

Analysis of Deaths due to Drowning - A Retrospective Study

M. Sugatha¹, K. Parwathi²

ABSTRACT

Introduction: Drowning refers to death within 24 hours of a submersion incident. According to the WHO, it is the process of experiencing respiratory impairment from submersion/immersion in liquid. Determining the cause of death in bodies found in water is quite challenging which can be achieved with thorough investigation and complete autopsy after which only the pathologist certifies a death based on drowning. The experts in the field of Forensic Medicine are facing difficulties in estimation of time, cause and mode of death. Hence, the present study aimed to analyse the various aspects of drowning deaths whose Post Mortem were conducted in the mortuary of Osmania General Hospital in the year 2004.

Material and Methods: The present study was a retrospective study which was conducted among 150 dead subjects. All the dead bodies recovered from different sources of submersion irrespective of age or sex and either with fresh or decomposed bodies were included in this study. Detailed history related to place of the incident, type of water body, position of the body and other relevant findings were obtained from the previous records.

Results: The majority of the subjects with drowning were 82.6% of the males followed by 17.3% of the females. The place of drowning was found to be in ponds (41.3%) and ditch (29.3%) followed by rivers (17.3%) and lakes (8%). The time of drowning was seen in majority of the subjects i.e. 60% of subjects died 09:00-13:00 and 25.3% subjects during 13:01-18:00 followed by 8% at 0:0-8:59 and 6.6% at 18:01-23:59

Conclusion: The magnitude of drowning is higher among males in and around the jurisdiction of Osmania. It has been proved that drowning has become an undervalued problem with inclusion of child population. Hence, there is a necessity for prevention among all the ages by the government so that overall burden caused by drowning can be reduced.

Keywords: Death, Drowning, Autopsy, Retrospective

INTRODUCTION

One of the most classical definitions is provided by Roll: "death by drowning is the result of a hampering of the respiration by obstruction of mouth and nose by a fluid medium (usually water)". It is one of the most important causes of accidental death in the world, claiming approximately 1, 40,000 victims every year. According to the World Health Organization it was found that about 372,000 deaths occurred from drowning in 2012, due to which it has become the world's third leading unintentional injury killer. Drowning is a form of asphyxiation death. It is a silent killer where people while drowning may not be able to call for help, as they are expending energy to breathe or to keep their head above water.^{1,2}

In high income countries (HIC), drowning often occurs in

recreational swimming pools whereas in low middle income countries (LMICs) drowning happens in natural water bodies such as ponds, ditches, rivers, lakes, drains, sumps and dams. Lack of water safety awareness, risky behaviour around water, and perceived risk are also considered important risk factors. Globally, the common risk factors found in all the age groups were travelling on overcrowded or poorly maintained vessels and disasters related to water (e.g., flood, extreme rainfall, storm surges, and tsunamis or cyclones).^{3,4} During the drowning process, there are several phases of pathophysiology starting with phase of holding a breath followed by inspiration involuntary with gasping for air and unconsciousness. The death is due to irreversible brain damage which is secondary to the development of cerebral hypoxia. These phases are dependent on the duration for example age, pre-existing disease, tolerance of breath holding in victims and the water temperature. Consciousness is usually lost within 3 minutes of submersion.⁵

The water which is inhaled goes into the lungs in alveolar spaces which damage the surfactant leading to edema of pulmonary region with the transudation of fluid rich in protein in the alveolar spaces. The surfactant washout reduces the compliance of lung and ventilation-perfusion mismatch leading to hypoxemia secondary to non-oxygenation of blood flowing through under-ventilated portions of the lung.⁶ To find out cause of death in bodies found in water is challenging. Only after a thorough death investigation and complete autopsy the pathologist certify a death as being from asphyxia due to drowning, since it is a diagnosis of exclusion. However in spite of the proven utility of the autopsy to medical and judicial procedures, the procedure is infrequently requested even when indicated. Autopsy rates continue to fall all over the world. The situation is worse in developing countries where cultural beliefs and practices, lack of qualified personnel and poverty limit its application.⁷ The majority of bodies found in water are typically determined to have died from asphyxia due to drowning. Many have associated ischaemic cardiovascular disease,

¹Associate Professor, Department of Forensic Medicine, Osmania Medical College, Koti, Hyderabad, ²Professor and Head, Department of Forensic Medicine, Government Medical College, Mahabubnagar, Telangana, India

Corresponding author: Dr. M. Sugatha, Associate Professor, Department of Forensic Medicine, Osmania Medical College, Koti, Hyderabad, India

How to cite this article: M. Sugatha, K. Parwathi. Analysis of deaths due to drowning - a retrospective study. International Journal of Contemporary Medical Research 2019;6(4):D15-D19.

