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# LONGITUDINAL MONITORING IN THE 2022-25 QUADRENNIUM OF THE DROWNING PREVENTION KNOWLEDGE LEVEL (DPKL) OF SCHOOLCHILDREN IN RIO DE JANEIRO, BRAZIL

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## ABSTRACT

Drowning is a silent, rapid, serious global public health problem that is neglected. Additionally, young people receive insufficient education about drowning prevention. The objective was to monitor changes in the Drowning Prevention Knowledge Level (DPKL) in school children and adolescents in Rio de Janeiro, Brazil. The methodology was a longitudinal study carried out from 2022 to 2025 with students from Elementary School (5th, 6th, 7th, 8th and 9th years) and High School (1st year) from CAp-UERJ. 12 classes were monitored, totaling 334 students in the sample, throughout the study, evaluated four times (2022, 2023, 2024 and 2025). Namely, four classes, with a total of 116 students in the 8th year, four classes with a total of 112 students in the 9th year and four classes with a total of 106 students in the 1st year. The structured DPKL questionnaire, divided into three parts and containing 20 items, was answered at school by the students. In the 1st part, they correlated the universal figures used on signs to prevent drowning with the texts that mean those images (7 questions); in the 2nd part, they had to relate the colors of the green, yellow and red flags and their meaning in relation to swimming conditions in the sea (3 questions); and in the last part, the student marked yes or no on statements related to the correct behavior to be adopted in the aquatic environment (10 questions). Each class received 4 interventions based on the individual DPKL result. The results showed, when analyzing all the series together, the excellent performance (100% of correct answers) in the four-year period 2022-25 in correctly recognizing what the plates represent. There was a tendency to improve knowledge of the meaning of 2022-25 in all the green, yellow and red flags, with emphasis on the prevalence of 100% correct answers in the three flags of students who are in the 9th year in 2025. It is noteworthy that when analyzed all together, in relation to the correct attitude towards entering rough seas, in 2022, the prevalence of correct answers was (99.1%), in 2023 (98.2%), in 2024 (99.6%) and in 2025 (98.7%). This fluctuation in the prevalence of correct answers reinforces the idea of maintaining care for this population. In addition to being in cahoots with the perception that teenagers overestimate their swimming skills and need constant attention. When all students were analyzed in comparison over the four-year period, an improvement in the excellent DPKL

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was noted, going from 86% in 2022 to 99% in 2025. Furthermore, 100% of the 9th year was classified as excellent in the DPKL. It can be concluded that there were improvements, after the interventions, in the DPKL in all years of schooling investigated, with a linear trend of better performance as the student's year of schooling increased. Students at school are receptive to preventive messages about drowning, which makes the school a suitable and effective place for these actions. The diagnostic use of DPKL to monitor school-age students can help identify values and concepts of safety in certain regions of the country or specific groups that are unfamiliar with aquatic environments and thus help to formulate preventive interventions if necessary.

**Keywords:** Drowning. Water safety. Prevention. Schoolchildren.

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## INTRODUCTION

Drowning is neglected (LI et al., 2023), silent, rapid (WILLIAMS et al., 2023) and emerging as a critical concern (DIMMER et al., 2025), as it is a serious global public health problem (ISIN & PEDEN, 2024) with more than 370 thousand deaths per year worldwide (WHO, 2022).

Using drowning prevention prevents premature mortality (PEDEN et al., 2022) and has the potential to save many more lives than rescuing or treating drowning people (DAVIS et al., 2024). Child drownings can and should be reduced with a view to their eventual elimination (VINCENTEN et al., 2023). Firstly, it is necessary to anticipate their triggers using a proactive and mainly educational approach (PINO et al., 2023a). Education on aquatic prevention should begin in the prenatal period and continue throughout childhood and adulthood (WILLIAMS et al., 2023) with the approach of many actors (PINO et al., 2023b), such as educators and parents. (HAMILTON et al., 2024).

In fact, educational activities involving children have a positive impact on drowning prevention (XIE et al., 2022). Education campaigns on aquatic prevention in the school environment can help prevent future drowning incidents (ISIN & PEDEN, 2024). The challenge, however, is to provide cost-effective interventions (for greater accessibility) that are pedagogically efficient and replicable (PINO et al., 2023b).

Children receive insufficient education about drowning prevention in swimming lessons and are not achieving essential skills that help prevent drowning (PIDGEON et al., 2020). In fact, swimming is not universal for “everyone” and also fails to cover all aspects that can protect against drowning. Schools globally cover “all” children and, in this environment, drowning prevention can be introduced to try to spread attitudes and values that save lives.

An American report recommends finding ways to incorporate aquatic prevention into the school curriculum (WILLIAMS et al., 2023). At school, it is possible to access students, who will probably be very receptive to preventive messages (PINO et al., 2023). Thus, the school is possibly the most appropriate place to use competence-based teaching, giving the educational process a capacity for practical use of what is taught in theory (KOON et al., 2023), requiring that this content acquire functionality for the student (ZABALA, 2010).

Chinese researchers mention that schools could organize more educational activities and water safety courses, thus improving students' knowledge of drowning prevention, awareness and safety skills (LI et al., 2023).

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A competency brings together knowledge, skills and attitudes for its perfect execution (ZABALA, 2010). In motor tasks in water, it is understood that it is not enough to perform motor skills, but that this performance occurs based on defined concepts and with appropriate attitudes for their implementation (VASCONCELLOS & MACEDO, 2021).

Therefore, there may be a significant need for increased water safety education for children (DAVEY et al., 2019). This education can come after a diagnostic assessment of the Drowning Prevention Knowledge Level (DPKL) (VASCONCELLOS et al., 2019) so that it is possible to understand the limitations of students that can cause childhood injuries due to drowning, followed by education of students and their friends (AL-QURASHI et al., 2019).

Awareness actions in water safety classes at school are based on skill development. The concepts, skills and attitudes necessary for aquatic skills are aligned with conceptual, procedural and attitudinal pedagogical content in drowning prevention (VASCONCELLOS et al., 2023).

In this context, it is up to the teacher to select educational content and define the concepts, based on the results of the DPKL, that need to be taught so that students do not put themselves in risky situations, drown and have preventive awareness (VASCONCELLOS et al., 2023). Then, after defining these concepts, objectives can be determined, content and methodologies can be chosen to consolidate it as a skill to be learned by the student by experiencing them concretely in classes (VASCONCELLOS et al., 2022).

The objective of this study was to carry out longitudinal monitoring of changes in the Level of Drowning Prevention Knowledge in elementary school children and adolescents at CAp-UERJ, Rio de Janeiro, Brazil.

## MATERIALS AND METHODS

This is a longitudinal study carried out in the four-year period from 2022 to 2025 with children and adolescents studying Elementary School (5th, 6th, 7th, 8th and 9th year) and High School (1st year) at the Instituto de Aplicação Fernando Rodrigues da Silveira (CAp-UERJ), belonging to the State University of Rio de Janeiro. The institution is a component of the public network in the State of Rio de Janeiro, Brazil. In the first semester of 2022, the period in which the study began, 1,140 students participated in CAp-UERJ classes,

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distributed between the 1st year of Elementary School and the 3rd of High School, totaling 48 classes.

After surveying the number of students per class in each grade, contact was made with the Physical Education teachers at CAp-UERJ who teach classes for the classes to be researched, who, once informed about the importance, objectives and methodology of the study, authorized it to be carried out.

In 2022, 12 classes were selected to monitor the study, distributed among four 5th year classes, four 6th year classes and four 7th year classes. The classes were selected because they contain, according to Xie et al. (2022), the target audience at highest risk of drowning due to lower awareness of this risk. Furthermore, in this age group, students are able to read, interpret figures, symbols and can be followed longitudinally for enough time to collect data and identify variations in relation to the theme researched during their school career.

The 12 classes were monitored until 2025, totaling 334 students in the sample, throughout the study, evaluated four times (2022, 2023, 2024 and 2025). Namely, in 2025 the study included four classes with a total of 116 students who were in the 8th year, four classes with a total of 112 students who were in the 9th year and four classes with a total of 106 students who were in the 1st year of high school. All children and adolescents aged 9 to 17 who were studying the 5th, 6th and 7th years in 2022, respective 6th, 7th and 8th years in 2023, 7th, 8th and 9th years in 2024 and finally 8th, 9th years and 1st year in 2025 were considered eligible.

