

Prevalence and diffusion of helmet use at ski areas in Western North America in 2001–02

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Objective: The purpose of this study was to examine diffusion of and predictors of helmet use among skiers and snowboarders in the Western United States and Canada.

Design: 6400 skiers and snowboarders at 29 ski resorts in the Western United States and Canada were interviewed on chair lifts and observed for helmet use during two consecutive ski seasons (winters 2001 and 2002).

Setting: Skiers and snowboarders were observed and interviewed at 29 ski resorts in Alaska, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, and British Columbia as part of a sun protection project.

Subjects: Participants completing the survey consisted of 3525 adult skiers and snowboarders in the 2002 season and 2978 adult skiers and snowboarders in the 2001 season.

Main outcome measure: The outcome measure for all analyses was prevalence of helmet use by skiers and snowboarders.

Results: Helmet use by skiers and snowboarders is increasing and is most prevalent among snowboarders, experts, and more frequent skiers/snowboarders. No evidence was found for the hypothesis that helmet use is diffusing more rapidly among earlier adopters of helmets than later adopters.

Conclusions: Although controversy remains, helmets are rapidly diffusing as a safety device at western North American ski resorts. Expert and more frequent skiers and snowboarders are more likely to wear helmets, which may indicate that helmets are recognized as a safety device.

Winter recreation plays an important part in maintaining fitness, providing cross training activity, and perhaps preventing disease.^{1,2} However, sports such as skiing and snowboarding also have a risk of injury. Although it accounts for only 15% of all injuries, severe trauma to the head is the most frequent cause of death and severe disability among skiers and snowboarders.^{3–10} These head injuries have various causes, including skiing and snowboarding without a helmet, excessive speed, aerial maneuvers, crowded slopes, and more snowboarders.^{5,8,9,11–17} Research on the protective effect of safety helmets in preventing severe injuries and death in risky sports suggests that helmets may moderate the severity of head injuries.^{5,8,9,13,15,16,18–20}

The overall effectiveness of protective helmets in moderating head injuries among skiers and snowboarders continues to be debated. The National Ski Areas Association, which represents a majority of ski areas in North America, recommends that people thoroughly research the pros and cons of wearing helmets before making a personal choice to wear or not.²¹ Though some ski areas now require children in ski schools to wear helmets,^{22–25} no such requirement exists for males, adult beginners, older adult skiers, and snowboarders, all of whom suffer a disproportionate share of head injuries on the slopes.^{4,5,7,9,12,13,18–20,22}

This study follows up on an earlier survey examining the prevalence of helmet use. In that study, only 12% of the skiers and snowboarders surveyed were observed to be wearing helmets.²⁶ Research on the natural adoption of new products such as skiing and snowboarding helmets shows that adoption rates follow an escalating curve especially when they are first introduced into the marketplace. In fact, this principle is a key tenet of the diffusion of innovations theory (DIT)²⁷ which has been widely used in marketing, public health, communication, geography, sociology, and

economics. Given this theoretical framework, we expected an increase in the proportion of skiers and snowboarders wearing helmets since the initial survey was conducted and thus we predicted:

Hypothesis 1: The prevalence of helmet use by skiers and snowboarders significantly increased from 2001 to 2002.

The previous survey²⁶ also revealed that helmet use was higher among particular demographic groups and groups defined by skill, experience, and equipment. To replicate those findings the following hypotheses were also tested:

Hypothesis 2: Helmet will use will be greater among: (a) more educated guests; (b) frequent skiers/snowboarders; (c) experts and intermediates; and (d) snowboarders rather than less educated guests, occasional skiers/snowboarders, beginners, and skiers.

Finally, in the first survey, the prevalence of helmet use among some subgroups exceeded the average of 12%—guests residing in the Rocky Mountain region (19.2%) and Canada (15.1%), experts (18.6%), those who skied or snowboarded the largest proportion of days (27.2%), and snowboarders (22.0%). DIT predicts that once a group's prevalence of use of a new product such as helmets reaches 15% or more, the rate of adoption should accelerate within that group. This is because non-users begin to overestimate the number of people who have adopted the new product and feel more social pressure to use it.^{27,28} Thus, based on the previous survey and DIT, it was predicted that:

Hypothesis 3: Guests residing in the Rocky Mountain region and Canada, who are experts, who ski or snowboard the largest proportion of days, and who are snowboarders will show a greater rate of increase in the use of helmets from 2001 to 2002 than corresponding groups (guest from outside this region, non-experts, occasional skiers/snowboarders, and skiers).

METHODS

Sample

The study employed two samples collected in consecutive years. Sample 1 consisted of 2978 adult (age 18 and older) alpine skiers and snowboarders surveyed in 2001 on chairlifts at 28 resorts Alaska, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, and British Columbia (see Buller *et al*²⁶ for a description of recruitment and eligibility criteria). Sample 2 comprised 3422 alpine skiers and snowboarders during winter 2002 at 29 ski areas in the same states. These ski areas were relatively diverse in terms of location, size, ownership, lift ticket prices, and employee and guest demographics and represented both inexpensive local resorts as well as expensive destination resorts. Less than 5% of the participants who were approached for an interview were ineligible (under 18, ski area employee, refusal).

