ORIGINAL RESEARCH

Gender Differences Among Long-Distance Backpackers: A Prospective Study of Women Appalachian Trail Backpackers

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Objective.—Backpacking is a popular recreational activity, yet the differential experiences of women are unknown. The objective was to compare women with men backpackers to determine the extent to which injuries and illnesses limit endurance outdoor recreational activities.

Methods.—This was a prospective cohort surveillance survey of 334 persons who hiked the Appalachian Trail for ≥ 7 days. At the end of their hike, 280 subjects completed a questionnaire. Male hikers served as controls for injury and illness.

Results.—Women comprised 26% (72 of 280) of the sample. The mean ($\pm$ SD) duration of hiking was 144 ± 66 days covering 1570 ± 680 miles. Fifty-seven percent (41 of 72) of women and 72% (150 of 208) of men attained their goal ($P = .02$). The occurrence of individual musculoskeletal problems, such as strains, sprains, arthralgias, tendonitis, and fractures, were similar ($P = .9$) between sexes. The occurrence of diarrhea (56%) was also similar (relative risk [RR] 1.0; $P = .9$) between sexes. Of regularly menstruating women, 87% (43 of 49) had menstrual changes while hiking, such as change in frequency (45%) or character (43%) (RR 3.1; 95% CI, 2.0–4.8; $P < .001$). Shortened duration of menses was most common (41%). Amenorrhea occurred in 22% (11 of 49) of women, including 5 of 25 taking oral contraceptive pills (OCPs). Breakthrough, midcycle bleeding occurred in 20% (10 of 49) of women.

Conclusions.—Women had similar experiences as compared with men when backpacking. Menstrual changes were very common including amenorrhea. Prolonged amenorrhea raises concern for potential bone mineral density loss, and OCPs should be considered to prevent such loss.

Key words: women's health, backpacking, women, injury, camping, amenorrhea, estrogen

Introduction

Hiking and backpacking are among the most popular and fastest growing outdoor recreational activities in the United States. In 2002, 32% of American women participated in outdoor adventure activities, with 7.4% of women backpacking and 29% hiking (G.T. Green and H.K. Cordwell, unpublished data, 2002).¹

Previous research has suggested that women engaging in outdoor recreational activities are constrained by factors such as personal safety concerns, inadequate facilities and information, insufficient funds, and outdoor pests.² Participation in camping or hiking alone in re-

mote areas may arouse fear of sexual assault or harassment.

There are few studies examining wilderness morbidities and mortalities and virtually none that examine the differential experiences of women. Among female backpackers, there has been a solitary investigation of young women (mean age 19.5 years) at an Outward Bound School under a supervised environment for 23 days.³ This study revealed a high rate of injury (85%–94%) and illness (69%) among both sexes.³ 'Female health concerns' were reported by 31% of participants.³

This study examined the medical experiences of female backpackers on the Appalachian Trail. The major objective was to determine if there are differential experiences between women and men in regards to injuries, illnesses, and factors prompting quitting hiking ear-

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Table 1. Characteristics of subjects by gender

Characteristic	Mean $\pm$ SD or No. (%)		P value
	Men (n = 208)	Women (n = 72)	
Age (yr)	35 $\pm$ 15	33 $\pm$ 13	.34
Length of trip (d)	138 $\pm$ 60	144 $\pm$ 66	.47
Length of trip (miles)	1660 $\pm$ 690	1570 $\pm$ 680	.38
Weight loss (kg)	6.6 $\pm$ 6.4	3.5 $\pm$ 6.0	.0003*
Weight loss (%)	7.9 $\pm$ 6.8	4.6 $\pm$ 7.7	.001*
Backpack weight (kg)	19.6 $\pm$ 3.9	17.3 $\pm$ 3.6	<.001*
Backpack weight (% body weight)	25.0 $\pm$ 5.9	27.9 $\pm$ 5.4	<.001*
Treated water consistently (%)	45 (21)	22 (31)	.03*
Had diarrhea (%)	116 (56)	40 (56)	.90
Days of diarrhea per mo	0.7 $\pm$ 1.2	1.0 $\pm$ 2.1	.26
Consistent hand washing (%)	108 (52)	47 (66)	.01*

*Statistical significance, $P < .05$.

lier than planned. Gynecological concerns among long-distance backpackers were also examined.

