, analysis, or interpretation of data: P.P, B-F,O.A, M.I and R.D; Drafting of the manuscript: B.F, T.V; Critical revision of the

manuscript for important intellectual content: R.N, M.I; Statistical analysis: O.A; Supervision: B.F, M.I"

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Declarations

Ethics approval The study was performed in line with the principles of the Declaration of Helsinki and was approved by the Ethical Committee of the Faculty of Education and Sport Sciences—University of Vigo (Spain).

Consent to participate Written informed consent was obtained from the parents, and verbal consent was obtained from all participating children.

Competing interest The authors declare no competing interests.

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Supplementary materials:

The following supplementary video can be downloaded at:
<https://link.springer.com/article/10.1007/s00431-024-05601-8#Sec15>

LoCoMan DIY step by step



01



03



02



04



*Figure RESULTS-15. Self-built construction sequence of the LoCoMan.
(Author-created figure)*

6.4 DISSEMINATION OF RESULTS AND SCIENTIFIC AWARDS

In addition to publication in scientific journals, the set of studies that comprise this doctoral thesis has sought maximum dissemination and knowledge transfer through the presentation of various findings and didactic proposals at numerous conferences, receiving recognition in the form of awards and mentions. Below are the most notable ones.

1. Communication in congress. Title: Can children learn to prevent drownings with a song? A pilot study in primary school students. 35th SEPEAP Congress (Spanish Society of Pediatrics). A Coruña. 2021.
2. Communication in congress. Title: Educational Project for Drowning Prevention in Primary Education promoted from the area of Physical and Musical Education. VI International Congress on Research and Didactics of Physical Education – ADDIJES. Granada 2022.
3. Communication in congress. Title: Drowning prevention in children through puppets. An innovative experience. VII International Congress on Research and Didactics of Physical Education – ADDIJES. Granada 2023.
4. Communication in congress. Title: LOCOMAN: learning cardiopulmonary resuscitation by building your own manikin at school. 37th SEPEAP Congress (Spanish Society of Pediatrics). Gijón. 2023.

Throughout this pre-doctoral stage, grants and awards have been received, and the work developed has had impact and transfer in different professional contexts through blogs, courses, or impact on social media channels.

5. Grant. Pediatric Society of Galicia: 0 child drownings in Galicia. Year 2019.
6. Award. Finalist in the 1st edition of the national RCP Schools awards by the Spanish Heart Foundation (Originality Category). Year 2022. LOCOMAN Project. (Figure RESULTS-16.). Available at <https://www.youtube.com/watch?v=DCVf7p-YHFI&t=1990s> (min. 33)



Figure RESULTS- 16. Spanish Heart Foundation Youtube presentaion

- Reference in institutional blog <https://mymanikins.info/> [access 2024] promoted by the Swiss Lifesaving Society SLRG, which includes the study of LoCoMaN (Figure RESULTS-17.).

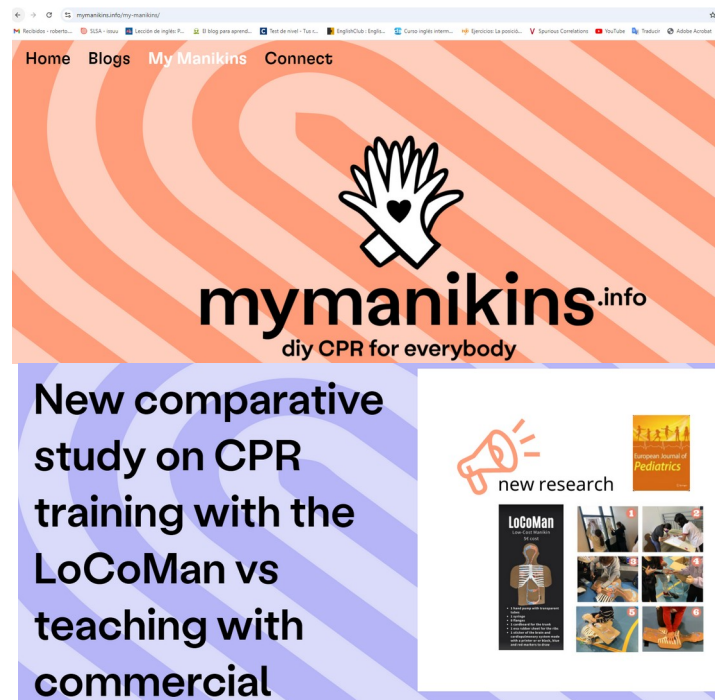
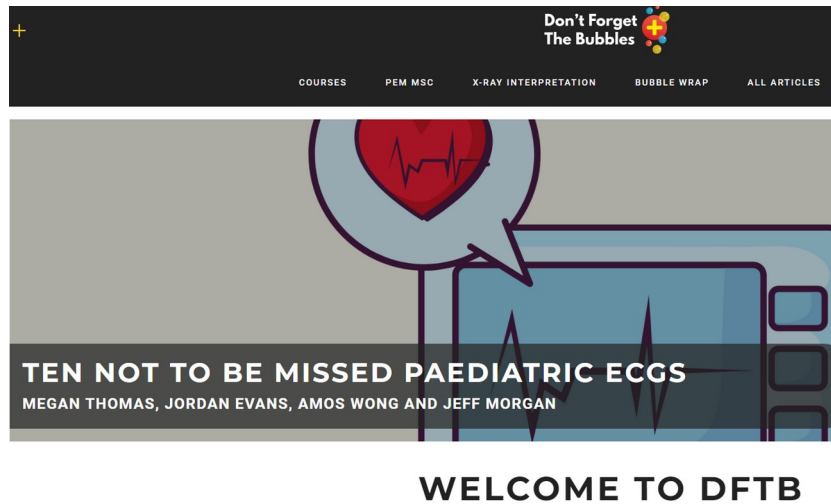


