Szpilman, D.; Gaino Pinheiro, A.M.; Madormo, S.; Palacios-Aguilar, J.; Otero-Agra, M.; Blitvich, J. y Barcala-Furelos, R. (202x). Analysis of the Drowning Risk Associated with Aquatic Environment and Swimming Ability. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte vol. (*) pp. *. Http://cdeporte.rediris.es/revista/___*

ORIGINAL

ANALYSIS OF THE DROWNING RISK ASSOCIATED WITH AQUATIC ENVIRONMENT AND SWIMMING ABILITY

ANÁLISIS DEL RIESGO DE AHOGAMIENTO ASOCIADO AL ENTORNO ACUÁTICO Y COMPETENCIA NATATORIA

Szpilman, D.[1]; Gaino Pinheiro, A.M.[2]; Madormo, S.[3]; Palacios-Aguilar, J.[4]; Otero-Agra, M.[5]; Blitvich, J.[6] y Barcala-Furelos, R.[7]

[1] MD. Medical Director of the Brazilian Society of Lifeguard (Brazil). david@szpilman.com
[2] Gustavo Borges Academy Swimming Methodology (Brazil). apinheiro@metodologiagb.com.br
[3] PE. Technical direction of the National Institute of Children's Swimming INATI (Brazil). sandra@viaesporte.com.br
[4] PhD. Faculty of Sports Sciences and Physical Education. University of Coruña (Spain). jose.palacios@udc.es
[5] PhD. RN. REMOSS Research Group. Faculty of Education and Sports Sciences of Pontevedra, University of Vigo, Pontevedra, (Spain). martinoteroagra@gmail.com
[6] PhD. School of Health Sciences and Psychology at Federation University Australia, (Australia). jennyblitvich486@gmail.com
[7] PhD. REMOSS Research Group. Faculty of Education and Sports Sciences of Pontevedra, University of Vigo, Pontevedra, (Spain). CLINURSID Research Group. Department of Psychiatry, Radiology and Public Health, University of Santiago de Compostela, (Spain). roberto.barcala@uvigo.es

Spanish-English translator: Jennifer Blitvich, jennyblitvich486@gmail.com and Sandy Duran Muñoz, duranmsandy@hotmail.com

ACKNOWLEDGMENTS

The authors would like to thank the experts involved in the design of the risk matrix and all the people who have contributed to this work.

Código UNESCO / UNESCO code: 3212 Salud Pública / (Public Health)
Clasificación Consejo de Europa Otras (actividades acuáticas) / Other (water activities)

Recibido 20 de junio de 2020 **Received** June 20, 2020
Aceptado 25 de octubre de 2020 **Acepted** October 25, 2020

ABSTRACT

A high level of swimming can be a protective factor against drowning, however, this relationship has not yet been empirically demonstrated, based on water competence level and aquatic environment. This study designed a drowning risk matrix based on the probabilistic analysis of a questionnaire answered by 3,181 participants. The occurrence of Aquatic Stress/Distress (ASD) was analysed based on 5 skill levels and three aquatic scenarios: a) Pool without waves or currents, b) Lakes, reservoirs, rivers and beaches without waves or currents, c) Rivers, beaches or pools with waves and/or currents. The results were expressed in Odds Ratio (OR). ASD risk exceeded OR of 25 in the most dangerous environment and increased for all scenarios as aquatic competency worsened. Three out of four swimmers have experienced an ASD and this event could have been an incentive to improve their water competence.

KEY WORDS: aquatic stress/distress; drowning; risk analysis; water safety; swim.

RESUMEN

Un alto nivel de natación puede ser un factor protector ante el ahogamiento, sin embargo, esta relación todavía no ha sido empíricamente demostrada, en base al nivel de habilidad y entorno acuático. Este estudio diseñó una matriz de riesgo de ahogamiento en base al análisis probabilístico de un cuestionario respondido por 3.181 participantes. Se analizó la ocurrencia de Estrés/Distrés acuático (EDA) en base a 5 niveles de competencia y tres entornos acuáticos: a) Piscina sin olas ni corrientes, b) Lagos, embalses, ríos y playas sin olas ni corrientes, c) Ríos, playas o piscinas con olas y/o corrientes. Los resultados se expresaron en Odds Ratio (OR). El riesgo de EDA superó el OR de 25 en el entorno más peligroso y se incrementó para todos los escenarios conforme la competencia acuática era peor. Tres de cada cuatro nadadores han sufrido EDA y este evento pudo ser un incentivo para mejorar sus competencias acuáticas.

PALABRAS CLAVE: habilidad natatoria, ahogamiento; análisis de riesgo; seguridad acuática; estrés/distrés acuático.

List of statistical acronyms and variables

OR: Odds Ratio. ES: Effect Size.
ASD: Aquatic Stress/Distress. LAC: Level of Aquatic Competence. AE: Aquatic Environments. L (1-5): Level of aquatic competence [1 the best competence – 5 the lowest competence]. PC: Physical Condition.

1. INTRODUCTION

It is widely accepted that a high level of swimming competency can be a protective factor against drowning,[1-3] especially if learning begins in childhood.[4] However, the relationship between swimming competency and drowning has never been scientifically proven.[5] Traditionally, the term drowning has been understood as synonymous with death, however, drowning is a process in which one experiences difficulty in breathing due to submersion or immersion in a liquid,[6] with two possible consequences; death (fatal drowning) or survival (non-fatal drowning). Survival to an aquatic incident may be due to the victim's ability to get out of danger (with or without assistance) or by post rescue care (first aid).