As an exclusion criterion, having a mental disability to the point of preventing completion of the questionnaire was used. Namely, the same students who began the study in 2022 were reassessed in 2023, 2024 and 2025, with only 2 losses from the research sample due to students changing schools.

The research instrument answered by the students was significantly integrated with other Physical Education school content (PINO et al., 2023) through the structured questionnaire developed by Vasconcellos et al. (2022), divided into three parts containing 20 items on Drowning Prevention Knowledge Level (DPKL). In the first part, students correlated the universal figures used on signs to prevent drowning with the texts that mean those images (7 questions), as shown in figure 1. In the second part, they had to relate the colors of the green, yellow and red flags used on beaches and their meaning in relation to bathing conditions (3 questions). In the last part, the student marked yes or no on

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statements related to the correct behavior/attitude to be adopted in the aquatic environment, in order to avoid injuries and prevent drowning (10 questions).

Figure 1: sequence of plates adapted from the Brazilian Aquatic Rescue Society (SOBRASA): plate 1 lifeguard absent; board 2 emergency telephone; plate 3 prohibited pushing; sign 4 prohibited diving; sign 5 no swimming; plate 6 background location and plate 7 lifeguard present.


Upon receipt of the completed questionnaire, researchers reviewed it for completeness. Data analysis included calculating means for continuous variables and percentages for categorical variables. The DPKL was stratified into five bands, namely, those who scored 0-2 points as very weak DPKL holders; 3-4 points as weak; 5-6 points as regular; 7-8 points as good and 9-10 points as excellent DPKL. The DPKL verification result was the sum of each correct answer, which was worth 0.5 points each, obtained from the 20 items surveyed in the three parts of the questionnaire.

The more correct answers the student had, the better their DPKL (VASCONCELLOS et al., 2022). In addition to completing the questionnaire, each class received an annual intervention on drowning prevention.

## INTERVENTION

As a form of school intervention, in 2022, 2023, 2024 and 2025, up to two weeks after the diagnostic assessment on the Drowning Prevention Knowledge Level, the researchers returned to the school with the individual results of the questionnaire. The students were seated on the court and received their corrected questionnaire with a score from 0 to 10. The researchers read the questionnaire, item by item, to provide the correct answer to the 20 items and also explain the importance of knowing the meaning of each part of the test in relation to prevention, in addition to allowing students to ask about preventing injuries in the aquatic environment.

The interventions lasted an average of 30 minutes, on water safety, where the research professor worked on conceptual pedagogical content, showing the meaning of the word linked to prevention and its antagonism, such as: prohibited versus released; safe

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versus dangerous; present versus absent; shallow versus deep; clean versus dirty (VASCONCELLOS et al., 2023). Preventive information was taught at school with very basic concepts in a progressive manner and adapted to the age of children and adolescents (PINO et al., 2023a).

Other examples were discussed, such as the meaning of the colors shown on the flags that are posted on the beaches to indicate the current degree of danger at sea and the student learning to discern the risk of drowning. Since a lack of understanding about the dangers of water contributes to incidents in swimming pools or natural bodies of water (DIMMER et al., 2025). Certainly, the green flag means low risk, an appropriate place for bathing; yellow, medium risk of drowning; red, high risk of drowning; and the black one, an area unprotected by lifeguards. In fact, teaching signaling is recommended to prevent drowning (WILLIAMS et al., 2023).

For Vasconcellos et al. (2022), there is also a need to teach students the concepts of ditch or rip current, with a simple explanation that is appropriate to the age group, and with illustration, above all, explain that ditch means that in that location there is a movement of water towards the open sea and that this is a place where bathers should not stay, as there is a risk of being dragged to the bottom by the strong rip current formed. In this context, drowning prevention needs to be effective and not with messages of fear regarding death from drowning (HAMILTON et al., 2024).

Then, the teacher worked on attitudinal content, with the aim of the student learning to “know how to respect and live together” with norms, postures, values and attitudes, such as, for example, knowing how to respect the rules for using the aquatic environment and the teacher, adopting habits to prevent drowning and, finally, trying to internalize something that will be carried throughout life. For Stallman et al. (2017), our attitudes affect our behaviors, and it is our actual behaviors around aquatic environments that will keep us safe or not; they further add that it is important to instill respect for water from an early age. Above all, because the risk of drowning is determined by a complex interaction of individual behaviors, safety knowledge and awareness of dangers (PRATT et al., 2025).

Physical education classes are good for working on these behaviors, rules and discipline, as they have already experienced, since childhood, the rules of games in sport, respect for the opponent and, above all, for the referee in terms of accepting their decisions (VASCONCELLOS et al., 2024). This mediation is important, as among the factors

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associated with drowning are: problems arising from a lack of awareness, understanding of the dangers of water and an increase in aquatic risk behaviors (EKANAYAKA et al., 2021).

In the pedagogical intervention, when addressing the conceptual content in relation to what one must know to perform a procedural action, the student learned about how to "know how to do it, execute it", such as, for example, the appropriate procedures for entering the water in a shallow and/or deep place, how to swim in a situation of "falling into the rip current", the differences between swimming in the pool and the sea, how to help someone by providing a floating object instead of diving to try to save and become a victim. For Moreland et al. (2022), these interventions could also address the consistent use of life jackets on boats and among swimmers who are not very aquatic in natural waters, as this has the potential to reduce drowning deaths.

## RESULTS AND DISCUSSION

### KNOWLEDGE ABOUT THE 7 PLATES - 1ST PART OF THE DPKL TEST

**Table 1:** prevalence of correct answers to the meanings of the seven drowning prevention signs of students who were in the 5th year in 2022 followed until the 8th year in 2025.

| Seven plates | 5ºyear/2022 | 6ºyear/2023 | 7ºyear/2024 | 8ºyear/2025 |
|---|---|---|---|---|
| 1 lifeguard missing | 84,2% | 93,0% | 100% | 99,1% |
| 2 emergency phone | 98,2% | 100% | 100% | 100% |
| 3 prohibited pushing | 100% | 98,2% | 100% | 100% |
| 4 diving prohibited | 96,5% | 96,5% | 98,2% | 100% |
| 5 No Swimming | 96,5% | 96,5% | 98,2% | 100% |
| 6 deep spot | 96,5% | 98,2% | 99,1% | 100% |
| 7 lifeguards present | 87,7% | 93,0% | 100% | 99,1% |

The result of this study showed that students tended to improve, in the four-year period 2022-25, in their knowledge of the meaning of all the illustrations on the seven drowning prevention signs. When analyzing only the transition from the last year 2024-25, it was noted that in two plates, 1 and 7, respectively of lifeguards absent and lifeguards present, despite the high prevalence of correct answers, there was a slight reduction (0.9%) in the prevalence of correct answers (table 1).

This drop may be due to the fact that a small group (less than 1%) still confuses the illustrations on the lifeguard present and absent signs. Despite being a small group, lack of knowledge about the location being monitored by a professional can make a difference in preserving life. Beaches that are supervised by lifeguards are active in prevention and can also help in a rescue situation, thus avoiding the feared death from drowning (MORELAND et al., 2022). As a result, people tend to choose a place to stay that has lifeguards or

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rescue services (PRATT et al., 2025). In fact, the “lifeguard” is the professional who is responsible for guarding, protecting, caring for and anticipating risk situations (VASCONCELLOS et al., 2022).

**Table 2:** prevalence of correct answers to the meanings of the seven drowning prevention signs of students who were in the 6th year in 2022 followed until the 9th year in 2025.

| Seven plates | 6ºyear/2022 | 7ºyear/2023 | 8ºyear/2024 | 9ºyear/2025 |
|---|---|---|---|---|
| 1 lifeguard missing | 92,0% | 98,2% | 99,1% | 100% |
| 2 emergency phone | 99,1% | 100% | 100% | 100% |
| 3 prohibited pushing | 99,1% | 100% | 100% | 100% |
| 4 diving prohibited | 98,2% | 99,1% | 100% | 100% |
| 5 No Swimming | 99,1% | 99,1% | 100% | 100% |
| 6 deep spot | 98,2% | 100% | 100% | 100% |
| 7 lifeguards present | 92,9% | 97,3% | 99,1% | 100% |

When analyzing the results presented in tables 2, 3 and 4 of the students, it was noted that there was a tendency for improvement in the four-year period 2022-25 in the knowledge of all seven signs, to the point where 100% of the students got the meanings of all the illustrations on the drowning prevention signs right.

