

## MORTALITY FROM DROWNING IN THE STATE OF AMAZONAS: AN ECOLOGICAL STUDY

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**Abstract:** Aspiration of liquid by submersion characterizes the definition of drowning. Knowledge of the extensive river volume and the number of riverside communities in Amazonas is fundamental in analyzing the number of deaths from this disease in the region. The imperative of immediate treatment for drowning victims characterizes the issue as a medical emergency. However, the distance between communities and hospitals and the lack of public policies aimed at preventing drowning are obstacles to reducing the number of deaths from this important cause in the area. The objective of this study was to describe the frequency of deaths due to emergencies from external causes in the Brazilian state of Amazonas, focusing on accidental drownings in natural waters. An ecological study was carried out, with data extracted from the Mortality Information System (SIM/Datasus), in the years 2012 to 2021. From the database, mortality information was selected due to the occurrence of code W69 - drowning and submersion in natural waters of ICD - 10, referring to macro-regions of health, race, education, age group, gender and marital status. Data from 1,167 cases of death due to drowning in waters of the Amazonas natural river basin were included in the analyses, 88% of which were male, with a higher prevalence in the 20 to 29-year-old age group (20%), mixed race (77%) and singles (67%) with 4 to 7 years of education (29%), mainly in the Central health macro-region (65%). The study brought to light a notable and worrying finding: men aged 20 to 29 years had a higher prevalence of deaths due to drowning than children under 10 years of age. This result signals the need for a reassessment of public prevention and health education strategies, especially when considering that adult individuals must be more responsible and aware of their capabilities.

**Keywords:** Mortality; Immersion; Amazonas.

## INTRODUCTION

According to Szpilman et al. (2014), “drowning is the aspiration of liquid caused by submersion or immersion”, that is, it refers to the entry of liquid into the airways (trachea, bronchi and/or lungs). The Brazilian Aquatic Rescue Society – SOBRASA (2023) highlights that: (1) the mechanism of drowning injury begins from the moment the person is in a panic situation and has difficulties in the water, whether freshwater or salt water, you can no longer voluntarily expel the water through your mouth and, as a result, it is aspirated into the airways; (2) if the victim is not rescued, continuous aspiration and hypoxemia leads to loss of consciousness and apnea within minutes and even seconds; (3) then, there is tachycardia with a sequence of bradycardia, which generates electrical activity of the heart without a palpable arterial pulse and, finally, asystole.

Immediate intervention by bystanders and rescuers significantly improves the outcome of drowning victims. However, when cardiac arrest occurs and cardiopulmonary resuscitation (CPR) is required, neurological, pulmonary, cardiovascular damage, and other complications can occur for the victim. The need for CPR must be assessed as quickly as possible without compromising the safety of the rescuer. Aspiration of 1 to 3 mL/kg of liquid is enough to compromise lung surfactant function. All organic systems are affected, with cerebral hypoxia being the main contributing factor to morbidity and mortality (CHANDY; RICHARDS, 2023).

Annually, Brazil records 5,818 deaths from unintentional drowning, which is equivalent to 2.7 deaths per 100,000 inhabitants. It is estimated that 100,000 non-fatal drownings occur each year. This situation is the main cause of death among children aged 1 to 4 years, the second between 5 and 9 years old, the third between 10 and 14 years old and

the fourth among young people aged 15 to 24 years old, this age group being the most common cause of death. more vulnerable to drowning (20%). As for the places of occurrence, the majority of cases (75%) occur in fresh water, 15% on ocean beaches, 8.5% in artificial aquatic environments and 1.5% during transport on boats. These data directly reflect the fact that the Northern Region of Brazil has the highest proportional rate of drowning deaths per inhabitant, due to the large number of freshwater tributaries in the region, presenting 5.1 deaths per 100,000 inhabitants. Amazonas is the third state with the most deaths per inhabitant, behind only Roraima and Amapá. However, Amazonas is the only one among the three states mentioned above that did not demonstrate a reduction in its deaths per inhabitant due to drowning from 1998 to 2020 (SOBRASA, 2023).

