



ORIGINAL RESEARCH

Perceptions Among Backcountry Skiers During the COVID-19 Pandemic: Avalanche Safety and Backcountry Habits of New and Established Skiers

Esteban A. Valle, MD¹; Andrew P. Cobourn, BS¹; Spencer JH. Trivitt, BS¹; Jordy Hendrikx, PhD²; Jerry D. Johnson, DA²; David C. Fiore, MD¹

¹University of Nevada, Reno School of Medicine, Reno, NV; ²Montana State University, Bozeman, MT

Introduction—The coronavirus disease 2019 (COVID-19) pandemic impacted the ski industry worldwide by closing or limiting access to ski resorts. Subsequently, anecdotal reports of increased backcountry use emerged in the press, with concerns of inexperienced skiers causing or having problems in the backcountry. This study attempted to quantify this and identify motivations for new backcountry skiers.

Methods—Self-identified backcountry skiers and snowboarders (aged ≥ 18 y) in the United States and Canada completed an anonymous 29-question online survey distributed by regional avalanche centers, education providers, and skiing organizations (n=4792). Respondents were stratified by backcountry experience, defining “newcomers” who began backcountry skiing from 2019 to 2021, coincident with the COVID-19 pandemic. Percentages of ski days spent in the backcountry were compared before and during the COVID-19 pandemic using paired *t*-tests and across cohorts using repeated-measures analysis of variance. Avalanche education was compared using unpaired χ^2 tests.

Results—Of established skiers, 81% noticed more people in the backcountry and 27% reported increasing their own use. Participants reported spending 17% (95% CI, 15.8–17.9) more of their days in the backcountry during the COVID-19 pandemic, with newcomers increasing their time spent by 36% and established skiers increasing their time spent by 13% ($P < 0.0001$). Of newcomers, 27% cited the COVID-19 pandemic as motivation to enter the backcountry and 24% lacked formal avalanche education, which is significantly higher than the 14% of established skiers ($P < 0.0001$).

Conclusions—Influenced by factors related to COVID-19, reported backcountry use increased during the pandemic. Newcomers had a lower level of avalanche education and less confidence in evaluating terrain. Because 80% of participants were recruited from avalanche safety or education websites, this likely underestimates skiers lacking avalanche awareness or education and is further limited by the nature of online surveys.

Keywords: snow sports, mountaineering, risk assessment, risk-taking, motivation, education

Introduction

The coronavirus disease 2019 (COVID-19) pandemic affected the operation of many ski resorts in the latter half of the 2019 to 2020 ski season. As reported by the

National Ski Area Association in 2020, the American ski industry suffered a \$2 billion estimated loss when 93% of US ski resorts closed operations in March, months before many had planned. The effects of the pandemic on the US ski industry continued into the 2020 to 2021 season, with restricted ticket and pass sales and limited daily capacity, often requiring reservations in advance. In Europe, the effect of the pandemic during the 2020 to 2021 season was even greater, with many ski resorts remaining closed despite good snow conditions. As a result of these changes, many skiers and snowboarders were left with limited or no access to ski resorts. Others

Corresponding author: Esteban A. Valle, MD, Department of Emergency Medicine, University of Arizona College of Medicine – Tucson; e-mail: evalle@arizona.edu.

Submitted for publication January 2022.

Accepted for publication August 2022.

© 2022 Wilderness Medical Society. Published by Elsevier Inc. All rights reserved.

<https://doi.org/10.1016/j.wem.2022.08.005>

were forced to weigh their desire to ski at their favorite resorts against the risk of COVID-19 itself and uncertainty in ski resort operations, access, and lift lines.

In 2021, the International Report on Snow and Mountain Tourism reported 400 million annual skier visits worldwide (<https://www.vanat.ch/RM-world-report-2021.pdf>). Although 95% of participants ride at ski resorts, backcountry skiing has been the most rapidly growing aspect of the sport, increasing 8-fold from 1995 to 2017.¹ Instead of riding a powered ski lift, backcountry skiers typically hike uphill using touring equipment, although many use snowmobiles, or access backcountry terrain from ski lifts by exiting the ski resort boundary into “sidecountry” terrain. In the backcountry, avalanche hazards are neither assessed nor mitigated by ski patrols, and there is no expedient ski patrol rescue in case of injuries or avalanche. This greatly increases personal risks for backcountry skiers and necessitates higher levels of preparedness. The American Avalanche Association defines education standards for avalanche safety and rescue courses and recommends obtaining at least Level 1 certification and purchasing relevant safety equipment, such as an avalanche beacon, probe, and shovel, before entering avalanche terrain.² These factors make the choice to pursue backcountry skiing a significant investment in time, money, and avalanche education.