Figure RESULTS-17. Scientific dissemination in blogs and social media. Screenshot of the website <https://mymanikins.info/> promoted by the Swiss Lifesaving Society SLRG, which includes the study of LOCOMAN

- Reference in medical blog <https://dontforgetthebubbles.com/> [access 2024] promoted by Dr. Anke Raaijmakers. Bubble Wrap PLUS – June 2024, Don't Forget the Bubbles, 2024. Available at: <https://doi.org/10.31440/DFTB.62895>. (Figure RESULTS-18).



Don't Forget The Bubbles

Out-of-hospital cardiac arrest is associated with poorer outcomes, so training as many people as possible in the community in cardiopulmonary resuscitation (CPR) has the potential to close this gap, but manikins and courses are not cheap. Peixoto-Pino and colleagues investigated the option of [training primary school children](#) in a low-cost way. They used a (low-cost, ~€5) manikin with visual qualitative feedback and compared the results with the skills acquired by practice on a conventional manikin. School children were allocated to the low-cost (LoCoMan) or standard manikin (control) group. All participants practised for one hands-on skill session before performing a post-test on an instrumented CPR manikin. The control group achieved better chest compression depth, while the LoCoMan group showed more compressions with adequate chest recoil. The authors conclude that the approach can incentivise teachers to teach CPR and provide education outside the formal environment. Similar training initiatives (i.e. [MiniPOP](#) and others) have achieved great results.

Figure RESULTS-18. Screenshot of the scientific blog referencing the main aspects of LOCOMAN <https://dontforgetthebubbles.com/>.

7. GENERAL DISCUSSION

7 GENERAL DISCUSSION

Drowning is a public health problem that should be studied from different points of view and methodologies. One relevant strategy that could translate science to people and society is to prepare children to be future citizens with preventive attitudes and habits, and also to have the needed knowledge and skills to be effective elements of the drowning chain of survival. Following this approach, the main objective was to evaluate the effect of different educational interventions on the acquisition of concepts and skills for drowning prevention, rescue, and resuscitation. The most important findings were:

- a) The Spanish educational legislation includes various curricular elements linked to injury prevention and the teaching of first aid, especially CPR.
- b) Educational proposals based on children's songs contribute to the learning of codes and signage related to drowning prevention, the European emergency number, as well as the modification of potentially dangerous behaviors, such as attempting a rescue without knowledge.
- c) A “puppet show” can be an innovative and effective strategy to promote knowledge and attitudes of drowning prevention in children and parents.
- d) The throwing distance of rescue materials (conventional or alternative) increases with age of children, but lightweight and alternative materials like a PET bottle permits to double the distance compared to a ring buoy.
- e) A low-cost do-it-yourself manikin is a valid and easily available tool for teaching CPR to children

Drowning is a public health problem, and the WHO has established various strategies to reduce its incidence(7,48). These mainly focus on measures that promote awareness, the teaching of basic CPR, and swimming instruction(49). However, in the school, there are hardly any educational intervention proposals in this area. The few interventions mentioned in the scientific literature have shown how small actions can lead to significant changes in learning(27,29), and community interventions, especially in disadvantaged places like Bangladesh, are effective to reduce the incidence of drowning(3,26). It is commonly accepted that introducing prevention into the formal and informal education of children is beneficial for society. For example, the directors of Australian aquatic schools recommend that 11-year-old children should have specific knowledge about water safety and drowning prevention(29), so educational efforts should be promoted to increase safety knowledge(28) by developing programs with appropriate objectives and methodologies, as their effectiveness will depend on proper design(50).