Drowning is now considered a public health problem by the World Health Organization (WHO)[7] and given its as yet unknown magnitude has been compared to the "iceberg metaphor".[8] It is known to cause the death of more than 350,000 people annually,[7,9] most of whom are men, usually occurs in unattended places[10] and is usually due to preventable causes,[11] while little is known about non-fatal incidents. A Brazilian study revealed that for every drowning requiring medical care, five other bathers experienced some water incident without fluid aspiration (not drowning).[12] In New Zealand, for every young person who died from drowning, 27 people were rescued.[13] In Spain, in the two-year period 2016/2017, a total of 1,175 people died from drowning.[14]
The phase prior to or parallel to the drowning process is that of aquatic stress or distress (ASD).[15] Aquatic stress is a state of physiological imbalance or psychological conditions caused by a perceived risk of death by drowning. It is itself an incident in which the victim can manage the situation on his/her own or with the help of others (e.g., becoming involved in a rip current and relaxing, without swimming against it, until the force of the water flow can be overcome and the potentially dangerous situation can be eased). Instead, distress begins when a person does not have the rational ability to manage the stressful situation (e.g., a victim grabbing the lifeguard who is trying to save him or her). The term ASD as a triggering event to a rescue and/or drowning situation is the cornerstone for addressing the problem.

Usually, there are two strategies for drowning prevention: a) proactive interventions, mainly carried out by lifeguards and aimed at reducing the risk of the environment and b) reactive preventive interventions aimed at modifying the behaviours of bathers, teaching them to discriminate potentially dangerous situations and to have a better knowledge of their water skills.[5,15]
It is this last consideration that is the focus of our study, which aims to analyse the relationship between swimming competency, the aquatic environment and the probability of an ASD event. The aim is to create a useful tool for self-assessment of drowning risk.

2. MATERIAL AND METHODS

2.1. CREATION OF A DROWNING RISK TABLE

Twelve international experts in drowning prevention and swimming education were invited to develop a risk matrix that considers the most influential factors in drowning. The experts were selected based on their professional and scientific experience, accredited by their academic contributions and outreach activities.

The matrix was designed using the Delphi method in a mixed format (via email and in person) and consisted of three phases.

Phase 1: The experts considered the two most important variables in the risk of drowning; the level of aquatic competence and the different aquatic spaces. These factors have previously been considered as relevant by other authors.[5,12,16] For the preliminary design of the risk matrix, five levels of aquatic competence (LAC) and three aquatic environments (AE) were established. The LAC were:

- Level 1 the best competence: Swimmer with risk analysis and rescue knowledge.
- Level 2: Competent in four swimming strokes
- Level 3: Can to swim with more than one style and with advanced floating skills.
- Level 4: Has basic floatation skills.
- Level 5 the lowest competence: Cannot swim or floating.

The EA with different conditions were:

- Pools without waves or currents.
- Reservoirs, lakes, rivers and beaches without waves or currents
- Rivers, beaches or pools with waves or currents.

Phase 2: The experts quantified the risk based on their previous experience related to swimming instruction and/or water rescue. The initial categorization was ordered into three levels: high (red), medium (yellow), and low (green). The risk ranking was based on the risk ranking table by Messner et al.[17]

Phase 3: A first pilot matrix was developed, integrating LAC, AE and risk levels (Figure 1).

Aquatic Competence	Aquatic Environments		
	Pools without waves or currents.	Lakes, reservoirs, rivers and beaches without waves or currents.	Rivers, beaches with waves and/or currents.
Level 1: (the best competence) Swimmer with risk analysis and rescue knowledge	Low	Low	Low
Level 2: Competent in four swimming strokes	Low	Medium	Medium
Level 3: Can to swim with more than one style and with advanced floating skills	Low	Medium	High
Level 4: Has basic floatation skills	Medium	High	High
Level 5: (the lowest competence) Cannot swim or floating	High	High	High

Figure 1. Drowning Risk Matrix (preliminary version)

2.2. DATA COLLECTION AND VARIABLES

To verify the adequacy of the risk matrix to the probability of ASD, the experts developed a 7-question questionnaire, which participants had to answer in relation to their LAC; the AE they had attended; whether they had experienced any ASD situation and, if so, in what AE it occurred; and what was their LAC and physical condition (PF) at the time of experiencing an ASD event. Participants also identified their gender. The questionnaire is available in Spanish https://forms.gle/79b1oPk3WE32VxiN6 and Portuguese https://forms.gle/79b1oPk3WE32VxiN6.

The variables analysed were: a) LAC; b) AE; c) ASD, with option Yes and No; d) LAC during ASD; e) AE during the ASD event and f) PC ("Good physical condition"; "Regular physical condition"; "Low physical condition") during the ASD event.

2.3. PARTICIPANTS

The questionnaire was developed on the "Google Forms" platform and distributed through social networks (Facebook, WhatsApp, Twitter and Instagram). This method was chosen in order to achieve the highest number of responses and the most heterogeneous profile of participants. No inclusion criteria were required, other than to yield the anonymized data for research purposes. A total of 3,202 people answered the questionnaire. Twenty-one were excluded due to inconsistent responses (at least one response incompatible with another). The total number included in the analysis was

3,181, of which 1,482 (46.6%) were answered in Spanish and 1,699 (53.4%) in Portuguese. Figure 2 summarizes the development, recruitment, implementation and analysis of the questionnaire.