With the pandemic and its associated impacts on ski resorts, there have been many anecdotal and media reports of a surge in backcountry use and concerns of a commensurate increase in backcountry avalanche incidents and fatalities (Mander B. Ski in the Wild. *Wall Street Journal*. November 28, 2020; Branch J. Virus rules may factor into avalanche deaths. *New York Times*. February 10, 2021. B:8). This study was undertaken to help quantify that perception and assess how those first entering the backcountry during the pandemic differ from experienced backcountry skiers.

Methods

The data collection instrument was an anonymous cross-sectional online questionnaire with 29 items, incorporating multiple choice questions, numeric items, Likert-type items, visual-analog scales, numeric sliders, and free text entry responses (see [online Appendix](#)). The University of Nevada and Montana State University Institutional Review Boards approved the study as an “Exempt Protocol” (1690716-1 and JJ020521-EX, respectively). The survey was hosted on a common major commercial platform, and participants were recruited via online postings by regional avalanche centers, avalanche education providers, winter sports news sites and storefronts, and personal social media, including Facebook and

Instagram. Recruitment material was directly targeted toward backcountry recreationalists through calls to action worded, “Are you a backcountry skier or snowboarder?”

Interested participants were directed to a landing page that explained the inclusion criteria (self-identified backcountry skiers or snowboarders aged of >18 y). If they chose to proceed, they were consented, shown a standardized legal disclaimer as required by one of our hosting institutions, and allowed to proceed. The instrument assessed several target areas of our study, including the participant’s self-reported skiing/riding ability level, level of avalanche education, comfort with risk, and confidence in assessing avalanche terrain and the impact of the COVID-19 pandemic. These questions, where applicable, were modeled after items in prior studies that demonstrated a high degree of content validity.^{3,4} For brevity, the term “skier” is used throughout the article to refer to both backcountry skiers and snowboarders.

Participants were classified into 2 cohorts on the basis of their reported seasons of backcountry experience; respondents who answered that 2020 to 2021 was either their first or their second season comprised the novice category—which, for simplicity, we called the “newcomer cohort,” because their first season in the backcountry coincided with the COVID-19 pandemic. Likewise, respondents with >2 y of experience were identified as the “established cohort.” Similarly, participants were categorized into those who received no formal avalanche education and those who reported taking a Level 1 course or higher. Simple demographics, including gender, age, and zip code, were optionally reported. Statistical analysis was performed using R version 4.0.4,⁵ and figures were produced using the package ggplot2.⁶ Initial data cleaning was done to exclude participants who dropped out before completing at least the first 2 survey questions (which asked about experience level). Because no items were mandatory, all other statistical analyses were made to exclude nonresponders to relevant items, and participants were not included in paired analyses unless all items were answered.

Several items were analyzed as ordinal data using nonparametric Mann-Whitney *U* test (MWU) (for unpaired), Wilcoxon signed-rank test (WSR) (for paired), or Kruskal-Wallis *H* test (for paired/unpaired samples of ≥ 3 levels). For these tests, a delta of 1.00, which equates to a difference of 1 ordinal level, was chosen to define significance. *P* values were 2-tailed and considered significant at <0.05, and all CIs are reported at 95%. Data are presented as mean \pm SD for normal distributions and median (interquartile rate) for nonnormal distributions. Except as noted in the article, all analyses of variance (ANOVAs) are 1-way and between-subjects, with effect size reported as η^2 . Because a large sample size, by

