Epidemiology of unintentional drowning incidents of visitors at Lake Mead National Recreation Area, 2000-2010

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\textbf{ABSTRACT}

The purpose of this cross-sectional design study was to develop baseline data on trends and distribution of unintentional drowning incidents and risk factors contributing to fatalities during 2000-2010, at Lake Mead National Recreation Area (LMNRA). The three”Es” injury prevention conceptual model served as the framework for this study. The data collected were based on date of incident, time of injury, air temperature, gender, age, race/ethnicity, place of residence, pre-death recreational activity. Geographic Information System (GIS) was used to plot drowning incidents that occurred at LMNRA during 2000-2010. Descriptive statistics were used to organize, describe, summarize, and simplify the data. The results revealed that male visitors were victims of 86% of the fatalities during 2000-2010 at LMNRA. Most of the drowning incidents occurred among visitors between 25-44 years old. The relationship between unintentional drowning and usage of a personal flotation device was statistically significant \((r = -.376, p< 0.01)\). In addition, the relationship between age and alcohol use was statistically significant \((r = .196, p< 0.05)\). The study recommended several priorities for prevention and planning. The results from this study should be used to inform the development of hypotheses for case control studies designed to establish risk factors for drowning.

\textbf{Keywords}: Unintentional drowning, Personal Flotation Device, Alcohol, Lake Mead National Recreation Area, National Park Service.
Introduction

Injury is probably the most under recognized public health problem facing the nation (Committee on Trauma Research et al., 1985). Injury prevention has not traditionally been perceived as a major public health issue. Rather, injuries have been viewed as unavoidable “accidents” that are part of everyday life (Sleet et al., 2004). “Injuries affect all populations, regardless of age, sex, income, or geographic region” (Krug et al., 2000, p.523).

Injuries are a public health problem affecting local and international populations worldwide (Cortes et al., 2006). While there is an element of risk involved in many activities undertaken by individuals in their daily lives, the degree of risk experienced by visitors at national parks can be influenced by activities they participate in. For example, water-related activities such as boating, swimming and cliff diving, surf sports, fishing, and white-water rafting are often associated with serious injuries, and even fatalities incurred by visitors at national parks (Shyr, 2012).

On August 25, 1916, President Woodrow Wilson signed the act creating the National Park Service (NPS). Currently, there are 394 national parks that are developing programs with the health care community to highlight the unique role of parks in promoting health (Johnson, 2011). In essence, the history and development of recreation and tourism is closely affiliated with the development of national parks. From 1962-October, 2012, visitation to U.S. National Parks increased from 32 million to 254 million (Heggie, 2005; National Park Service et al., 2012). Many of us who visit national parks do so in order to access various elements of nature. However, an element that is often overlooked is that many national parks are inherently hazardous places that attract large numbers of visitors into environments that have been shaped by natural forces of great magnitude (Dingwall et al., 1989). Jon Jarvis, director of the National Park Service, said in an interview on C-SPAN: “The thing to remember is that our national parks have hazards. Our job is to inform the public of what they need to do to protect themselves, not fence off those hazards” (Bello, 2011).

The Pacific West Region (PWR) welcomed approximately 20% of all park recreation visits in 2007 to park units in PWR, and approximately 31% of all NPS fatalities occurred in the PWR. Data gathered from the Morning Repost during a one year period revealed that most common causes of unintentional fatalities in all parks are due to drowning, motor vehicle crashes, and falls (Newman & Chanlongbutra, 2008). An average of three visitors die in our national parks every week (due to unintentional injuries); water-related recreational activities accounted for 24% of visitors fatalities in 2010, and 76% of male visitors were victims of recreational fatalities in 2010. Also, in 2010, most of NPS fatal visitor injuries occurred within the 22-34 age group (Newman, 2011).