When investigating the plates separately, it was noted, for example, that there were improvements in all years in the recognition of plate number 2. Knowing where there is an emergency telephone (plate 2) and how to use it properly can speed up contact with a rescue team and can save a life (VASCONCELLOS et al., 2024). When drowning, every minute of waiting for help makes a huge difference to the degree of drowning a person may end up with and consequently increases the risk of death.

In relation to the regulatory signs, with a diagonal line inside the circle ( ), the improvement in the four-year period 2022-25 stands out, where all students began to have greater assertiveness on the signs that refer to rules, of what they can or cannot do, as in signs 3, 4 and 5 that respectively mention “no pushing”, “no diving”, “no swimming” which are conceptual questions in relation to what one must know to carry out an attitudinal action. This improvement in 2025 starts to identify signs of risky, wrong or dangerous activities, perhaps due to the increase in maturity linked to older age compared to when they were younger in 2022, 2023 or 2024.

This finding reinforces the importance of mediation to help teach prevention symbols to students. The symbol chosen to represent the prohibited sign seems to have been well disseminated among schoolchildren in previous interventions (VASCONCELLOS, et al.; 2024).

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**Table 3:** prevalence of correct answers to the meanings of the seven drowning prevention signs of students who were in the 7th year in 2022 followed until the 1st year in 2025.

| Seven plates | 7ºyear/2022 | 8ºyear/2023 | 9ºyear/2024 | 1ºyear/2025 |
|---|---|---|---|---|
| 1 lifeguard missing | 99,1% | 100% | 98,2% | 100% |
| 2 emergency phone | 100% | 100% | 100% | 100% |
| 3 prohibited pushing | 98,2% | 100% | 100% | 100% |
| 4 diving prohibited | 97,3% | 100% | 96,4% | 100% |
| 5 No Swimming | 97,3% | 100% | 96,4% | 100% |
| 6 deep spot | 98,2% | 100% | 100% | 100% |
| 7 lifeguards present | 97,3% | 100% | 98,2% | 100% |

**Table 4:** prevalence of correct answers to the meanings of the seven drowning prevention signs for students from all years together in 2022 followed until 2025.

| Seven plates | 2022/All | 2023/All | 2024/All | 2025/All |
|---|---|---|---|---|
| 1 lifeguard missing | 91,7% | 97,0% | 99,1% | 100% |
| 2 emergency phone | 99,1% | 100% | 100% | 100% |
| 3 prohibited pushing | 99,1% | 99,4% | 100% | 100% |
| 4 diving prohibited | 97,3% | 98,5% | 98,2% | 100% |
| 5 No Swimming | 97,6% | 98,5% | 98,2% | 100% |
| 6 deep spot | 97,6% | 99,4% | 99,7% | 100% |
| 7 lifeguards present | 92,6% | 96,7% | 99,1% | 100% |

In plate 6 (deep location), there was a tendency for improvement in all series. The great improvement is noteworthy, to the point that 100% of these students now correctly understand the meaning of this sign 6. Knowing how to identify whether the place is deep reduces the risk of drowning.

Furthermore, in plate 7 (lifeguards present) there was a trend of improvement in the four-year period 2022-25, except in the 8th year. A possible explanation for the drop in prevalence in eighth grade in 2025 could be inattention when taking the test. However, this group's lack of attention may indicate dangerous behavior in situations of lack of safety and possible drowning.

Without a doubt, the presence of a lifeguard is a protective factor in drowning events (BRAYNE et al., 2022), and in identifying the best place to swim (JOHNSON & LAWON, 2022).

Children who are not familiar with the environment are unaware of the signs, warnings of possible danger and are afraid to ask about the rules for using the place (VASCONCELLOS et al., 2022); Therefore, it is necessary to educate children to ask the lifeguard about the best place to safely enjoy the beach, river, lake, waterfall, pool, as well as to call the lifeguard when they see a drowning situation (PINO et al., 2023a).

In all seven boards, the results showed that there was a tendency for a linear increase in the prevalence of correct answers as the year of schooling increased in the 2022-23 biennium, however, this did not occur in 2023-24, but improved again in 2024-25.

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When analyzing all years of schooling together, there was a downward trend in four areas when analyzing the year 2023-24 and the improvement resumed in the biennium 2024-25 (table 4). This corroborates the idea that actions in the investigated group must be constant to reinforce, especially in older adolescents, preventive behavior and focused attention to understand the real meaning of what they see.

In fact, the probability of death from drowning persists into adolescence and is often attributed to a series of risk behaviors that increase at this stage of life (DIMMER et al., 2025). Behaviors observed, for example, on social media, can encourage unsafe activities near water, such as YouTube videos that show jumping from great heights into water (PEDEN et al., 2024). However, when used well, educational videos can help raise awareness to reduce hospital admissions related to drowning (PEDEN et al., 2024).

KNOWLEDGE OF THE 7 FLAGS - 2ND PART OF THE DPKL.

When analyzing the results, there was a tendency for improvement in knowledge of the meaning of 2022-25 in all flags: green, yellow and red (graph 1). It was also noted that, as age/education increased, preventive knowledge also increased in relation to the meaning of the flags. This was demonstrated in the linear growth trend according to the series (graph 1). Therefore, it is important to invest in preventive information for younger people (VASCONCELLOS et al., 2022).

Just as traffic signs are a universal language that communicates with everyone, playing a fundamental role in traffic safety on public roads. It is hoped that drowning prevention signs will one day be universal in the safety of any aquatic environment.

For Peden et al. (2022), there must be standardization in communication so that messages can portray safe behaviors. Failure to correctly identify a sign makes the environment less hostile and dangerous at first glance, causing people to ignore danger signs, potentially causing harm to the individual.

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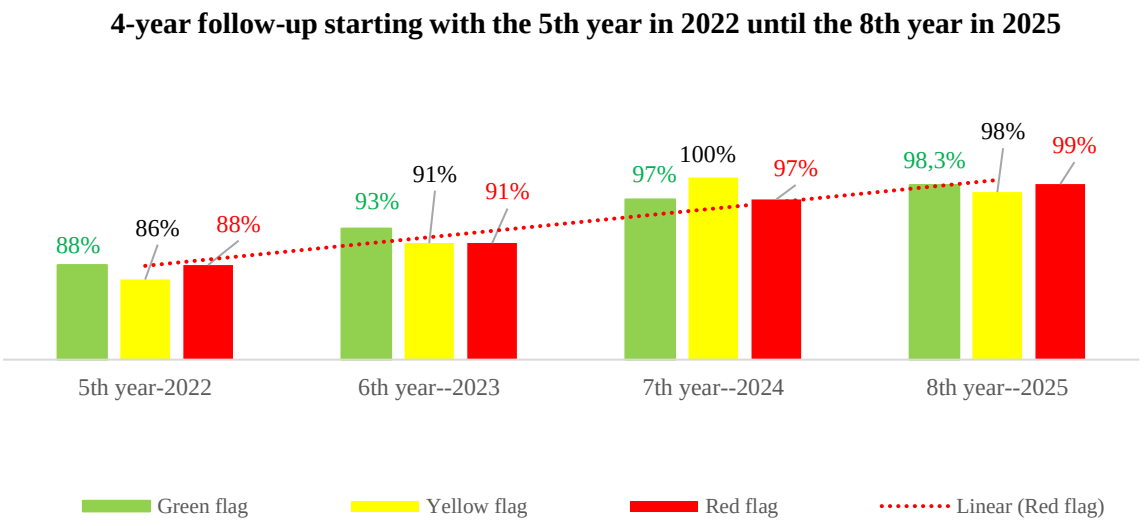
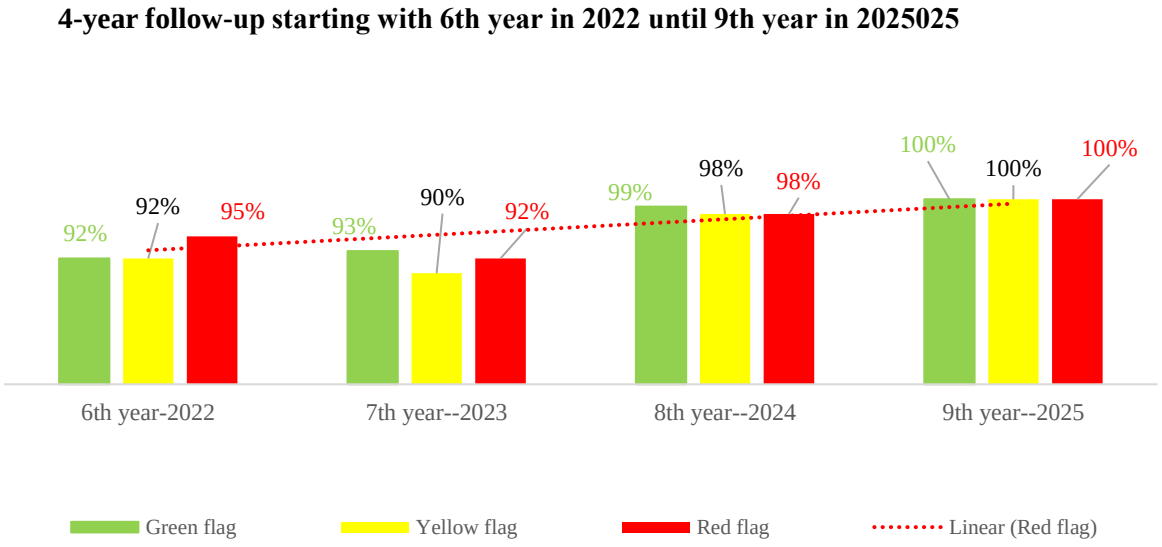
**Graph 1:** student monitoring, for four years, of the prevalence of correct answers regarding the meaning of the colors of the green, yellow and red flags, starting from 2022 until 2025.