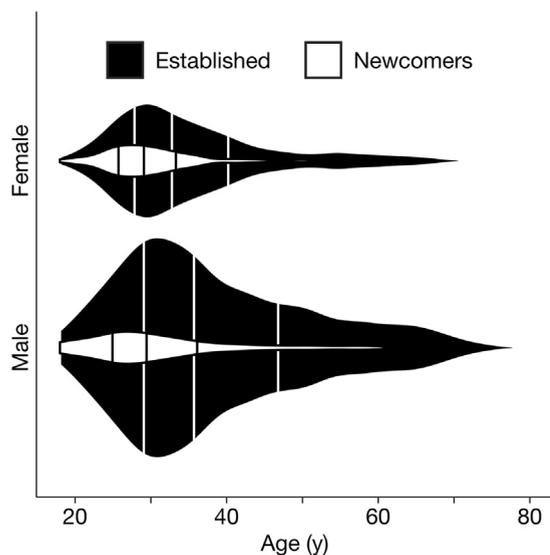


Figure 1. Age of respondents by sex. The age distribution of survey respondents by male or female sex and study cohort. The vertical lines within each category denote quartiles with respect to age ($n=4558$). Respondents reporting as neither male nor female ($n=30$) or those aged >80 y ($n=4$ males) are insufficiently numerous to be meaningfully visualized and are omitted for clarity.

nature, reduces variability and lowers the threshold of difference needed to meet statistical significance, we additionally report effect size next to P values, where appropriate, to assist the reader in estimating the importance of the finding or magnitude of difference.

Responses to questions using paired interactive numeric sliders, namely those about time split between the backcountry and resorts before and during the COVID-19 pandemic, were recoded using a simple linear transformation from the original (-100 to 100) scale to approximate a percentage scale. These sliders, unlike other item types, recorded a default, “placeholder” value even without any participant interaction. Because the paired sliders defaulted to the same random position, nonresponders were easily identified and removed from analysis on these questions.

Results

The survey produced a total of 5674 raw responses over the survey period of March 1, 2021 to March 31, 2021, with 4792 responses after eliminating 882 early drop-out participants. By recruitment source, the largest group of responses (49%, $n=2338$) was from organizations in backcountry and avalanche education, followed by US avalanche centers (31%, $n=1494$), and media or social media websites (16%, $n=746$). Most responses were from

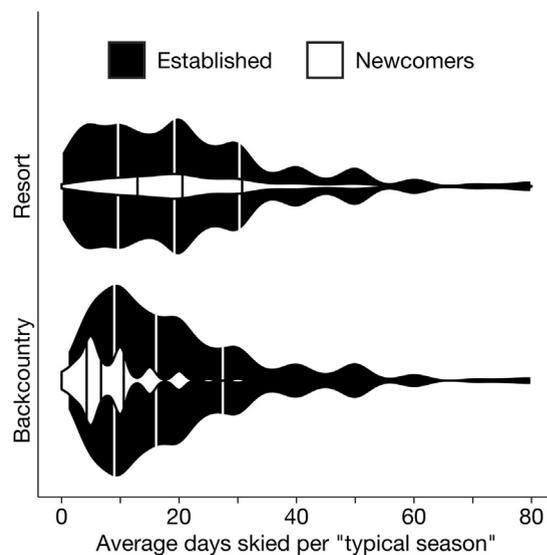


Figure 2. Average days skied in resorts and backcountry per season. The distribution of days skied in the backcountry and at ski resorts for established and newcomer respondents in a “typical season” as defined by the respondent. The vertical lines within each category denote quartiles with respect to days (resort, $n=4646$; backcountry, $n=4650$).

the United States, with only 21 (0.4%) participants reporting Canadian postal codes. Respondents were predominantly young males, as visualized in Figure 1, and mostly established backcountry skiers (84%) with >10 y of resort experience and 4 to 6 y of backcountry experience, as shown in Figure 2. They reported spending an average of 15 d in the backcountry and 20 d at resorts in a “typical season.”

Since the onset of the COVID-19 pandemic, survey participants reported spending a significantly higher proportion of their time in the backcountry instead of at resorts (Figure 3). Overall, since the COVID-19 pandemic began, participants reported spending 17% (95% CI, 15.8–17.9) more of their ski days in the backcountry; Welch’s paired $t(3026)=32$, $n=3027$, $P<0.0001$, $d=0.57$. Participants in the newcomer cohort reported a greater shift, spending 36% [95% CI, 33.3–38.7] more of their ski days in the backcountry ($n=475$) during the COVID-19 pandemic, compared with 13% [95% CI, 12.2–14.3] among established backcountry skiers ($n=2446$), which was significant on a 2-way repeated-measures ANOVA; $F(1, 5836)=122$, $P<0.0001$, $\eta^2=0.02$.