Survey procedures

During three day periods (one weekend day and two weekdays) from January to March in 2001 and 2002, face-to-face interviews were conducted on chairlifts and gondolas with a minimum run time of four minutes. The number of completed interviews per ski area ranged from 57 to 220, depending on the number of guests on the mountain during the interview periods. Teams of three to four trained interviewers performed the interviews. Each interviewer completed 12 to 20 surveys per day.

Interviewers followed a standard protocol in which they boarded the chair lift, attempting to sit at the end of the chair. On ascent, they began the four minute survey by first reading a consent statement approved by the institutional review boards of the participating institutions. Interviewers initially attempted to recruit the guest seated immediately next to them; if they were seated in the middle of the chair, they interviewed the person to their right. If that person refused, interviewers tried to recruit the person seated next to that guest. One interview was completed per lift ride; respondents were given a free sunscreen lip balm as a thank you. Interviewer assignments were made to ensure that surveys were completed on all chair lifts and balanced across lifts, but main lifts providing access to large areas of the mountain were over-sampled. Surveys were completed on lifts accessing every type of terrain from beginner' to experts' slopes, and ranging from groomed slopes to moguls and half pipes.

Measures

The primary measure in the present study was helmet use, made by direct observation of guest headgear at the end of each interview. For each survey, interviewers also recorded the resort name, chair lift name, and weather conditions (for example, wind, cloud cover). Interviewers asked respondents to report the time of day they started skiing or snowboarding; their level of expertise (beginner, intermediate, expert); the number of days they had skied/snowboarded in the 2001–02 season, race, ethnicity, age, education, and home zip code. Using procedures developed in the previous survey,²⁶ we calculated the proportion of days each respondent skied/snowboarded since December of the previous year, their region of residence, country, and whether the respondent was a "destination" (living 200 miles or more from the ski area) or "local" (<200 miles) guest. Finally, the guest's gender and type of equipment (ski or snowboard) was observed and recorded by interviewers.

Analysis plan

Analyses assessed the prevalence of helmet use and predictors of use, similarly to the initial survey.²⁶ We

performed univariate logistic regression analysis predicting the prevalence of helmet use during the 2002 season and with time (2001 v 2002) to test hypothesis one. To test hypotheses two and three, we performed a series of bivariate logistic regression analyses in which we included as predictors, guest characteristics (age, race, education, region of residence, destination v local guest, level of expertise), equipment (skis v snowboard), proportion of possible days skied/snowboarded, ski area features (region, ownership), and weather conditions (wind, cloud cover), along with time (2001 v 2002). Significant predictors (p<0.05) from these bivariate regressions were then entered into a backwards stepwise multivariate logistic regression model to identify the most parsimonious predictor model and test hypothesis 2. Two way interactions between the predictors and time in the bivariate logistic regressions evaluated hypothesis three by assessing whether the relationships between the key variables and helmet use changed from the first to the second survey as predicted.

Table 1 Odds ratios and confidence intervals (CI) for statistically significant (p<0.05) predictors in univariate logistic regression on helmet use (1 = yes; 0 = no) in 2002*

Predictor	Odds ratio	95% CI
<i>Guest characteristics</i>		
Age	1.00	0.996 to 1.01
Race (Other v white)	0.65	0.41 to 1.03
Gender (Male v female)	1.37	1.13 to 1.68*
Education (College graduate v high school or less)	1.17	0.87 to 1.58
(Some college v high school or less)	1.13	0.81 to 1.59
Proportion of days skied/snowboarded since 1 November		
(4th quartile v 1st quartile)	11.51	8.20 to 16.16*
(3rd quartile v 1st quartile)	5.89	4.09 to 8.20*
(2nd quartile v 1st quartile)	2.93	2.02 to 4.23*
Self reported ability (Intermediate v beginner)	1.46	0.88 to 2.41
(Expert v beginner)	3.38	2.05 to 5.58*
Type of equipment (snowboard v skis)	2.16	1.79 to 2.61*
<i>Home residence</i>		
(Far West v Rocky Mountain)	0.47	0.37 to 0.59*
(Southwest v Rocky Mountain)	0.45	0.28 to 0.72*
(Northwest v Rocky Mountain)	0.65	0.50 to 0.86*
(South Central v Rocky Mountain)	0.27	0.17 to 0.44*
(North Central v Rocky Mountain)	0.43	0.28 to 0.64*
(Southeast v Rocky Mountain)	0.25	0.15 to 0.42*
(Northeast v Rocky Mountain)	0.71	0.49 to 1.04
(Canada v Rocky Mountain)	1.16	0.70 to 1.94
(Other country v Rocky Mountain)	0.30	0.04 to 2.43
Type of guest (Destination v local)	0.68	0.57 to 0.82*
<i>Ski area characteristics</i>		
<i>Ski area region</i>		
(Southwest v Colorado)	0.69	0.49 to 0.95*
(Northwest v Colorado)	1.05	0.85 to 1.29
(California v Colorado)	0.61	0.49 to 0.76*
Ownership (Corporate v independent)	1.13	0.95 to 1.34
<i>Weather</i>		
<i>Cloud cover</i>		
(Cloudy v clear)	1.12	0.92 to 1.36
(Partly cloudy v clear)	1.15	0.73 to 1.14
<i>Wind</i>		
(Moderate/strong v calm)	1.12	0.89 to 1.42
(Light v calm)	1.15	0.95 to 1.40

*Only variables demonstrating statistically significant univariate relationships with helmet use were entered into the logistic regression—that is, gender, days skied/snowboarded, home residence, self reported ability, type of equipment, type of guest, and ski area region.

