

# Trend of Mortality Rate Due to Drowning in Iran (2013–2018)

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## Abstract

**Background and Objectives:** According to the World Health Organization, drowning is the 3<sup>rd</sup> leading cause of unintentional injury-related deaths worldwide, accounting for 360,000 annual deaths and 7% of all injury-related deaths. Low- and middle-income countries are the most affected, accounting for 90% of unintentional drowning deaths. This study aimed to calculate the rate of drowning mortality rate and to investigate its trend in Iran. **Materials and Methods:** Information on death due to drowning in Iran was extracted from Iranian Legal Medicine Organization. The crude mortality rate was calculated each year according to gender and province of the country. To examine the trend for different years, joinpoint regression was used. **Results:** From 2013 to 2018, a total of 5853 persons suffered from fatal drowning in Iran. The crude mortality rate in men was significantly higher than in women. The drowning mortality rate has decreased during the study period in both genders. The annual percent change in mortality rate was 3.2%. **Conclusions:** Although the death rate from drowning has declined in the country, targeted scale-up of known effective interventions such as swimmers supervision and basic survival skills are still needed for reducing mortality due to drowning, particularly in provinces with high mortality rates.

**Keywords:** Crude mortality rate, drowning, Iran, trend

## INTRODUCTION

Drowning is a major but often neglected public health problem that refers to the process of experiencing respiratory impairment from submersion or immersion in a liquid.<sup>[1]</sup> According to the World Health Organization report in 2015, this sensitive issue is the third leading cause of unintentional injury death that reduces the lives of almost 372,000 people and accounts for 7% of all injury-related death every year. According to worldwide reports, more than 90% of deaths from drowning occur in low and middle-income countries (LMICs).<sup>[2,3]</sup> This death toll is almost two-thirds of malnutrition and well over half that of malaria, but unlike these public health challenges, no broad prevention efforts are still made that target drowning.<sup>[1]</sup>

Iran is one of the dangerous countries for drowning due to access to the various rivers, lakes, dams, swimming pools, subterranean canals, and seas.<sup>[1]</sup> According to the 2017 global burden of disease (GBD) report, the number of drowning death

in Iran in 2017 is 1043.73 (1006.51–1110.13). Deaths due to drowning is the 10<sup>th</sup> leading cause of death in men and 25<sup>th</sup> in women in terms of the number of deaths due to any cause.<sup>[4,5]</sup> According to the statistics published by the Ministry of Health and Medical Education in Iran, there is a geographic difference in the drowning pattern. The mortality rate due to drowning oscillated from 4.1/100,000 populations in a coastal area in northern Iran to a low of 0.9/100,000 populations in central Iran, where there is no access to the sea. Despite prevention campaigns at the nongovernmental level, which mainly focus

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on cultural improvements, drowning continues to result in substantial morbidity and mortality.<sup>[6]</sup>

Despite the high rates of death, relatively few epidemiological studies have examined drowning in Iran.<sup>[7-10]</sup> Iran requires studies of drowning because it has many types of water settings aside from swimming pools, such as the Caspian Sea, Persian Gulf, Sea of Oman, and numerous rivers and dams. Furthermore, Iran as an upper-middle-income country, has a different ecological pattern among its provinces, and by analyzing the drowning pattern in its provinces, one can estimate the risk of drowning in countries with similar ecological, religion, or economical patterns. On the other hand, there is no national drowning prevention program and reporting system to ascertain the magnitude of this problem in Iran; thus, this study aimed to:

1. Estimate the mortality rate from drowning by provinces of Iran and its trend from 2013 to 2018
2. Examine the strength and limitations of the dataset available for drowning in Iran.

## MATERIALS AND METHODS

### Drowning data

In this descriptive and cross-sectional study, drowning mortality data from January 1, 2013 to December 31, 2018, were extracted from the legal medicine organization (LMO). Mortality from drowning was classified using the international classification of disease (ICD), 10<sup>th</sup> edition (ICD-10 codes: W65 to w74). Data were collected by the physicians that were responsible for the autopsy room in each province and then forwarded to the central level in Tehran. According to Iranian Law, all suspected cases of death should be referred to as the LMO for evaluation and determination of the cause of death. Drowning is one of the definitions of suspected deaths; hence, the LMO database is the most complete database in this field.

### Inclusion criteria

Considered cases were accidental nontransport drowning's.