This general discussion is structured into three blocks. The first, based on the review of Spanish educational legislation linked to first aid, is referenced in the article 1, as it promotes a reflection on what content and why it appears at each stage, based on the evidence published so far. The second block reflects the considerations on education for prevention discussed in articles 2 and 3 of this thesis. Finally, the third block of discussion focuses on the interventions (rescue and resuscitation) proposed in studies and publications 4 and 5.

7.1 DISCUSSION ARTICLE 1: SPANISH EDUCATIONAL LEGISLATION AND INJURY PREVENTION

In the first article, the Royal Decrees under the LOMLOE were analyzed, and it was found that accident prevention and basic first aid actions should begin in the second cycle of Primary Education. In the later years of this stage, there is an emphasis on safety behaviors and basic care (PAS and Recovery Position). With the start of Secondary Education, there is a substantial increase in content related to first aid, and it is the first time that CPR and the use of AED/SAED are explicitly mentioned. By the end of Secondary Education, all students should know Basic Life Support (BLS). In Baccalaureate, students are expected to have a risk analysis beyond the school environment and to be able to act even using the materials from a first aid kit.

The Royal Decrees are unclear about which first aid content should be taught, as its refer to them as "basic actions" without further specifications, leaving it to the teachers' discretion to interpret and therefore determine the content they will teach their students. In general, there is a consensus (see KIDs Save Lives statements) and a vast scientific literature supporting that children and adolescents must learn first aid, especially in schools' centers(45,46,51), and the Royal Decrees reflect those knowledge and competencies for which there is evidence that young people can learn. Calling 112(52), Recovery Position(53), CPR(36–38,54), FBAO(55), or AED(56,57) can be learned and executed from an early age, even earlier than the curricula indicate. According to this educational legislation, it can be stated that accident prevention and basic actions are promoted at all stages, but it is really from secondary education onwards that more specific concepts and skills related to BLS (CPR/AED/FBAO) and the recognition of signs and symptoms (stroke) appear.

In Primary Education, in the area of Physical Education, first aid procedures appear in the 5th and 6th grades, specifically the PAS conduct (Protect, Alert, and Assist). These basic knowledge and specific competencies are specified so that at 9 and 10 years old, children should be able to prevent different types of accidents, call emergency services, and give appropriate instructions to emergency call center. Primary Education is a globalized stage, where the contents of different subjects must be interconnected. In the area of Knowledge of the Natural, Social, and Cultural Environment for the third cycle, it mentions as "basic knowledge" the basic first aid actions, which allows for interdisciplinary work and content connection with the area of Physical Education, and which is the basis of the last article of this thesis **Assessing the quality of chest compressions with a DIY low-cost manikin (LoCoMan) versus a standard manikin: a quasi-experimental study in primary education**(58).

The area of Physical Education in secondary school has a transdisciplinary character, seeking an approach from multiple perspectives, while the first aid content is more specific than in primary school, its applicability covers any incident in physical activity and also in nearby social contexts (family, friends, environment...). It is worth noting that the greatest risk of drowning in natural aquatic spaces, for the adolescent profile, occurs in groups, unsupervised beaches, and mediated by alcohol consumption or serious recklessness(17), so in the early years of secondary education, the concept of "Protect, Alert, Assist (PAS)" is refreshed, and the 112 protocol (the emergency services call) is added again. From a public health perspective, this means activating the alert, with precise information, indicating who is calling, what is happening, how many victims need help, and what is being done for them. The European Resuscitation Council promotes three steps to activate the alert(59): 1) immediately call to emergency medical services (112) if a person is unconscious with absent or abnormal breathing, 2) a witness who is alone with a mobile phone should dial 112,

activate the speaker or other hands-free option, and 3) immediately start CPR assisted by the emergency dispatcher.

