

A Study on Epidemiology of Drowning Accidents associated with Recreational Aquatic Activity

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여가 수중활동과 관련된 익사사고의 역학 분석 연구

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Abstract The purpose of this study was to report the incidence of drowning accident in order to prevent and decrease the accidents of drowning. Data were obtained on all accidents of drowning accidents occurred from January to December 2007 were identified by using the Emergency Activity Daily Report Data from the National Emergency Management Agency (NEMA). The age, weather, date, location, time and case of the drowning accident were examined. The Chi-square test was used to compare each group. All comparisons were made at the $p < 0.05$ level of significance. The result show that the age of drowning accidents for victims aged 20-29 was 27.9%, and for victims aged 30-39 years, 18.7%. In regard to the age group, drowning accidents during recreational aquatic activity was age 20-39; 51(44.8%). In regard to the locations, the number of drowning accidents in a lake or reservoir during recreational aquatic activity was 62(53.4%). The number of drowning accidents in a lake or reservoir during etc was 51(58%). In regard to the days, the number of drowning accidents on Saturday during recreational aquatic activity was 30(25.8%), on Sunday 32(27.6%). The weather of drowning accidents during recreational aquatic activity was sunny 60(51.8%), rainy 40(34.4%), cloudy 16(13.8%). The season of drowning accidents during recreational aquatic activity was summer 53(45.7%). In regard to season, two groups are significantly different. Drowning is a leading cause of injury related accidents. Understanding the characteristics of drowning is the first step to developing prevention strategies that may be beneficial for people of all ages and under nearly all circumstances are increased swimming ability, lifeguard staffing, providing life jackets, and public education activities.

요 약 이 연구의 목적은 익사 사고를 방지 하기 위해 익사사고 발생율을 조사하고자 한다. 익사 사고의 역학 조사 데이터는 중앙응급의료기관에서 2007년 1월부터 12월까지 발생 한 익사 사고 일일 보고서 자료를 수집했다. 나이, 날씨, 시간, 위치, 익사 사고 사례 조사를 했으며, 자료처리는 수중 활동 집단과 기타활동 간 비교를 위해 Chi-square test 를 이용하였다. 유의도 검증은 $p < 0.05$ 수준이다.

연령은 20-29세 27.9%이며, 30-39세는 18.7%로 나타났다. 여가 수중활동 중 익사자의 연령은 20-39세 51(44.8%)에서 가장 높았다. 장소에 따른 비교를 한 결과, 여가 수중활동 중 호수나 저수지에서 익사 사고의 수는 62명(53.4%)이다. 반면에 호수나 저수지에서 기타활동 중 익사 사고의 경우는 51(58%)명이었다. 여가 수중 활동 중 익사 사고가 토요일에 30(25.8%), 일요일에 32(27.6%)로 나타났다. 날씨가 화창한 날에 여가 수중 활동 중 익사한 경우가 60(51.8%)로 많았다. 비오는 날은 40(34.4%), 흐린 날은 16(13.8%)였다. 여가 수중활동 중 익사한 경우 여름이 53(45.7%)였다. 계절에 의하면 여가 수중활동과 기타활동 간에 유의한 차이가 있다.

익사는 상해의 주요 원인이며, 한국에서 익사의 특성을 이해 하는 것은 익사사고예방 전략을 개발 하는데 기초자료이다. 예방 전략은 모든 연령대의 사람들을 위해 도움이 될 수 있다. 사고현장의 모든 상황에서 lifeguard 인력, 라이프 재킷, 수영능력 그리고 공공 교육 활동을 제공해야한다.

Key words : Epidemiology, Drowning, Emergency, Public eduction

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1. Introduction

Drowning is the second leading cause of unintentional injury death globally after road traffic injuries[1]. In 2000, an estimated 449,000 people drowned worldwide[2]. Strategies to prevent these accidents depend upon characteristics of the victim, such as age, and the specific circumstances surrounding the events, which may vary by country. For example, in many developed countries pool drownings are an important cause of drowning among toddlers. Four-sided pool fencing, which isolates a pool from the home, is an effective prevention strategy. However, fencing did not prevent a portion of the drownings, primarily in those situations in which the toddler gains unauthorized access to the pool[3]. Pool fencing also would not prevent drownings that occur when the toddler is known to be in the pool area or drownings in other settings, such as rivers or lakes. Lifeguards are one strategy to use with older age groups, but, unfortunately, it is impossible for lifeguards to cover all bodies of water at all times[4].

One preventive strategy that may be beneficial for persons of all ages, and under nearly all circumstances, is increased swimming instruction. However, a clear protective relationship between increased swimming ability and the risk of drowning has never been demonstrated. Although data are limited, the available evidence suggests that many drowning victims are able to swim[5].

