Indian Journal of Forensic Medicine and Pathology
Volume 15, Number 3, July-September 2022.
doi: https://dx.doi.org/10.21088/ijfmp.0974.3383.15322.2

ORIGINAL ARTICLE

Profile of Deaths Due to Drowning Reported for Medico-legal Autopsy at Tertiary Health Care Teaching Hospital

Ramesh Gadhari[1], Vikrant Kalokhe[2], Madhusudan Petkar[3], Nagsen Kamble[4], Rajendra Bangal[5], Sandesh Datir[6]

ABSTRACT

INTRODUCTION:

Drowning deaths are very crucial from medico-legal point of view. When we consider drowning deaths, surprisingly rising trend is seen in this aspect. Now it has become a global problem and there is great concern about reduction in mortality rate due to drowning. In view of this, thereis an immense need to understand the factors associated with drowning deaths, so that preventive measures can be taken to minimize such a global problem. To fulfill above goal present study was undertaken to understand the trend of drowning related deaths.

This retrospective study was done by assessing theautopsy cases done in mortuary of SBHGM College during the period from 1st January 2021 to 31st December 2021.

We found that 40 (76.92%) victims were male and 12 (23.07%) were female. Drowning deaths were most commonly seen in age groups of 21-30 years (25%). Married population constituted 35 (67.30%) cases and 16 (30.76%) were unmarried. Hindu community contributed to maximum number of cases with 51.92% cases. Students were the most common victims in drowning deaths accounting to 30.76% cases, followed by farmers i.e. 23.07% cases. Maximum deaths occurred in month of September (21.15%) attributing to rainy season. Maximum drowning deaths occurred between 6 am to 12 pm (n=18, 34.61%) followed by 12 pm to 6 pm (n=15, 28.84%). Most of the drowned victims were retrieved from well (46.15%), followed by dam (13.46%), canal (13.46%). It was reported that most of the drowning deaths were accidental in manner (48.07%).

From this study it is clear that drowning deaths occurred mostly in males of age group of 21-30 years. Married and Hindu population is largely involved. Profession wise distribution clearly indicates that students and farmers are quite susceptible to drowning tragedy. Most of the drowning cases were accidental in nature followed by suicides and occurred commonly in wells in rural area and lakes in urban area.

KEYWORDS |Drowning Deaths; Asphyxia; Global Problem; Male; Married; Students; Well; Accidental.

Author's Credentials:

[1]Associate Professor & HOD, [4]Assistant Professor, Department of Forensic Medicine & Toxicology, S.B.H. Government Medical College, Dhule 424001, Maharashtra, India, [2]Associate Professor & HOD, Department of Forensic Medicine & Toxicology, A.C.P.M. Medical College, Dhule 424001, Maharashtra, India, [3,5,6]Professor, Department of Forensic Medicine & Toxicology, Symbiosis Medical College for Women, Symbiosis International (Deemed University), Pune 412115, Maharashtra, India.

Corresponding Author:

***Vikrant Kalokhe,** Associate Professor & HOD, Department of Forensic Medicine & Toxicology, A.C.P.M. Medical College, Dhule 424001, Maharashtra, India.*

Email: *vikrant_kalokhe@yahoo.co.in*

***Received on:** 18.04.2022*

***Accepted on:** 20.06.2022*

How to cite this article:
Ramesh Gadhari, Vikrant Kalokhe, Madhusudan Petkar, et. al./Profile of Deaths Due to Drowning Reported for Medico-legal Autopsy at Tertiary Health Care Teaching Hospital. Indian J Forensic Med Pathol.2022;15(3):149-155.