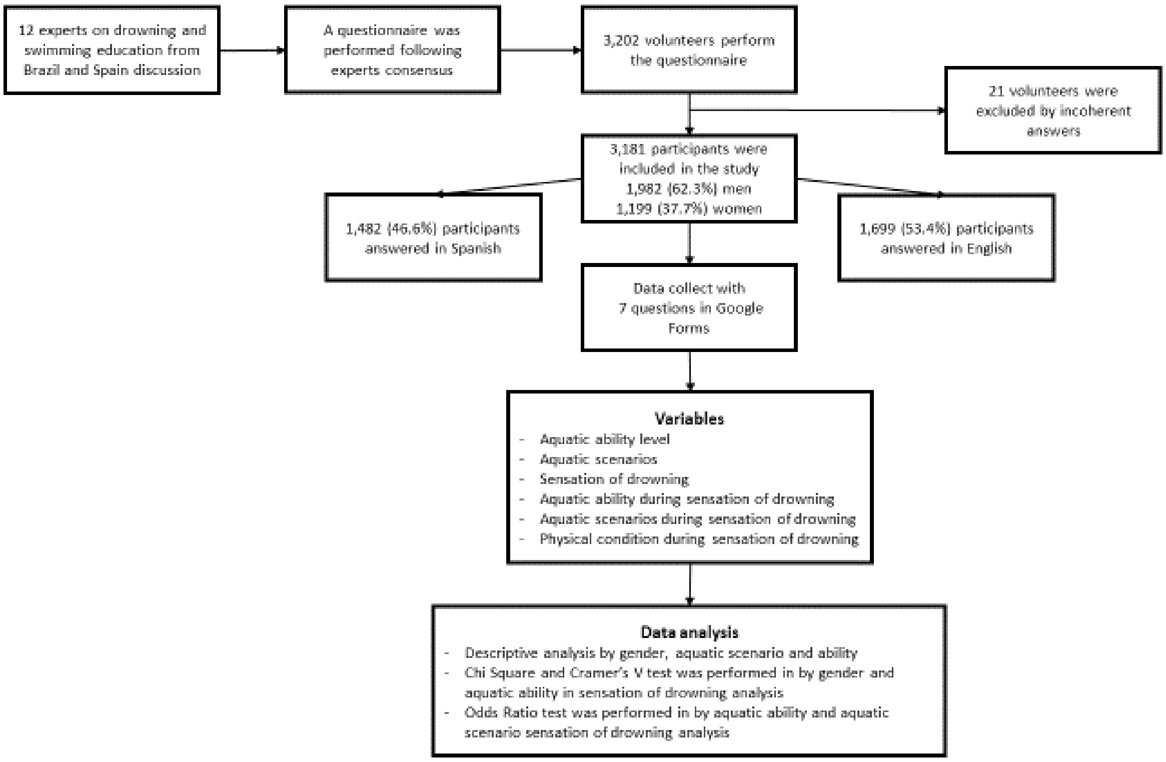

Figure 2. Flowchart of research steps.

2.4. DATA ANALYSIS

A descriptive analysis of the different variables was carried out, stratified by gender, LAC and EA. IBM SPSS software for Windows version 21 (IBM Corp., Armonk, NY, USA) was used. For the analysis according to gender, the Chi Square test was used, and in the comparisons with significant results the effect size (ES) was calculated with the Cramer V test. The following values were used to measure the intensity of the effect: Small (0.06 - 0.18); Medium (0.181 - 0.29); Large (> 0.29).[18] The questionnaire included the option "select all the AEs you have experienced (not restricted to one option)". For this analysis we considered; none, one or a combination.

A descriptive analysis was conducted comparing the LAC before and after the ASD event, to determine if the incident caused any variation in the victim's water competence.

To analyse the risk matrix in each LAC and for each AE, relative frequencies and "Odds Ratio" (OR) were used to classify the risk at different levels and colours. The OR was calculated for each LAC in the three AE, according to the answers to question 6 (see questionnaire in supplementary material). The highest level of competence (level 1: Can swim, risk analysis and rescue) and the scenario with the lowest hypothetical risk (pool without waves or currents) were taken as reference (OR = 1.00). The statistically significant variation between cases was used to modify the pilot table developed by the expert consensus (Figure 1) to a new corrected table (Figure 3) based on the analysis of the questionnaire responses, using the risk probabilities described in the literature for the OR: Trivial (< 1.5); Low (1.5 - 3.5); Medium (3.51 - 9.0); High (> 9.0).[19]

3. RESULTS

A total of 3,181 questionnaires were analysed. Table 1 summarizes the descriptive results of the questionnaire. 62.3% of the participants were men and 37.3% were women. Men indicated having the highest LAC in L1 (M 58.6% vs W 26.1%; $p < 0.001$), while in the rest of the levels (L2 - L5) women have higher percentages ($p \leq 0.002$).

The analysis of the EA shows that only 0.2% of the participants never entered the water and that more than half had experienced all three EA. Almost two-thirds (63.9%) of the participants indicated that they had experienced some event of ASD, in one or more EA (for every 2 people who experienced ASD, one did not). Men experienced ASD to a greater extent than women (M 66.6% vs W 59.5%; $p < 0.001$). In the analysis of the AEs and their use (not restricted to one), 2,251 (70.8%) reported pools without waves or currents, 2,120 (66.6%) lakes, dams, rivers and beaches without waves or currents and, 2,695 (84.7%) lakes, dams, rivers and beaches with waves and/or currents. The analysis of the occurrence of ASD in light of water competency level (LAC) found that at level 1 (Swimmer with risk analysis and rescue training), a higher proportion of men reported an ASD event than women (M 33.6% vs W 13.6%; $p < 0.001$). The second largest gender difference for those who had experienced ASD occurred at the lowest level of aquatic competency (cannot swim or float) (W 24.8% vs. M 16.2%, $p <0.001$).

Significant differences in EA were found when an ASD event occurred: The aquatic environment in which an ASD event occurred most frequently was theoretically the most dangerous (lakes, dams, rivers, and beaches with waves and/or currents), especially for males (total 72.4%; W 69.3% vs M 74.0%, $p = 0.023$). In contrast, women reported the most AED in the theoretically lowest risk environment; pool without waves or currents (W 15.7% vs M 9.9%, $p <0.001$).

About half of the participants indicated that they were in optimal physical condition at the time of the ASD event (total 48.0%; M 49.5% vs W 46.7%; $p = 0.234$). Only when physical condition was low were significant differences between genders found (W 21.9% vs. M 15.7%; $p < 0.001$).