The Lake Mead National Recreation Area is the sixth most visited park, and is the third largest area of the National Park Service System outside of Alaska, with 1.5 million acres of land and another 200 acres of water within its boundaries. Lake Mead National Recreation includes Lake Mead and Lake Mohave reservoirs, portions of the Colorado River and the surrounding desert uplands of Nevada and Arizona. About 8-10 million visitors come to Lake Mead National Recreation Area each year. Its name conjures up the image of water, and it delivers 290 square miles of it on which to boat, fish, sail, and water ski. However, boating and swimming are the major forms of water recreation during the summer months when lake temperatures warm into the 80 degrees range (National Park Service et al., 2010).

Unintentional drownings accounted for 37% of fatalities in U.S. national parks during 2007-2011. During the same period, Lake Mead National Recreation Area accounted for the most fatalities (Shyr, 2012). In order to reduce unintentional drownings, Lake Mead personnel are interested in determining the burden of the problem. Thus, the purpose of this descriptive study was to develop baseline data on trends and distribution of
unintentional drownings and risk factors contributing to fatalities during 2000-2010. To our knowledge, no published studies have examined drowning incidents at Lake Mead National Recreation Area. For the purpose of this research, unintentional drowning was defined as fatalities from water-related recreational activities (e.g., boating, swimming, cliff jumping/diving, fishing, and surfing).

It is anticipated that the results of this study will help Lake Mead to more effectively target water-related unintentional injury prevention efforts. In addition, we hope this study will provide a science-based approach to understanding the major causes of unintentional drowning incidents at LMNRA. By gaining a better understanding of unintentional drowning, educational efforts and resource allocation can be better targeted for visitor’s risk management. Having knowledge of fatality trends, pre-death activities, and the factors contributing to fatalities is valuable information for recreational travelers in national parks. Because Lake Mead is the largest reservoir in the United States in maximum water capacity, it is anticipated that this study will identify some key issues for future research pertaining to unintentional drowning incidents.

**Materials and methods**

This study utilized cross-sectional (descriptive) design methodology because of its ability of describing variables and their distribution patterns. Cross-sectional designs can also provide valuable information about prevalence, as well as examining the associations of variables (Cummings et al., 2007). However, according to Vogt (2005, p.72), “cross-sectional studies provide only indirect evidence about the effects of time and must be used with great caution when drawing conclusions about change.”

To fulfill the purpose of the study, the following research questions were addressed:

- Which visitors (based on gender, race, and age group) are more likely to be victims of water-related fatalities at Lake Mead National Recreation Area?
- What months, days, time of day, and where are unintentional drowning incidents more commonly occurring at Lake Mead National Recreation Area?
- What is the relationship between unintentional drowning and selected variables (alcohol, age, weather, usage of life vests)?

The cross-sectional data used for this study were obtained from Lake Mead National Recreation Area Incident Reports from January 1, 2000-December 31, 2010. Approval to access files of the Incident Reports was obtained from the Chief Ranger at Lake Mead National Recreation Area. Inclusion criteria for this convenience sample (n = 116) consisted of all water-related recreational fatalities from unintentional drowning incidents. Exclusion criteria included all suicide and homicide files, and files with unknown or unspecified cause of fatality.

The data were coded and then processed through the Visitor Injury Data System (VIDS), in summer of 2012. Microsoft Access 2010 database was the primary mode of data entry. The Visitor Injury Data System was developed by the National Park Service through its Public Risk Management Program. VIDS allows parks to compare their data to other parks and to combine data for national comparisons. Activity, cause of injury, nature of injury classifications within VIDS are based on definitions used by the Centers for Disease Control and Prevention’s Web-based Injury Statistics Query and Reporting System (WISQUARS). CDC’s WISQUARS is classified as an interactive database that provides fatal and non-fatal incidents and adapted for the specific use of categorizing the unique outdoor and recreational activities relevant to visitor’s experiences in national parks.
Data collected were based on: date of incident, time of injury, wind speed, air temperature, gender, age, race/ethnicity, pre-death activity, and primary contributing factor(s) of each incident. Geographic Information (GIS) was used to plot drowning incidents that occurred at LMNRA during 2000-2010. Statistical Package for the Social Sciences (SPSS), Version 20 for Windows was used to analyze the data. Frequencies, percentages, cross-tabulations, measures of central tendency, variability, and correlations were used to describe the direction of relationships between variables. The magnitude of relationships were interpreted using Davis’ (1971) descriptors (negligible = .00 to .09; low = .10 to .29; moderate = .30 to .49; substantial = .50 to .69; very strong = .70 to 1.00). The minimum acceptable size for a correlational analysis is considered by most researchers to be no less than thirty. Samples larger than thirty are much more likely to provide meaningful results (Fraenkel & Wallen, 1993).