DOI: <http://dx.doi.org/10.21276/ijcmr.2019.6.4.54>

either as a contributing factor, or the underlying causative factor. Some of them are due to homicidal circumstances while others are natural or get drowned due to intoxication inspite of knowing swimming or under the influence of drugs. In a study done by Modell et al. showed that it was appropriate to apply to the latter the notion of “drowning without aspiration”. In this case, further investigations provided evidence that underlying natural disease may have contributed to and/or caused death in water.⁸

The signs of drowning are because of the delay in recovering the body and on the development of the putrefaction phenomenon which changes the positive signs of drowning as per Casper’s Dictum which accelerates putrefaction by 8 times in water. The most important sign of drowning is presence of large amount of froth from nostrils and mouth in freshly drowned bodies which is also evident in both upper and lower airways. In such cases of drowning, the volume of froth is very rich than in other origins.⁹

It has been described in the literature that diagnosis of drowning is one of the most difficult in the field of forensic medicine. Also, the external examination and the autopsy findings are not specific in most of the cases and investigations of laboratory are debatable which was also found in the literature.¹⁰ Hence, the present study aimed to analyse the various aspects of drowning deaths whose post mortem were conducted in the mortuary of Osmania General Hospital in the year 2004.

MATERIAL AND METHODS

The present study was a retrospective, which was conducted for one year during January 2004- December 2004. Total 150 cases were included in the study. All the dead bodies recovered from different sources of submersion irrespective of age or sex and either with fresh or decomposed bodies were included in this study.

Detailed history related to place of the incident, type of water body, position of the body and other relevant findings were obtained from the previous records. During post mortem examination, condition of clothing, skin changes, examination of natural orifices, injuries on body and cadaveric spasm were studied. All the three principle cavities were examined. In 20% of cases, diatoms were examined with standard protocol in tissue and samples of water collected from place of death.

The presence and quantity of fluid in the paranasal sinuses was evaluated. The quantity was expressed in one of three following categories: 1-2 mm fluid, more than 2 mm but less than 50% or filled equal or more than 50% of the volume of the sinus. The thickness of the mucosa was assessed as normal.

STATISTICAL ANALYSIS

The statistical analysis was performed by using SPSS software version 21. The descriptive statistics was used as percentages and is presented in the form of tables and graphs.

RESULTS

In the present study, the maximum subjects associated with

drowning were males 82.6% followed by females with 17.3% (Graph-1). It was found that the most frequently involved age group with drowning was 25 years to 64 years (52%) and 18-24 years (16.6%) followed by more than 65 years (16%). The least age group involved was less than 1 year and 1-4 years followed by 5-9 years and 10-14 years (Graph-2).

It was observed from Graph-3, that for majority of the subjects the place of drowning was found to be in ponds (41.3%) and ditch (29.3%) followed by rivers (17.3%) and

S. No	External feature in autopsy	Number	%
1.	Cutis Anserina	12	8
2.	Froth at the mouth and nostrils	34	22.6
3.	Soddening	52	34.6
4.	Degloving	4	2.6
5.	Congested conjunctiva	28	18.6
6.	Bluish finger nails and lips	20	13.3

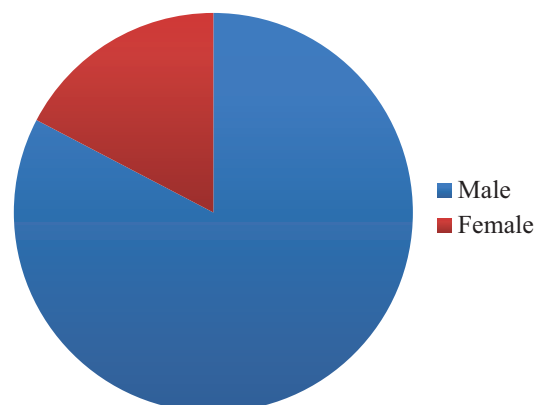
Table-1: Shows the external features in autopsy among the subjects

S. No	Internal features at autopsy	Number	%
1.	Froth in trachea	21	14
2.	Mud in trachea	4	2.6
3.	Froth in larynx	14	9.3
4.	Voluminous lungs	44	29.3
5.	Emphysema Aquosum	20	13.3
6.	Rib markings on lungs	26	17.3
7.	Paltauf’s hemorrhages	16	10.6
8.	Aorta staining	5	3.3