Table 1: Descriptive data of LAC, AE and ASD

Variable	Options	Total 3,181 (100.0%)	Woman 1,199 (37.7%)	Man 1,982 (62.3%)	*p* value	Association X^7	Association Cramer
LAC	L1	1,475 (46.4%)	313 (26.1%)	1,166 (58.6%)	< 0.001**	362.03**	0.34 Big
	L2	515 (16.2%)	226 (18.8%)	289 (14.6%)	0.002*		
	L3	755 (23.7%)	390 (32.5%)	365 (18.4%)	< 0.001**		
	L4	255 (8.0%)	141 (11.8%)	114 (5.8%)	< 0.001**		
	L5	181 (5.7%)	129 (10.8%)	52 (2.6%)	< 0.001**		
AE	AE1	153 (4.8%)	66 (5.5%)	87 (4.4%)	< 0.001**	90.51**	0.17 Small
	AE2	204 (6.4%)	117 (9.8%)	87 (4.4%)	0.211		
	AE3	654 (20.6%)	200 (16.7%)	454 (22.9%)	< 0.001**		
	AE1 y AE2	123 (3.9%)	71 (5.9%)	52 (2.6%)	< 0.001**		
	AE1 y AE3	248 (7.8%)	120 (10.0%)	128 (6.5%)	< 0.001**		
	AE2 y AE3	66 (2.1%)	20 (1.7%)	46 (2.3%)	< 0.001**		
	AE1, AE2 y AE3	1,727 (54.3%)	602 (50.2%)	1,125 (56.8%)	0.154		
	Never entered the water	6 (0.2%)	3 (0.3%)	3 (0.2%)	0.534		
ASD	YES	2,033 (63.9%)	713 (59.5%)	1,320 (66.6%)	< 0.001**	16.48**	0.07 Small
	NO	1,148 (36.1%)	486 (40.5%)	662 (33.4%)			
Variable	**Only those who answered YES in ASD**	**Total 2.033 (100,0%)**	**Woman 713 (59,5%)**	**Man 1.320 (66,6%)**	***p* value**	**Association X^7**	**Association Cramer**
LAC during ASD	L1	541 (26.6%)	97 (13.6%)	444 (33.6%)	< 0.001**	101.72**	0.22 Small
	L2	289 (14.2%)	104 (14.6%)	185 (14.6%)	0.725		
	L3	501 (24.6%)	203 (28.5%)	298 (22.6%)	0.003*		
	L4	311 (15.3%)	132 (13.6%)	179 (18.5%)	0.003*		
	L5	391 (19.2%)	177 (24.8%)	214 (16.2%)	< 0.001**		
EA During ASD	AE1	243 (12.0%)	112 (15.7%)	131 (9.9%)	< 0.001**	17.36*	0.09 Small
	AE2	203 (10.0%)	66 (9.3%)	137 (10.4%)	0.421		
	AE3	1.471 (72.4%)	494 (69.3%)	977 (74.0%)	0.023†		
	AE1 and AE2	7 (0.3%)	2 (0.3%)	5 (0.4%)	0.718		
	AE1 and AE3	54 (2.7%)	23 (3.2%)	31 (2.3%)	0.240		
	AE2 and AE3	33 (1.6%)	10 (1.4%)	23 (1.7%)	0.563		
	AE1, AE2 and AE3	22 (1.1%)	6 (0.8%)	16 (1.2%)	0.441		
PC during ASD	Good PC	986 (48.5%)	333 (46.7)	653 (49.5%)	0.234	12.31*	0.08 Small
	PC regular	684 (33.6%)	224 (31.4%)	460 (34.8%)	0.118		
	Low PC	363 (17.9%)	156 (21.9%)	207 (15.7%)	< 0.001**		
Variables	**Only those who asnwered NO in ASD**	**Total 1,148 (100.0%)**	**Woman 486 (42.3%)**	**Man 662 (57.7%)**	***p* value**	**Association X^7**	**Association Cramer**
LAC in people who have never experience d an ASD event	L1	505 (44.0%)	128 (26.3%)	377 (56.9%)	< 0.001**	125.31**	0.33 Big
	L2	222 (19.3%)	101 (20.8%)	121 (18.3%)	0.289		
	L3	273 (23.8%)	161 (33.1%)	112 (16.9%)	< 0.001**		
	L4	97 (8.4%)	58 (11.9%)	39 (5.9%)	< 0.001**		

	L5	51 (4.4%)	38 (7.8%)	13 (2.0%)	< 0.001**		

Levels: Swimmer with risk analysis and rescue training (L1),Competent in 4 strokes (L2), Can Swim more than one style, with advanced floating skills (L3), Has basic floating skills (L4), Cannot swim or float (L5) Aquatic Scenario (AE): Scenarios: Pools without Currents or Waves (AE1), Reservoirs, Lakes, Rivers or Beaches without Currents or Waves (AE2), Rivers, Beaches or Pools with Currents or Waves (AE3). Aquatic Distress/Stress (ASD). Physical Condition (PC). Value of p for Chi Square = 0.05. * significant comparison with p < 0.01. ** significant comparison with p < 0.001. Association value with Cramer's V value: Small (0.06 - 0.18); Medium (0.181 - 0.29); Large (> 0.29)

For those who had experienced an ASD event, the LAC at the time of questionnaire completion was significantly increased (p < 0.01) compared to the time of the event. This improvement influenced approximately one in two swimmers in L1, L2, and L4, and one in three in L3 (Table 2).