The proposal for this study was reviewed and approved by University of Nevada, Las Vegas, School of Community Health Sciences graduate and ethical committee.

Results

**Demographic data of visitors of unintentional drowning incidents (2000-2010)**

Of the 116 incidents, local visitors (i.e., from Nevada) accounted for 58.60%, other states accounted for 37.1%, and international visitors accounted for 4.3%. Over four-fifths (86%) of the fatalities occurred among male visitors. The ages of visitors ranged from 4-70 years with a mean of 35.67 years (SD = 16.01). The distribution of age categories (see Figure1) revealed that 38% of unintentional drowning incidents were attributed to visitors in the age group of 25 to 44 years. Visitors in the 45 and above category were more likely to be victims of boating incidents. Swimming and diving incidents appear to be equally common among visitors 15 to 44 years old.
During 2000-2012, Whites and Hispanics accounted for most of the water-based fatalities when compared to Blacks and Asians. Whites were more likely to be victims of boating fatalities when compared to other ethnic groups in the study (see Figure 2).
Figure 2. Frequency of drowning incidents by race at LMNR (2000-2010).

*Distribution of fatalities based on months, time of day, and days of the week*

Fatalities peaked during the month of August and were lowest in March and November. Combined, May, June, and August accounted for most of the fatalities (58%) (see Figure 3).
Figure 3. Monthly distributional unintentional drowning incidents at LMNRA (2000-2010)

Of the 116 incidents, 72 (62%) occurred between noon and 6:00 PM (see Figure 4). Recreational visitors’ fatalities (56%) were most common on Saturdays and Sundays (see Figure 5). Overall, there was an average of 10.54 drowning victims per year.
Figure 4. Distribution of unintentional drowning incidents by time of day at LMNRA (2000-2010)
Figure 5. Distribution of fatalities by day of week at LMNRA (2000-2010)

Data from GIS charting revealed the clusters of drowning incidents at LMNRA during 2000-2010 (see Appendix).
Usage of personal flotation devices

Almost three-quarters (71%) of the victims were not wearing a personal flotation device (PFD) at the time of their death. Commonalities existed between Hispanics and Whites in their lack of PFD usage at the time of their death during 2000-2010. On the other hand, when compared to other ethnic groups in this sample, Whites were more likely to be wearing a PFD at the time of selected unintentional drowning incidents during 2000-2010 (see Figure 6). Visitors within the 15-24 (31%) and 25-44 (40%) age groups were less likely to be wearing a PFD at the time of their death at LMNRA during 2000-2010.

![Usage Rate of PFD](image)

*Figure 6. Usage of PFDs by ethnic groups at LMNRA (2000-2010)*

Use of Alcohol

Three-quarters (75%) of the unintentional drowning incidents accounted for no usage of alcohol at the reported time of fatality (fatalities). There were no reported cases of alcohol use among Blacks when compared to the other ethnic groups in this study. Six percent (seven) of the reported incidents among age groups were classified as “unknown.”
Relationship between unintentional drowning and selected variables

The relationship between unintentional drowning and PFD usage was moderate, negative, and significant (r = -0.376, p < 0.01). There was also a significant and low negative relationship between unintentional drowning and gender (r = -0.265, p < 0.01).

Relationship between other variables of interest

There was a significant and low positive relationship between age and PFD usage (r = 0.189, P < 0.05). In addition, the relationship between age and alcohol use was significant, positive, and low (r = 0.196, p < 0.05).