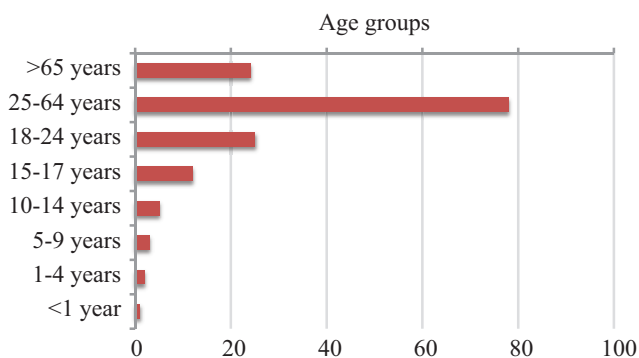
Table-2: Shows the internal features in autopsy among the subjects

S. No.	Amount of fluid in pleural cavity	Number	%
1	<100ml	22	14.6
2	100-<200 ml	67	44.6
3	200-<300 ml	34	22.6
4	300-<400 ml	12	8
5	>400 ml	15	10

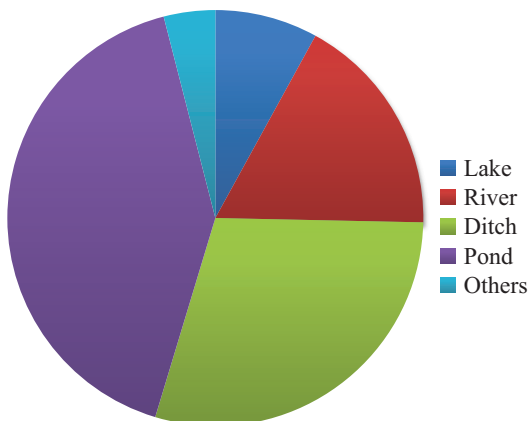
Table-3: Shows the amount of fluid in pleural cavity among the study subjects



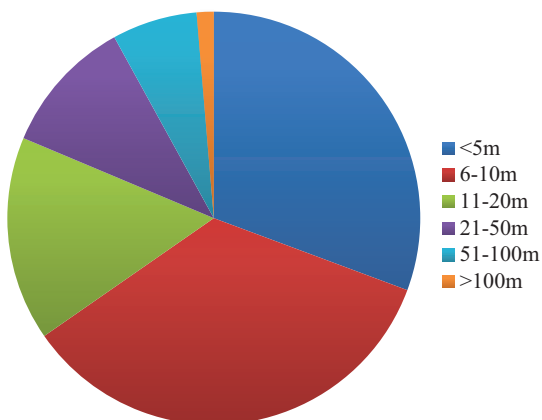
Graph-1: Shows the distribution of gender among the study subjects



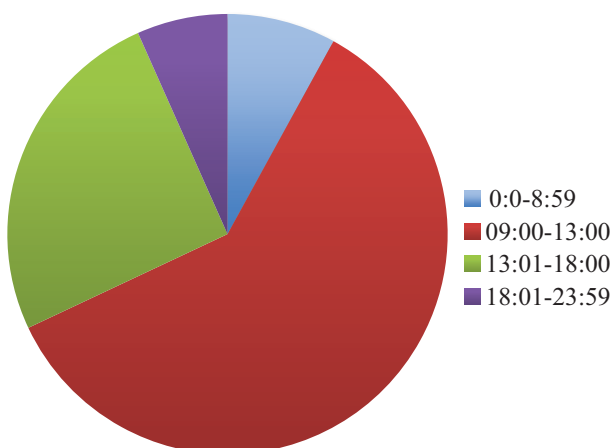
Graph-2: Shows the age group among the study subjects



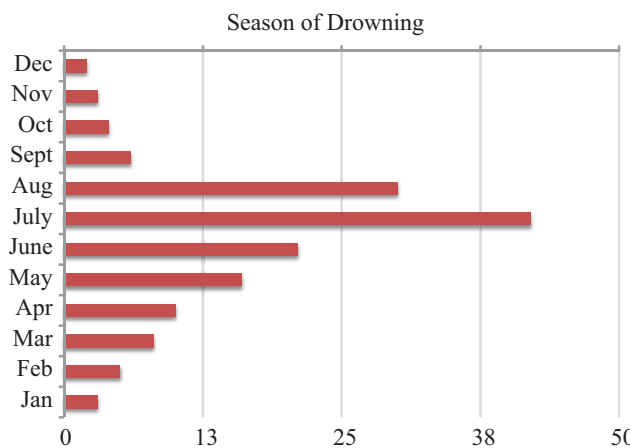
Graph-3: Shows the place of drowning among the study subjects



Graph-4: Shows the distance of water bodies among the study subjects



Graph-5: Shows the time of drowning among the study subjects



Graph-6: Shows the season of drowning among the study subjects

lakes (8%). The time of drowning was seen in majority of the subjects i.e. 60% of subjects died 09:00-13:00 and 25.3% subjects during 13:01-1800 followed by 8% at 0:0-8:59 and 6.6% at 18:01-23:59 (Graph-4).