Table 2: Evolution of LAC since the ASD event

		LAC during the ASD event			**Total**	**Association**	
		Same level	**Worse level**	**Better level**		**χ^2**	**Cramer**
LAC at time of questionnaire	L1	497 (51.2%)	473 (48.8%)	0 (0.0%)	970 (47.7%)	198.14**	0.22 Medium
	L2	139 (47.4%)	132 (45.1%)	22 (7.5%)	293 (14.4%)		
	L3	291 (60.4%)	162 (33.6%)	29 (6.0%)	482 (23.7%)		
	L4	87 (55.1%)	54 (34.2%)	17 (10.8%)	158 (7.8%)		
	L5	116 (89.2%)	0 (0.0%)	14 (11.8%)	130 (6.4%)		
	Total	1,130 (55.6%)	821 (40.4%)	82 (4.0%)	**2,033 (100.0%)**		

Levels of aquatic competency (LAC); Levels: Swimmer with risk analysis and rescue training (L1), Competent in four swimming strokes (L2), Can Swim more than one style, with advanced floating skills (L3), Has basic floating skills (L4), Cannot swim or float (L5) Aquatic Scenario (AE): p value for Chi Square = 0.05. * significant comparison with p < 0.01. ** significant comparison with p < 0.001. Association value with Cramer's V value: Small (0.06 - 0.18); Medium (0.181 - 0.29); Large (> 0.29)

Figure 3 shows the modified risk matrix, based on the information provided by the participants. This new matrix is based on the risk probability ranking described by Cohen.[19] The update consisted of a subdivision of the high risk category into two levels: High Risk (described in orange) and Critical Risk (described in red). All the analyses were performed taking as reference (OR = 1) the values of the first level (Swimmer with risk analysis and rescue training) in the Pool AE without waves or currents. In pools without waves or currents, the first three levels (L1 - L3) all showed a lower than 10% risk, with an OR < 1.5. The lower the LAC, the higher the risk in this aquatic space: medium risk in level 4 (Has basic floating skills; 15.9%; OR = 3.41) and critical risk in L5 (Cannot swim or float; 34%; OR = 9.24). In the second AE (Lakes, reservoirs, rivers and beaches without waves or currents) a similar pattern is observed, the lower the LAC, the higher the risk. In the third AE (with waves and/or currents), the risk percentages presented critical values at all levels, with the lowest risk for the first level of aquatic competence (48.1%; OR = 16.65) and the highest risk for the fourth level (62.0%; OR = 29.31). All the OR in rivers, beaches or pools with waves and/or currents were higher than 9 (high risk described by Cohen[19]), indicating that the higher values of LAC do not represent an absolute protection factor for the environment with greater apparent danger (in the presence of waves and currents). In the remaining AE (pools or environments without waves/currents), the lower the LAC, the higher the risk of ASD; a person who cannot swim is 9 times more likely to experience ASD compared to a swimmer with risk analysis and rescue training. The highest risk (29 times higher) is found in AE3. The best swimmers (those at the top level) hardly experience ASD events in pools and water spaces without waves or currents, but their risk increases significantly when they are active in waves or currents (OR 16.65). The highest risk in a pool for non-swimmers (L5) (OR = 9.24), is lower than the risk for the best swimmers, in the most dangerous scenario (waves and currents) (OR = 16.65).

Aquatic Competence	Aquatic Environments: Pools without waves or currents. ASD	Lakes, reservoirs, rivers and beaches without waves or currents. ASD	Rivers, beaches with waves and/or currents. ASD
Level 1: (the best competence) Swimmer with risk analysis and rescue knowledge	LOW N = 37 (5,3%) OR 1,00	LOW N = 45 (6,7%) OR 1,30	CRITICAL RISK N = 449 (48,1%) OR 16,65
Level 2: Competent in four swimming strokes	LOW N = 26 (7,0%) OR 1,35	LOW N = 16 (4,4%) OR 0,83	CRITICAL RISK N = 327 (51,1%) OR 25,85
Level 3: Can to swim with more than one style and with advanced floating skills	LOW N = 43 (7,5%) OR 1,45	MEDIUM N = 47 (8,6%) OR 1,68	CRITICAL RISK N = 386 (58,7%) OR 25,47
Level 4: Has basic floatation skills	MEDIUM N = 48 (15,9%) OR 3,41	HIGH RISK N = 46 (16,6%) OR 3,65	CRITICAL RISK N = 196 (62,0%) OR 29,31
Level 5: (the lowest competence) Cannot swim or floating	CRITICAL RISK N = 103 (34,0%) OR 9,24	HIGH RISK N = 56 (21,2%) OR 3,97	CRITICAL RISK N = 172 (53,1%) OR 20,31

Figure 3. Drowning risk matrix (final version). The colors of the cells represent the Odds Ratio (OR). The levels for the ranges were as follows: Low risk (Green): 0 - 9.9% of ASD cases. Medium risk (Yellow): 10 - 19.9% of ASD cases. High risk (Orange): 20 - 29.9% of ASD cases. Critical risk (Red): > 30% of ASD cases.

4. DISCUSSION

The purpose of this research was to evaluate the occurrence of an ASD event in order to develop an easy to understand tool, so that people can know their risk in the practice of aquatic activities in different EA. The ASD risk matrix shows that even advanced swimmers are potentially at risk of drowning.