A novel aspect is the appearance of BLS, which is defined as the set of maneuvers that allow recognizing cardiac arrest, alerting emergency services, and knowing first aid maneuvers. These maneuvers include consciousness evaluation, airway opening (and clearing if necessary), artificial respiration if possible, and quality chest compressions. In summary, BLS includes basic CPR, AED, and FBAO and how to assess their need through ABC approach; A (airway), B (breathing), C (circulation), which involves knowledge of airway opening maneuvers (head-tilt/chin-lift), cardiopulmonary resuscitation, the recovery position, and airway obstruction maneuvers in case of choking (back blows and Heimlich maneuver).

In the third and fourth years of secondary education, "actions in case of accidents" is established as basic knowledge, but not exclusively derived from physical activity practice, leaving it to the teaching program to include actions, for example, in aquatic incidents through lifesaving and rescue training, mountain incidents, traffic accidents, or other emergency actions such as active bleeding control.

Although in previous courses students were introduced to BLS concepts, in the third and fourth years, the use of the AED is specifically mentioned(57). It is noteworthy that this content can be learned in earlier stages, as it is technically very simple, and evidence has shown that younger students are already capable of learning its use(57). Possibly, the emphasis that the Spanish educational law(43) places on this level is justified in the search for active cardioprotection, and that students are no longer just mere recipients of knowledge, but exercise proactive citizenship that acts in case of cardiac arrest, even being able to identify warning signs and symptoms of different pathologies (for example, stroke).

From the analysis of specific competencies, evaluation criteria, and basic knowledge mentioned in the Royal Decree(44) for this stage, it is deduced that students should not only be mere recipients of knowledge and master basic skills. Teenagers must regulate their own safety, become aware of risks, and make decisions in critical situations autonomously.

A relevant aspect is the mention of injury and incident prevention not only in the terrestrial environment but also in the aquatic environment. This nuance is more important than it may seem, however, child and adolescent drowning ranks among the top three causes of unintentional death, and in the adolescent stage, there is a trend change, moving from drowning mainly in pools caused by lack of supervision by caregivers, to drowning in natural spaces (beaches, rivers, and reservoirs) in the absence of adults and in the presence of groups of friends(9). Therefore, a fundamental content at this stage is active prevention and education in active safety in any aquatic environment or nautical sport(17)..

Regarding basic knowledge, at this stage, BLS techniques continue to be reinforced, including CPR, AED use, and FBAO, although it only indicates the Heimlich maneuver (a part of airway FBAO techniques) which is also mistakenly classified as a cardiovascular accident, as well as stroke which is a cerebrovascular accident, and its inclusion is pertinent because in Spain it is the second cause of death and the first of acquired disability, so at the curricular level, it would encompass prevention related to a healthy lifestyle eliminating conditions and/or harmful habits such as dyslipidemia, smoking, alcoholism, obesity, and sedentary lifestyle, as well as the early identification of warning signs and symptoms by the general population, as early treatment reduces mortality and mitigates sequelae(60).

Also as basic knowledge, the kit of a first aid kit and its use is included, which is generally used for minor incidents, usually for the treatment of wounds and minor contusions. Therefore, at this stage, students should identify the types of wounds, how to treat them, and

the aseptic measures for these procedures (hand washing, glove use, avoiding contaminant sources, etc.).

Another novelty incorporated into compulsory education is the knowledge of school alert protocols, which are the set of coordinated actions to provide an immediate and effective response to students who suffer from a chronic condition susceptible to decompensation and even life-threatening. They usually refer to allergic crises (anaphylaxis), seizure crises (epilepsy), diabetic crises (hypoglycemia), severe asthma crises, and congenital heart diseases. In these cases, there must be a protocol of action that goes from identification to immediate alert according to the plan designed for this purpose, and a series of procedures that should be previously established and in which students can participate. For example, identifying a severe anaphylactic reaction during recess and alerting the teaching staff, or collaborating in an epileptic attack, separating tables, chairs, or potentially harmful objects for the person suffering the crisis.

In the second year of Baccalaureate, electives are offered that can be marked by different communities such as "Physical Activity and Health" or can be of the center's own offer that can have names as specific as "First Aid." In these cases, the curricular content linked to accident prevention and first aid can be expanded or reinforced.