**Graph 2:** student monitoring, for four years, of the prevalence of correct answers regarding the meaning of the colors of the green, yellow and red flags, starting from 2022 until 2025.



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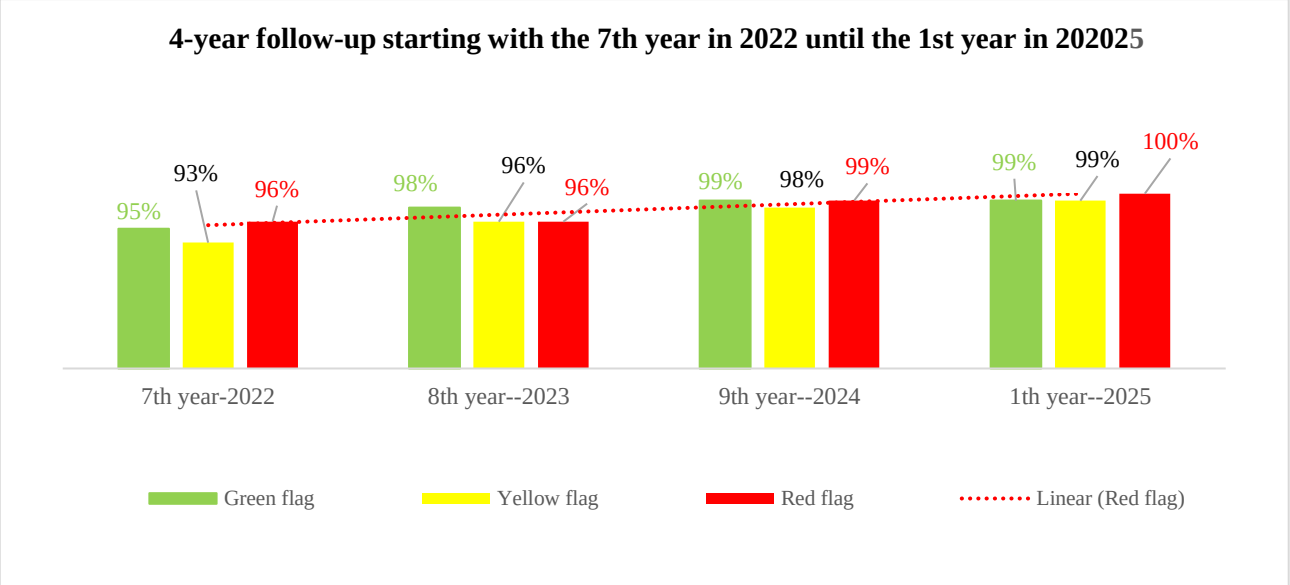
**Graph 3:** student monitoring, for four years, of the prevalence of correct answers regarding the meaning of the colors of the green, yellow and red flags, starting from 2022 until 2025.




The yellow flag, analogous to a traffic sign, indicates “caution” but some people misinterpret the yellow flag to mean private swimming areas (Woods et al., 2022). Red indicates “stop immediately” and, in this context, can be used to prevent the movement/use of an aquatic environment (VASCONCELLOS et al., 2022). The green flag means a “cleared” place for swimming, however, no place is completely safe and, therefore, attention to children in the water is very important.

Young children represent a particularly vulnerable group due to their limited ability to effectively assess risks and insufficiently developed swimming skills, which impede their autonomy in aquatic environments (PINO et al., 2023b).

In relation to what is shown in graph 2, it is noteworthy to have reached a prevalence of 100% of correct answers in the three flags in the four-year period 2022-25. Knowing the meaning of the flags is important because it prevents a young person from putting themselves at risk when sea conditions are not favorable for swimming.

When analyzing the results presented in graphs 3 and 4, an improvement trend was noted in all flags and the students' full knowledge of the meaning of the red flag (100% correct answers) stands out. Knowing the red flag is important because, on the beach, it indicates a high risk of drownings and incidents. It means that the place has waves, currents and other dangerous factors, making it contraindicated for all swimmers.

When comparing all students together in the four cross-sectional analyzes (2022, 2023, 2024 and 2025), the results showed a tendency to improve the correct correlation

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regarding the yellow flag, increasing the prevalence from 92%, 93%, 98% and reaching 99%, in relation to the green flag of 91%, 95%, 98% and then 99% and also in relation to the red flag, where the prevalence of success rate was at 93% on two occasions, and increased to 98% and finally reached 100%, as shown in graph 4.

In a general analysis, in 2024, although the accuracy rate of the meanings of the flags with their color indication was high (98%), the red flag, which indicates a high degree of risk of death, did not present, in any of the years, 100% accuracy (graph 4). This indicated the need to continue the intervention to spread knowledge about its meaning. For KOON et al., 2023, there must be education efforts so that young people behave safely and avoid dangers and risks. It is possible that the mediations combined with increased maturity have had positive effects, as in 2025 everyone got the meaning of the red flag right.

When analyzed all the years together, it is possible to verify that almost all students got the meaning of the colors of the flags right (graph 4). In fact, interventions in this study that teach the real meaning of flags produce greater improvements in knowledge than what was found in the study by Pino et al., (2023a), where approximately half of the children were unaware of the meaning of flags before the intervention, especially the yellow flag. After the intervention, knowledge improved, as all students identified the meaning of the red flag and more than 90% recognized the green and yellow flag (PINO et al., 2023a).

Continuing to teach about the meaning of the red flag is important, as studies have shown that people avoid some places to swim or dive because they associate the red flag with the meaning of dangerous (WOODS et al., 2022).

Although the causes of drowning are numerous and complex, prevention can be achieved through a combination of simple (PEDEN et al., 2022) and viable actions that teach the real meaning of flags and signs (VASCONCELLOS & BLANT, 2024). These intervention actions need to be well targeted to be able to guarantee learning and retention of what has been learned in the medium term in children.

