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No Hiking Beyond this Point! Hiking Risk Prevention Recommendations in Peer-Reviewed Literature

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ABSTRACT

Outdoor recreation in wild areas has many benefits, but also poses risks. We conducted a systematic review of the prevention recommendations in peer-reviewed articles about hiking incidents (injury, illness, or need for rescue) published between 1970 and 2015. Searches in PubMed, Web of Science, and Engineering Village yielded 91 articles after screening for relevance. A total of 559 prevention recommendations were extracted from articles. The foci of the recommendations were categorized using a systems-oriented approach to accident prevention, an adapted Haddon matrix. Five non-mutually exclusive categories were used: hiker, groups and relationships, agent inducing the incident, institutions and sociocultural practices, and equipment. We also coded prevention recommendations that pertained to education within each of the five categories. Sixty percent of the prevention recommendations focused on changing the hiker's decisions and behaviors, and 39% referred to institutions and sociocultural practices. Few addressed the social influences of groups and relationships (8%), equipment (16%), or the agent of harm (16%). Education was the focus of 27% of the recommendations. We conclude that effective prevention needs to include multiple aspects of outdoor recreation systems and their interactions with the hiker's behavior and characteristics.

Management implications: This systematic review introduces outdoor recreation managers to the systems-oriented Haddon matrix framework for accident prevention in outdoor recreation. By using this framework, this paper:

1. Views accidents as resulting from interactions of individuals with both social and physical environments.
2. Highlights areas for prevention that tend to be missing from published safety recommendations (groups, agent of harm, and equipment).
3. Gives examples of how managers can look at outdoor risk prevention from a broader perspective in order to find innovative solutions to common accidents and rule violations.

Outdoor recreation in natural areas has psychological and physical health benefits (e.g., Kaplan & Berman, 2011; Thompson & Aspinall, 2011). Recreation in natural settings also poses risks of injury and illness that can lead to considerable costs. For example, between 1992 and 2007, there was an average of 11.2 search and rescue operations each day in U.S. National Parks for a total cost of over $58.5 million (Heggie & Amundson, 2009). Like other research on public health issues, research on accidents and illnesses in outdoor recreation such as day hiking and backpacking is conducted with the ultimate goal of reducing the incidence of such events by advancing scientific understanding. The objectives of this systematic review were to extract and categorize prevention recommendations from peer-reviewed publications on outdoor recreational accidents with an emphasis on hiking in the United States. Prevention recommendations found in peer-reviewed publications are important because they indicate the status of current thinking of scholars about prevention, and it is scholars involved in empirical research who are likely to be responsible for developing and testing evidence-based prevention strategies. By highlighting the

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prevention recommendations in peer-reviewed literature, we hope the results of this study can inform and inspire future research developing an evidence basis for recommendations that could reduce search-and-rescue and other hiking incidents in the U.S.

This article focuses primarily on hiking as an outdoor recreation. Hiking has become increasingly popular over the last several decades. According to the National Survey of Recreation and the Environment conducted by the U.S. Forest Service, approximately 12% of Americans participate in hiking (Cordell, 2012). Most studies find that hiking incidents represent a large percentage of search and rescue (SAR) and other incidents requiring interventions, although percentages can vary widely depending on locale. For example, Heggie and Amundson (2009) found that 48% of SAR incidents in U.S. National Parks between 1992 and 2007 were hiking related. Another study found that almost 60% of recent incidents in Yosemite National Park SAR involved hiking, and 46% of all incidents involved hiking on trail (Boore & Bock, 2013). An earlier review of incidents in eight California National Parks found that 31% involved hiking (Montalvo, Wingard, Bracker, & Davidson, 1998). In addition, 90% of heat-related illness incidents in Grand Canyon involved hikers (Noe, Choudhary, Cheng-Dobson, Wolkin, & Newman, 2013), and 45% of incidents in Shenandoah National Park involved hiking (Forrester & Holstege, 2009).

Statistics establishing the risk of hiking versus other outdoor activities are difficult to establish because it is not feasible for institutions managing the many outdoor areas to collect data on the percentage of total users involved in hiking versus other activities. For example, in a review of SAR incidents in U.S. National Parks, Heggie and Heggie (2009) state that their "study was limited by a lack of accurate visitation data and specific participation rates to use as denominators in determining the proportion of participation in recreational activities" (p. 26). Even for the Appalachian trail, estimating the number of hikers is complex (Zarnoch, Bowker, & Cordell, 2011). Nevertheless, the percentages cited above show that injuries and illnesses while hiking are a significant public health concern.