In conclusion, there is a growing trend in curricular content linked to first aid, but still very scarce or nonexistent in drowning prevention. However, the curriculum, being so open or rather, poorly defined in some aspects (for example, when it refers to accident prevention), is what allows teachers to offer meaningful educational proposals, therefore, creating curricular content based on needs, interests, and experience. For this reason, different preventive and interdisciplinary or transgenerational strategies are proposed, such as article 2 ; **Drowning prevention through school health education. Evaluation of the SOS 112 pilot Project**(61) and article 3; **The "DrownSafe" Project: Assessing the Feasibility of a Puppet Show in Teaching Drowning Prevention to Children and Parents**(62), and proposal for learning rescue and resuscitation skills (motor skills), such as in article 4; **Training Children for Prehospital Aquatic Interventions: Assessing Throwing Skills Using Traditional and Alternative Materials in a Simulated Water Rescue** and article 5; **Assessing the quality of chest compressions with a DIY low-cost manikin (LoCoMan) versus a standard manikin: a quasi-experimental study in primary education**(58).

7.2 EDUCATION FOR PREVENTION: FROM SONGS TO PUPPETS

This discussion is a compendium of articles 2 and 3 of this thesis. A priority aspect of this thesis was teaching prevention (signage, EMS alert, and awareness for safe rescue). Specifically, these two articles aimed to evaluate and improve the recognition of beach flags (red, green, and yellow). In the second study, initially, just over half of the children (55%) knew the meaning of the red flag, which changed after the educational intervention. Despite how simple it may seem, this circumstance was also found by Wilks et al. in a study in Australia, showing that children and adolescents generally have low knowledge about aquatic prevention(17,63). The lack of attention by swimmers to beach signage is a well-documented fact(64), which can pose an added risk due to lack of knowledge, and it is inevitable to suggest that it could be resolved with basic prevention advice from primary school. Interestingly, in the third study, a very high percentage of children recognized the colors of the flags (around 90%). Perhaps the difference lies in that the first activity was within the formal school setting, while the second was outside school hours, a voluntary, extracurricular activity outside a formal educational channel, so possibly the attending

families, in many cases, had a predisposition towards drowning prevention. This is why the school can be an appropriate environment for implementing safety programs(65), as it can reach most young people, who are usually very receptive to preventive messages. Drowning prevention can be meaningfully integrated with other school content (such as physical education or science). In early childhood education, one can start with very basic concepts like knowing the meaning of flags or who to call in an emergency(27), to more complex content and skills in primary education, including swimming and self-rescue skills, active and reactive prevention, throwing floating objects to someone who seems to be drowning, cold can kill, think and look before jumping(11,29,50,66). In secondary education (adolescence), the focus should be on acquiring attitudes(50) and developing more complex skills like recognizing rip currents or identifying other aquatic risks(17). The continuous evolution of education towards more integrative and meaningful models is not alien to aquatic safety education, where the challenge for understanding requires innovation and teamwork(49). Turgut et al. (28) developed an educational program in secondary school, and after its implementation, there was a 32% increase in water safety knowledge levels, with the evaluation consisting of pointing out in pictograms which situations were safe and which were not. Our study also found a 21% increase in water safety knowledge after listening to the song. In this sense, the use of songs as an educational tool or to promote behaviors related to prevention or emergencies has already been analyzed in the literature(67,68).

But in addition to using songs, implementing other pedagogical strategies, such as education through puppets, has already shown scientific evidence of its potential in other areas of knowledge(69,70). Moreover, bringing drowning prevention to the educational community can create a common knowledge space, strengthening the presence of witnesses (children and adults) who have a common awareness when it comes to preventing, alerting emergency services, or intervening in case of drowning. Precisely, plays and puppets serve pedagogically not only for children but also for families. The use of puppets in the shape of children serves as a pedagogical tool since they can be perceived as peers by other children. This educational approach is practical and cost-effective, and it also allows for addressing false beliefs within an imaginary scenario(71). However, children's learning from puppets may not necessarily align with their learning from real-world social agents, such as adults(72). To mitigate potential discrepancies between the imaginary and the real, a collective activity involving parents and children was promoted. In this activity, puppet representations were used to impart new knowledge and encourage safer behaviors related to drowning prevention at the family level.

The puppet show emphasizes numerous common elements in drowning prevention, which are often also the responsibility of parents. The main factor is the lack of supervision(11,12,73), and for this reason, the story depicts two non-fatal drownings, as the parents of the puppet protagonist were not at the scene of the incident. The puppet show aimed to focus on this main strategy, and according to The American Academy of Pediatrics, parents and caregivers should never – even for a moment – leave children alone or in the care of another child in bathtubs, swimming pools, or open water(10). The primary preventive strategy is supervision, defined as direct, contact supervision, where adults are within arm's reach of the child(11). Adequate supervision comprises three key components: proximity, attention, and continuity(74). Therefore, parents play an active role and become aware of the importance of supervision. After the intervention, half of the parents indicated an increase in their knowledge about preventing drowning after attending the puppet show. Moreover, over 80% of the children responded that bathing alone was an incorrect behavior. Another

positive outcome from the puppet show was an increase in parents' intention to visit supervised beaches, recognizing that lifeguards provide additional security(10).