In addition, during the COVID-19 pandemic 19% of all participants reported spending almost all (95% or more) of their time in the backcountry, substantially higher than the 8% who did so before the COVID-19 pandemic. These shifts were significant on McNemar’s tests of paired proportions: $X^2(1)=359$, $P<0.0001$, $g=0.45$; and $X^2(1)=101$, $P<0.0001$, $g=0.25$,

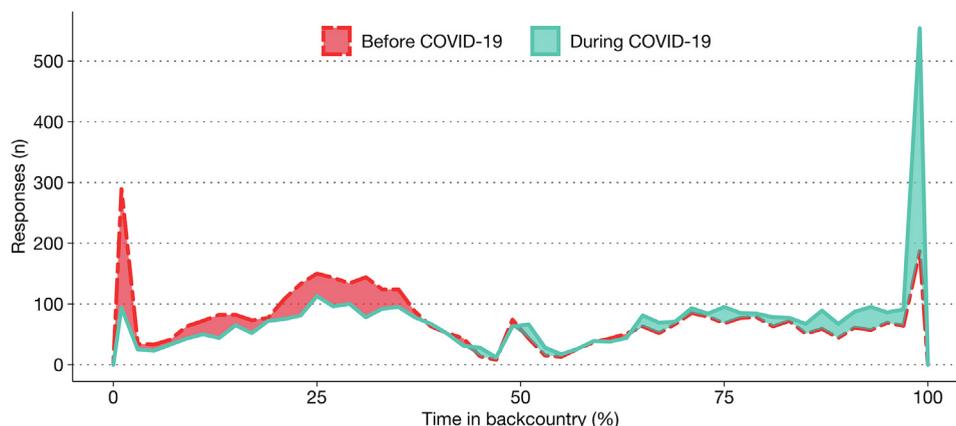


Figure 3. Increase in backcountry versus resort days during the COVID-19 pandemic. Percentage of ski days spent in the backcountry versus in resorts before and during the COVID-19 pandemic. Participants reported spending a higher percentage of their ski days in the backcountry since the beginning of the pandemic. Additionally, during the pandemic, the number of participants who reported skiing almost exclusively at resorts decreased, whereas the number of participants who reported skiing almost exclusively in the backcountry increased ($n=3,027$). COVID-19, coronavirus disease 2019.

respectively; $n=3027$. When asked about their perceptions of overall backcountry use, 81% of established skiers reported noticing more people in the backcountry during the COVID-19 pandemic ($n=3898$).

Established skiers were also surveyed on changes in their own habits due to the COVID-19 pandemic. The majority (97%) reported entering the backcountry with the same number of partners, with none reporting fewer partners ($n=2632$). No respondents reported changing the distance they toured from the trailhead ($n=3125$). When surveyed on whether the COVID-19 pandemic had influenced the frequency of their backcountry use, 27% reported more frequent use, 56% reported no change, and 17% reported less frequent use ($n=4026$). As a validation measure, these responses were tested in participants against reported changes to the percentage of days in the backcountry (as reported above). A 2-way repeated-measures ANOVA demonstrated significance to the expected (commensurate) relationship, suggesting consistency within respondents' answers; $F(2, 6456)=204$, $P<0.0001$, $\eta^2=0.06$.

The newcomer cohort respondents ($n=572$) were surveyed about whether certain consequences of the COVID-19 pandemic were important in their decision to first enter the backcountry. The consequences that participants agreed or strongly agreed were important included resort closures (27%), uncertainty about resort operations (26%), and limited resort access (35%).

All participants were also surveyed on their perceptions of the relative risks of sustaining injury and getting COVID-19 in the backcountry compared with at a resort. The majority (91%) of respondents believed that they had

at least a somewhat higher chance of getting COVID-19 at a resort ($n=4224$). Conversely, 72% of the newcomer cohort believed that they were more likely to get injured in the backcountry, a significantly higher proportion than the 56% of established skiers who shared this belief; unpaired $t(739)=8.4$, $P<0.0001$, $n=3679$, $d=0.36$.