Teaching symbols that can help with prevention is important in younger schooling, as children learn to interpret symbols before they even learn to read (VASCONCELLOS et al., 2022). According to the World Health Organization, in addition to teaching children basic water safety skills, the teacher also needs to teach about the inherent risks, such as water depth, visibility, current, presence of sharp objects, water temperature, dangerous animals and/or microbes (WHO, 2022), as there is a lack of knowledge about how to avoid

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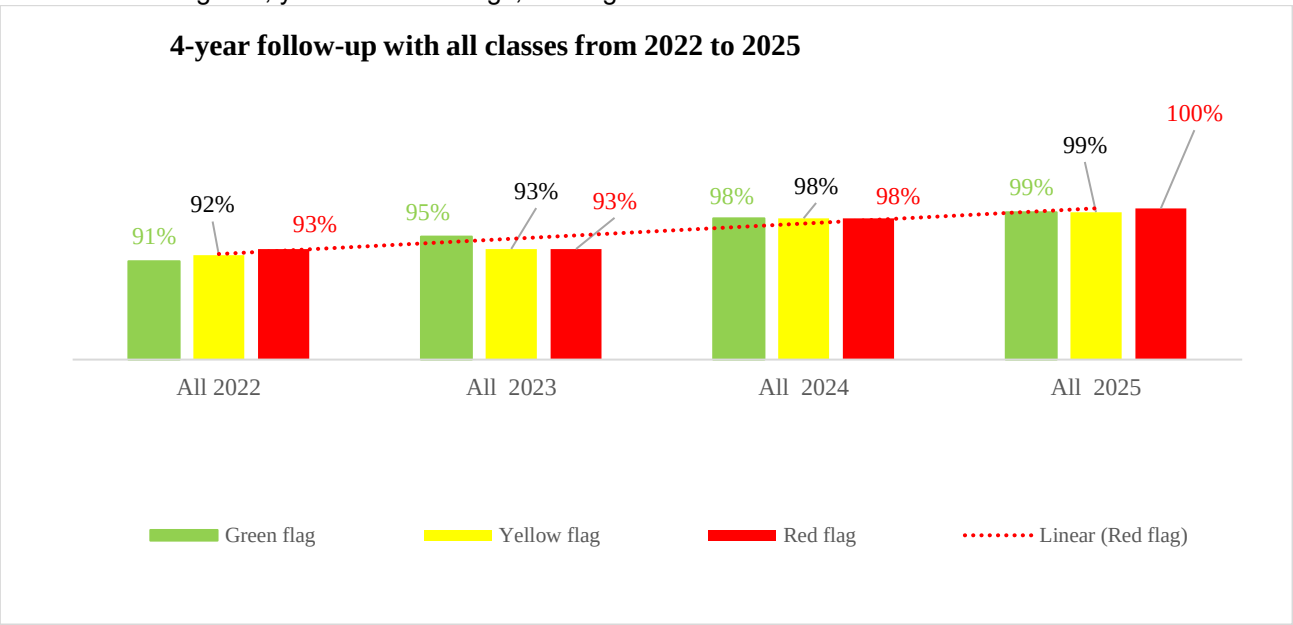
water incidents (OLIVEIRA et al., 2021), as even the toilet or a bucket of water can cause drowning or death of a child. babies and therefore must always be covered and empty, respectively, when there are children around (SIDDIQUI & SINGH, 2022). Furthermore, knowing a risk and not preventing it is not an accident, but negligence (CASTILHO, 2024).

**Graph 4:** student monitoring, for four years, of the prevalence of correct answers regarding the meaning of the colors of the green, yellow and red flags, starting from 2022 until 2025.




This teaching of conceptual content, such as flags, can help prevent drowning by raising student awareness (VASCONCELLOS et al., 2019) and avoiding high-risk behaviors in the aquatic environment (LIN et al., 2019).

## BEHAVIOR IN SWIMMING, POOL OR OTHER AQUATIC ENVIRONMENT - 3RD PART OF THE DPKL

In relation to correct behavior in the pool or swimming class, the results showed that all (100%) of the students began to answer, to question 1, that they should play without pushing other students from the edge of the pool or into the water (table 5).

This improvement in pushing behavior in the 2022-25 four-year period is a behavioral indication of success in interpersonal relationships, as these students are not ignoring the fact that this behavior presents a risk to another person (VASCONCELLOS et al., 2024). On this topic, Koon et al., 2023, mention that, in addition to raising awareness about prevention, there should be more programs to motivate safe interpersonal behavior. O risco de uma criança empurrada na piscina se afogar é motivo para que esse

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comportamento seja visto como inadequado por ser um comportamentos de risco com probabilidade de se afogar (XIE et al., 2022).

Regarding the drain (hole) that sucks water from the pool (question 2), the result showed that the youngest were the ones who improved the most, from 77.2% to 99.1% in the four-year period 2022-25. In fact, the children were unaware of the dangers of putting their hand or any part of the body in the suction drain, some did not even know that there was a drain where the water was sucked into the pool (VASCONCELLOS et al., 2024) which could suck in the part of the body that it touches, which could cause serious injury or drowning (VASCONCELLOS et al., 2022). This reinforces the importance of investing in preventive information for this audience (VASCONCELLOS et al., 2023).

Regarding questions 3 and 4, students seem to feel more autonomous and mention that they do not need to wait for the teacher's authorization to enter the pool or tell them to leave the pool. This attitude seems to be an attempt to exercise their autonomy, ignoring the risks of this behavior. In the 1st year, for example, 4.7% of students mentioned that they did not need to ask permission to get out of the water (table 7).

The swimming pool in swimming class is like a classroom, where the student must not leave without the teacher's consent. Leaving without warning can result in the student falling into a deep part of the pool or even into another pool that is not being used and unattended. Entry can only be done when there is supervision. Even for those who already know how to swim, the ideal is that there is always supervision, because, if the person feels unwell, has cramps or has any difficulty that could cause drowning, they can ask for help.

Perhaps this result is due to the fact that they are teenagers, as in childhood they begin to have more autonomy and many begin to visit aquatic environments unaccompanied, making it necessary to educate young people on how to use these spaces correctly and safely. At this stage of life, identity formation occurs and they absorb many values, habits and ideas from the world around them to shape their personality. For this reason, Koon et al., 2023, highlight the need for carefully designed education programs that consider and address these changes at this stage of life.

In relation to the preventive behavior addressed in question 5, it was noted that everyone improved in their awareness of avoiding accidents. It seems that the concept of prevention is already very clear for this group, as only the 5th year had answered correctly with 100% correct answers in the year 2022 (VASCONCELLOS et al., 2023).

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Prevention is defined as a multidisciplinary approach that reduces the risk of drowning and builds resilience through implementing evidence-based measures that address hazards, exposures and vulnerabilities to protect an individual, community or population against fatal and non-fatal drownings (SCARR & JAGNOOR, 2024).

In relation to entering the pool by diving in a dangerous and inappropriate way (question 6), the study found that they became more aware of the danger, caused by diving head first or diving with a “somersault”. During the mediation, it was explained to the students how this type of diving can cause a cervical injury and, consequently, can lead to severe motor disability, such as quadriplegia, depending on the level of the injury. Diving in shallow waters can cause irreversible consequences. The results of this study warn to be careful with the 1st year of high school, as it was the only year in which there was no improvement in correct answers in the 2024-25 biennium, in relation to diving. Attention with this age group is justified, as in adolescence, one of the main risk factors includes their involvement in diving behaviors (DIMMER et al., 2025).

For Vasconcellos (2022b), it is important not to dive in unknown, shallow, murky waters, places without lighting, not to participate in games when diving and to look for warning signs about the depth of the water before entering. The message to young people needs to be “diving into the pool: think first!”

The small worsening, from 2024-25, of the 8th year in the prevalence of correct answers about not playing near the bottom drain is noteworthy. Namely, the bottom drain (question 7), also called the bottom drain, is one of the devices responsible for suction of the pool water by the pump and, if a person gets close, they can be sucked to the point that their body gets caught in the bottom of the pool and even causes death by drowning (VASCONCELLOS et al., 2022), so it is necessary to be careful with drains (GUPTA et al., 2019).

In swimming pools, malfunctions in the pool's water drainage system can result in serious injuries or even death, and children are mainly affected by these accidents. To prevent such accidents, safety practices related to the water circulation system must be developed in swimming pools and similar areas (ATILGAN et al., 2021).

The results showed that there was an excellent improvement in 2025 in the prevalence of classes, except in the 1st year of schooling, in relation to the correct awareness of students that they should not run around the pool (question 8). This may indicate that mediation helped to enhance prevention measures, thus considering the risks

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of these practices. In fact, there is a risk of falling in the area around the pool due to it being a constantly wet/slippery place and not suitable for running (VASCONCELLOS et al., 2023). Many pools have posted a sign around the pool that says, “Walk, don’t run!” Falls in or around the pool can result in terrible health consequences, such as serious injuries, human disabilities or even deaths (ALQAHTANI et al., 2022). Therefore, children should be discouraged by lifeguards and family members from engaging in risky behavior in swimming pools due to the danger posed to the child (JOHNSON & LAWSON, 2022).

In relation to behaviors linked to safe swimming classes (VASCONCELLOS, 2020), the research results showed that, when analyzing the oldest students as a whole, there was a reduction in the correct answers of students who answered, for example, that one should swim across the river and enter the rough sea just because they take swimming lessons. This demonstrates that the student is unable to discern and have an attitude of humility to recognize that, even though they know how to swim in the pool, they do not have the specific ability to swim across a river or enter rough seas, etc. Adolescents need to have emotional control to reason whether they should enter the sea (GUPTA et al., 2019) and whether they are in good health to swim (ISIN & PEDEN, 2022).