The region of the large hydrographic basin of the Amazonas river deserves to be highlighted as it is considered the largest in the world. Of the total 7 million square kilometers of river area, around 4 million square kilometers - more than half of the area - are on Brazilian soil, covering the states of Acre, Amazonas, Roraima, Rondônia, Mato Grosso, Pará and Amapá, while the remainder covers several countries in South America, such as Colombia, Ecuador, Peru, Venezuela, Guyana, Suriname and Bolivia. The Amazonas River has more than a thousand tributaries and is around 7 thousand kilometers long (GUITARRARA, 2023). Along this large expanse of rivers and lakes, riverside populations live, represented by a range of different social groups - whether indigenous, non-indigenous and immigrants from different regions, surviving from fishing and agriculture (FRAXE, 2007). In relation to housing, most houses are made of wood, suspended, due to periods of flood, or even floating houses are built on the rivers (GAMA et al., 2018). Due to the intrinsic relationship of

these residents with river areas, it is urgent to think about the greater risk of water accidents in this region.

Upon the occurrence of a drowning, the fire department, 193, must be called, and if unavailable, a call can also be made to SAMU 192. These resources become quite inaccessible to the riverside population, since the areas Located far from large urban centers, they generally do not have the infrastructure and equipment to make a call. The National Primary Care Policy, implemented by ordinances MS/GM n° 2,488 and 2,490, of 2011, enabled advances in health care for riverside populations with the creation of Basic River Health Units (UBSF), for example. Through these units, contact with emergency services can be made more easily so that help can be provided to drowning victims in these communities, although there is still a shortage of UBSFs in the region (AGUIAR TL, et al., 2019).

Therefore, given the alarming numbers of drownings and the importance for communities of the large river volume in Amazonas, it is necessary to understand the profile of the individual who dies from this cause in order to improve public policies aimed at preventing this problem. Therefore, the objective of this study is to describe the frequency of deaths due to emergencies from external causes in the Brazilian state of Amazonas, focusing on accidental drownings in natural waters.

## **METHOD**

This is an observational study of the descriptive ecological type, carried out in a public domain secondary database of the Department of Informatics of the Unified Health System (DATASUS), on August 2, 2023. On the DATASUS website, on the Tabnet page, the vital statistics tab was opened, the topic was selected: Mortality - since 1996

according to ICD-10.

It was then determined that they would be deaths due to external causes with a geographic limit in Amazonas, using the filter number of deaths due to drowning and submersion in natural waters (category W69 in ICD-10) in assembling the tables, according to the variables: health macro-regions, race, education, age group, gender and marital status in the years 2012-2021. Tables were generated from the DATASUS system itself, which served as the basis for developing the table containing the main results found. The electronic spreadsheet creation program, Microsoft Office Excel, was used to create this table.

As this was an epidemiological study of secondary analysis, from a public domain database and in accordance with resolution 466/2012 of the National Health Council, there was no need for submission to the Research Ethics Committee.

## **RESULTS**

During the period studied, a total of 1167 deaths were observed due to drowning and submersion in natural waters, the profile of which in terms of gender, age group, color/race, marital status and education are described in the Table below.

The health macro-region with the highest number of deaths was Central, totaling 64.78% of occurrences. Occurrences in the West and East macro-regions correspond to 15.51% and 19.71% of total deaths, respectively.

## **DISCUSSION**

According to the Brazilian Institute of Geography and Statistics (IBGE) (2017), the State of Amazonas is divided, geographically, into regions called immediate and intermediate. The 62 municipalities in Amazonas form 11 immediate regions, and of these, 4 intermediate regions are formed:

	West		East		Center		Total	
	n	%	n	%	n	%	n	%
<b>Gender</b>								
Male	149	82,32%	200	86,96%	685	90,61%	1034	88,60%
Female	32	17,68%	30	13,04%	71	9,39%	133	11,40%
Ignored	0	0,00%	0	0,00%	0	0,00%	0	0,00%
<b>Age</b>								
Minor 1 year	2	1,10%	1	0,43%	3	0,40%	6	0,51%
1 to 4 years	21	11,60%	29	12,61%	53	7,01%	103	8,83%
5 to 9 years	16	8,84%	20	8,70%	35	4,63%	71	6,08%
10 to 14 years old	12	6,63%	15	6,52%	41	5,42%	68	5,83%
15 to 19 years old	23	12,71%	20	8,70%	77	10,19%	120	10,28%
20 to 29 years old	37	20,44%	32	13,91%	164	21,69%	233	19,97%
30 to 39 years old	29	16,02%	35	15,22%	143	18,92%	207	17,74%
40 to 49 years	15	8,29%	28	12,17%	93	12,30%	136	11,65%
50 to 59 years old	14	7,73%	28	12,17%	67	8,86%	109	9,34%
60 to 69 years old	3	1,66%	13	5,65%	42	5,56%	58	4,97%
70 to 79 years old	7	3,87%	8	3,48%	16	2,12%	31	2,66%
80 years and over	2	1,10%	1	0,43%	9	1,19%	12	1,03%
Age ignored	0	0,00%	0	0,00%	13	1,72%	13	1,11%
<b>Color/Race</b>								
White	15	8,29%	17	7,39%	44	5,82%	76	6,51%
Black	1	0,55%	6	2,61%	7	0,93%	14	1,20%
Yellow	0	0,00%	0	0,00%	3	0,40%	3	0,26%
Brown	120	66,30%	198	86,09%	581	76,85%	899	77,04%
Indian	45	24,86%	9	3,91%	109	14,42%	163	13,97%
Ignored	0	0,00%	0	0,00%	12	1,59%	12	1,03%
<b>Marital status</b>								
Single	98	54,14%	134	58,26%	547	72,35%	779	66,75%
Married	7	3,87%	26	11,30%	60	7,94%	93	7,97%
Widower	1	0,55%	3	1,30%	3	0,40%	7	0,60%
Legally separated	2	1,10%	1	0,43%	5	0,66%	8	0,69%
Other	28	15,47%	20	8,70%	21	2,78%	69	5,91%
Ignored	45	24,86%	46	20,00%	120	15,87%	211	18,08%
<b>Education</b>								
None	35	19,34%	24	10,43%	86	11,38%	145	12,43%
1 to 3 years	21	11,60%	26	11,30%	99	13,10%	146	12,51%
4 to 7 years	53	29,28%	64	27,83%	220	29,10%	337	28,88%
8 to 11 years old	28	15,47%	61	26,52%	194	25,66%	283	24,25%
12 years and over	1	0,55%	8	3,48%	24	3,17%	33	2,83%
Ignored	43	23,76%	47	20,43%	133	17,59%	223	19,11%

Table: Frequency of deaths from drowning, by health Macroregion, in the years 2012-2021

Source: Prepared by the authors (2023)



Manaus, Tefé, Lábrea and Parintins. However, in this present study, we used the classification of the three health macro-regions determined by Resolution CIB/AM Number: 118/2018, of the Bipartite Intermanager Commission of the State of Amazonas (2018), which divides the Amazonas state into central, eastern and west. This division is in line with one of the organizational principles of the Unified Health System (SUS), regionalization, necessary to correct territorial inequalities and promote equity, based on well-established epidemiological criteria (BRAZIL, 1990).

It was observed from our study that the central Amazonas macro-region had the highest number of deaths due to drowning. This fact can be explained by the population concentration in this region, which corresponds to around 71% of the total population of Amazonas (IBGE, 2022). Added to this fact is the extensive river area present in this region, made up of the main tributaries of the Amazonas river, which have large volumes of water, such as the Negro, Purus rivers and others (AMAZONAS, 2018). Furthermore, the population-based cross-sectional study - SAMARA - evaluated socioeconomic and health aspects of a riverside population in the municipality of Coari, in the central region of Amazonas, and observed that, of the approximately 76 thousand inhabitants in 2010, one third lived in riverside locations, around lakes, streams and the Solimões River, of which approximately 80% did not have community water transport (GAMA et al., 2018). Therefore, the number of individuals living in the vicinity of rivers and lakes is observed, creating a greater risk of water accidents.

The male gender was predominant in relation to the female gender in terms of the percentage of deaths in all age groups, except for those aged 1 to 4 years, where the female gender slightly exceeds the male percentage.

This result can be explained by the fact that men are more frequently exposed to aquatic environments and risky behaviors, such as swimming alone and drinking alcoholic beverages, as they tend to overestimate their swimming capacity (NUNES, 2023). Furthermore, crime and violence, which can result in drowning, are strongly related to males due to their social experiences throughout personal development. These experiences direct the individual to interpret environmental information as potentially threatening and act aggressively (FERREIRA, 2021).