Discussion

The results from this study are generalizable only to the 116 incidents in this study.

Risk factors: gender and age

Based on the findings of this study, an indicative risk factor seems to be gender. The ratio of male to female drowning rates was 6:1. This suggests that males appear to be clearly overrepresented when one considers unintentional drowning incidents. The risk by gender may be attributed to increase time spent in water-related activities and risk-taking behaviors among males (O’Carroll et al., 1988; Wintemute, et al., 1977). Comparable studies consistently reported that males accounted for around 90% of boating related fatalities/drownings (Smith, et al., 2001; O’Connor et al., 2005). International Life Saving Federation (2007) states that the most common activities in which men engaged in as they drowned were boating and swimming. This statement is supported by the results of this study.

Unintentional drowning incidents were more likely to be higher for visitors from 25-44 years. This finding suggests that age and inexperience may have a role in unintentional drowning incidents. Molberg et al., (1993), reported that young operators (aged < 30 years) had almost 5 times the odds of being involved in a fatal boating incident than older operators.

Months, days, time of day, and location

During 2000-2010, most unintentional drowning incidents at LMNRA were more likely to occur during summer months, Saturdays and Sundays, and between noon and 6:00 PM. These findings appear to correlate with the peak time of outdoor recreation in National Park Service units, and corresponding summer vacation period. Based on the GIS mapping information, unintentional incidents were more likely to occur at Boulder Beach and Callville Bay. These incidents were probably attributed to selected factors that cause human error (e.g. fatigue, inappropriate activities, and inappropriate responses).

Relationship between unintentional drowning and selected variables

A summary of correlational analyses suggest the following: As unintentional drowning incidents increased, it appears that usage of PFDs were likely to decline among visitors. Male visitors were more likely to be victims of unintentional drowning incidents when compared to their female counterparts. As unintentional drowning incidents increased among visitors within the 15-24 and 25-44 age groups, not wearing a PFD also increased. It appears that alcohol use was not a major contributing factor of unintentional drowning incidents among victims within the various age groups during 2000-2010).

Limitations of the study
• Because Lake Mead is the largest reservoir in the United States in maximum water capacity, causes and risk factors in this study are regional and may not apply to other regions.

• It may be difficult to assess whether pre-existing health morbidities contributed or caused selected unintentional drownings,

• It may not be possible to adjust for other variables that might affect risk, such as swimming ability, boating skills and experience.

• Because convenience sampling was used in this study, “generalizations must be made on the basis of non-statistical considerations” (Daniel, 2009, p.166).

Conclusion

These drowning incidents that LMNRA experiences are a preventable occurrence, thus the information obtained from this study should be used to develop more effective prevention strategies. The results of this study suggest that the following variables may serve as potential predictors of unintentional drowning research: gender, usage of PFDs, alcohol consumption, and age. Effective forms of risk reduction prevention by LMNRA should be based on the three “Es” prevention model, education, enforcement, and engineering:

5.1. Education/Environmental

• Conduct PFD public education/promotion campaigns.

• Conduct boater training to include information on the risk of alcohol.

• Use public education to explain the risks of drowning if alcohol is consumed while participating in natural water activities.

• Create specific lake safety awareness messages to address residents and non-residents.

• Develop prevention materials that target high risk groups.

Enforcement

• LMNRA needs to increase ranger patrols and safety education efforts during noon to 6:00 PM at selected locations identified by GIS.

• Apply for grant funding to assist in acquiring needed resources to employ lifeguards at selected sites during summer months.

• Create signage that is site and hazard specific at targeted areas identified by GIS.

Engineering/Environmental Strategies

• Continue to investigate new designs and models in emergency response equipment.

• Expand on state wide drownings database to input statistics in a consistent and detailed system.

• Continue risk reduction strategies focused on reducing drowning incidents to help attract more visitors to LMNRA.
Appendix: Geographic Information System (GIS) showing clusters of unintentional drowning incidents at LNMRA (2000-2010)

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