Participants reported a median self-perceived ability level of "Advanced/Expert" for resort skiing, which was 1 full level higher than that in the backcountry cohort, in which the median was "Strong" (95% CI, 1.00–1.00) (WSR, $W=3896198$, $n=4719$, $P<0.0001$, $r=0.96$). There was also an association between seasons of experience and self-perceived backcountry ability (Figure 4), with the newcomer cohort reporting lower ability (median "Intermediate" versus "Strong") by 1 level (95% CI, -1.00 to -1.00) (MWU=542,551, $n=4761$, $P<0.0001$, $r=0.55$).

Although most respondents reported having formal avalanche training (Level 1 or higher), 24% of the newcomer cohort lacked any formal avalanche training. This proportion was significantly higher than the established cohort's 14%; unpaired $\chi^2(1)=42$, $P<0.0001$, $V=0.10$ (Figure 5). The effect of survey referral source on reported avalanche education is demonstrated in Figure 6: participants who reported having formal training ($n=4023$) were more likely to have been referred to the survey via avalanche education organizations (55%) than those without formal avalanche education ($n=728$), who were predominantly referred through local avalanche forecast centers (50%) or online media and social media outlets (30%); unpaired $\chi^2(3)=408$, $P<0.0001$, $V=0.30$. Almost all participants reported carrying appropriate avalanche safety equipment (avalanche beacon, probe,

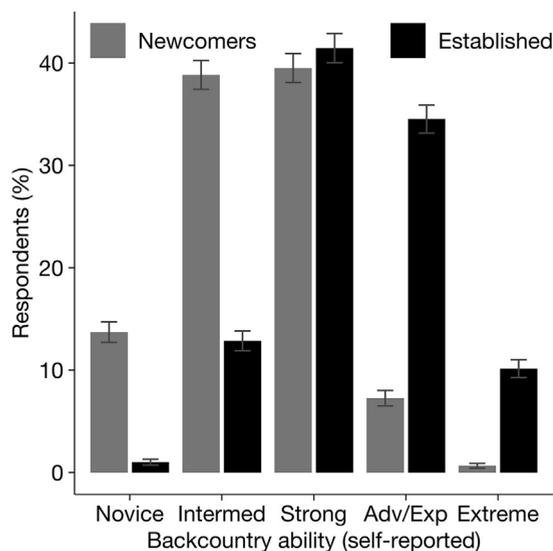


Figure 4. Backcountry skiing/riding ability by cohort. Collectively, the established cohort reported having a significantly higher backcountry skiing ability compared with the newcomer cohort (n=4761). CIs are shown at 95%. Adv/Exp, advanced/expert; Intermed, intermediate.

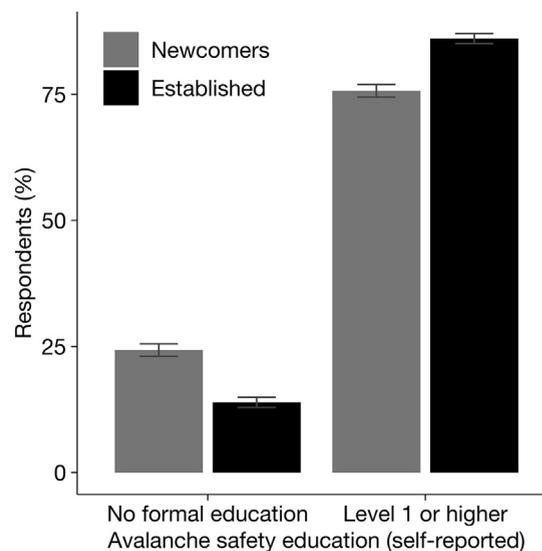


Figure 5. Formal avalanche education by cohort. The participants in the newcomer cohort reported lower overall levels of avalanche education, and a significantly higher proportion of respondents in this cohort lacked any formal education in avalanche safety. CIs are shown at 95%.

and shovel) while in the backcountry, with 97% carrying all 3 and only 2% of people carrying none (total n=4621).