7.3 EDUCATION FOR INTERVENTION: FROM RESCUE TO RESUSCITATION

The articles 3 and 4 of this thesis focus on teaching skills for rescue and resuscitation. The recommendations for inexperienced lay persons are that when they witness an aquatic incident and perceive someone who may be drowning, they should not enter the water, as they would put themselves at risk(18). Therefore, they should attempt the rescue by throwing an object that allows the person at risk of drowning to float(13). One of the WHO's principles is the recommendation to teach safe rescue techniques without entering the water(3). For this reason, the concept of "throw, row and don't go" has become popular(75,76), as it is considered one of the paradigms of bystander risk prevention(13). However, this recommendation lacks practical experiences and data that answer the question of what is the most suitable material for a witness (mainly a child) to help a person in the water, despite some organizations like the Water Safety Council (AWSC) recommending that children should be capable of throwing a rescue flotation aid to a partner at a distance of 5 meters before completing primary school (11-12 years old), although the AWSC reports that only a small percentage of children are capable of mastering this rescue skill(77).

The scientific organizations' emphasis on teaching children safety skills is motivated by their vulnerability to drowning(2,9,11), particularly in middle and low-resource countries(48,78), where kids are often untrained in aquatic rescues(79). Consequently, "non-expert" witnesses should use non-contact rescue techniques without entering the water(18). It is necessary for water safety programs to address two concurrent circumstances in aquatic incidents: the impulse to rescue without analyzing risks and the fact that when a witness throws an object to save a drowning person, it is often their first time doing so(76).

Rescue materials available to bystanders can be in different places, such as beaches, ports, or promenades, usually a ring buoy with a rope, or recently rescue tubes as in Hawaii(80). But, are ring buoys the most efficient rescue material when the rescuers are young children? It was observed that the heavier material (ring buoy) reaches an average distance of 2 meters at 6 years old and only increases by an additional 2 meters throughout primary education, reaching 4 meters by age 12. In contrast, the lighter material (PET-bottle) permit to double the distance achieved by 6-year-olds, practically reaching the same distance (4 meters) as preadolescents in the last year of primary education when throwing the ring buoy. At the age of 12, using the PET-bottle, teenagers can achieve distances similar to those of adults throwing a lifeline (approximately 7 meters). To achieve an effective throw, two components are needed: strength and coordination. These must be acquired progressively through anthropometric growing, biological maturation and motor stimulation. Specifically, motor stimulation, as provided in physical education lessons, allows trained children to reach greater distances than adults. School physical education can play a fundamental role in improving throwing skills, and this skill is a fundamental component of body schema and part of basic physical education.

7.4 PRACTICAL IMPLICACIONES

One fundamental aspect of this research, which is highly practical, is the development of low-cost strategies that can be implemented globally.

The creation of artistic works (e.g. songs) can be reproduced in any school in the world. The modification of inexpensive floating elements like plastic bottles, being the object thrown the farthest, is undoubtedly the most accessible and could be easily adopted by all children as

their Rescue-Pet. The construction of DIY manikins, like LoCoMan, can contribute to the principles promoted for years by various scientific societies such as the European Resuscitation Council or the American Heart Association, which promote school teaching of CPR under the concept KIDS SAVE LIVES(81), developing audiovisual resources(82), educational songs(83), social networks(84), gamified methodologies(37,85), or innovative materials(86,87) that are achieving significant and stable learning over time.

The use of educational resources that are easy to distribute and low-cost can be an alternative for mass training of the child population. Drowning is a global problem, and the means to prevent it are not the same in all countries, which is why the WHO in the Practical guidance for the provision of day-care(3), basic swimming and water safety skills, and safe rescue and resuscitation training recommends the adaptation of materials for low-resource settings. The creation of DIY materials is itself an efficient pedagogical strategy(88,89), and in drowning prevention, teachers in schools form a powerful core for promoting life skills(90). The combination of school education with community-wide programs, especially involving parents, can effectively reduce drowning incidents(30).

This doctoral thesis proposed four low-cost easy to apply interventions, which are also available online to be used by any educational center, community interested in drowning prevention, or families who want to offer accessible and evidence-based aquatic education.