What is noteworthy, when analyzed together (table 8), is the worsening prevalence of the behavior of entering rough seas (question 10). They had decreased from 2022-23 to 98.2% and managed to improve to 99.6% accuracy in relation to the correct attitude towards entering rough seas in 2023-24, however, in 2024-25, they decreased again (98.7%). This fluctuation in the prevalence of correct answers reinforces the idea of maintaining care for this population. In addition to being in collusion with the perception that adolescents overestimate their swimming skills (DIMMER et al., 2025) and require constant attention. It was expected that the older they were, the greater their ability to interpret texts and answer questionnaires, more practical experiences, more teaching and consequently, the more knowledge they would have regarding safe conduct (VASCONCELLOS et al., 2024), however, this did not happen universally at school.

In Sweden, swimming is part of the primary school curriculum, as learning to swim at a young age can reduce the number of children who drown, and therefore swimming is considered a life-saving skill for them (LÕHMUS et al., 2022). However, Pidgeon et al., (2018) reinforce that young people must be taught not to underestimate the risk of drowning and also not to overestimate their ability to swim in order to avoid drowning. The

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costume of taking swimming lessons means they think they already “know how to swim” in any environment and are armored against drowning.

Swimming classes can contribute to improving aquatic prevention attitudes (VASCONCELLOS & BLANT, 2024) when they promote teaching about safe behaviors in different aquatic environments (EKANAYAKA et al., 2021) and when they do not generate a false sense of security, which can put them at risk when they are, for example, swimming in deep places or with currents (WILLIAMS et al., 2023). However, few schools offer swimming lessons during the period the child is studying (HAMILTON et al., 2024). Furthermore, swimming is still underused when the aspect is the prevention of drowning in children (VASCONCELLOS, 2019), where the skills that must be developed are multiple and go beyond the private teaching of individuals in swimming classes (VASCONCELLOS & VIANA, 2024). There are a series of skills and competencies that must be mastered before a child has the full capacity to avoid drowning (PIDGEON et al., 2020). For Vasconcellos & Macedo, (2021), swimming students need to learn beyond the procedural content included in the aquacity test. They need to learn a) attitudinal content, which the actions are focused on teaching the student, so that they can be able to respect and/or know how to live with (rules of use, teacher guidelines, their limits, norms, postures, prevention habits and attitudes); b) conceptual content, which are the actions focused on teaching the student, so that they can be able to interpret and/or know about (signs, symbols, warnings, meanings, risks, danger and concepts).

According to Pinto & Murcia (2023), the concept of aquatic competence encompasses three areas of knowledge (knowing how to do, knowing, knowing how to be), in three dimensions (aquatic literacy, drowning prevention and environmental education), where the personal conduct profile, self-perception of competence and real competence are essential elements for its understanding and development. Therefore, aquatic education must include knowledge, skills and values related to aquatic safety (CASTILHO, 2024).

When analyzing table 5, it was noted that there were improvements in the 10 attitudes that pool-goers and swimming students need to have so that they can enjoy the aquatic environment more safely, be it river, beach and above all swimming pool. Despite the improvement in 2022-25, the slight reduction in 2024-25 in question 7, which refers to playing near the bottom drain in the pool, draws attention.

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When analyzing table 6, it was noted that, despite the improvement in the four-year period 2022-25, when analyzed from 2024-25, two behaviors had a slight reduction in the prevalence of correct answers, despite being less than 1%. It is possible that these older students still practice pushing their classmates in the pool and are more likely to take more risks in the sea.

**Table 5:** 4-year follow-up, prevalence of correct attitudes linked to swimming class students

| Questions<br>I must... | 5º year 2022 | 6º year 2023 | 7º year 2024 | 8ºyear 2025 |
|---|---|---|---|---|
| 1 play by pushing other students into the water? | 94,7% | 91,2% | 99,1% | 100% |
| 2 put your hand in the drain (hole) that sucks water from the pool? | 77,2% | 86,0% | 99,1% | 99,1% |
| 3 wait for the teacher to call you to enter the pool? | 100% | 100% | 99,1% | 100% |
| 4 ask or tell the teacher when you are going to leave the pool? | 91,2% | 78,9% | 95,5% | 98,3% |
| 5 avoid injuries in the pool and value prevention actions? | 100% | 96,5% | 95,5% | 99,1% |
| 6 entering the pool with a somersault “somersault” jump? | 94,7% | 96,5% | 98,2% | 100% |
| 7 play near the bottom drain in the pool? | 98,2% | 96,5% | 100% | 99,1% |
| 8 play races in the wet area around the pool? | 98,2% | 94,7% | 100% | 100% |
| 9 trying to swim across the river why do I take swimming lessons? | 96,5% | 96,5% | 98,2% | 98,3% |
| 10 getting into rough seas because I take swimming lessons? | 100% | 96,5% | 100% | 100% |

**Table 6:** 4-year follow-up, prevalence of correct attitudes linked to swimming class students

| Questions<br>I must... | 6ºyear 2022 | 7º year 2023 | 8ºyear 2024 | 9ºyear 2025 |
|---|---|---|---|---|
| 1 play by pushing other students into the water? | 89,9% | 92,0% | 100% | 99,1% |
| 2 put your hand in the drain (hole) that sucks water from the pool? | 89,3% | 96,4% | 99,1% | 100% |
| 3 wait for the teacher to call you to enter the pool? | 99,1% | 98,2% | 98,2% | 99,1% |
| 4 ask or tell the teacher when you are going to leave the pool? | 95,5% | 94,6% | 93,8% | 95,5% |
| 5 avoid injuries in the pool and value prevention actions? | 97,3% | 98,2% | 100% | 100% |
| 6 entering the pool with a somersault “somersault” jump? | 98,2% | 99,1% | 100% | 100% |
| 7 play near the bottom drain in the pool? | 98,2% | 100% | 99,1% | 100% |
| 8 play races in the wet area around the pool? | 97,3% | 97,3% | 99,1% | 100% |
| 9 trying to swim across the river why do I take swimming lessons? | 100% | 100% | 100% | 100% |
| 10 getting into rough seas because I take swimming lessons? | 99,1% | 98,2% | 100% | 99,1% |

**Table 7:** 4-year follow-up prevalence of correct attitudes linked to swimming class students

| Questions<br>I must... | 7º year 2022 | 8º year 2023 | 9º year 2024 | 1ºyear 2025 |
|---|---|---|---|---|
| 1 play by pushing other students into the water? | 92,9% | 95,5% | 100% | 100% |
| 2 put your hand in the drain (hole) that sucks water from the pool? | 96,4% | 97,3% | 100% | 100% |
| 3 wait for the teacher to call you to enter the pool? | 99,1% | 100% | 100% | 100% |
| 4 ask or tell the teacher when you are going to leave the pool? | 88,4% | 98,2% | 96,4% | 95,3% |
| 5 avoid injuries in the pool and value prevention actions? | 99,1% | 100% | 99,1% | 100% |
| 6 entering the pool with a somersault “somersault” jump? | 99,1% | 100% | 100% | 99,1% |
| 7 play near the bottom drain in the pool? | 97,3% | 100% | 99,1% | 99,1% |
| 8 play races in the wet area around the pool? | 97,3% | 100% | 100% | 99,1% |
| 9 trying to swim across the river why do I take swimming lessons? | 99,1% | 100% | 99,1% | 99,1% |
| 10 getting into rough seas because I take swimming lessons? | 98,2% | 100% | 99,1% | 97,2% |

When analyzing table 7, it was noted that the prevalence of correct attitudes linked to students in swimming classes, despite a tendency for improvements in all 10 questions

