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Characterizing surf zone injuries from the five most populated beaches on the Atlantic-fronting Delaware coast

Delaware surf zone injury demographics

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ABSTRACT

Introduction: Beaches are a popular destination for recreation activities. Surf zone injuries (SZI) can occur resulting from a variety of in-water activities. Little is known regarding the sustained injury types, or demographics of injured persons and activities leading to injuries.

Methods: This study examines the distribution of SZI types, activities and populations occurring on Delaware Beaches as recorded by a local level III trauma center (Department of Emergency Medicine at Beebe Healthcare in Lewes, Delaware).

Results: There were 2021 injuries over the eight study years (2010–2017). The relative demographics of the injured population are similar despite fluctuating injury totals (mean [SD], 253.1 [104.4]). Non-locals (n = 1757) were 6.7 times more likely to be injured as their local (n = 264) counterparts (RR, 2.62; 95% CI, 2.08–3.31). Males (n = 1258) were 1.7 times more likely to be injured than their female (n = 763) counterparts (RR, 1.29; 95% CI, 1.21–1.37). Serious injuries, defined as patients requiring admission to a trauma service, represented 9.1% (n = 184) of injuries. Fatal SZI (n = 6) were categorized as serious injuries. Wading (50.1%) was found to be the dominant activity associated with injury followed by body surfing (18.4%), and body boarding (13.3%).

Conclusion: To the authors' knowledge, this study is one of the first to investigate long-term trends in SZI data, injury activity, and demographics. Better understanding of the characteristics of injuries will allow for improved awareness techniques, targeted at populations with higher injury rates.

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1. Introduction

Beaches are widely associated with tourism and recreation. People visiting beaches as tourists are often unaware or unfamiliar of oceanic processes, resulting in neglect of beach dangers [1]. Lack of awareness of potential beach hazards is problematic and results in several hundred injuries to water users each summer in Delaware alone [2]. Water users (WU) were defined as those beachgoers who were clearly in the water and potentially at risk of injury. Surf zone injuries (SZI) range in severity from minor sprains and fractures to life altering spinal injuries and even fatalities [2]. The financial cost to injured persons and their family can vary from a few thousand dollars for an isolated emergency department visit to millions of dollars in lifetime medical care for patients left with permanent disabilities [3]. The emotional damage can be devastating, especially in the case of permanent disability or fatality.

Delaware beaches are guarded between the hours of 0900 and 1700, seven days a week from Memorial Day (last Monday of May) until Labor Day (first Monday in September). They are heavily used with estimated summer attendance at five of the most populated beaches exceeding 7.5 million persons [4]. Puleo et al. [2] estimated 1–2.5 WU per linear meter of beach on crowded days. SZI occurring at beaches other than the five most populated beaches included in the study represented only <0.2% of the total injuries recorded. Delaware beaches receive visitors from many states and countries. However, most visitors arrive from upstate Delaware, or the surrounding Mid-Atlantic states of Virginia, Maryland, Pennsylvania, and New Jersey.

Previous studies involving beach risks identified hazards both internationally and in the United States (USA). The majority of past research involved rip currents and investigated drowning occurrences [5–7]. Rip currents are estimated to be the source of 80% of beach related rescues in the USA [4]. However, rescues might not be as prevalent in locations like DE, due to the local morphology and hydrodynamics. For example, in 2016 there were 26 SZI and 13 rip-related rescues at Dewey Beach, DE [4]. There has been some research on surf-related injuries resulting from

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activities such as shallow water diving [8–12], surfing or body boarding [10,12–17], wind surfing [18], and skim boarding [19]. Hoag Hospital, Orange County, CA has collected SZI data for over 30 years. However, Hoag's medical data collection was limited to spinal column and cord injuries only. Long term data documenting demographics of SZI population are needed to draw inferences about the injured population. The present study uses eight years of data to better understand Delaware SZI statistics.

2. Methods

2.1. Data source

Injury data along the Atlantic-fronting Delaware coast from the five most populated beaches (Fig. 1) were collected by the Department of Emergency Medicine at Beebe Health Care in Lewes, DE (ACS Level III trauma center). Survey data did not include physical characteristics of the patients, but did provide demographic details (Section 2.2). Demographics of the injured populations were used to assess similarities between years and determine higher risk groups. However, it is important to determine if the higher risk of a group was due to disproportionate populations in the water, or due to a behavioral component of that group.

Population data of WU were collected by researchers on the beach between the summers of 2014 and 2016. One weekday population count and one weekend count were taken each summer to estimate the daily variation of WU throughout the day. Two WU counts were taken at hourly intervals between 0900 and 1700 (guarded hours) and averaged. For practical purposes, counts were taken along a fixed 100-m alongshore stretch of each beach near a beach access point and in direct vicinity of a beach patrol stand. The summer counts were then averaged to estimate the distribution of WUs during a weekday and weekend day. The number of males and females in the water along the same stretch of beach was also counted once daily between the hours of 1300 and 1500. The daily counts between 1300 and 1500 were then extrapolated to total daily counts using the daily counts variation (see [2] for complete description of methodology).