The age group from 20 to 29 years old was the one that predominated in the Central and West regions (21.69% and 20.44% respectively). The East region, however, had a higher rate in the 30 to 39 age group (15.22%). The occurrence of a greater number of deaths among adults than among children is related to the social role of both. This happens because although adults develop greater awareness of their capabilities - despite childhood innocence - they are the most subject to occupational risks, especially in riverside communities, where adults generally fish in the large Amazonas rivers, while children study and help the mother with household chores (DA-GLÓRIA, 2019). This way, there is greater exposure to the risk of drowning among the adult population and deaths during this period of life increase.

Furthermore, the proportion of deaths among infants under 4 years of age had important relevance in the total frequency. This pattern demonstrated that the highest proportion of deaths among children under 15 years of age in the West and Central health macro-regions - the rate among the 15 to 19 age groups in these regions exceeded the previous age groups -, while in the East health macro-region this value it was only surpassed from the age group of 20 to 29 years old. The disproportionate number of deaths in

individuals aged 1 to 4 years is in line with the epidemiological study by Pellegrino et al. (2023), which revealed that drowning is the third leading cause of deaths due to injury among children in this age group. A second peak of death after the age of 4 was found in the World Health study (2014), which showed a significant increase in deaths between 15 and 19 years of age - data consistent with mortality in the West and Central health macro-regions.

Regarding the relationship of deaths from unintentional drownings in natural waters with the color/race of the victims, it was found that the highest prevalence of this occurrence is in the brown population (77.04%) and the lowest prevalence in the yellow population (0.29 %), which were consistent with the study by Silva and collaborators (2021), which obtained 82.54% and 0.06% of deaths in the brown and yellow races, respectively. A similarity was also observed with the studies by Nogueira and others (2017), which analyzed mortality from drowning in children under 5 years of age, finding the same relationship. Furthermore, the proportion of incidents mentioned above is compatible with data from the 2010 Census, showing that 68.88% of Amazonas residents are mixed race, justifying the greater occurrence of this incident in this population.

The single marital status was the most prevalent for drowning in the northern region, with 66.75% of total deaths. This finding is in line with the study by Nunes et al. (2023), carried out in the state of Alagoas, where single people represent 57.2% of deaths due to drowning in accidental cases. Furthermore, the study by Bordoni et al. (2019), also confirms the highest proportion of drowning deaths in single victims (77.1%) in autopsy reports on suspected cases from the legal medical institute of Belo Horizonte, in Minas Gerais. According to the study by Siegler et al. (2013), marital status is associated with

survival, a fact that helps to understand the lower prevalence of deaths due to drowning in married people and higher prevalence in single people. The aforementioned study states that premature mortality for those who have never married is 2.33 times the risk for those who have a spouse, when analyzing marital history and the calendar of death during middle age. Among the factors that can be linked to the relationship between the benefits of the marital relationship and health are: socialization, caution and care.

It was observed that, of those affected, 53.13% had between 4 and 11 years of education, with the majority being individuals with 4 to 7 years of education (28.88%), a category that was prevalent in all macro-regions. considered in this study. Furthermore, only 2.83% of Amazonas affected by drowning have 12 years or more of schooling and 12.43% have no schooling, with the majority of these being in the central region - which is expected as it is the most inhabited (IBGE, 2022).

The highest frequency of schooling between 4 and 7 years and non-schooling overlapping schooling above 12 years configures the expected profile for the population of the state of Amazonas, since in 2021, there were 702,763 students enrolled in primary education and only 211,302 in secondary education, with even lower numbers for higher education (IBGE 2022). Considering that drownings mainly affect riverside communities, this lack of education becomes more evident, given the need for long journeys to access school in these regions (FRANÇA, 2016).

It is important to highlight that drowning data in the region may be underreported, as the forest regions and rivers in the interior of Amazonas are far from urban centers with the power to report injuries and mortality, possibly contributing to an underestimated number of drowning deaths.

## CONCLUSION

Thus, the present study revealed a marked prevalence of accidental drownings in natural waters in Amazonas, predominantly among brown men, aged 20 to 29 years, single and with 4 to 7 years of education. These incidents were mainly concentrated in the Central health macro-region. These findings

highlight the critical need to reformulate drowning prevention strategies and promote health education, with a special focus on young adults, emphasizing risk awareness and training in swimming and aquatic survival skills. Implementing targeted, culturally sensitive programs can mitigate this public health concern and save lives.

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