INTRODUCTION

Drowning can be defined as a form of asphyxia caused by aspiration of fluid into air passages, caused by complete or partial submersion in water or other fluid.[1] In 2019, an estimated 236000 people died from drowning, making drowning a major public health problem worldwide. In 2019, injuries accounted for almost 8% of total global mortality. Drowning is the 3rd leading cause of unintentional injury death, accounting for 7% of all injury related deaths. The global burden and death from drowning is found in all economies and regions, however: low and middle income countries account for over 90% of unintentional drowning deaths; over half of the world's drowning occurs in the WHO Western Pacific Region and WHO South-East Asia Region; drowning death rates are highest in the WHO Western Pacific Region, and are 27-32 times higher than those seen in the United Kingdom or Germany, respectively.[2]

India is a vast country having plenty of water supplies from rivers, ponds, wells and an extensive seacoast. Under such conductive circumstances, it is a matter of small wonder that cause of death due to drowning is a frequent event where medico legal expertise is called upon to investigate.[3]

There were 83 deaths due to drowning every day in India in the year 2018, according to the Accidental Deaths and Suicides in India (ADSI) report published by the National Crime Records Bureau (NCRB) earlier this month. However, in a country full of unguarded ponds, lakes, and rivers, the government has not come up with any policies like barriers around water bodies, safety lessons in schools, and safe boating laws, to prevent drowning accidents. In the year 2018, there were 29,696 incidences of drowning, resulting in deaths of 30,187 people. Out of these, 258 deaths were caused by capsizing of boats, 19,939 deaths were caused by accidental fall into water bodies, while 9,990 cases were caused by unspecified causes. Drowning (7%) was the third major cause of all accidental deaths reported in India, after traffic accidents (43%) and sudden deaths (11%). Accidental fall into water bodies made up for 66% of the drowning deaths in 2018. According to a report published by the Lancetin December 2019, there were about 62,000 drowning deaths in India in the year 2017. This was nearly twice of all (30,279) drowning deaths reported in ADSI 2017. The rate of years of life lost (YLL) by drowning were highest in the central states of Madhya Pradesh (MP) and Chhattisgarh, and the northeastern state of Assam, accounting for 11% of all drowning deaths.[4]

Despite this large burden, drowning is neglected as a public health issue. So there is need to focus on this issue by doing research extensively and providing as much as data to public health authorities. Surprisingly no study was available on this topic in north Maharashtra region. Hence an attempt was made to throw a light on such burning issue through present study.

AIMS AND OBJECTIVES

To analyze the drowning deaths autopsied in S.B.H. Government Medical College, Dhule, Maharashtra with respect to associated factors like age, sex, marital status, religion, occupation, seasonal variation, timing of death, place of incidence and manner of death. By doing detailed analysis, definite conclusion can be drawn and preventive measures toreduce drowning deaths may be suggested.

METHODOLOGY

In this retrospective study, all the medico legal autopsies done on persons died due to drowning during the period from 01/01/2021 to 31/12/2021 at mortuary of Forensic Medicine department of S.B.H.G.M. College were considered. Inquest reports, postmortem examination reports and clinical case papers if available were scrutinized thoroughly and data was entered into properly designed proformas. For present study parameters like age, sex, marital status, religion, occupation, place of retrieval of dead body, region of incidence, timing of incidence, month wise distribution, seasonal variations and manner of drowning were taken into consideration. Then data was

properly tabulated, analyzed and compared with earlier similar studies.

RESULT

Age & Sex:

During period from 01/01/2021 to 31/12/2021, 985 autopsies were conducted in Department of Forensic Medicine. Out of which 52 autopsies were performed to investigate deaths due to drowning. When sex wise distribution of cases is considered, we found that males outnumbered females. Males constituted 40 (76.92%) cases while females constituted 12 (23.07%) cases. Male to female ratio was 3.3:1. Deaths due to drowning were commonly seen in age group 21-30 years (25%) followed by age group 11-20 years (23.07%) and age group 41-50 years (19.23%). No cases were found in extreme age groups. Predominance of male was seen in all age groups. In case of males, predominant age group was 41-50 years (25%) while in females predominant age groups were 11-20 years and 21-30 year. Both age groups show same percentage i.e. 41.66%. (Table 1)

Table 1: Distribution of cases according to age groups and sex.

Age in years	Male	Female	Total cases/ (%)
0-10	0	0	0
11-20	7	5	12 (23.07%)
21-30	8	5	13 (25%)
31-40	7	1	8 (15.38%)
41-50	10	0	10 (19.23%)
51-60	5	0	5 (9.61%)
61-70	3	1	4 (7.69%)
>71	0	0	0
Total	**40**	**12**	**52 (100%)**

Marital status:

Maximum deaths due to drowning were seen in married people who constituted 35 cases (67.30%) while in unmarried group 16 cases (30.76%) were seen. In one case marital status could not be determined. (Table 2)

Table 2: Distribution of cases according to marital status.