Questionnaires were distributed to beachgoers during the 2016 and 2017 summer seasons to quantify population demographics on the beach in relation to injured and WU populations. Questionnaires were filled out by individuals over the age of 18, who either were at the

beach while responding to the questions, or had attended a Delaware beach at some point during the summer. Beachgoers are defined as individuals that completed a questionnaire, but did not necessarily enter the water.

2.2. Study variables

Injury patient demographic and medical information were extracted by the trauma registrar from Beebe Healthcare. Patient data include, for example, time of injury, activity, age, gender, zip code, and location of injury. Injury activity was grouped into eight categories: wading, body surfing, body boarding, skim boarding, diving, surfing, swimming and other. Of the 47 “other” injuries, six were rafting or tubing, four were kayaking, and two were paddle-boarding. The other 35 injuries were recorded as “unknown” by the trauma registrar. Wading injuries, defined as injuries occurring while the individual is standing in shallow water (<1 m), were considered “low risk” SZI. These injuries resulted from the WU being in the water, and not by participating in a sporting activity in the surf. Injured individuals were considered locals if their documented zip code began with a 199XX (southern Delaware zip codes). Serious injuries were categorized as patients requiring admission to a trauma service.

The geographic location of the injury occurrence was recorded as one of the five most populated Atlantic-fronting Delaware beaches (Cape Henlopen State Park, Rehoboth Beach, Dewey Beach, Delaware Seashore State Park, and Bethany Beach; Fig. 1). WU population counts provided estimates as to the distribution of individuals in the water at different times during the day to compare with timing of injury. Beachgoers questionnaires determined the age, gender, home zip code, and number of family members of surveyed persons on the beach. An additional question also asked whether or not the person had observed rip current-related material, SZI, or shore break warnings.

2.3. Data analysis

Data are reported with descriptive statistics as case counts, means, medians, standard deviations, standard error (SE), and percentages to describe the injury sample and patterns. Demographics are organized by injury activity, and reported as distributions by age, gender, and local vs. non-local. Statistical analyses were conducted using MATLAB (version R2016b; The MathWorks, Inc., Natick, MA). Estimates of

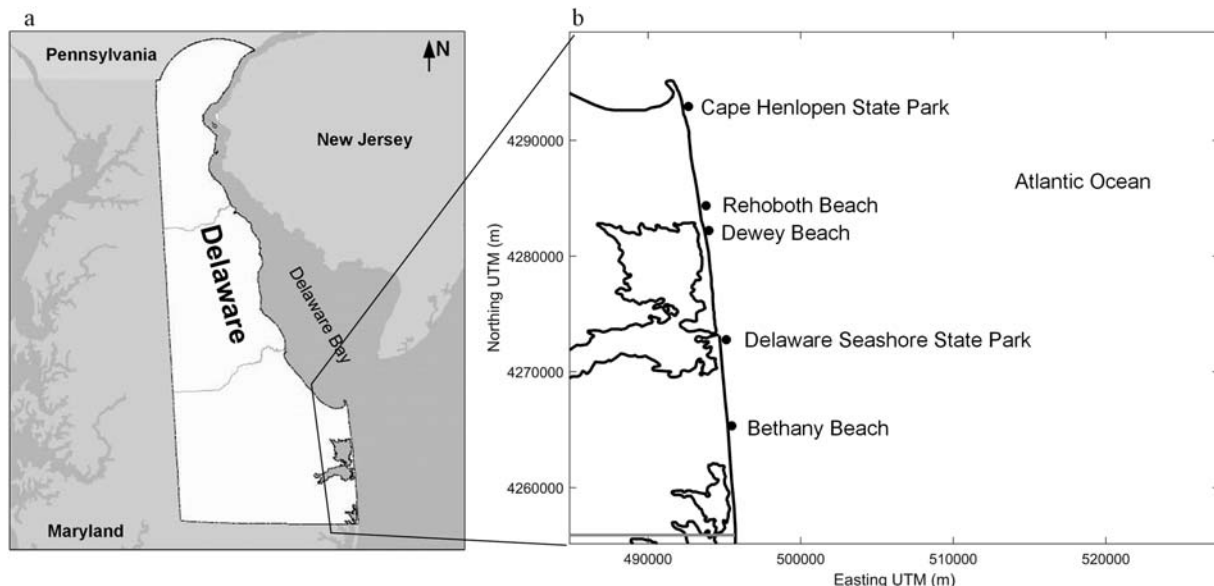


Fig. 1. a The state of Delaware along with neighboring states and the Delaware Bay. b The Atlantic-fronting shoreline of Delaware showing the five study beaches.

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