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Brief report

High fecal hand contamination among wilderness hikers

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Information about hand hygiene and fecal hand contamination among the general public is limited. Hands are an important vector in transmission of various pathogenic bacteria. We found high (31%) prevalence of fecal hand contamination among healthy adults engaged in hiking.

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A variety of publications have suggested that there is an increased risk of gastroenteritis acquisition among recreational users of North American wilderness. Ever since a report of campers in the Unita Mountains of Utah hypothesized transmission of giardiasis through untreated drinking water, concern about backcountry water quality has grown,¹ in spite of published literature arguing against it,² and recommendations regarding the importance of treatment of North American backcountry waters are widespread.³

In nonwilderness settings, attention has focused on the role of suboptimal personal hygiene in transmission of gastrointestinal illness.⁴ However, despite widespread concern about disease transmission among wilderness users and the prevalence of 21% to 56% gastrointestinal illness in this population,^{5,6} there have been few peer-reviewed articles that suggest an association between poor hygiene and illness among backpackers.^{5,7} To our knowledge, no study has demonstrated fecal contamination on the hands of backpackers. Such information could be extremely valuable because it would provide evidence supporting hygiene strategies as a preventive intervention in a population commonly affected by gastrointestinal illness. This study examined patterns of fecal hand colonization among hikers in a North American wilderness area.

METHODS

This report describes 2 groups: The first, studied cross-sectionally, included 61 individuals who were entering or leaving (after having spent at least 1 night camping) a high-use trail head. The second, studied longitudinally, consisted of 11 participants on a 5-night backpacking trip sponsored by a local college, who were tested prior to and at the conclusion of the trip. The study was approved by the Institutional Review Board for the Protection of Human Subjects at Upstate Medical University.

Participants were provided a questionnaire asking how many nights they had been camping; if they cleaned their hands; and, if so, when and how. Entering participants were asked to answer with their anticipated behavior. Participants were then asked to soak their dominant hand in a sterile bag containing 50 mL of sterile saline for 30 seconds. Study personnel collected the bags, decanted into individual sterile tubes, and transported on ice to the laboratory within 12 hours of collection.

Samples were filtered through 0.2- μ m polycarbonate filters (Fisher Scientific, Pittsburgh, PA) and removed to conical tubes containing 5 mL of sterile saline. Bacteria were eluted by vortexing for 1 minute. Eluted suspensions were diluted 1:5 and 1:10 in sterile saline. One hundred-microliter aliquots of diluted and undiluted eluate were inoculated onto CHROMagar ColiformEC (Hardy Diagnostics, Santa Maria, CA) and Bile Esculin agar (Becton Dickinson, Franklin Park, NJ) plates and incubated aerobically for 48 hours then examined quantitatively for growth. CHROMagar ColiformEC plates were assessed for colonies of *Escherichia coli* (pink-violet), coliforms (turquoise), and noncoliform gram-negative rods (white-colorless). Bile Esculin agar plates were examined for black colonies suggestive

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of *Enterococcus* spp. Representative colonies were subjected to Gram's stain and catalase and pyrrolidonylarylamidase testing; only catalase-negative, pyrrolidonylarylamidase-positive, gram-positive cocci were considered presumptive *Enterococci*.

Statistical analyses included descriptive measures (frequencies, means, and standard deviations). Independent *t* test analysis and nonparametric testing were employed to compare fecal (coliforms and *Enterococcus*) bacterial colony forming unit counts (f-CFUs) among the first group and entering hikers from the second group. (Their exit data were excluded because of a possible training effect.) A paired *t* test was employed to compare f-CFUs among the second group. The overall means were compared and included those with zero CFUs in independent *t* test analysis. Additional analyses compared results between individuals based on their reported hygiene practices.

RESULTS

Cross-sectional sample

Seventy-two hikers were enrolled: 42 entering and 30 exiting. Overall, 31% (22) had hands colonized with fecal bacteria (Fig 1). Among those, 33% (95% confidence interval: 19%-47%) and 27% (95% confidence interval: 11%-43%) were entering and exiting, respectively. The interquartile range for hikers with fecal flora was 50 and 675 CFU, and the median was 175 CFU. The mean (SD) hand f-CFUs among entering hikers was higher (379 [$\pm 1,160$]) than among exiting (53 [± 123]), but the difference was not statistically significant ($P = .078$). In a separate, nonparametric analysis, the mean rank of the CFU levels of entering hikers was 37.9 and 34.6 for exiting hikers, $P = .42$.