### Population data

Population data that are essential for the denominator in rate calculating were sourced from the general statistics office of Iran. The population count in Iran is conducted every 5 years. So, a population of Iran was not available during the study; the population of the 2011 and 2016 (equal to 1390 and 1395 Hijri), which was officially counted and published, was considered as the basic population for estimating the country's population in the other years. The average growth rate was calculated using the geometric method and the following formula:

Growth Rate =

$$\left( \frac{\text{Population of the country based on the 2016 census}}{\text{Population of the country based on the 2011 census}} \right)^{\frac{1}{5}}$$

### Study measures

The key measure in this study was the mortality rate per 1,000,000 population. Drowning mortality rate was estimated

by dividing the number of deaths in each province of Iran or the whole country by the mid-year population of the province and once for all the country.

### Data analysis

The obtained data were entered into SPSS version 22 software (IBM Corp, University of Chicago, Illinois, USA). The study results were presented using descriptive statistics like count, the percentage in tables or figures.

To examine the trend for different years, joinpoint regression based on the log-linear model was used. Join point regression analysis describes changing trends over successive segments of time and the amount of increase or decreases within each segment. The resulting line segment between join points is described by the annual percent change (APC) that is based on the slope of the line segment and the average APC (AAPC). The analysis for the trend was carried out by the joinpoint Regression Program 4.7.0.0 (<https://surveillance.cancer.gov/joinpoint/>).

### Ethical consideration

Our investigation was approved by the ethics committee of Shahid Beheshti University of Medical Science, Tehran, Iran (IR. SBMU.RETECH.REC.1398.399).

## RESULTS

Over the 6 years between 2013 and 2018, a total of 5853 drowning deaths were recorded by LMO. Most of the deaths due to drowning occurred predominantly in men (sex ratio: 5.54 male/female). This gender difference was statistically significant ( $P = 0.03$ ).

The total number of drowning deaths per year decreased from 1074 in 2013 to 1026 in 2018. Table 1 shows the number of drowning deaths and the crude mortality rate of drowning between 2013 and 2018. The drowning mortality rate has decreased during the study period ( $P$  value for trend: 0.19). The mortality rate for drowning in women was less than in men. This favorable situation can be observed in the study period.

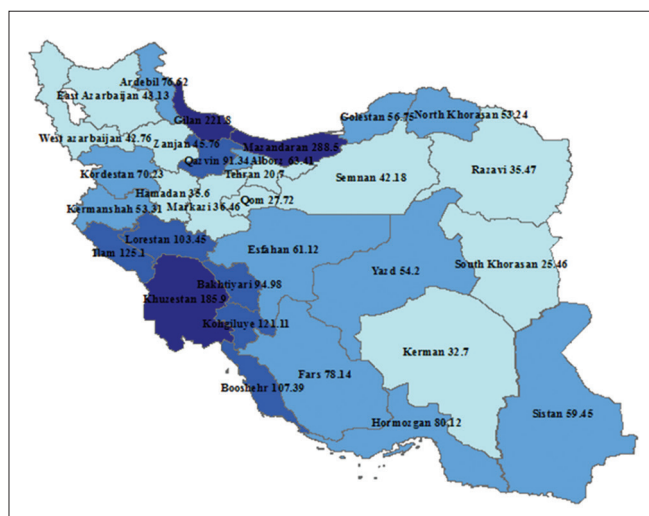
The five provinces with the highest mortality rate from drowning were found in the Mazandaran, Gilan, Khuzestan, Ilam, and Charmahal, and Bakhtiyari, respectively. Tehran (20.7 death per 1,000,000 population) South Khorasan (25.46 death per 1,000,000 population) and Qom (27.72 death per 1,000,000 population) had the lowest mortality rate. The 5-year mortality rate due to drowning 1,000,000 people in Iran provinces shown in Figure 1.

Based on the information presented in Table 2, Mazandaran, Gilan, and Khuzestan had the highest drowning mortality rate in all years of the study.