For teachers and educators:

- Article 1 analyzes educational legislation and provides support for training in schools, offering teachers valuable information on what content to teach at each level.
- Articles 2 and 5 propose interdisciplinary educational proposals, simultaneously including different areas of the curriculum based on meaningful learning.
- Article 3 discusses how the educational community can intervene in community prevention.
- Article 4 develops a mandatory content in Physical Education (throwing), giving it meaning and functionality, based on meaningful learning (throwing to save a life).

For everyone:

- Article 2 and its fundamental element (the song) is available on YouTube. <https://www.youtube.com/watch?v=8qSE8H43rpQ>
- Article 3, the puppet show, and additional capsules are available on YouTube. https://www.youtube.com/watch?v=1Z3gI_dgb9Q&t=868s
- Article 4 promotes the use of a PET-bottle for rescue without entering the water.
- Article 5 teaches how to make a low-cost DIY manikin with feedback, available openly on the European Journal of Pediatrics website. <https://link.springer.com/article/10.1007/s00431-024-05601-8#Sec15>

All our proposals are based on global and free distribution (creative commons) through the internet, making them accessible to millions of people.

7.5 LIMITATIONS

The investigations in this thesis by compendium of scientific publications have presented various limitations that have been described in each of the articles, generally referring mainly to the limited number of participants or the geographical location of the research (children enrolled in the city of Santiago de Compostela for articles 3, 4, and 5, as well as families from

the province of Pontevedra and Ourense for article 2). The intention of our studies (educational innovation) was to conduct feasibility analyses of means, resources, or actions never published before, so the validity focuses on the process and resource, not the final outcome (reducing drowning). Future studies should address the effect of the educational programs and resources offered in this doctoral thesis.

8. CONCLUSIONS

8 GENERAL CONCLUSIONS

The conclusions of this thesis are organized into three sections, corresponding to the three hypotheses developed in the various articles of this compilation of publications.

8.1 CONCLUSIONS (C) ACCORDING TO H1 AND O1

C1. The current Spanish curriculum provides content from primary education, especially in injury prevention and first aid, promoting basic CPR mainly in secondary education and prevention in aquatic environments at the Baccalaureate grade.

8.2 CONCLUSIONS ACCORDING TO H2 AND O2

C2. Innovative educational proposals improve the schoolchildren's knowledge of concepts and codes related to drowning prevention.

- **C2.1** Children's songs with preventive messages succeed in improving knowledge about beach signage (flags), increasing the perception of responsible attitudes towards safer swimming, as well as the recognition of the European emergency number 112
- **C2.2** A community educational model based on a puppet show is effective in promoting knowledge and safer behaviors for drowning prevention in both young children and their parents.

8.3 CONCLUSIONS ACCORDING TO H3 AND O3

C3. Rescue and resuscitation skills can be trained and developed with low-cost materials without being inferior to conventional commercial materials.

- **C2.1** Children can throw rescue materials with good precision, but at different distances depending on the material's characteristics; however, heavier materials like the ring buoy may not be suitable for long distances in contrast with lighter and smaller alternatives, such as PET-bottles.
- **C2.2** The use of a low-cost handmade at school or home manikin with visual feedback can be an alternative for basic CPR training and learning in schools and can be integrated into common educational projects across various subjects.

9. FUTURE PERSPECTIVES BASED ON THIS RESEARCH

9 FUTURE GAPS BASED ON THIS RESEARCH

Drowning prevention requires a continuous search for new information to offer real proposals from research, education, and public health policies. This research has contributed to the educational field but should be complemented and updated with other lines of research that complement and provide continuity to this line of research:

1. **Measure the impact of research on drowning risk.** The studies in this doctoral thesis are based on educational and didactic proposals aimed at raising awareness and developing skills (such as throwing an object to perform a rescue without entering the water) or learning basic CPR in an innovative, didactic, and low-cost way. In addition, it will be necessary to conduct follow-up studies to understand the applicability in real-life risk situations over time.
2. **Determine the frequency and re-training of lifesaving skills.** The different studies have been conducted at the primary education level, focusing on prevention, especially at the earliest ages (early primary grades) and in primary and secondary education for the development of lifesaving skills (throwing and CPR). In addition, future studies should analyze the best age for initiation for each content and how often retraining would be necessary to both increase competencies around water safety and prevent forgetting in terms of prevention and loss of skill in manipulative activities.
3. **Implementation of educational programs in low-resource areas.** A strength of our studies is that they provide low-cost and therefore easily available resources, such as a song and a puppet show available online on YouTube, as well as DIY materials like the throwing bottle or the LOCOMAN manikin. The next step in this path should be to assess the real implementation a big scale and in different settings of this strategy and to analyze its benefit-cost ratio.
4. **Expansion to other target groups with functional diversity.** These studies have been developed mainly in the school environment, where we have encountered students with functional diversity, which has posed a challenge in adapting materials and resources. In the future, it should be developed and researched the most effective adaptations based on the diverse characteristics of the children