When surveyed on their willingness to accept risk in the backcountry on a scale of 1 to 10 (from completely unwilling to very willing to take risks), the newcomer cohort reported a willingness of 2.8 ± 1.7 to take risks compared with the established cohort at 3.4 ± 1.9 , with a difference in means of -0.61 (95% CI, -0.76 to -0.46); unpaired t (754) = -7.9 , $P < 0.0001$, $n = 4364$, $d = 0.33$. As shown in Figure 7, the newcomer cohort also reported feeling less comfortable assessing avalanche risk in various conditions and terrain than the established cohort. Newcomers reported a median confidence in assessing “simple” conditions and terrain, which was 1 full degree lower (95% CI, 1.00–1.00) than that in the established cohort at “moderately complex”; $MWU = 629336$, $P < 0.0001$, $r = 0.47$.

Discussion

The COVID-19 pandemic had a complex effect on skiing and riding, both in resorts and the backcountry, with many skiers shifting their choice of where to ski and how to access the terrain. This study attempted to identify new backcountry skiers and ascertain attitudes and perceptions of both new and established backcountry skiers regarding several downstream effects of the COVID-19 pandemic. Four main findings of this study merit further

comment: 1) both new and experienced backcountry skiers reported spending more of their time in the backcountry since the pandemic started; 2) for many, changes in ski area operations were a significant factor for this increase; 3) this cohort of inexperienced backcountry skiers expressed less confidence in their ability to assess avalanche risk than the experienced cohort; and 4) almost one-quarter of new backcountry skiers lacked any formal avalanche education.

Our finding that people reported spending more time in the backcountry supports what has been reported in the media and experienced anecdotally by many (including 81% of our respondents). This qualitative study did not aim to quantify overall how many new backcountry skiers were created during the COVID-19 pandemic; however, it does demonstrate that both new and established backcountry skiers reported spending significantly more of their time (17%) in the backcountry since the start of the COVID-19 pandemic. It is also notable that the proportion of our respondents who spent nearly all their time at resorts before the pandemic was cut in half, whereas those who spent nearly all their time in the backcountry had doubled.

Although most new backcountry users did not report that COVID-19 was a major factor in their decision to start backcountry skiing or riding, it is notable that more than one-quarter did consider resort closures due to COVID-19 and uncertainty of resort operations as important factors in their decision and that 35% believed

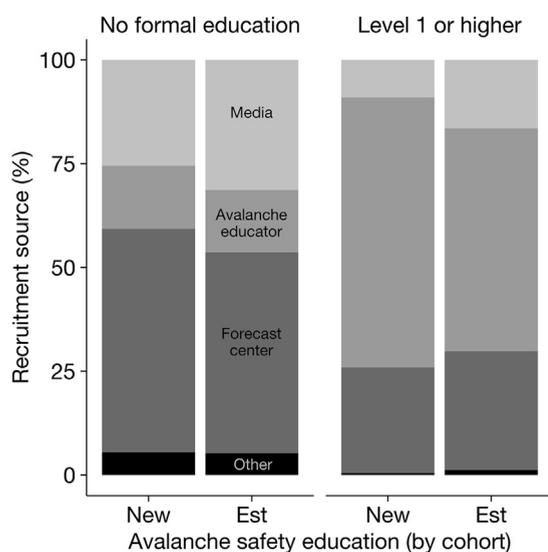


Figure 6. Formal avalanche education by survey referral source. The participants who reported having formal (Level 1 or higher) avalanche education ($n=4023$) were more likely to have been referred to the study through the websites of avalanche education providers, such as the American Institute for Avalanche Research or the American Avalanche Institute. Those reporting no formal education ($n=738$) were more likely to have been referred through online media and social media outlets or from local avalanche forecast centers. New, newcomer cohort; Est, established cohort.

that limited resort access was an important motivator. Even before the COVID-19 pandemic, backcountry skiing had already seen its greatest year-over-year growth; hence, any further increase in popularity represents a profound impact on the sport, as evidenced by the reports of ski shops selling out of backcountry touring equipment and avalanche education providers being overwhelmed by skiers' demand (Mander B. Ski in the Wild. *Wall Street Journal*. November 28, 2020).