Marital status	Male	Female	Total cases/ (%)
Married	27	8	35 (67.30%)
Unmarried	12	4	16 (30.76%)
Not known	1	0	01 (1.92%)
Total	**40**	**12**	**52 (100%)**

Religion:

Hindu community contributed to maximum number of cases with 51.92% cases, followed by Buddhist in 26.92%, Christian in 15.38% and Muslim in 3.84% cases. In one case religion could not be determined. (Table 3)

Table 3: Distribution of cases according to religion.

Religion	Male	Female	Total cases/ (%)
Hindu	20	7	27 (51.92%)
Muslim	2	0	02 (3.84%)
Christian	6	2	08 (15.38%)
Buddhist	11	3	14 (26.92%)
Not known	1	0	01 (1.92%)
Total	**40**	**12**	**52 (100%)**

Occupation:

Students were the most common victims in drowning deaths seen in 30.76% cases, followed by farmers in 23.07% cases, labors in 13.46% cases and house wives and service shared equal percentage i.e. 9.61%. (Table 4)

Table 4: Distribution of cases according to type of occupation.

Occupation	Male	Female	Total cases/ (%)
Farmer	12	0	12 (23.07%)
Fisherman	3	0	3 (5.76%)
Student	10	6	16 (30.76%)
Service	5	0	5(9.61%)
Businessman	3	0	3(5.76%)
Housewife	0	5	5(9.61%)
Labor	6	1	7 (13.46%)
Not known	1	0	1 (1.92%)
Total	**40**	**12**	**52 (100%)**

Month & Time:

Maximum deaths were occurred in month of September (21.15%), followed by February (13.46%), June (11.53%) and least number of deaths were observed in month of April & December i.e. (1.92%) cases. When seasonal variation is considered, maximum deaths occurred during rainy months of June to September (44.46%, n=23) followed by summer months of February to May (30.76%, n=16) and winter months of October to January (25%, n=13). When time factor is considered, maximum drowning deaths occurred between 6 am to 12 pm (n=18, 34.61%) followed by 12 pm to 6 pm (n=15, 28.84%) and 6 pm to 12 am (n=11, 21.15%). In four cases exact time of death was not known. (Table 5)

Table 5: Distribution of cases according to month and timing of incidence.

(Year 2021) Month wise	Timing of Incidence					Total cases/ (%)
	12 am to 6 am	6 am to 12 pm	12 pm to 6 pm	6 pm to 12 am	Not known	
January	0	1	1	1	1	4 (7.69%)
February	2	1	3	0	1	7 (13.46%)
March	0	1	0	2	1	4 (7.69%)
April	0	1	0	0	0	1 (1.92%)
May	0	3	0	1	0	4 (7.69%)
June	0	1	3	1	1	6 (11.53%)
July	1	1	0	0	0	2 (3.84%)
August	0	2	2	0	0	4 (7.69%)
September	0	6	3	2	0	11 (21.15%)
October	1	1	1	1	0	4 (7.69%)
November	0	0	1	3	0	4(7.69%)
December	0	0	1	0	0	1 (1.92%)
Total	**4**	**18**	**15**	**11**	**4**	**52 (100%)**

Place of Incidence:

Most of the drowned victims were retrieved from well (46.15%), followed by dam (13.46%), canal (13.46%). Lake and river constituted same percentage i.e. 11.53%. Pond & water tank constituted 1.92% each. If urban and rural difference is considered, maximum cases occurred in rural region (n=42, 80.76%) whereas in urban region (n=10, 19.23%) cases were observed. In urban region maximum dead bodies were recovered from lake (n=4, 33.33%) while in rural region maximum dead bodies were recovered from well (n=23, 57.50%). (Table 6)

Table 6: Distribution of cases according to the place of retrieval of body & region.