The distance of water bodies was 6-10m among 34.6% of the subjects. About 30.6% of the bodies were found at a distance of <5m followed by 16% at a distance of 11-20 m. The least number of subjects involved at a distance of 21-50 m were 10.6% and 51-100 m was 6.6% followed by more than 1.35 at 100 m (Graph-5). The season of drowning as depicted from (Graph-6) was found that the maximum subjects were among 28% and 20% which was during July and August followed by June and May in 14% and 10.6%. The least commonly involved seasons were found to be December (1.3%), November (2%), January (2%) and October (2.6%) followed by February (3.3%), September (4%), March (5.3%), and in April (6.6%). Concentration of cases was more during the weekends.

Table no. 1 shows the external features of autopsy and was found that in 34.6% of the cases soddening and 22.6% of cases with froth at the mouth and nostrils were observed. Congested conjunctiva was seen in 18.6% of the subjects. In least number of subjects, degloving (2.6%), cutis anserina (8%) and bluish finger nails and tips (13.3%) were observed. Table-2 shows the internal features of autopsy and was seen that voluminous lungs and rib markings on lungs were observed in 29.3% and 17.3%. Very few subjects were found with mud in trachea 2.6%, aorta staining 3.3%, and froth in larynx in 9.3% subjects followed by Paltauf's haemorrhages in 10.6%, emphysema aquosum in 13.3% and froth in trachea among 14% of the subjects.

Table no. 3 shows the amount of fluid in pleural cavity, it was found that majority of the subjects 44.6% were found with 100-<200 ml and 22.6% with 200-<300ml followed by <100 ml in 14.6% of the subjects and >400 ml among 10% of the subjects. Only 8% of the subjects were observed with 300-<400ml.

DISCUSSION

The death mechanism of drowning is quite complicated with the involvement of asphyxia and filling of the airways with fluid along with effects at hydrostatic and osmotic level.

While the existence of so-called “dry drowning” is also argued, it is considered that certain victims may suffer airway obstruction from laryngeal spasm or due to vagal inhibition. The time from immersion to cardiac arrest lasts from seconds to minutes but it is increased in cold environments.¹¹

The findings in autopsy among drowning cases is usually characteristic and is not diagnostic in many cases. The first observations may be sand, weeds, grass or other vegetation covering the body, wrinkling of the skin of the hands and feet (so-called “washer-woman” changes), and injuries to the dorsum of the feet and to the knees which are seen externally. However, these findings merely show that a body has been submerged, instead has been traumatized by dragging across a river or hit against the rock bottom.¹²

The rates were higher among males for both fatal and non-fatal drowning when compared to females, which is equally observed in low middle income countries as reported by the WHO Global Report on drowning. This higher incidence in males is due to increased exposure to risky situations, increased risk taking behaviour, and involvement in activities outside the home are more in comparison to females and these findings are in concordance with the findings of the present study.¹³

In the present study, all the events of drowning took place in ponds, sumps and ditches which were located approximately 20 m from the residences of the victims, and most frequently during the annual monsoon season, which is in line with the studies reported in literature. In a study done in Bangladesh revealed that monsoon rainfalls can lead to floods with increased level of in rivers, canals, ponds, and ditches leading to higher risk of drowning among children and adults.¹⁴

It was seen that majority of the cases took place during daylight hours. This pattern of season and time of drowning are also seen in this study. Another findings at autopsy of marked pulmonary edema resulting in “emphysema aquosum” which is found to be not specific for drowning, as significant edema takes place in variety of conditions including congestive heart failure, narcotic drug overdose, or following prolonged resuscitation.¹⁵

When a body is retrieved from water there are possibilities, leading it to accidental, suicidal or homicidal case or drowning precipitated by underlying natural disease.¹⁶ In case of, the risk is 15-19 times higher among those suffering from epilepsy. So, the reason of death may not be drowning but due to an unrelated injury, accidental or inflicted, under the influence of drugs, in intoxicated state or due to natural disease. It has been seen from the literature that channel-pathies of cardiac system like LQT1, may lead to arrhythmias which can lead to death during swimming.¹⁷