Not surprisingly, the risk perceptions of the newer skiers differed from those of the more experienced skiers. On average, they perceived a higher injury risk in the backcountry and had less confidence in their ability to assess avalanche terrain. They also reported a lower overall self-perceived skiing ability, both in the backcountry and at resorts. Although a detailed analysis of the downstream incidence of avalanche and search and rescue use between these cohorts was beyond the scope of this study, these traits seem to be grossly reflected in the avalanche fatalities through these years. The winter of 2020 to 2021 was unique not only because of the COVID-19 pandemic but also because of the persistent and widespread unstable snowpack across the wider United States mountain west. This, unfortunately, was reflected by a historic number of avalanche fatalities.⁷ Contrary to popular belief, the US Forest Service notes

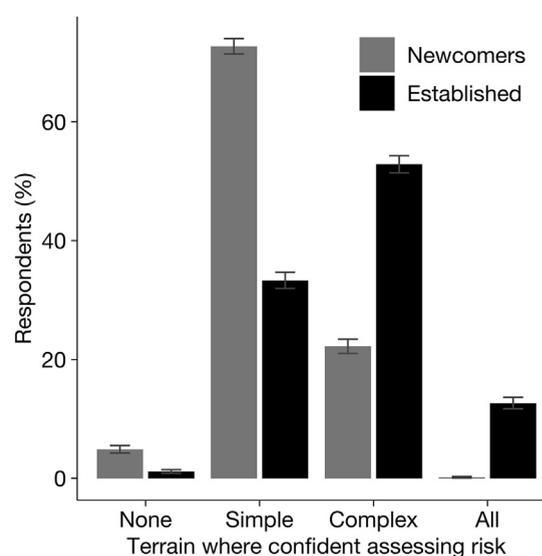


Figure 7. Confidence in assessing avalanche risk in various conditions and terrain. The participants in the newcomer cohort reported a median confidence in assessing avalanche risk in “simple” conditions and terrain, which was significantly lower than that of the participants in the established cohort, who felt comfortable assessing risk in “moderately complex” conditions and terrain ($n=4566$). CIs are shown at 95%. None, not confident at all; Complex, moderately complex.

that most of these recent avalanche fatalities (among all types of backcountry users, including snowmobilers) were experienced recreationalists.^{7,8} This may be a reflection of the self-described differences in ability and risk perception reported by the more experienced established cohort.

Lastly, almost one-quarter of the newcomer cohort lacked any formal avalanche training, a figure which is likely underrepresented given that 80% of our respondents were recruited from avalanche education providers or avalanche centers. Given the serious danger of avalanches and the importance of both mitigating risk through careful decision making and training for immediate companion rescue in case of a burial, the lack of formal education among the newcomer cohort is a substantial concern to public health. As this cohort continues to ski without this training, their risk-taking behaviors are likely to increase with more comfort in the backcountry environment and positive reinforcement from each run completed without consequences despite having made potentially dangerous choices.⁹

LIMITATIONS

We report several limitations to this study, including those common to all web-based surveys, such as but not

limited to biases, such as sampling, selection, nonresponse, social desirability, acquiescence, anchoring, and recall. Asking respondents about their backcountry use “before COVID-19” begets a substantial inherent risk of recall bias. Similarly, although our instrument employed such phrasing to frame relevant questions as comparing before or during the COVID-19 pandemic to facilitate statistics, participants reported their seasons of experience in terms of whole seasons. Because the COVID-19 pandemic onset part way through the 2019 to 2020 season, it is expected that some participants reporting this as their first backcountry season ($n=263$) may have entered the sport before its onset, which limits our ability to absolutely associate all newcomers with the pandemic. Further, responses were only collected for a single month during ski season because unexpectedly high participation rates achieved our participation target fairly early. It is expected that a longitudinal survey over many months may capture some skiers who are only active for part of the season or in areas with variable snow conditions and avalanche risk throughout the year.

Additionally, although we attempted to reach inexperienced backcountry skiers by requesting that ski areas and retailers recruit skiers to our survey on their websites, this was met with limited engagement, and most of our recruitment was ultimately through avalanche educators (49%) and avalanche forecast centers (31%). This likely biases responses toward persons already engaged with avalanche safety, with the expectation that this likely causes our estimates and conclusions to substantially underestimate skiers with little to no avalanche education, and those who are not aware of avalanche danger. Similarly, we recognize that our conclusions may have suffered from nonresponse bias from those with limited education or experience and who may have, therefore, decided not to complete our survey. Additionally, respondents were predominantly from the western United States, further limiting generalizability, especially to American Northeast skiers.