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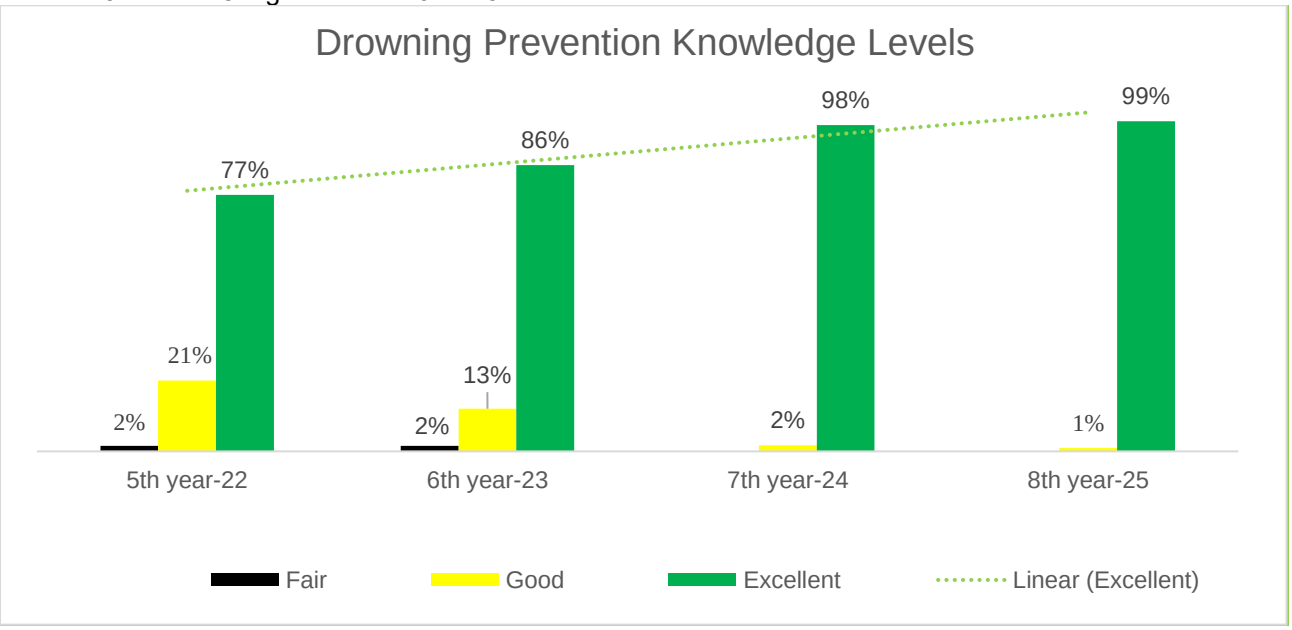
when compared from 2022-25, it was identified that from 2023 to 2025 there was a small drop in the number of correct answers in relation to questions 4 and 10. It is possible that these students do not consider it important to request to leave, and they think they are more independent and do not need to notify the teacher when they are going to leave the water.

In relation to table 8, it was noted that, when analyzed together, all classes of 2022-25, only question 10 there was a slight reduction in the accuracy of meanings. All other questions tended to improve knowledge of the meaning and awareness of appropriate behavior in each aquatic environment.

**Table 8**: 4-year follow-up, prevalence of correct attitudes linked to swimming class students

| **Questions**<br>I must... | **All 2022** | **All 2023** | **All 2024** | **All 2025** |
|---|---|---|---|---|
| 1 play by pushing other students into the water? | 90,5% | 92,9% | 99,7% | 100% |
| 2 put your hand in the drain (hole) that sucks water from the pool? | 87,6% | 93,2% | 99,4% | 100% |
| 3 wait for the teacher to call you to enter the pool? | 99,4% | 99,4% | 99,1% | 100% |
| 4 ask or tell the teacher when you are going to leave the pool? | 91,7% | 90,5% | 95,2% | 96,3% |
| 5 avoid injuries in the pool and value prevention actions? | 98,8% | 98,2% | 98,2% | 100% |
| 6 entering the pool with a somersault “somersault” jump? | 97,3% | 98,2% | 99,4% | 100% |
| 7 play near the bottom drain in the pool? | 97,9% | 98,8% | 99,4% | 99,4% |
| 8 play races in the wet area around the pool? | 97,6% | 97,3% | 99,6% | 100% |
| 9 trying to swim across the river why do I take swimming lessons? | 98,5% | 98,8% | 99,1% | 99,1% |
| 10 getting into rough seas because I take swimming lessons? | 99,1% | 98,2% | 99,6% | 98,7% |

**Graphs 5:** Prevalence of Drowning Prevention Knowledge Levels (DPKL) of schoolchildren after monitoring from the 5th to the 8th grade from 2022-25.



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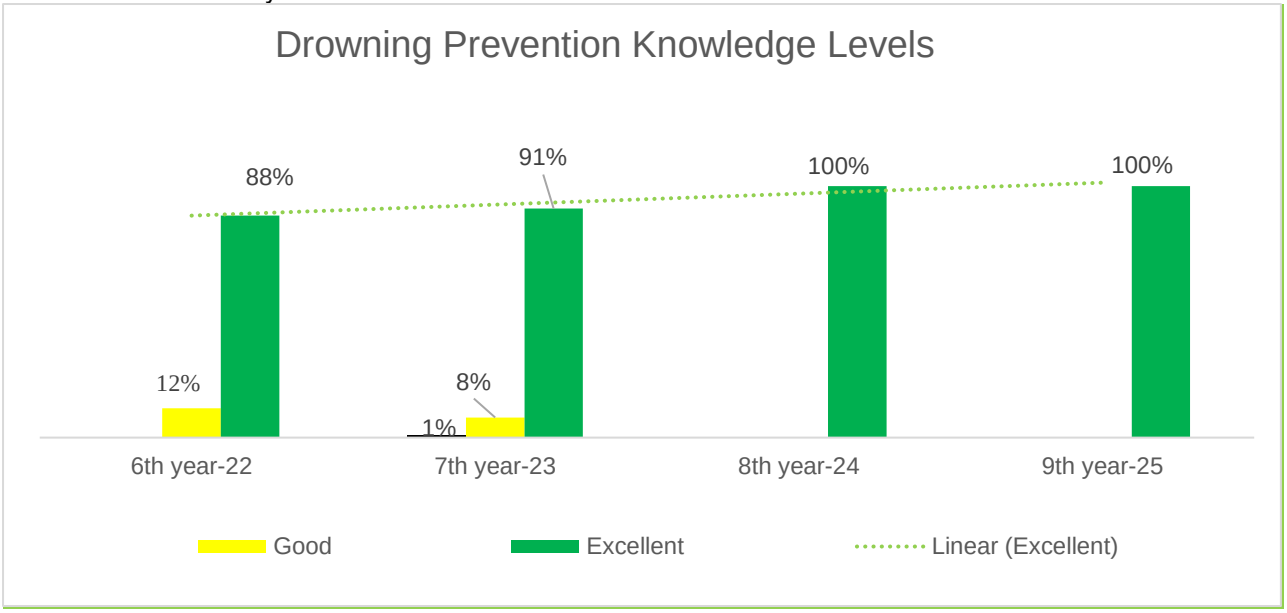
DROWNING PREVENTION KNOWLEDGE LEVELS - SUM OF THE THREE PARTS OF THE QUESTIONNAIRE

When analyzing graph 5, it was noted that the DPKL of students who were monitored from the 5th to the 8th year had a significant improvement trend, going from 77% of excellent DPKL in 2022 to 99% in 2025. Those who had regular DPKL became good or excellent in 2025.

**Graph 6:** Prevalence of Drowning Prevention Knowledge Levels (DPKL) of schoolchildren after monitoring from the 6th to the 9th year of 2022-25.




When analyzing the results as shown in graph 6, it was noted that the DPKL of the students who were monitored from the 6th to the 9th year now has their entire DPKL classified as excellent since 2024. This demonstrates that this group assimilated the interventions and that they began to know symbols and concepts related to preventive attitudes towards accidents in the liquid environment. Simple educational actions were effective in increasing the level of assimilation of drowning prevention concepts.