The common problem that arises usually starts with the scene of death. Such scenes are uncontrolled, with long sections of rivers, or areas of sea or lakeshore which is particularly in cases of death in multiple drowning in underwater disaster victim identification/management exercises. Failure to locate a body quickly may lead to extensive changes because of decomposition and post mortem predation of animal. Variety of animals such as

aquatic fauna and fishes can harm the body significantly leading to change in shape of the body.¹⁸

CONCLUSION

The magnitude of drowning is higher among males in and around the jurisdiction of Osmania. It is clear that drowning is a worldwide most ignored public hazard with inclusion of child population. There should be significant unresolved and unresolvable issues which are related to the cause, mechanism and manner of death which should be encountered in the evaluation of individual cases

REFERENCES

1. Winskog C. Underwater disaster victim identification: the process and the problems. *Forensic Sci Med Pathol.* 2012; 8:174–8.
2. Van Beeck EF, Branche CM, Szpilman D, Modell JH, Bierens JJ. A new definition of drowning; towards documentation and prevention of a global public health problem. *Bull World Health Organ.* 2005; 83:853–6.
3. Byard RW, James RA, Gilbert JD. Diagnostic problems associated with cadaveric trauma from animal activity. *Am J Forensic Med Pathol.* 2002; 23:238–44.
4. Krishna Murthy, P. Chandra Sekhara Rao. Prospective study of mechanical asphyxial deaths. *International Journal of Contemporary Medical Research* 2018; 5:H1-H4.
5. Smith NM, Byard RW, Bourne AJ. Death during immersion in water in childhood. *Am J Forensic Med Pathol.* 1991; 12:219–21.
6. Zuckerman GB, Conway EE. Drowning and near drowning: a pediatric epidemic. *Pediatr Ann.* 2000; 29:360–6.
7. P. Chandrasekhara rao, V. Krishnamurthy, T.T.K. Reddy, V. Sivakameswara Rao. A study of hyoid bone fractures in mechanical asphyxial deaths. *International Journal of Contemporary Medical Research* 2016; 3:3317-3320.
8. Hyder A.A, Arifeen S, Begum N, Fishman S, Wali S, Baqi A.H. Death from drowning: Defining a new challenge for child survival in Bangladesh. *Inj. Contr. Saf. Promot.* 2003; 10:205–210.
9. Callaghan J.A, Hyder A.A, Khan R, Blum L.S, Arifeen S, Baqi A.H. Child supervision practices for drowning prevention in rural Bangladesh: A pilot study of supervision tools. *J. Epidemiol. Community Health* 2010; 64: 645–647.
10. Piette M, Timperman J. Serum strontium estimation as a medico-legal diagnostic indicator of drowning. *Med Sci Law* 1989; 29: 162-171.
11. Guevarra J.P, Franklin R.C, Basilio J.A, Orbillo L.L, Go J.J. Child drowning prevention in the Philippines: The beginning of a conversation. *BMC Public Health* 2010; 10:156.
12. Laosee O, Khiewyoo J, Somrongthong R. Drowning risk perceptions among rural guardians of Thailand: A community-based household survey. *J. Child Health Care* 2014, 18, 168–177.
13. Meddings D, Hyder A.A, Ozanne-Smith R.A. Global Report on Drowning: Preventing a Leading Killer. Available online at www.who.int/violence_injury_prevention/global_report_drowning/en/.

14. Shen J, Pang S, Schwebel D.C. Cognitive and Behavioral Risk Factors for Unintentional Drowning among Rural Chinese Children. *Int. J. Behav. Med.* 2016;23;243–250.
15. Rahman F, Bose S, Linnan M, Rahman A, Mashreky S.R, Haaland B, Finkelstein E. Cost-effectiveness of an injury and drowning prevention program in Bangladesh. *Pediatrics* 2012;130:e1621–e1628.
16. Abhishek Kumar, Srinivas Gupta, MSVK Raju, Anuj Sharma, Ashok Prasad. Suicide, impulsivity and its relationship to platelet serotonin levels. *International Journal of Contemporary Medical Research* 2016; 3:3077-3082.
17. Elvira VS, Cristina M, Luigi C, Stefania Z, Giulio C. Sudden death in water: Diagnostic challenges. *Case Report. Egypt J Forensic Sci* 2016; 6: 22-25.
18. Byard RW, James RA, Gilbert JD. Diagnostic problems associated with cadaveric trauma from animal activity. *Am J Forensic Med Pathol.* 2002; 23:238–44.

Source of Support: Nil; **Conflict of Interest:** None

Submitted: 01-03-2019; **Accepted:** 10-04-2019; **Published:** 03-05-2019