Methods

Data for this study were obtained via a prospective, observational cohort survey. The prospective design sought to incorporate a diverse group of backpackers, including those hiking only a section as well as the entire Appalachian Trail. In the initial recruitment stage, participants were approached while hiking and interviewed. Interviews occurred for 12 weeks from May 15 to August 5, 1997, over 1600 km stretching from New Hampshire to North Carolina. If hikers met the inclusion criteria of hiking for >7 days, the nature and purpose of the study were explained. A stamped postcard was given to participants requesting their name, address, and medical problems experienced. No teaching or other intervention occurred during recruitment. Of the 353 hikers approached, 352 agreed to participate, but 18 were excluded because of a lack of a permanent address.

In the second phase of the study, on October 1, 1997, a 4-page questionnaire was mailed to participants. The questionnaire assessed demographic information, achievement of the individual's original goal, medical history, and occurrence of medical problems. The 25 most common medical problems identified during the initial recruitment phase were assessed via a form with checkboxes. An open-ended question also allowed individuals to self-report other health concerns not listed. Women were given a one-page supplement regarding gynecological issues including history, menses in the previous year, and changes during hiking. Women served as their own gynecological controls.

Analyses were performed using SAS version 6.12 (Cary, NC). All continuous variables were compared using t tests. Comparison of categorical data was performed using χ^2 tests. Comparisons of cohorts are expressed using relative risk (RR) and 95% CI. Case-control comparisons are expressed using the odds ratio (OR) and 95% CI. Institutional Review Board approval was obtained.

Results

Of 334 backpackers, 280 (84%) responded with completed surveys. Women comprised 26% (72 of 280) of the sample. Median follow-up time was 30 days from hiking completion. Demographic and comparative gender data are presented in Table 1. When the 25 most common injuries and illnesses were examined, there were few statistically significant differences between sexes (Table 2). When musculoskeletal injuries were compared, there were no significant differences between sexes. The occurrence of diarrhea was similar between sexes (RR 1.0; 95% CI, 0.8–1.3; $P = .9$); although, women performed water disinfection more consistently (OR 1.47; $P = .03$). There was no correlation between weight loss and diarrhea. Women self-reported more hypothermia (RR 3.4; 95% CI, 1.2–9.9; $P = .02$), paresthesias (RR 1.4; 95% CI, 1.1–2.0; $P = .03$), and sunburns (RR 1.9; 95% CI, 1.3–2.8; $P < .01$).

When the sexes were compared, 57% (41 of 72) of women and 72% (150 of 208) of men attained their hiking goals ($P = .02$). The primary reasons for women abandoning hiking earlier than planned (Table 3) were time limitation (27%), injury (20%), financial (16%), and social or family constraints (13%). The observation

Table 2. Incidence of injuries and illness in male and female hikers

<i>Injury illness</i>	<i>Women n (%)</i>	<i>Male n (%)</i>	<i>RR</i>	<i>P-value</i>
Musculoskeletal				
Acute joint pain	26 (37)	76 (36)	1.01	.9
Back pain	18 (25)	46 (22)	1.15	.6
Achilles heel pain	16 (23)	39 (19)	1.21	.5
Chronic joint pain	14 (20)	48 (23)	0.86	.6
Muscle cramps	14 (20)	41 (20)	1.01	.9
Muscle strain	11 (15)	25 (12)	1.30	.4
Tendinitis	11 (15)	27 (13)	1.20	.6
Shin splints	10 (14)	29 (14)	1.02	.9
Sprained ankle	9 (13)	23 (11)	1.15	.7
Fracture	3 (4)	8 (4)	1.10	.9
Cutaneous				
Feet blisters	45 (63)	135 (65)	0.98	.9
Paresthesias	33 (46)	65 (31)	1.49	.03*
Chafing	31 (44)	112 (54)	0.81	.14
Sunburn	28 (39)	44 (21)	1.87	.002*
Lost toenails	25 (35)	58 (28)	1.27	.2
Poison ivy	22 (31)	35 (17)	1.85	.01*
Tick bites	20 (28)	48 (23)	1.23	.4
Rash	16 (23)	28 (13)	1.68	.07
Skin infection	3 (4)	12 (6)	0.74	.8
Infectious				
Diarrhea	40 (56)	116 (56)	1.02	.9
Respiratory infection	19 (27)	21 (10)	2.66	<.001*
Vomiting	8 (11)	25 (12)	0.94	.9
Viral illness	6 (8)	14 (7)	1.26	.6
Lyme disease	2 (3)	7 (3)	0.84	.8
Constipation	1 (1)	14 (7)	0.21	.13
Urinary tract infection	0 (0)	2 (1)	0.00	NA
Miscellaneous				
Dehydration	14 (20)	41 (20)	1.01	.9
Allergies	9 (13)	13 (6)	2.04	.08
Hypothermia	7 (10)	6 (3)	3.43	.02*
Heat exhaustion	3 (4)	10 (5)	0.88	.8