According to a report of domestic, living environment changes and water leisure sport is widely advertised as an increased frequency of occurrence of drowning death[6]. The damage information report is estimated the caused scale as the domestic drowning injury[7]. Drowning injuries occur differently based on geographic and social characteristics; therefore, local characteristics should be considered to establish preventive measures[8]. The death group had respiratory acidosis. Because the survival group did not show significant hypernatremia, isotonic saline as an initial fluid was thought to be appropriate[2].

As evidenced by the lack of citations of patents in the scientific literature, academic researchers very rarely use patent databases. Thus, inventions that might have significant potential to prevent drowning can be overlooked and research effort and resources may be

spent reinventing similar devices. Therefore, this paper seeks to report the data from National Emergency Management Agency (NEMA) about the incidence and characteristics of drowning in the review the current evidence regarding the prevention and accidents of drowning in Republic of Korea(9).

This research separate between recreational aquatic activity and etc factors that will provide the basic research to prevent the drowning accident.

2. Methods

The study subjects are drowning deaths that occurred from January to December 2007. This period was chosen because this was the earliest 12-month period covered by National Emergency Management Agency and so could be expected to have the largest proportion of cases completed. In this study a search was made of Korea with the Emergency Activity Daily Report Data from the National Emergency Management Agency. The number of the drowning deaths was 204 cases(9).

In addition, searches were undertaken of the National Emergency Management Agency website looking for cases with conditions other than drowning that might have occurred in the water leading to an initial report of drowning. For each of the drowning cases that was closed, the unit record file on the National Emergency Management Agency website was inspected.

In this study, 204 cases are divided to recreational aquatic activity group and etc group by drowning reason. And two groups are compared by age, date, weather, location and season.

Collected data were analyzed using SPSS WIN version 13. The Chi-square test was used to compare each group. All comparisons were made at the $p < 0.05$ level of significance.

3. Results

The number of drowning victims under age 10 was 17 (8.3%) with a lack of risk factor recognition. The age of drowning accidents for victims aged 10-19 was 15.7%. The age of drowning accidents for victims aged 20-29

was 27.9%, and for victims aged 30-39 years, 18.7%. The age of drowning accidents for victims aged 40-49 was 15.2%. The number of drowning victims over age 50 was 29 (14.2%)(Table 1).

[Table 1] The number of the drowning deaths

Age(Year)	Case count	%
<10	17	8.3
10-19	32	15.7
20-29	57	27.9
30-39	38	18.7
40-49	31	15.2
>50	29	14.2
Total	204	100

In regard to the age group, the number of under age 19 of drowning accidents during recreational aquatic activity was 23(19.8%), age 20-39; 51(44.8%), over age 40; 42(36.2%). The number of under age 19 of drowning accidents during etc was 26(29.5%), age 20-39; 44(50%), over age 40; 18(20.5%). In regard to age, two groups are significantly different($p<0.000$)(Table 2).

[Table 2] The age of the drowning deaths

Age(Year)	Recreational Aquatic Activity	etc	p value
≤19	23	26	0.000
20-39	51	44	
≥40	42	18	
Total	116	88	

In regard to the locations, the number of drowning accidents in a lake or reservoir during recreational aquatic activity was 62(53.4%), in the sea or beach 37(31.9%), in a valley (14.7%). The number of drowning accidents in a lake or reservoir during etc was 51(58%), in the sea or beach 17(19.3%), in a valley 20(22.7%). In regard to locations, two groups are significantly different($p<0.05$) (Table 3).

[Table 3] The locations of the drowning deaths

Weather	Recreational Aquatic Activity	etc	p value
Lake or River	62	51	0.039
Sea or beach	37	17	
Valley	17	20	
Total	116	88	

In regard to the days, the number of drowning accidents on Saturday during recreational aquatic activity was 30(25.8%), on Sunday 32(27.6%). Nearly half of the drowning accidents occurred during the weekend. The number of drowning accidents on Saturday during etc was 16(18.2%), on Sunday 14(15.9%). According to the days, recreational aquatic activity and etc are significantly different($p<0.000$) (Table 4).

[Table 4] The days of the drowning deaths

Date	Recreational Aquatic Activity	etc	p value
Monday	10	13	0.000
Tuesday	9	12	
Wednesday	11	13	
Thursday	12	11	
Friday	12	9	
Saturday	30	16	
Sunday	32	14	
Total	116	88	

The weather of drowning accidents during recreational aquatic activity was sunny 60(51.8%), rainy 40(34.4%), cloudy 16(13.8%). The weather of drowning accidents during etc was sunny 31(35.3%), rainy 39(44.3%), cloudy 18(20.4%). In regard to weather, two groups are significantly different($p<0.000$) (Table 5).