Realistic perception of limitations and not overestimating one's abilities, combined with correct risk assessment, is crucial to drowning prevention.[20]

Aquatic environments are very popular spaces for recreation or health[16] and proof of this is that only 0.2% of the participants in this study responded that they never used any of these environments. However, there is still limited evidence indicating which factors may be protective and which precipitate drowning in adults.[21] It is noteworthy that most participants have at some point been exposed to risk situations; 8 out of 10 have experienced AE3, regardless of LAC, something that has already been reported in other studies.[16-22]

"Learn how to swim" has been the primary educational approach to reducing drownings.[1-3] This study showed that typically, the higher the LAC, the lower the occurrence of ASD in all three AE, with some exceptions (in the LAC), in lakes, reservoirs, rivers and beaches without waves and currents, and in LAC 5, in the presence of waves and currents). Sotés et al[3] indicated that education in the aquatic environment, information on danger and a greater perception of safety, could reduce deaths on the beach, however, our study has shown that aquatic competency does not completely eliminate vulnerability. Our data argue that swimmers with a good LAC and good physical condition have greater protection in lower risk aquatic environments (such as pools and beaches without waves or currents), but that the risk remains very high when the conditions of the aquatic environment are dangerous. In this sense, good physical condition does not eliminate the high risk when faced with waves or currents, 48.5% of swimmers indicated that they were in excellent physical condition when they experienced the ASD event. Personal risk exposure should also be considered in this analysis. Acquiring the best swimming skills involves a greater number of hours in the water environment, and therefore may increase the risk of ASD.[23]

In our study, almost two-thirds of the participants reported experiencing ASD at least once. Swimmers with "risk analysis and rescue training" had the most frequent experience with ASD (26.6%), followed closely by swimmers who mastered more than one style and had advanced flotation skills, at 24.6%. The results obtained emphasize the idea that the risk increases with greater exposure time. Expert swimmers have probably had to spend more time to reach that level and therefore have experienced more dangerous situations during their training process. Another relevant aspect is that they tend to swim longer distances, more frequently and for longer periods of time.[16] Rivers, beaches or pools with waves and/or currents is the environment in which the greatest number of responses indicated ASD events (72.4%) and this is consistent with the scientific literature linking increased risk with wave height, tidal level and rip currents.[3,24] Currents represent one of the greatest risks for any swimmer, as the speed of their flow can reach 2 m/s in 100 m.[3.25] Only high level swimmers can swim at a speed of 2 m/s; for example, the speed of the 100 m world record in freestyle is ~2.22 m/s. A British study showed that lifeguards do not exceed 1 m/s when they reach the surf zone[25], this is half of the peak speed a rip current can reach. It seems reasonable to conclude that, in extreme circumstances, even swimmers with the highest levels of water experience could be involved in an ASD event.

The difference between men and women is also a factor highlighted in the category Swimmer with risk analysis and rescue skills. A higher proportion of men reported this highest LAC level, but despite this, for every ASD a woman experienced, men were 2.5 times more likely. This may be because male swimmers, compared to women swimmers, enjoy a longer exposure time[26], swim in natural aquatic spaces more frequently, alone and/or at night.[26] Women have shown to be more cautious in their perception of drowning risk, better identifying their vulnerabilities and, in general, choosing to avoid or prevent the risk to a greater extent than men.[21] This gender difference is worthy of further research.

A key finding in this study is that, after experiencing an ASD situation, a large number of participants improved their LAC, suggesting that the stress/distress situation may have acted as a trigger to improve their aquatic skills. It is also possible that, for some, this may have affected them negatively and these individuals may have chosen not to enter the water again in reaction to the traumatic event experienced or, they may have chosen to swim in safer spaces. Factors such as age[16] or education[3] may improve the perception of risk and this may motivate swimmers to increase their aquatic competence. Several studies suggest that children and young adults can gain significant skill improvements from 10-20 swimming lessons over an 8- to 12-week period.[21,27] Participating in swimming programs is recognized as a strategy to achieve better LAC in children and to provide water-safety education[28,29] which may reduce the risk of drowning when in an ASD situation, however, it may also increase the frequency of ASD events. Typically, learning to swim takes place in calm water (such as swimming pools). Initial skill development may give a false sense of security because learners are not sufficiently prepared to deal with the more complex aquatic conditions of other AE. Prevention is the most effective strategy for safe swimming enjoyment. Therefore, it is necessary to include the concept of aquatic safety in the educational framework[30,31] which should be complemented with the acquisition of the best possible aquatic competence, choosing supervised environments and implementing a national plan for drowning prevention in view of the legislative gap existing in many communities.[32]

4.1. PRACTICAL IMPLICATIONS OF THE STUDY

In this study, the experiences of stress/aquatic distress of a large group of people have been investigated. Through the development of a simple risk perception matrix, it is possible to demonstrate that, in pools without waves and/or currents, a person with a lower level of competence has a 9.24 times higher risk of an ASD than a person with the highest level of competence; while, in reservoirs, lakes, rivers or beaches with waves and/or currents, the risk increases at all levels. This information is very important in illustrating the risk of ASD events and the possibility of drowning in different aquatic environments. Figure 3 is the most relevant practical application of our study. The diagram shows the risk of ASD, for each level of aquatic competency in each aquatic space.

