

ORIGINAL RESEARCH

# An Assessment of Diarrhea Among Long-Distance Backpackers in the Sierra Nevada



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**Introduction.**—Diarrhea is a common problem among long-distance backpackers, ranging in overall incidence from 11–56% as reported by previous studies on the Appalachian Trail and Long Trail. Differences in age, sex, and regularity of standard backcountry hygiene recommendations and practices have been shown to significantly affect the incidence of diarrhea. No study to date has investigated these trends among long-distance backpackers on the John Muir Trail (JMT) in the Sierra Nevada mountain range of California.

**Methods.**—Retrospective analysis of online survey data gathered from long-distance backpackers who attempted a JMT trek in 2014. Data were assessed for the significance of variables that might contribute to the incidence and severity of on-trail diarrhea.

**Results.**—Of 737 valid responders, 16.4% reported experiencing diarrhea (82% with minimal/mild severity; 18% with significant severity). Regular hand sanitizer use was significantly correlated with more severe diarrhea ( $P < .05$ ), but had no effect on incidence. Regular hand sanitizer users followed all other recommended hygiene practices as frequently as or better than those not using hand sanitizer regularly. Of all backpackers, 88% filtered or treated their drinking water regularly, with 18% of those reporting diarrhea of any severity.

**Conclusions.**—JMT backpackers have a comparatively lower incidence of diarrhea than backpackers on other major long-distance backpacking routes in the United States. Most JMT backpackers follow standard backcountry hygiene recommendations, including regular filtration or treatment of drinking water. No statistical significance was found between the incidence of diarrhea and compliance with standard hygiene recommendations. Regular hand sanitizer use was significantly correlated with more severe diarrhea but was not associated with incidence. There was no significant difference in compliance with standard backcountry hygiene practices between regular and infrequent hand sanitizer users.

*Keywords:* backpacking, diarrhea, John Muir Trail, Sierra Nevada, hand sanitizer

## Introduction

The John Muir Trail (JMT), a world-famous long-distance backpacking trail in the Sierra Nevada mountain range of California, is often compared with other long-distance backpacking trails in the United States, such as the Appalachian Trail (AT), which stretches from Georgia to Maine, and the Long Trail in Vermont. In the past 25 years, several studies have found significant correlation between long-distance backpacker demographics and on-trail hiking behaviors and specific morbidities encountered during such activities. In these previous analyses, diarrhea was consistently regarded as a significant morbidity among long-

distance backpackers, ranging in overall reported incidence from 10.7 to 56%, depending on the year and geographical region surveyed.<sup>1–6</sup> Furthermore, within previous AT studies, the incidence of diarrhea was found to differ among particular populations of backpackers, with variables including age, sex, and regularity of following standard backcountry recommendations for hand hygiene, dish washing, and water filtration practices.<sup>4–6</sup> However, no studies to date have attempted to determine the incidence of diarrhea and the potentially implicit variables among long-distance backpackers in the Sierra Nevada or, specifically, on the JMT.

## Methods

### STUDY DESIGN

This is a retrospective analysis of online survey data gathered from long-distance backpackers who attempted

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a JMT trip in 2014. Backpackers were recruited through JMT-related message boards on Yahoo! Groups and Facebook as well as through in-person recruitment on the JMT. Participants completed an online 60-page, 87-question posthike survey after the 2014 hiking season. The online survey and the original data were maintained by a private JMT enthusiast who granted permission for use of the data for this study. Institutional review board approval through the University of California, San Francisco was obtained for retrospective analysis of the survey data.

In the survey, participants were informed that the data may be used for future research and opted into the study by submitting the survey. All data were de-identified by replacing the personal e-mail used to link survey answers with a nonidentifying survey participant identification number. Survey data pertaining to backpacker demographics, on-trail hygiene practices, and diarrhea incidence and severity were analyzed.

## SETTING AND SUBJECTS

The JMT is a long-distance backpacking trail in the Sierra Nevada mountain range of California, stretching from Yosemite Valley to Mount Whitney, the highest point in the contiguous United States. It passes through some of the crown jewels of America's park system: Yosemite, John Muir and Ansel Adams Wildernesses, Kings Canyon, and Sequoia National Parks. This 338- to 354-kilometers (210 to 220 miles)-long trail (depending on one's starting point) is generally accessible from July through September. For almost all of its length, the trail is in the High Sierra backcountry (above 2438 meters [8000 feet]) and within designated wilderness areas that require permits from either the National Park or Forest Service. Most backpackers attempt to through-hike the entire length of the JMT hike from north to south and complete the trek over the course of several weeks, with several resupply stops along the way. For the majority of its length, backpackers must obtain water from various trailside lakes and streams.

Participants who completed the survey included long-distance backpackers who had attempted some portion of the JMT in 2014. A total of 769 surveys were collected. In an effort to avoid inclusion of data from "day hikers" or "weekend backpackers" in our desired study population, respondents who completed less than 2 days' distance of total backpacking (for which a "day" was considered the average amount of miles hiked per day for all backpackers) were excluded. Seventeen backpackers were eliminated based on this criterion. Additionally, respondents who did not complete sections of the survey needed for data analyses were also excluded,

which removed 15 more backpackers. Following these exclusion criteria, our study comprised a population of 737 valid respondents from the 769 total received surveys.

## STUDY DATA

From the 87-question survey, we analyzed response data associated with the following demographic variables: age, sex, prehike body weight, prehike physical activity (hours/week), prehike self-assessed physical condition, previous hiking or backpacking experience (days in previous 10 years), solo or group backpacking itinerary, on-trail average pack weight, on-trail hygiene compliance (water filtration/treatment, hand hygiene, etc), and posthike difficulty assessment (Table 1). Self-reported data on the incidence and severity of diarrhea were also examined, where severity was reported on a scale from 1 (minimal) to 5 (severe).

## DATA ANALYSIS

Data analysis was performed by transferring the participants' responses from a Microsoft Office Excel spreadsheet into SPSS statistical software. Statistical significance was set at  $P < .05$ . Questions regarding compliance rates with suggested backcountry hygiene practices (washing hands with soap and water, use of hand sanitizer, boiling or pretreating water before cooking and cleaning, and management of human waste) were surveyed on a scale of 1 to 5 (1 = never, 2 = occasionally, 3 = regularly, 4 = almost always, 5 = always). Diarrhea severity was also surveyed via a 0 to 5 numerical spectrum (0 = not at all, 1 = minimal, 3 = significant, 5 = severe). There were no descriptive texts in the survey for diarrhea severity scores of 2 or 4.

In running statistical analyses, compliance variables and diarrhea were considered as both continuous and

**Table 1.** Backpacker demographics from 2014 hiking season (n=737)

<i>Characteristic</i>	<i>Mean ± SD</i>	<i>Mean ± SD</i>
Age (years)	43 ± 14	
Height (cm / in)	175 ± 10	69 ± 4
Starting weight (kg / lbs)	75.9 ± 15.4	167.5 ± 34.1
Ending weight (kg / lbs)	72.5 ± 14.5	159.9 ± 32.0
Pack weight (kg / lbs)	17.6 ± 4.5	38.9 ± 10.1
Total distance hiked (km / mi)	278 ± 125	173 ± 78
Sex	Count (%)	
Male	420 (57)	
Female	281 (38)	
Declined to state	36 (5)	

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