*RR, relative rise.

† $P < .05$.

revealed that women often hiked with companions, yet the rate of abandoning hiking because of a hiking partner quitting was similar between sexes (4%). Environmental and dietary reasons were not significant factors (4%). Previous experience did not statistically increase success (OR = 1.6; 95% CI, 0.9–3.0; $P = .1$). There was no overall difference in previous backpacking experience ($P = .2$) (Figure 1). However, the proportion of hikers with less than a weekend's backpacking experience was larger among women (39%, RR 1.8; 95% CI, 1.2–2.7; $P = .003$).

Women's backpacks were lighter than men's, and

when indexed as percent baseline body weight, women carried slightly lighter loads (Table 1). Men lost twice as much body weight than women ($P < .001$). With adjustment for baseline weight, there was a significant difference of percentage weight loss (men, $8\% \pm 7\%$; women, $5\% \pm 8\%$ $P = .001$).

GYNECOLOGICAL ISSUES

Sixty-four women (89%) fully completed the gynecologic survey (Figure 2). Twenty percent (13 of 64) of

Table 3. Reasons for hiking cessation by gender

	Women (%)	Men (%)
Time limitation	27	27
Injury	20	25
Financial	16	23
Social/family	13	22
Psychological	13	16
Occupation	7	12
Diet/nutrition	4	4
Companion quit	4	4
Environmental	4	1
Illness	0	3
Conditioning	0	3

them were postmenopausal, and oral contraceptive pills (OCPs) were used by 39% (25 of 64). Two hikers used Depo-Provera (medroxyprogesterone) and their induced amenorrhea are not included in further discussion. Of regularly menstruating women, 87% (43 of 49) had menstrual changes, such as change in frequency or character, while hiking (RR 3.1; 95% CI, 2.0–4.8; $P < .001$) compared with the previous year. The most common change in menses was a shortened duration ($n = 20$). Seven women had a shorter frequency of menses, and 4 had irregular menstrual frequencies. Vaginal discharge was reported by 9% (6 of 64) of women, but this was minimally increased over baseline according to medical history (RR 1.2; 95% CI, 0.4–3.7; $P = .8$).

Twenty-two percent (11 of 49) of the women became amenorrheic while hiking, and only one of these women had missed any menses in the previous year. Despite taking OCPs, 5 women were amenorrheic during their hiking trip. Breakthrough, midcycle bleeding occurred in 10 women, including 6 women on OCPs. Only 3 women reported breakthrough bleeding in the previous year (OR 3.9; 95% CI, 1.01–15.3; $P = .04$). Although some female hikers with small-dose estrogen OCPs experienced midcycle bleeding, there was no statistical difference ($P = .9$) in the average OCP-estrogen content between those with breakthrough bleeding ($33 \pm 3 \mu\text{g}$) or amenorrhea ($34 \pm 2 \mu\text{g}$) as compared with those in whom this did not occur ($32 \pm 4 \mu\text{g}$). There was no statistical difference between hike duration ($P = .08$), distance ($P = .1$), initial weight, ($P = .8$), percentage weight loss ($P = .4$), or pack weight ($P = .9$) between those with amenorrhea or breakthrough bleeding and those who did not experience such changes. Four women (6%) reported a history of a urinary tract infection within the previous year, but no urinary tract infections were reported among women in this study.

Figure 1. Backpacking experience: a comparison by gender.