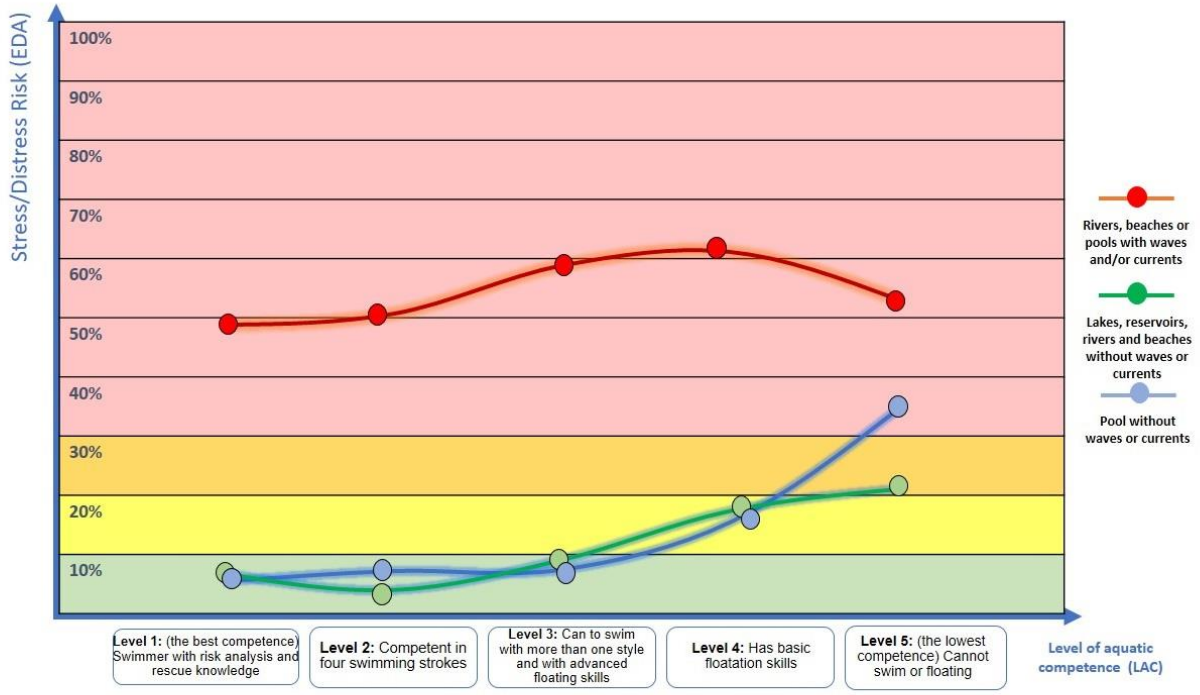

Figure 4. Probability of ASD based on LAC and EA.

4.2. LIMITATIONS

There are limitations of this study that should be noted. The recruitment of participants was done through social networks. This may lead to a gap in older people or in places with more restricted internet access. The responses obtained have been from people who have survived an ASD event; however, this study cannot provide the circumstances that have involved ASD resulting in death or severe morbidity. The questionnaire did not ask about time of exposure to each aquatic environment. Future research should include this construct as it may be the explanatory factor for the high incidence of ASD in expert swimmers. Finally, note that participants indicated their "perceived" level of competence and this was not confirmed through skills assessment. It is possible that participants may have, in some cases, under- or over-estimated their actual competence.

5. CONCLUSION

The risk of drowning is always present in any aquatic environment and affects all bathers to a greater or lesser extent. This study found that three out of four people have experienced, at some point, a stressful and/or distressing situation in the water, with real risk of drowning.

In pools or natural water spaces without waves or currents, the better the water competency, the lower the risk of drowning. However, the level of aquatic competency or physical condition does not rule out the risk in environments with waves and currents, and could generate a situation of false security, especially in men. For bathers with poorer skills, the risk increases exponentially as the aquatic environment becomes more dangerous. Awareness of their limitations is possibly one of the best prevention tools. Swimmers who at some point in their lives have experienced a stressful or distressing aquatic event have a tendency to increase their level of swimming proficiency. The drowning risk matrix can be an important tool in drowning prevention through a simple, accessible and visual scale.

6. REFERENCES

1. Brenner RA, Taneja GS, Haynie DL, Trumble AC, Qian C, Klinger RM, et al. Association between swimming lessons and drowning in childhood: a case-control study. Archives of Pediatrics & Adolescent Medicine 2009;163(3):203-10. https://doi.org/10.1001/archpediatrics.2008.563
2. Pharr J, Irwin C, Layne T, Irwin R. Predictors of Swimming Ability among Children and Adolescents in the United States. Sports 2018;6(1). https://doi.org/10.3390/sports6010017
3. Sotés I, Basterretxea-Iribar I, Maruri MLM. Are the Biscayne Universitary students ready to go to the beach safely? Ocean & Coastal Management 2018;151:134-49. https://doi.org/10.1016/j.ocecoaman.2017.10.012
4. Talab A, Rahman A, Rahman F, Hossain J, Scarr J, Linnan M. 270 Survival swimming – effectiveness of swimsafe in preventing drowning in mid and late childhood. Injury Prevention 2016;22(Suppl 2):A99–A99. https://doi.org/10.1136/injuryprev-2016-042156.270
5. Brenner RA, Saluja G, Smith GS. Swimming lessons, swimming ability, and the risk of drowning. Injury Control and Safety Promotion 2003;10(4):211-6. https://doi.org/10.1076/icsp.10.4.211.16775
6. van Beeck EF, Branche CM, Szpilman D, Modell JH, Bierens JJLM. A new definition of drowning: towards documentation and prevention of a global public health problem. Bull World Health Organ 2005;83(11):853-6.
7. World Health Organization. Global report on drowning: preventing a leading killer. World Health Organization 2014. https://apps.who.int/iris/handle/10665/143893
8. Schuman SH, Rowe JR, Glazer HM, Redding JS. Risk of drowning: An iceberg phenomenon. Journal of the American College of Emergency Physicians 1997;6(4):139-143. https://doi.org/10.1016/S0361-1124(77)80201-3
9. Wu Y, Huang Y, Schwebel DC, Hu G. Unintentional Child and Adolescent Drowning Mortality from 2000 to 2013 in 21 Countries: Analysis of the WHO Mortality Database. International Journal of Environmental Research and Public Health 2017;14(8). https://doi.org/10.3390/ijerph14080875
10. Quan L, Bierens JJLM, Lis R, Rowhani-Rahbar A, Morley P, Perkins GD. Predicting outcome of drowning at the scene: A systematic review and meta-analyses. Resuscitation 2016;104:63-75. https://doi.org/10.1016/j.resuscitation.2016.04.006
11. Peden AE, Franklin RC, Queiroga AC. Epidemiology, risk factors and strategies for the prevention of global unintentional fatal drowning in people aged 50 years and older: a systematic review. Injury Prevention: Journal of the International Society for Child and Adolescent Injury Prevention 2018;24(3):240-7. https://doi.org/10.1136/injuryprev-2017-042351