Place	Region		Total cases/ (%)
	Urban	Rural	
Lake	4	2	6 (11.53%)
Dam	0	7	7 (13.46%)
Well	1	23	24 (46.15%)
River	1	5	6 (11.53%)
Canal	2	5	7 (13.46%)
Pond	1	0	1 (1.92%)
Water tank	1	0	1 (1.92%)
Total	**10**	**42**	**52 (100%)**

Manner:

When the cases were analyzed as per the manner of death, we found that most of the deaths were accidental (48.07%), followed by suicidal deaths (26.92%) and in 7.69% cases manner was homicidal. In nine (17.30%) cases manner could not be commented as these cases were under investigation. Both in male and female accidental drowning was common. (Table 7)

Table 7: Distribution of cases according to manner of drowning.

Manner	Male	Female	Total cases/ (%)
Accident	19	6	25 (48.07%)
Suicide	11	3	14 (26.92%)
Homicide	3	1	04 (7.69%)
Not known	7	2	09 (17.30%)
Total	**40**	**12**	**52 (100%)**

DISCUSSION

Out of 985 autopsies conducted in the year 2021, 52 autopsies attributed to deaths due to drowning. Drowning related deaths were found to be high in males (n=40, 76.92%) with male: female ratio of 3.3:1. This is similar to the study conducted by Phad LG and Dhawane SG5, Tanuj Kanchan et al.[6], Thakar MK and Guleria P7, Manigandaraj G, Selvakumar R.[8] One of the reasons Reason for male predominance of drowning, may be that men are more commonly involved in outdoor activities. Courageous behavior of men can also be the reason for more susceptibility of men to drowning.

Deaths due to drowning were commonly seen in age group 21-30 years (25%) followed by age group 11-20 years (23.07%) and age group 41-50 years (19.23%). This is similar to the study conducted by G.S.R.K.G. Ranga Rao et al.[3], Phad LG and Dhawane SG[5], Manigandaraj G, Selvakumar R[8], Raja SekharUppu et al.[9], A G Vijay Kumar et al.[10], Paranitharan P et al.[11] while contradictory to the study of Vishva Deepak Bijawat et al.[12], Niraj Kumar et al.[13], GH Nayak and M Karlawad.[14] Persons belonging to age group 21-30 years are more courageous and have careless attitude while doing recreational activities in or around water bodies. This can be the reason behind the high mortality in this age group.

Deaths due to drowning were more in married people who constitute 35 cases (67.30%), as compared to unmarried group which constituted 16 cases (30.76%). This result is consistent with the study of G.S.R.K.G. Ranga Rao et al.[3] and Phad LG and Dhawane SG.[5] It may be due to more involvement of married people in activities related with water bodies and also due to financial crisis or family disputes making them susceptible for suicidal drowning.

Hindu community contributed to maximum number of cases with 51.92% cases, followed by Buddhist in 26.92%, Christian in 15.38% and Muslim in 3.84% cases. Similar finding was observed by Phad LG and Dhawane SG[5], MP Baral and NSubedi.[15] It may due to the dominant population of study area is Hindu

In 30.76% of deaths due to drowning in the present study, the victims were students, followed by farmers in 23.07% cases, labourer in 13.46% cases and house wives and service shared equal percentage i.e. 9.61%. This is consistent with the study of Phad LG and Dhawane SG[5] in which most common victims were students (18.75%). It may be due to immaturity and courageous behavior of students. It was observed that most of them were non swimmer.

Maximum deaths occurred in the month of September (21.15%), followed by February (13.46%), June (11.53%) and least number of deaths were observed in month of April & December i.e. (1.92%) cases. When seasonal variation is considered, maximum deaths occurred during rainy months of June to September (44.46%, n=23) followed by summer months of February to May (30.76%, n=16) and winter months of October to January (25%, n=13). Raja Sekhar Uppu et al.[9] also found same finding.Similar finding was noted by MP Baral and N Subedi.[15] In a study of Aminur Rahman et al.[16] most of the drowning deaths occurred in monsoon season. In rainy season water level of water bodies like river, lake, pond, dam etc. rise significantly making the population vulnerable

to drowning.