Discussion

In comparing the experiences of female and male backpackers, their general experiences were remarkably similar. Both the distance and duration of women's backpacking trips were similar to men's. Women did not experience significantly more musculoskeletal problems.

Women were slightly less likely to achieve their individual goals. It was unclear as to why this occurred. The reasons given for quitting early were similar to those of men. Whereas earlier research suggested environmental factors, such as safety or outdoor pests, as limitations to participating in outdoor recreation,² they were not significant reasons for leaving the outdoors in this study.

Two previous retrospective studies of successful Appalachian Trail and Long Trail hikers did not address gynecological issues.^{4,5} This study sampled both successful and unsuccessful backpackers in an attempt to represent the broad cross section of women backpacking today. Previous investigation of Outward Bound backpackers sampled principally inexperienced, young (mean age 19.5 years) women from upper socioeconomic backgrounds (2004 course cost, \$2895).³

The most significant medical issue that arose with long-distance backpacking was gynecologic abnormalities. A significant proportion (22%) of female backpackers experienced amenorrhea. Whereas many respondents commented as to the practical benefit of amenorrhea during hiking, the medical implications are of concern. Complications of intense exercise include low estrogen and progesterone with risk of loss of trabecular bone and early osteoporosis.^{6,7} In athletes, the observed prevalence of amenorrhea is 5% to 66%^{8,9} compared with 1%

Figure 2. Profile of gynecological status.

to 5% in the general population.^{10–12} Our study was consistent with these data, for our study revealed 22% of women having amenorrhea. In a study of adult female athletes, 72% of the amenorrheic women were either osteopenic or osteoporotic.¹³

Whereas no study of female backpackers has been performed, it is likely that those with amenorrhea also experience bone mineral density (BMD) loss. For every one SD decrease in BMD, a 50% to 100% increase in fractures is predicted.¹⁴ The duration of amenorrhea and body weight are predictors of BMD.¹³ Weight-bearing exercise does not offset the negative effect of decreased estrogen on the skeleton of amenorrheic athletes.¹³ Although the incidence of long-distance backpacking and amenorrhea may be only temporary, the BMD loss may be irreversible despite resumption of menses.^{9,15,16} This raises concern over a possible later increased risk for premature osteoporotic fractures.

Amenorrheic athletes using estrogen in doses used for menopausal women have shown maintenance but no gain of BMD.¹⁷ With OCP doses, BMD has improved in amenorrheic women.¹⁸ In our study, several women who took standard OCPs had difficulties with breakthrough bleeding. This may be indicative of the need for larger-dose OCP in these metabolically active women. No pharmacokinetic study of estrogen metabolism has been performed in active women. Likely, the nutritional,¹⁹ weight,²⁰ and activity changes of backpacking may alter production and metabolism of estrogen.

Official recommendations encourage amenorrheic

women to ingest ≥ 1500 mg of calcium daily to assure calcium balance.^{9,21,22} In backpacking, the typical diet of starches and dehydrated foods does not provide this. Further investigation is warranted because it has also been shown that current calcium intake is unrelated to BMD for both amenorrheic and eumenorrheic athletes.¹⁵

Limitations

Limitations of this study include the small sample size for gynecological comparisons among subgroups. Indeed, this portion of the study was underpowered to detect statistical differences. For weight loss and amenorrhea, we calculated the sample sizes required for an 80% power to be 49 persons. Inquiry regarding menses was at time of follow up, potentially introducing a recall bias. Previous research on validity of written questionnaires addressing menstrual changes demonstrated that written questionnaires may, if anything, underestimate the amount of menstrual irregularity in the past year.²³ A more precise mechanism of data collection would have been the use of daily logs of menstrual activity recorded before and during hiking. Duration of amenorrhea was not quantified because some women's menses had not normalized at the time of the survey. Future research could include quantifying prehike, posthike, and 1-year follow-up BMD data.

Conclusions

Women had similar experiences with injuries and illness when backpacking as compared with men. Our evaluation of women's issues revealed that menstrual changes were very common, including amenorrhea. Mid-dose OCPs should be evaluated for their effect on BMD loss in amenorrheic women undertaking extended backpacking trips.