According to the joinpoint regression, the 6-year trend of crude mortality rate due to drowning was decreasing: APC was 2.6% (95% confidence interval [CI] -6.1-1) for male, 4.1% (95% CI - 15.9-9.4) for female and 3.2% (-8.8-2.7) for both genders [Figure 2]. It should be noted that none of

**Table 1: The number of drowning deaths and the crude mortality rate by sex within 6 years from 2013 to 2018 in Iran**

Years	The population of the country	Number of death			Mortality rate/1,000,000		
		Total	Male	Female	Total	Male	Female
2013	76,081,588	1074	892	182	14.12	23.22	4.83
2014	77,025,063	1063	894	169	13.80	22.97	4.43
2015	77,980,238	898	783	115	11.52	19.85	2.98
2016	78,947,258	879	858	168	11.13	21.47	4.31
2017	79,947,258	913	798	115	11.42	19.70	2.92
2018	80,917,422	1026	858	168	12.68	20.91	4.21



**Figure 1:** The mortality rate due to drowning in 1,000,000 person in Iran provinces (2013–2018)

the above trends were significant. The model did not show any joinpoint, and hence, the AAPC is the same as APC.

## DISCUSSION

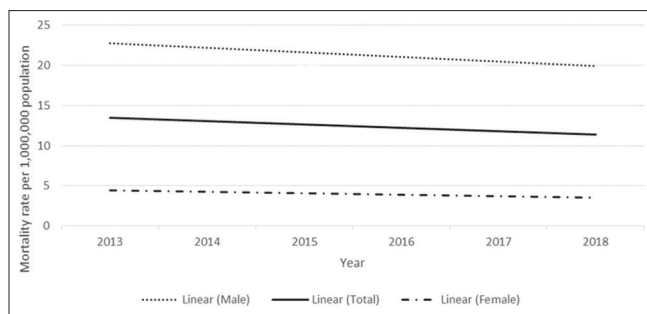
This study aimed to calculate the mortality rate due to drowning and investigate trends and patterns of crude mortality rate due to drowning in Iran over 6 years. This research demonstrates a decrease in drowning mortality over 6 years up to 2018 at the national level. This decreasing trend was observed in men and women. Our results were consistent with the GBD study on drowning mortality rates in 2016.<sup>[11]</sup> Despite the existence of widespread debates in the mass media and the Iranian parliament about drowning, apart from legislation that swimming pools should earn standard quality control certificate from Iran national standard organization, there is no other documented law in this regard.<sup>[12]</sup> Derakhshan *et al.* conducted a trend analysis for drowning in Iran. Based on the result of their research, the drowning mortality has declined in Iran from 1990 to 2015, but this decline has not been similar among the provinces,<sup>[10]</sup> and this finding is in concordance with our research.

Consistent with our research, studies reporting deaths in males and females from drowning concluded more male deaths than female deaths.<sup>[10,13,14]</sup> This could be due to several factors; in Iranian culture, men are more likely to swim and tend to have

**Table 2: The crude mortality rate across Iran's provinces from 2013 to 2018**

Provinces of the country	Years of the study					
	2013	2014	2015	2016	2017	2018
East Azerbaijan	4.52	5.00	4.69	5.17	6.14	17.48
West Azerbaijan	9.30	6.66	6.58	5.58	7.04	7.87
Ardebil	13.57	10.34	14.27	15.80	8.66	14.12
Esfahan	8.52	11.46	10.15	10.45	9.57	11.22
Alborz	9.72	11.47	8.50	11.70	12.17	10.44
Ilam	14.23	24.71	28.02	26.06	20.68	11.97
Bushehr	19.85	18.46	10.82	15.84	12.03	31.06
Tehran	3.95	3.57	3.51	3.37	2.79	3.70
Charmahale Bakhtiari	20.98	13.10	15.11	17.08	14.77	14.60
southern Khorasan	2.93	1.42	6.90	6.70	6.50	1.26
Khorasan Razavi	8.22	5.03	5.28	4.89	5.13	7.20
North Khorasan	15.00	6.93	5.78	12.73	2.32	10.44
Khuzestan	31.31	33.46	31.05	28.24	28.66	33.92
Zanjan	10.74	3.88	6.73	5.72	4.73	14.07
Semnan	7.75	7.59	5.94	7.27	5.70	8.36
Sistan and Baluchistan	12.01	11.42	7.10	9.91	10.45	9.20
Fars	13.77	12.56	13.06	10.42	11.54	17.13
Qazvin	17.27	20.33	10.45	11.12	13.35	19.40
Qom	4.24	0.83	8.10	4.75	2.32	7.56
Kurdistan	14.52	12.37	8.34	10.76	13.72	11.07
Kerman	4.02	6.61	7.81	2.89	5.37	6.23
Kermanshah	8.73	9.75	8.21	7.69	11.27	7.68
Kohgiluyeh	10.46	35.30	24.61	18.52	16.83	16.56
Golestan	25.07	6.07	3.28	5.95	9.10	7.95
Gilan	42.96	43.19	38.64	41.66	32.01	24.01
Lorestan	15.95	11.95	14.79	17.62	26.13	17.03
Mazandaran	69.03	74.14	42.84	35.80	41.11	29.45
Markazi	2.12	5.63	4.22	7.01	7.00	10.47
Hormozgan	16.71	18.13	10.62	10.95	11.82	13.19
Hamedan	3.99	4.00	6.87	2.87	9.20	8.65
Yazd	11.96	14.55	6.29	5.33	7.03	9.55