[Table 5] The drowning cases by weather

Weather	Recreational Aquatic Activity	etc	p value
Sunny	60	31	0.000
Cloudy	16	18	
Rainy	40	39	
Total	116	88	

The season of drowning accidents during recreational aquatic activity was spring 22(18.9%), summer 53(45.7%), fall 19(16.4%), winter 22(19.0%). The season of drowning accidents during etc was spring 22(25%), summer 24(27.3%), fall 26(29.5%), winter 16(18.2%). In regard to season, two groups are significantly different($p<0.05$). According to season, during recreational aquatic activity, nearly half of the drowning accidents occurred during summer (Table 6).

[Table 6] The season with the drowning deaths

Date	Recreational Aquatic Activity	etc	p value
Spring	22	22	0.045
Summer	53	24	
Fall	19	26	
Winter	22	16	
Total	116	88	

4. Discussion

It is intuitive that most drowning cases would occur in warm sunny summer weather, however this study quantifies the degree to which this is a factor. Nearly half of the drowning accidents occurred during summer and nearly half of these occurring on the weekends and mostly during sunny hot weather. These factors become important when formulating prevention strategies to consider staffing requirements, lifeguards, or the timing of public education campaigns(10).

This study identified 204 drowning deaths that occurred in Korea from 1 January to 30 December 2007. The estimated contribution was high for people engaged in recreational aquatic activity including swimming (56.9%) and low in drowning due to ect including occupation (43.1%).

In this study, we investigated the difference of drowning deaths between people engaged in recreational aquatic activity including swimming and due to ect including occupation.

In regard to the age, victims aged 10-19 was 15.7%, 20-29; 27.9%, and over age 50; 14.2%. According to annual report, the incidences of drowning-related injury were 2,486 in 2001, 2,364 in 2002, and 2,595 in 2003 (average of 2,482). The average annual death were 1,954. Victims were more likely to be male and especially high incidence rates were found for two groups: (1) Children aged 5-9 years, (2) Adults aged 40 and older[11].

In regard to the age group the proportion of under age 19 of drowning accidents during recreational aquatic activity was 19.8%, age 20-39; 44.8%, over age 40; 36.2%. The proportion of under age 19 of drowning accidents during etc was 29.5%, age 20-39; 50%, over age 40; 20.5%. So, government has to make a special

prevention strategy for age 20-39.

In regard to the locations, the proportion of drowning accidents in a lake or reservoir during recreational aquatic activity was 53.4%, in the sea or beach 31.9%, in a valley 14.7%. The proportion of drowning accidents in a lake or reservoir during etc was 58%, in the sea or beach 19.3%, in a valley 22.7%. It is important to note that there are no lifeguards, rescue equipment or life jackets for people at lakes or beaches. A prevention strategy for providing life saving equipment at designating swimming areas would be expected to reduce the mortality from these causes.

The weather of drowning accidents during recreational aquatic activity was sunny 51.8%, rainy 34.4%, cloudy 13.8%. The weather of drowning accidents during etc was sunny 35.3%, rainy 44.3%, cloudy 20.4%. In regard to weather, two groups are significantly different.

According to season, during recreational aquatic activity, nearly half of the drowning accidents occurred during summer. The seasonal distribution of incidence rates showed that predictably, incidents were most frequent between the beginning of July and September(12).

The results of this study show that reason of drowning deaths is a key to prevent drowning accidents. In other words, to make more effective prevention strategies, government has to make two types of plan according to reason of drowning deaths.

The main circumstance types involved in the drowning cases were recreational aquatic activity, with half of swimming and incidental incidents involved the drowning accidents of a person attempting to rescue a family member or friend from the water. The fact that such a large number of cases involve recreational swimming activities suggest that prevention strategies must target the recreational swimmers. In addition, the large number of persons who drown while attempting to rescue a swimmer in distress suggest that prevention strategies should be aimed at helping rescuers of drowning victims by equipping them with life saving gear. Potential solutions might be legislation or regulations that require life rings at every pool side or in designated swimming areas with instructional signage.

The strategy to increase swimming ability in the population is inherently attractive because, if effective, it could decrease drowning risks in a number of situations,

for all age groups, and could potentially be effective in both developed and developing countries. It is most likely however that multiple interventions and activities will be required to reduce the incidence of drowning.