When analyzed separately by grade, the improvement in the 9th year stands out, 100% of which were classified as excellent in the DPKL. (Graph 6)

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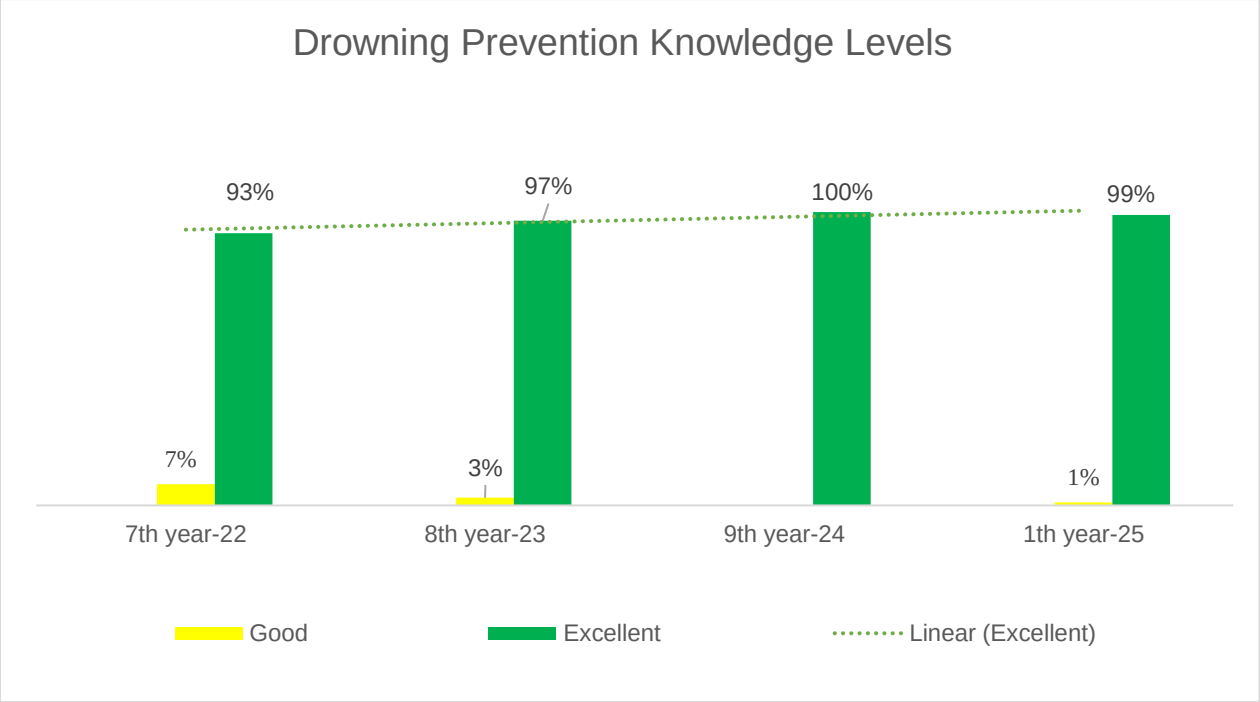
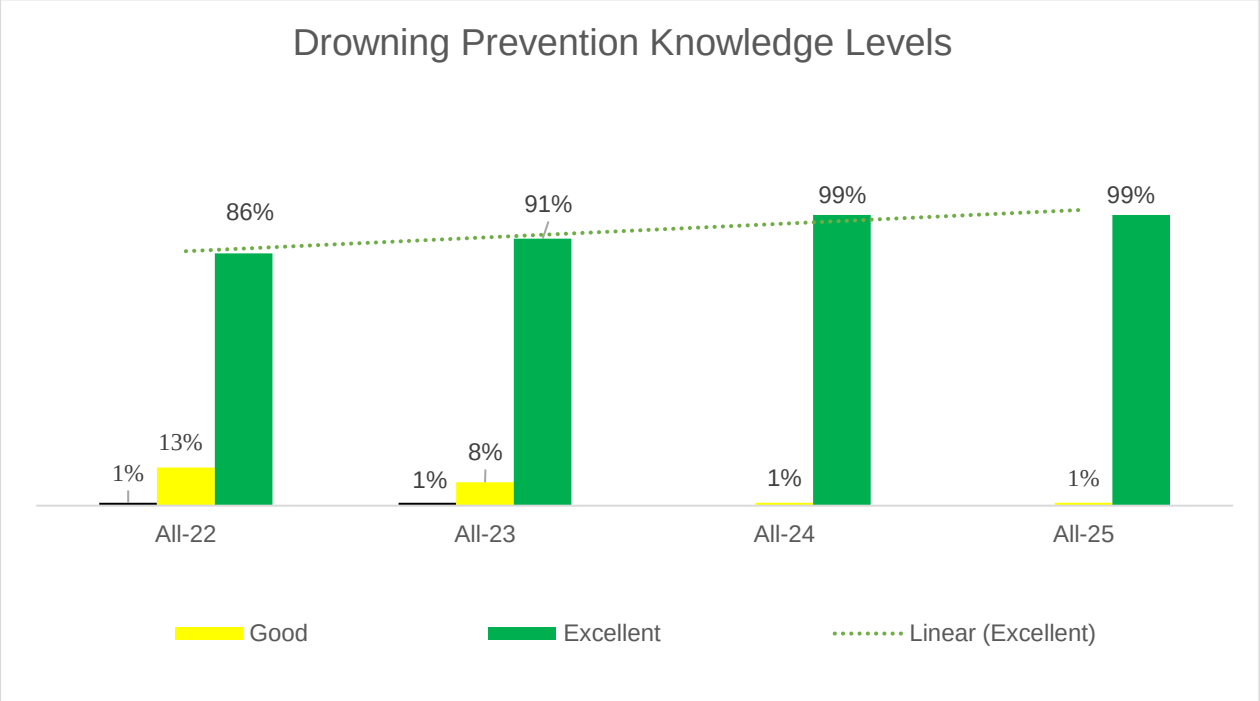
**Graph 7:** Prevalence of Levels of Drowning Prevention Knowledge (DPKL) of students after monitoring from the 7th to the 1st year of 2022-25.




**Graph 8:** Prevalence of Levels of Drowning Prevention Knowledge (DPKL) of students after monitoring from the 7th to the 1st year of 2022-25.




When analyzing the results as presented in graph 7, it was noted that the DPKL of the students who were monitored from the 7th to the 1st year, almost all (99%) of the students were classified as excellent. Having a diagnostic tool that can evaluate and

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monitor the DPKL of students can help prevent accidents in the liquid environment. Children and adolescents tend to copy the attitudes of their friends, in this sense, each student at this investigated school has a fundamental role in multiplying values and attitudes to prevent drowning when they are outside of school. In fact, the study by Koon et al., 2023, mentions that friends are a primary motivator in childhood and can contribute to prevention.

When analyzing all students in comparison in the years 2022-25, an improvement in the DPKL was noted, going from 86% in 2022 with excellent to 99% in 2025 (graph 8).

The fact that annual interventions improve DPKL in schoolchildren demonstrates that prevention can be a good resource to invest in to prevent future drownings. Small actions, when well directed at school, seem to have an impact on improving the DPKL (VASCONCELLOS et al., 2024). It is expected that this knowledge will be put into practice when they are in the aquatic environment.

It is necessary to adopt more effective and efficient strategies to prevent drowning in places with few financial resources (MUGEERE et al., 2022) and which do not have adequate safety regulations (VASCONCELLOS; MASSAUD, 2022).

This study meets the proposal of the United Nations by carrying out low-cost and effective interventions (SCARR et al., 2022) to face the global challenge of preventing drowning (LEAVY et al., 2023).

It is necessary to teach, in addition to the correct identification of signs and flags (GUPTA et al., 2019), the correct attitudes to be put into practice at a given moment in life, in these scenarios (swimming pools, beaches, rivers, dams and lakes). Having attitudes that value prevention and not recklessness/irresponsibility are virtues for safely enjoying the aquatic environment.

It is expected that post-intervention attitudes will always be prudent, that is, that each student can act with caution, attention, care, without haste, avoid danger and consider the risks.

## CONCLUSIONS

There were improvements, after four years of monitoring and interventions at school, with 99% having achieved an excellent Drowning Prevention Knowledge Level in all years of schooling investigated, with a linear trend of better performance as the student's year of schooling increased. In the 2022-25 four-year period, there were improvements in

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knowledge of the meaning of all the illustrations on the seven drowning prevention signs, the three flags (green, red and yellow), as well as the 10 behaviors in the pool.

Students at school are receptive to preventive messages about drowning, which makes the school a suitable and effective place for these actions. Physical education teachers are from the health field and can try to add to their conceptual and attitudinal content, which is already part of the routine, content aimed at preventing drowning.

The diagnostic use of the DPKL test to monitor school-age students can help identify risk behaviors in certain regions or specific groups and thus help to formulate mediation if necessary. Students receiving the intervention, their friends and physical education teachers can help create a prevention network that can start at school and continue outside of school.

It is hoped that other schools can also disseminate concepts and values of preventive knowledge with students from these and other grades so that the number of drowning deaths can decrease in the country.

Thanks to professors Izabel Maria da Silva Sobral and Pietro Rodrigues Corrêa who participated in the intervention in 2022-23 and scholarship holders Lívia Viana and Silvia Caloiero in 2023-24, as well as to SOBRASA for donating banners, umbrellas, blouses, sheriff badges and drowning prevention folders.

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