When time factor is considered, maximum drowning deaths occurred between 6 am to 12 noon (n=18, 34.61%) followed by 12 noon to 6 pm (n=15, 28.84%) and 6 pm to 12 midnight (n=11, 21.15%). This clearly indicates that maximum cases of death happened during day time. This is contradictory to the study done by Manigandaraj G and Selvakumar R.[8] During day time especially in morning hours (6 am to 12 noon) most people are exposed to water bodies for routine activities making them susceptible for drowning.

Most of the drowned victims were retrieved from well (46.15%), followed by dam (13.46%), canal (13.46%). Lake and river constituted same percentage i.e. 11.53%. Pond & water tank constituted 1.92% each. Agricultural activities are dominant in present study area hence number of wells is higher than any other water bodies. This could be the reason for the observation that most of dead bodies were recovered from well. Interestingly this finding does not match with any of the mentioned studies. In a study of Mukesh Kumar Thakar et al.[17] most of the drowning took place in rivers and canals while a few cases occurred in wells and ponds. The study of Amy E Peden et al.[18] indicates that most common locations of drowning incident were other/unspecified locations.

When urban and rural difference is considered maximum cases occurred in rural region (n= 42, 80.76%) followed by urban region (n=10, 19.23%). In urban region maximum dead bodies were recovered from lake (n=4, 33.33%) while in rural region maximum dead bodies were recovered from well (n=23, 57.50%). As the water bodies are more in number in rural region than urban region, more incidence of drowning occur in rural region. However, this finding is inconsistent with the study of Phad LG and Dhawane SG[5] in which maximum number of drowning deaths had occurred in urban region constituting 57.38% cases followed by rural region constituting 42.62% cases.

When we analyzed the observations as per the manner of death, we found that most of the deaths were accidental (48.07%), followed by suicidal deaths (26.92%) and in 7.69% cases manner was homicidal. Contributing factors like careless attitude, lack of swimming skills and lack of protective measures around water bodies are responsible for more accidental drowning cases. Similar results were obtained by Thakar MK and Guleria P[7], Raja Sekhar Uppu[9], A G Vijay Kumar et al.[10], Paranitharan P[11], Vishva Deepak Bijawat[12], GH Nayak and M Karlawad[14] while contradictory results seen in study of Manigandaraj G and Selvakumar R[8], Niraj Kumar[13], MP Baral and N Subedi.[15]

CONCLUSION

From this study it is evident that drowning is responsible for significant number of deaths in males of age group of 21-30 years. Married and Hindu population is largely involved. Profession wise distribution clearly indicates that students and farmers are quite susceptible to drowning. Most of the deaths occurred during rainy season. Many incidences happened during day time particularly in morning hours. Most of the drowning cases were accidental in nature followed by suicides and occurred commonly in wells in rural area and lakes in urban area.

Considering above mentioned associated factors influencing drowning,following measures can be suggested to minimize the incidences of drowning:

- Training of Swimming in schools and colleges should be made compulsory.
- Vulnerable population like fisherman and farmers should undergo swimming training programs and should be made aware about aquatic safety measures to be taken while doing activities related with water.
- Measures should be taken to protect the water bodies like fencing and meshing of lakes, dams, ponds etc. with proper warning sign boards which can reduce accidental drowning. Such large water bodies should be constantly under vigilance of respective authorities, particularly in day time and onsite

availability of rescue team may significantly reduce the problem. Small water bodies like well, tanks should be closed.

- Awareness programs about prevention of drowning should be undertaken particularly in rainy season.
- Cardiopulmonary resuscitation training to save drownedvictims should be given to society at large.

Conflict of Interest:
There is no conflict of interest among the authors.
Source of Funding:
The author declares that this is a self-funded research project.