4.1 Study Limitations

The analysis presented here was based only on closed cases in NEMA. The main determinant of whether a case is closed or open is the time since the accidents occurred. Therefore, there are few reasons that would suggest that closed cases might differ importantly to open cases, especially in terms of the involvement of alcohol[13-14]. It is difficult to assess the effect that a lack of information on cases might have had on identifying drowning accidents and adequately understanding how they occur. There were several examples of drowning accidents that were not initially identified because the case was still open and there was insufficient information in NEMA to allow the accidents to be identified as being due to drowning[15]. The comparison to national accidents data suggests this was not a major problem, at least in terms of identifying drowning accidents. Detailed findings, including patient numbers, are available elsewhere[16]. Unfortunately, the NEMA files were incomplete in regards to specific information involving weather statistics, causes. As a result of this, we were unable to use approximately 50 files. This study is based on the remaining 204 files.

5. Conclusion

This analysis is one of the first uses of the NEMA as an information source for significant drowning accidents in a warm weather country. The use of firefighter and police investigation pro forma, which includes focus on the timing and circumstance, would make a considerable contribution to better understanding how and to what extent alcohol use contributes to drowning accidents, and how such contribution might be prevented. It is difficult to assess the effect that a lack of information on cases might have had on identifying drowning accidents and adequately understanding how they occur. The data demonstrate that most drowning occur during warm

summer weekend days at lakes and river. Understanding the most frequent characteristics of drowning in the Republic of Korea is the first step to formulating prevention strategies. It is likely that effective prevention of drowning in the Republic of Korea will be consistent with better equipment and with public educational campaigns designed to decrease the drowning rates. Understanding the characteristics of drowning in the Republic of Korea is the first step to developing prevention strategies. Effective preventive strategies for most swimming situations for persons of all ages are : 1) increased swimming abilities 2) effective lifeguard staffing 3) availability of life jackets and life rings 4) public education activities.

References

- [1] World Health Organization, "Facts about injuries: Drowning ", Violence and injury department, 2003.
- [2] Peden, M. M, McGee, K, "The epidemiology of drowning worldwide", Injury Control and Safety Promotion, pp. 195-199, 2003.
- [3] Harborview Injury Prevention and Research Center "Systematic reviews of childhood injury prevention interventions: Drowning", <http://depts.washington.edu/hiprc/childinjury>. accessed February 5, 2008,
- [4] Branche C. M, Stewart, S, "Lifeguard effectiveness: A Report of the working group: Center for Disease Control and Prevention". 2001.
- [5] Barss, P, "In collaboration with The Canadian Red Cross. National Drowning Report. Visual Surveillance Report: 2000 Edition. The Canadian Red Cross Society, 2000.
- [6] Jung DB, Analysis of predictive factors in the assessment of near-drowning in children. J Korean Soc Emer Med. 9, pp. 437-444. 1998.
- [7] Available at : injury.cdc.go.kr. Shin SD. The epidemiologic characteristics of drowning in Korea.
- [8] Kim HB, Analysis of the Clinical Features and Prognostic Factors in Sea Water Drowning Patients. J Korean Soc Emer Med. 9, pp. 242-247. 2011.
- [9] National Emergency Management Agency, " Emergency Activity daily Report Data 2006-2007", <http://www.nema.go.kr/data/statistic>. accessed April 25, 2008.
- [10] English D, Holman C, Milne E, Winter M, Hulse G,

Codde J, Bower C, Corti B, de Klerk N, Knuiman M, Kurinczuk J, Lewin G, Ryan G, "The Quantification of Drug Caused Morbidity and Mortality in Australia 1995. Commonwealth Department of Human Services and Health: Canberra", 1995.

- [11] Kim K., Kim JY, Shin SD, "The Epidemiologic Characteristics of Drowning in Korea", J Korean Med Assoc. Vol.19. pp. 527-534, 2008.
- [12] Poseidon Technologies, "The Poseidon System", www.poseidon-tech.com/us/company.html accessed 20 August 2007.
- [13] Driscoll T, Harrison J, Steenkamp M, "Review of the role of alcohol in drowning associated with recreational aquatic activity", Injury Prevention. Vol. 10, pp. 107-113, 2004.
- [14] Gunatilaka, A. and Owanne-Smith, J, " A survey of inventions aimed at preventing drowning: Study report, November", www.monash.edu.au/muarc/reports/papers/drowning.html. accessed April 10, 2008.
- [15] Howland, J., Hingson, R, "Alcohol as a risk factor for drownings: a review of the literature" Accident Analysis and Prevention. Vol. 20, pp.19-25, 1988.
- [16] Gooden B, "Drowning and alcohol", Medical Journal of Australia. Vol. 11, pp. 175-181, 1984.

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