From the peer-reviewed literature focusing on hiking incidents, we extracted hiking injury and illness prevention recommendations and classified them using a Haddon matrix (Haddon, 1980, 1995). The Haddon matrix is regarded as having brought epidemiological concepts fully into the injury control literature and has been widely applied in prevention research, covering topics such as motor vehicle accidents, falls, and injuries during ambulance transport (Brice et al., 2012; Runyan & Baker, 2009). The Haddon matrix organizes factors contributing to an injury or illness event into categories: host/human, agent/vector, and the physical and social environments (Haddon, 1980; Runyan & Yonas, 2008). The host/human is the person experiencing the illness or injury. The agent/vector, in the case of illnesses, is the infective substance such as a bacterium or virus. In the case of injury, the agent is the means of energy transfer to the host that induces the injury, such as the repeated impact of the foot on rocks or the impact of the human body with parts of a vehicle in an automobile crash. The physical and social environments are the contexts in which the event occurs. Runyan and Yonas (2008) expanded the framework to include relationships and enhanced the sociocultural context.

Importantly, the Haddon matrix promotes conceptualizing injury and illness events as resulting from "interactions among the host, agent, and environment" (Runyan, 2003, p. 60); therefore, bringing the Haddon matrix into the literature on outdoor recreation accidents and illnesses has potential to broaden the current thinking about prevention. To our knowledge the Haddon matrix has only rarely been used for outdoor accidents (see Gruen, 2009, for conceptual application of a Haddon matrix to reducing crocodile attacks in Australia). Using a Haddon matrix in the present context provides a comprehensive way of thinking about the possible countermeasures to reduce both the frequency and severity of outdoor injuries and illnesses

The Haddon matrix differs from methods of 'accident analysis" such as the "Accimap" (Rasmussen, 1997) or "STAMP" (Leveson, 2004), although both involve thinking about the entire context in which an incident is situated. Accident analysis methods focus on identifying the causes of accidents and injuries and can inform the development of needed system changes and accident prevention measures (Salmon, Cornelissen, & Trotter, 2012), whereas the main goal of the Haddon matrix is to identify prevention strategies (primary, secondary and tertiary) in a situation with a risk of injury or illness (Haddon, 1980). Since this study was focusing on prevention strategies, the Haddon matrix was used rather than accident analysis. In addition, we did not use accident analysis because those methods require a level of detail that is usually not available in outdoor recreation accident reports (Goode, Salmon, Lenné, & Finch, 2015).

Recent research on accident and prevention analysis in other areas has noted the prevalence of prevention recommendations focused on changing the victim's behavior, while at the same time highlighting the importance of taking a broader systems approach to prevention and making recommendations for changes at all levels (e.g., physical, social, institutional; see Goode et al., 2015, for an example). Following this trend, we expected that the outdoor risk prevention strategies found in peer-reviewed articles would primarily be targeted at changing the behavior of the participant in the outdoor activity, the hiker.

1. Method

1.1. Search strategy

Peer-reviewed articles (including published conference papers) were located in PubMed, Web of Science, and Engineering Village using the time frame 1/1/1970 to 12/31/2015. The search terms used were a combination of (hike* or hiking* or wilderness*) and (injur* or illness* or accident*). Fig. 1 gives the resulting numbers of articles found in each database. Titles and abstracts were initially screened for inclusion by the first author. We excluded any articles as well as any prevention recommendations focused only on motorized outdoor recreation, watercraft, swimming, bicycles, snow recreation, technical climbing, hunting, or fishing unless these articles also included hiking. We excluded purely technical climbing, but not articles that covered approach hiking. As mentioned previously, we focused on hiking because it is typically found to be the most common activity associated with outdoor

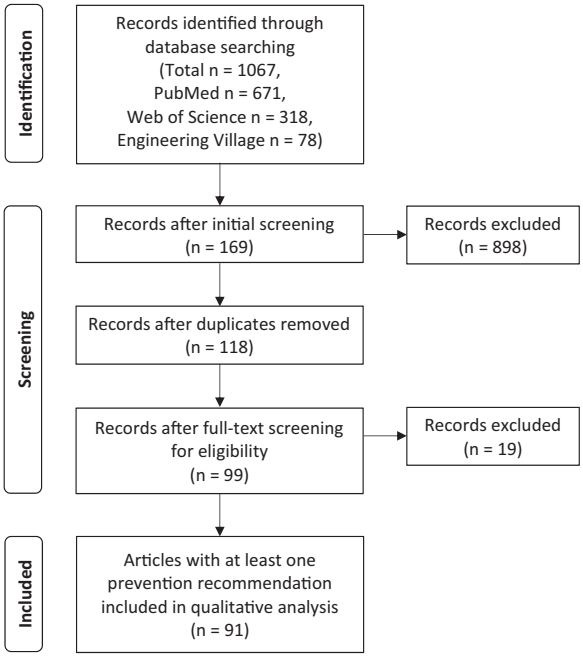

Fig. 1. Flow diagram illustrating the number of journal articles found in the databases searched, screened for eligibility, and included in the analysis.