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References

1. Technical Appendix Table V2. 1994–95 National Survey on Recreation and the Environment, USDA Forest Service and the University of Georgia, Athens, Georgia. Available at: <http://www.srs.fs.fed.us/trends/ch5app.pdf>. Accessed March 19, 2004.
2. Johnson CY, Bowker JM, Cordell HK. Outdoor recreation constraints: an examination of race, gender, and rural dwelling. *South Rural Soc.* 2001;17:111–133. Available at: <http://www.srs.fs.fed.us/pubs/ja/uncaptured/ja-johnson004.pdf>. Accessed March 19, 2004.
3. Twombly SE, Schussman LC. Gender differences in injury and illness rates on wilderness backpacking trips. *Wilderness Environ Med.* 1995;4:363–376.
4. Crouse B, Josephs D. Health care needs of Appalachian trail hikers. *J Fam Pract.* 1993;36:521–525.
5. Gardner TB, Hill DR. Illness and injury among long-distance hikers on the Long Trail, Vermont. *Wilderness Environ Med.* 2002;13:131–134.
6. Prior JC, Vigna Y. Gonadal steroids in athletic women: contraception, complications and performance. *Sports Med.* 1985;2:287–295.
7. Drinkwater BL, Nilson K, Chesnut CH, et al. Bone mineral content of amenorrheic and eumenorrheic athletes. *N Engl J Med.* 1984;311:277–281.
8. Yeager KK, Agostini R, Nattiv A, et al. The female athlete triad: disordered eating, amenorrhea, osteoporosis. *Med Sci Sports Exerc.* 1993;25:775–777.
9. Otis CL, Drinkwater BL, Johnson M, Loucks A, Wilmore J. American college of sports medicine position stand: the female athlete triad. *Med Sci Sports Exerc.* 1997;29:I–ix.
10. Bachman GA, Kemmann E. Prevalence of oligomenorrhea and amenorrhea in a college population. *Am J Obstet Gynecol.* 1982;144:98–102.
11. Pettersson F, Fires H, Nillius SJ. Epidemiology of secondary amenorrhea: incidence and prevalence rates. *Am J Obstet Gynecol.* 1973;117:80–86.
12. Singh KB. Menstrual disorders in college students. *Am J Obstet Gynecol.* 1981;140:299–302.
13. Renckens ML, Chesnut CH III, Drinkwater BL. Bone density at multiple skeletal sites in amenorrheic athletes. *JAMA.* 1996;276:238–240.
14. Johnston CC Jr, Slemenda CW. Risk prediction in osteoporosis. *Am J Med.* 1991;91:47S–48S.
15. Drinkwater BL, Nilson K, Ott S, Chesnut CH III. Bone mineral density after resumption of menses in amenorrheic athletes. *JAMA.* 1986;256:380–382.
16. Jonnavithula S, Warren MP, Fox RP, Lazaro MI. Bone density is compromised in amenorrheic women despite return of menses: a 2-year study. *Obstet Gynecol.* 1993;81:669–674.
17. Hergenroeder AC. Bone mineralization, hypothalamic amenorrhea, and sex steroid therapy in female adolescents and young adults. *J Pediatr.* 1995;126:683–689.
18. Hergenroeder AC, Smith EO, Shypailo R, Jones LA, Klish WJ, Ellis K. Bone mineral changes in young women with hypothalamic amenorrhea treated with oral contraceptives, medroxyprogesterone, or placebo over 12 months. *Am J Obstet Gynecol.* 1997;176:1017–1025.
19. Berrino F, Bellati C, Secreto G, et al. Reducing bioavailable sex hormones through a comprehensive change in diet: the diet and androgens randomized trial. *Cancer Epidemiol Biomarkers Prev.* 2001;10:25–33.
20. Longcope C, Baker S. Androgen and estrogen dynamics: relationships with age, weight, and menopausal status. *J Clin Endocrinol Metab.* 1993;76:601–604.
21. Committee on Sports Medicine. Amenorrhea in adolescent athletes. *Pediatrics.* 1989;84:394–395.
22. Otis CL. Exercise associated amenorrhea. *Clin Sports Med.* 1992;11:351–362.
23. Schneider MB, Bijur PE, Fisher M, Friedman SB, Toffler PA. Menstrual irregularity in female military cadets: comparison of data utilizing short-term and long-term recall. *J Pediatr Adolesc Gynecol.* 2003;16:89–93.