When evaluating changes to the percentage of ski days spent in the backcountry, we attempted to exclude nonresponders by eliminating what we identified as placeholder values recorded by our survey platform, as detailed in the methods section. Although all efforts were taken to accurately identify such cases, we were unable to identify any participants who agreed with and so purposefully left the placeholder or whose purposeful responses inadvertently mimic a placeholder. Because of this, some true respondents were likely eliminated, the mathematical result being some degree of overestimation of the magnitude of change reported. For process integrity, we ran these statistics without eliminations, and

significance was retained on all tests at a similar high degree. Lastly, our study was only intended to assess subjective changes in backcountry use and perceptions, and was not designed nor able to assess the quantitative growth, or exactly how many new backcountry skiers the conditions around the COVID-19 pandemic have created compared with baseline.

Conclusions

Our participants' responses support the media reports that backcountry use increased substantially during the COVID-19 pandemic, and that the pandemic was influential in many people's decision to first enter the backcountry. The fact that nearly one-quarter of our respondents who started backcountry skiing since the beginning of the pandemic reported having no formal avalanche training is concerning—a figure that is likely underestimated by this study. Avalanches offer no warning and occur in a wide variety of terrain; without training, most avalanche risks are incredibly difficult to assess, if not entirely invisible. As such, the newcomer cohort represents an especially important demographic for outreach and education efforts in the coming seasons as backcountry skiing becomes increasingly more popular each year.

Acknowledgments: The authors thank Molly Thompson at the University of Nevada, Reno, for her technical assistance in early statistical analysis and methodology. The authors also thank the avalanche centers and education providers who promoted our research and work so hard to help people stay safe in the backcountry.

Author Contributions: Study concept and design (EAV, APC, SJHT, JH, JDJ, DCF); data acquisition (EAV, APC, SJHT, DCF); data analysis (EAV); drafting of the manuscript (EAV, APC, SJHT, DCF); critical revision of the manuscript (EAV, JH, JDJ, DCF); and approval of final manuscript (EAV, APC, SJHT, JH, JDJ, DCF).

Financial/Material Support: None.

Disclosures: DCF is a volunteer board member and medical advisor of the Sierra Avalanche Center. His involvement with this research is independent of that appointment, and the Sierra Avalanche Center has not endorsed or otherwise supported this study other than hosting our survey URL on their webpage.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.wem.2022.08.005>.

References

1. Birkeland KW, Greene EM, Logan S. response to avalanche fatalities in the United States by Jekich et al. *Wilderness Environ Med.* 2017;28(4):380–2.

2. Van Tilburg C, Grissom CK, Zafren K, McIntosh S, Radwin MI, Paal P, et al. Wilderness Medical Society practice guidelines for prevention and management of avalanche and nonavalanche snow burial accidents. *Wilderness Environ Med.* 2017;28(1):23–42.
3. Mannberg A, Hendrikx J, Johnson J. Risky positioning—social aspirations and risk-taking behaviour in avalanche terrain. *Leis Stud.* 2021;40(4):495–512.
4. Johnson J, Hendrikx J. Using citizen science to document terrain use and decision-making of backcountry users. *Citiz Sci.* 2021;6(1):8–23.
5. R Foundation for Statistical Computing. R: a language and environment for statistical computing. Available at: <https://www.R-project.org/>. Accessed July 4, 2021.
6. Ginestet C. ggplot2: elegant graphics for data analysis. *J R Stat Soc Ser A Stat Soc.* 2011;174(1):245–6.
7. Beekman K. Avalanche fatalities, COVID, and backcountry skiing: the real story behind a historic season. *Avalanche Rev.* 2021;40(1):34–5.
8. Peitzsch E, Boilen S, Logan S, Birkeland K, Greene E. Research note: how old are the people who die in avalanches? A look into the ages of avalanche victims in the United States (1950–2018). *J Outdoor Recreat Tour.* 2020;29:100255.
9. Johnson J, Mannberg A, Hendrikx J, Hetland A, Stephensen M. Rethinking the heuristic traps paradigm in avalanche education: past, present and future. *Cogent Soc Sci.* 2020;6(1):1807111.