12. Szpilman D, de Barros Oliveira R, Mocellin O, Webber J. Is drowning a mere matter of resuscitation? Resuscitation 2018;129:103-6. https://doi.org/10.1016/j.resuscitation.2018.06.018
13. Moran K, Webber J. Leisure-related injuries at the beach: An analysis of lifeguard incident report forms in New Zealand, 2007-12. International Journal of Injury Control and Safety Promotion 2014;21(1):68-74. https://doi.org/10.1080/17457300.2012.760611
14. Abelairas-Gómez C, Tipton MJ, González-Salvado V, Bierens JJ. El ahogamiento: Epidemiología, prevención, fisiopatología, resucitación de la víctima ahogada y tratamiento hospitalario. Una revisión de la literatura. Emergencias. 2019;31:270-80.
15. Szpilman D, Tipton M, Sempsrott J, Webber J, Bierens J, Dawes P, et al. Drowning timeline: a new systematic model of the drowning process. The American Journal of Emergency Medicine 2016;34(11):2224-6. https://doi.org/10.1016/j.ajem.2016.07.063
16. McCool J, Ameratunga S, Moran K, Robinson E. Taking a risk perception approach to improving beach swimming safety. International Journal of Behavioral Medicine 2009;16(4):360-6. https://doi.org/10.1007/s12529-009-9042-8
17. Messner S, Moran L, Reub G, Campbell J. Climate change and sea level rise impacts at ports and a consistent methodology to evaluate vulnerability and risk (pp. 141-153). Presentado en COASTAL PROCESSES 2013, Gran Canaria, Spain. https://doi.org/10.2495/CP130131
18. Cramer H. Mathematical methods of statistics. Campaign: Princeton University Press. 1999.
19. Cohen J. CHAPTER 1 - The Concepts of Power Analysis. En Statistical Power Analysis for the Behavioral Sciences (Revised Edition) (pp. 1-17). Academic Press. 1977 http://www.sciencedirect.com/science/article/pii/B9780121790608500062
20. Stallman RK, Dahl D, Moran K, Kjendlie PL. Swimming ability, perceived competence and perceived risk among young adults. En Proceedings of the XIth International Symposium for Biomechanics and Medicine in Swimming, Oslo, 16th -19th June 2010 (pp. 377-378). Oslo: Norwegian School of Sport Science.
21. Petrass LA, Blitvich JD. Preventing adolescent drowning: understanding water safety knowledge, attitudes and swimming ability. The effect of a short water safety intervention. Accident; Analysis and Prevention 2014;70:188-94. https://doi.org/10.1016/j.aap.2014.04.006
22. Moran K, Stallman R, Kjendlie P, Dahl D, Blitvich JD, Petrass LA, et al. Can you swim? An exploration of measuring real and perceived water competency. International Journal of Aquatic Research and Education 2012;6(2):122–35. https://doi.org/10.25035/ijare.06.02.04
23. Baker SP, O'Neil B, Ginsburg MJ, Li G. The injury fact book. New York: Oxford University Press. 1992
24. Koon W, Rowhani-Rahbar A, Quan L. The ocean lifeguard drowning prevention paradigm: how and where do lifeguards intervene in the drowning process? Injury Prevention: Journal of the International Society for Child and Adolescent Injury Prevention. 2017 https://doi.org/10.1136/injuryprev2017-042468

25. MacMahan JH, Thornton EB, Reniers AJHM. Rip current review. Coastal Engineering 2006;53(2):191-208. https://doi.org/10.1016/j.coastaleng.2005.10.009
26. Howland J, Hingson R, Mangione TW, Bell N, Bak S. Why are most drowning victims men? Sex differences in aquatic skills and behaviors. American Journal of Public Health 1996;86(1):93-6. https://doi.org/10.2105/AJPH.86.1.93
27. Olaisen RH, Flocke S, Love T. Learning to swim: role of gender, age and practice in Latino children, ages 3-14. Injury Prevention: Journal of the International Society for Child and Adolescent Injury Prevention 2018;24(2): 129-34. https://doi.org/10.1136/injuryprev-2016-042171
28. Barcala-Furelos R, Carbia-Rodríguez P, Peixoto-Pino L, Abelairas-Gómez C, & Rodríguez-Núñez A. Implementation of educational programs to prevent drowning. What can be done in nursery school? Medicina Intensiva 2017 https://doi.org/10.1016/j.medin.2017.08.005
29. Turgut T, Yaman M, Turgut A. Educating Children on Water Safety for Drowning Prevention. Social Indicators Research 2016;129(2):787-801. https://doi.org/10.1007/s11205-015-1109-0
30. Sanz-Arribas I, Calle-Molina MT, Martínez-de-Haro V. Efectos de una formación inclusiva para la prevención del ahogamiento en personas con discapacidad intelectual. Retos 2019;35(1):289-293. https://doi.org/10.47197/retos.v0i35.68653
31. López-García S, Díez Fernández P, Amatria Jiménez M, Maneiro Dios R, Abelairas Gómez C, Moral García JE. El ahogamiento como principal causa de muerte en las primeras etapas de la vida, el docente como interviniente para la educación y su prevención. Retos 2020;38(2):811-817. https://doi.org/10.47197/retos.v38i38.72134
32. López-García S, Abelairas-Gómez C, Moral García JE, Barcala-Furelos R, Palacios-Aguilar J. La coordinación de socorristas acuáticos profesionales en espacios acuáticos naturales (playas) [The Management of Lifeguards in Natural Acuatic Spaces (Beaches)]. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte 2016;16(62):403-422. http://dx.doi.org/10.15366/rimcafd2016.63.001

Número de citas totales / Total references: 32 (100%)
Número de citas propias de la revista / Journal's own references: 1 (3.1%)

.