REFERENCES

1. ***Anil Aggrawal,***
Forensic Medicine and Toxicology for MBBS, 1st edition, Avichal Publishing Company, New Delhi 2016 page no 293.
2. *Drowning. World Health Organization. Available from:http://www.who.int/news-room/facts-sheet/detail/drowning. (Last cited on 2022 March 27).*
3. ***G.S.R.K.G. Ranga Rao, Jakkam Surendar, G.K.V. Prasad.***
A Comprehensive Study of Drowning in and Around Kakinada, Two Years Retrospective Study. Sch. J. App. Med. Sci., 2014; 2(4D):1397-1401.
4. *83 Deaths Every Day in 2018 Due to Drowning in India: Report. News Click. Available from:http://www.newsclick.in/83-deaths-very-day-2018-due-drowning-india-report. (Last cited on 2022 March 27).*
5. ***Phad LG, Dhawane SG.***
Epidemiological profile of drowning deaths: a cross sectional study. Egypt J Forensic Sci.2018;8(1). DOI:10.1186/s41935-018-0056-8.
6. ***Tanuj Kanchan, Prateek Rastogi, Manoj Kumar Mohanty.***
Profile of near drowning victims in coastal region of Karnataka, JIAFM,2007;29(4).
7. ***Thakar MK and Guleria P. Tracking***
Drowning Trends in Himachal Pradeshduring 2006-2010. Anil Aggrawal's Internet Journal of Forensic Medicine and Toxicology [serial online], 2015;16(1) (JanJune2015)Availablefrom:http://anilaggrawal.com/ij/vol_016_no_001/papers/paper004.html.
8. ***Manigandaraj G, Selvakumar R.***
Demographic profile of drowning deaths autopsied in Chennai. MedPulse International Journal of Forensic Medicine, July 2021; 19(1): 01-06.
9. ***Raja Sekhar Uppu, BVS Ananda Rao, Beemsetty Rajesh.***
An Autopsy Study of Drowning Deaths in and around Visakhapatnam. Indian Journal of Forensic Medicine & Toxicology, January-March 2020; 14(1): 23-27.
10. ***AG Vijay Kumar, MG Shivaramu, U Kumar.***
Pattern of Drowning Cases in Rural Area: A Retrospective Autopsy Study. Journal of Medical Sciences and Health, Sep-Dec 2015;1 (3): 18-20.
11. ***Paranitharan P, Perera WNS, Lakmal S, Priyanath DC, Senanayake TAAW & Kumari MKJK.***
Deaths Following Drowning in Sri Lanka- A Retrospective Study. Sri Lanka Journal of Forensic Medicine, Science & Law, December 2020; 11(2): 1-8.
12. ***Vishva Deepak Bijawat, Binaca Gandhi, Ankit Kumawat, Ravi Kumawat.***
A Study on Profile of Drowning Casesat JLN. Medical College, Ajmer. PARIPEX - Indian Journal of Research, July 2020; 9(7): 46-48.
13. ***Niraj Kumar, Vivek Mangare, Naman Kandpal, Aishwarya Bajpei.***
Autopsy based profile of drowning cases at a tertiary care centre near a hilly river. Indian Journal of Forensic and Community Medicine, January-March, 2019; 6(1):28-32.
14. ***Gajanan H Nayak, Mahalaxmi Karlawad.***
A Medicolegal Examination of Drowning Deaths-A Retrospective Study. International Journal of Science and Research, January 2017; 6(1):811-814.
15. ***Madan Prasad Baral, Nuwadatta Subedi.***
Demographic and autopsy characteristics of drowning deaths in a major autopsy center of Gandaki province of Nepal. Journal of Gandaki Medical College-Nepal, Jan-Jun 2021;14(1):50-3.
16. ***Aminur Rahman, Olakunle Alonge, Al-Amin Bhuiyan, Priyanka Agrawal, Shumona Sharmin Salam, Abu Talab, Qazi Sadeq-ur Rahman and Adnan A. Hyder.***
Epidemiology of Drowning in Bangladesh: An Update. Int. J. Environ. Res. Public Health 2017, 14, 488; doi:10.3390/ijerph14050488.
17. ***Mukesh Kumar Thakar, Sandeep Singh Sahota, Rajvinder Singh.***
Deaths due to drowning in Punjab- A survey (2005 to 2006). Medico-Legal Update, January-June 2009; 9(1): 18-22.
18. ***Amy E Peden, Alison J Mahony, Paul D Barnsley, Justin Scarr.***
Understanding the full burden of drowning: a retrospective, cross sectional analysis of fatal and non-fatal drowning in Australia. BMJ Open 2018; 8: e024868. doi:10.1136/bmjopen-2018-024868.