more risky behaviors such as swimming alone, boating, or drinking before swimming. It is mentioned in other studies in LMICs that most of the deaths due to drowning occur in men.<sup>[10,15]</sup> Based on the systematic review conducted by Tyler in 2017, men are at higher risk of drowning than women. According to the article, the male usually displays riskier behavior than their female equivalents and consequently expose themselves to more dangerous circumstances.<sup>[16]</sup>



**Figure 2:** The 6-year trend of crude mortality rate due to drowning in both genders, Iran, 2013–2018

Based on the results, Gilan, Golestan, Mazandaran, and Khuzestan provinces have the highest mortality rates due to drowning in the study period. This result can be attributed to the proximity of these provinces to the Caspian Lake, Persian Gulf, Oman Sea, and various rivers, lakes, and dams.<sup>[10]</sup> Higher drowning rates in these provinces were also mentioned in the studies conducted by Monsef *et al.*,<sup>[17]</sup> Akbapour *et al.*,<sup>[8]</sup> and Divsalar and Khademi.<sup>[18]</sup> Zanjan province has the highest number of dams in the country, which justifies drowning in this province. The key point is that the installation of fences on dams during the study period has reduced the number of deaths from drowning in this province.<sup>[19]</sup> In Qom province, there is little access to water resources except for the public swimming pool, and the main reason for the diminution in the number of deaths was employing certified lifeguards.<sup>[1]</sup> The reduction in drowning deaths in Esfahan can be attributed to the dried out of Zayandehrood river that is the largest liver in central Iran.<sup>[20]</sup> Urmia Lake that is located in West Azerbaijan, also dried out during the study period, which also affects decreasing drowning deaths in this province.<sup>[21]</sup> As shown in this study, drowning is not a phenomenon for the coastal area, and all provinces of the country are involved in this problem with varying degrees. Therefore, it is essential to design drowning prevention programs for all provinces in the country.

According to the LMO report, about one-third of deaths due to drowning occurred in rivers. In Iran, most rivers do not have warning signs surrounding them that warn people to avoid swimming in these waters. Furthermore, due to increasing financial problems, many children do not have the benefit of swimming in private pools.<sup>[22]</sup>

There is some limitation in our analyses. First, in this study, denominator for rate calculation was the population of the place of residence. People exposed to the risk of drowning include residence and nonresidence of area, but there is no information available on the population of nonresidents. Secondly, the lack of registration of many demographic and epidemiological data such as age, socioeconomic factors of deceased, drowning place (sea, river, pool, dam, etc.), time, month and season of drowning, native or nonindigenous person drowned in the LMO database was another important limitation.

It is recommended to design appropriate interventions for the prevention of drowning and also update the registry questionnaires to provide appropriate information for health care providers and policymakers. Finally, the data collected does not include underlying medical conditions such as ischemic heart disease, cardiac arrhythmias, and seizures. These conditions are known as risk factors for drowning.

## CONCLUSIONS

This study revealed that mortality from drowning decreased in the study period but at different levels by province. This decline has taken place while there is no systematic intervention for the reduction of drowning rate except mandatory standard quality control certificates for swimming pools. So, designing more and newer actions by officials and authorities can reduce more the burden of the problem. Despite the decreasing trend, our country still needs to design training programs and harm reduction approaches for reducing the mortality from drowning, especially in high-risk provinces. Our final suggestion is that Forensic Medicine provides more accurate information about the demographic characteristics of the deceased, the location of drowning, and the cause of drowning, and so on.

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## Conflicts of interest

There are no conflicts of interest.

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