10. REFERENCES

10 REFERENCES

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APPENDIX

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Barcala-Furelos R, **Peixoto-Pino L**, Zanfaño-Ongil J, Martínez-Isasi S. Desafíos en la enseñanza escolar de los primeros auxilios: análisis de la legislación educativa (LOMLOE) y orientación curricular [Challenges in teaching first aids at schools: analysis of spanish educational legislation (LOMLOE) and curricular guidance]. *Rev Esp Salud Publica*. 2024 Feb 23;98:e202402013. Spanish. PMID: 38391131.


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Muchas gracias por su atención

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Peixoto-Pino L, Barcala-Furelos R, Paz-García B, Varela-Casal C, Lorenzo-Martínez M, Gómez-Silva A, Rico-Díaz J, Rodríguez-Núñez A. The "DrownSafe" Project: Assessing the Feasibility of a Puppet Show in Teaching Drowning Prevention to Children and Parents. *Children (Basel)*. 2023 Dec 23;11(1):19. doi: 10.3390/children11010019. PMID: 38255332; PMCID: PMC10814459.

PEIXOTO PINO LUCÍA
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 Dom 29/09/2024 18:07
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One of the articles that comprise my doctoral thesis by compendium have been published in the *Children Journal* (MDPI).

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Thank you very much for your attention.

Profesora Lucía Peixoto Pino

Departamento de Didácticas Aplicadas. Área de Didáctica da Expresión Corporal

Facultade de CC. da Educación. Universidade de Santiago de Compostela

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CP 15782. Santiago de Compostela (A Coruña)

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APPENDIX II: APPROVAL BY THE ETHICS COMMITTEE

Universidade de Vigo

Facultad de CC de la Educación y del Deporte
Pontevedra.

Carlos Ayán Pérez, Secretario del Comité de Ética de la Facultad de Ciencias de la Educación y del Deporte,

HAGO CONSTAR:

Que los siguientes proyectos de investigación presentados por el Profesor Dr. D. Roberto Barcala Furelos, han sido aprobados por dicho Comité:

Proyecto: Evaluación del aprendizaje de conceptos relacionados con el ahogamiento a través de la canción infantil.

Equipo investigador: Roberto Barcala Furelos, Carlos Alves Rivas, Julia Devesa Prieto, Martín Otero Agra, Lucía Peixoto Pino, Antonio Rodríguez Núñez.

Código asignado: 08-0721

Proyecto: Evaluación de la viabilidad para la enseñanza de rcp con un maniquí construido con material de reciclaje.

Equipo investigador: Roberto Barcala Furelos, Antonio Rodríguez Núñez, Lucía Peixoto Pino, Javier Rico Díaz

Código asignado: 02-250322

Proyecto: Efecto de la teatralización sobre el aprendizaje de conceptos asociados a la prevención del ahogamiento y rcp

Equipo investigador: Roberto Barcala Furelos, Begoña Paz García, Martín Otero Agra, Eloy Carracedo Rodríguez, Lucía Peixoto Pino, Antonio Rodríguez Núñez

Código asignado: 06-170123

Proyecto: Lanzamiento de rescate con diferentes materiales en entornos simulados

Equipo investigador: Roberto Barcala Furelos, Miguel Lorenzo Martínez, Ezequiel Rey Eiras, Eloy Carracedo Rodríguez, Enrique García Ordóñez, Lucía Peixoto Pino, Javier Rico Díaz

Código asignado: 07-170123

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This doctoral thesis addresses child drowning prevention through innovative educational strategies, emphasizing the World Health Organization's call for early intervention. It highlights the creation and dissemination of accessible educational materials, particularly targeting low-resource communities. The research includes reviewing Spanish educational legislation and developing interdisciplinary programs that integrate into school curricula, focusing on prevention, rescue, and resuscitation. Four interventions are proposed: using a song and puppet show for prevention, a water rescue technique involving flotation aids, and teaching basic CPR with low-cost manikins. The thesis concludes that such programs are feasible and beneficial for widespread implementation, particularly among young schoolchildren.