Sixty-four hikers (89%) completed the questionnaire. Those cleaning their hands by any method had nonstatistically significant lower mean hand f-CFUs (\pm standard deviation) when compared with hikers who reported not cleaning their hands: 153 (± 594) versus 461 ($\pm 1,560$), respectively, $P = .672$. Those who cleaned their hands had mean rank of the CFU levels of 33.9 and those who did not 32.1, $P = .67$.

Longitudinal sample

Among the 11 participants longitudinally sampled, they were more likely to carry fecal bacteria on their hands prior to the trip (8 [73%]) than at the end of the trip (6 [55%]). Comparison of mean hand f-CFUs was similar, and the Wilcoxon signed-rank test showed no difference in hand colonization before and after trip, $P = .27$. There were no differences in reported hygiene practices before and after hike.

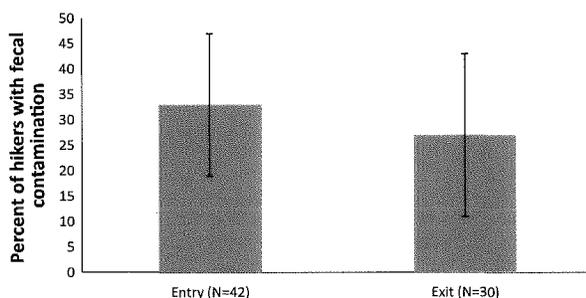


Fig 1. Prevalence and 95% confidence intervals of fecal hand contamination among hikers entering or exiting a trail.

DISCUSSION

This is the first description of fecal hand contamination among healthy individuals engaging in outdoor activities. We show higher prevalence of fecal hand contamination than previously reported among adults from urban and day care settings where the prevalence ranged between 7% and 23%^{8,9} with the exception of high rates (79%) among staff caring for diapered infants.¹⁰ The high prevalence is concerning because poor hygiene and fecal hand contamination have been linked to diarrheal illnesses among healthy subjects.^{7,11}

The prevalence of fecal hand contamination in entering and exiting hikers was similar (33% and 27%, respectively), which suggests that backpacking alone does not contribute to fecal hand contamination. However, the prevalence is high and worrisome because gastrointestinal illnesses are important cause of illness among hikers.⁵ Future studies should focus on observed hand hygiene behavior, method, and its effect on fecal hand contamination. As inoculation may occur around meal times, sampling of hands just prior to food preparation and consumption might also yield useful data. Both of these would require involved methods so as to minimize the chances of influencing study subject behavior. Because of this, and the technical difficulty of transporting specimens to the laboratory from remote places in a timely fashion, they were outside of the scope of this early study.

Studies among backpackers have demonstrated that reported poor hygiene is associated with diarrheal illness,^{5,7} suggesting that fecal-oral transmission is an important vector of disease. The presence of fecal bacteria on hands in spite of reported hygiene is not surprising; prior findings show that self-reported hygiene practices are unreliable.^{12,13} Prospective studies monitoring hand hygiene and risk of gastrointestinal illness would aid in identifying most effective preventive measures in this population.

The study was limited by small sample size, by sampling short-term hikers, and by sampling performed at only 2 sites in New York State. However, the larger, cross-sectional study took place in a high-volume trail head that is visited by general public and quite typical of many other sites in the country. Nevertheless, our results may not apply to all hikers.

Finally, entering participants had access to a common bathroom, and exiting participants had access to the trail register book prior to sampling. It is possible that these could be common sources of contamination. On the other hand, such facilities are common in most backcountry settings. Obtaining samples from these sources to assess for fecal contamination may also be beneficial going forward so as to obtain more information about sources of contamination in the wilderness.

Our study adds to a growing body of evidence that supports suboptimal hand hygiene among backpackers. It is our hope that users of the wilderness, and most importantly organizations that teach wilderness skills, will emphasize proper hygiene practices in all outdoor activities.

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