Table 2 Odds ratios and confidence intervals (CI) for statistically significant ($p < 0.05$) predictors in multivariate logistic regression on helmet use (1 = yes; 0 = no) in 2002*

Predictor	Odds ratio	95% CI
<i>Guest characteristics</i>		
Self reported ability		
(Intermediate v beginner)	1.15	0.67 to 1.92
(Expert v beginner)	1.90	1.10 to 3.28*
Proportion of days skied/snowboarded since November 1		
(4th quartile v 1st quartile)	8.24	5.77 to 11.76*
(3rd quartile v 1st quartile)	4.84	3.39 to 6.92*
(2nd quartile v 1st quartile)	2.68	1.85 to 3.89*
Type of equipment (snowboard v skis)	2.07	1.68 to 2.54*
<i>Ski area characteristics</i>		
Ski area region		
(Southwest v Colorado)	0.86	0.60 to 1.21
(Northwest v Colorado)	1.02	0.82 to 1.28
(California v Colorado)	0.60	0.48 to 0.76*

RESULTS

In 2002, 3739 alpine skiers and snowboarders were approached to complete the survey. Removing those 181 guests who were ineligible (27 under age 18; 82 employed at the ski area; 60 previously interviewed, and 12 not English proficient), 3525 of 3558 eligible guests completed the survey, yielding a completion rate of 99.1% (0.9% refused [n = 33]). However, there were 103 exclusions because headgear was not recorded.

Of the guests surveyed in 2002, 79.0% skied and 21.0% snowboarded, with 5.1% saying they were beginners, 52.8% intermediates, and 42.1%, experts. They varied in age: 16.1% 18–25, 24.4% 26–35, 26.9% 36–45, 18.5% 46–55, and 14.0% 55 years or older. Men comprised 72.2% of the sample, while 9.6% had a high school diploma or less, 21.1%, some trade or college education, and 69.3%, a college degree. Guests were interviewed at ski areas in Colorado and the central Rocky Mountains (36.2%), California (29.9%), the Pacific Northwest (28.8%), and the Southwest (9.1%). But guests lived throughout the United States (Rocky Mountain [25.2%], Far West [29.1%], Southwest [4.8%], Northwest [13.3%], South Central [6.7%], North Central [6.7%], Southeast [5.9%], and Northeast [5.8%]), in Canada (2.3%), and in foreign countries (0.3%).

Survey responses from 2001²⁶ and 2002 from 26 resorts that participated in both surveys were combined to analyze trends over time. In this combined sample, 80.0% skied and 20.0% snowboarded, with 5.6% saying they were beginners, 54.8% intermediates, and 39.6%, experts. Guests varied in age: 15.3% 18–25, 24.8% 26–35, 27.8% 36–45, 18.9% 46–55, and 13.2% 55 or older. The majority of the sample was male (71.9% men) and 9.6% had a high school diploma or less, 22.1%, some trade or college education, and 68.3%, a college degree. Guests were interviewed at ski areas in Colorado and the central Rocky Mountains (37.3%), California (24.5%), the Pacific Northwest (28.1%), and the Southwest (10.1%). But guests lived throughout the United States (Rocky Mountain [26.7%], Far West [23.6%], Southwest [4.9%], Northwest [13.1%], South Central [6.9%], North Central [6.9%], Southeast [6.0%], and Northeast [5.8%]), in Canada (3.6%), and in foreign countries (2.5%).

Hypothesis 1

Hypothesis 1 was confirmed. The prevalence of helmet use by skiers and snowboarders in 2002 was 19.8%, which was statistically significantly higher than the 12.1% observed in 2001 ($p < 0.001$).

Table 3 Prevalence of helmet use in 2002 in categories within statistically significant univariate predictors

Predictor	Prevalence of helmet use (%)
<i>Age</i>	
18–25	23.4
26–35	19.4
36–45	16.9
46–55	15.8
55 or older	27.1
<i>Gender</i>	
Male	21.3
Female	16.4
<i>Home residence</i>	
Rocky Mountain	29.2
Far West	16.2
Southwest	15.7
Northwest	21.3
South Central	10.1
North Central	15.0
Southeast	9.4
Northeast	22.7
Canada	32.4
Other country	11.1
<i>Self reported ability</i>	
Beginner	10.3
Intermediate	14.3
Expert	27.9
<i>Proportion of days skied or snowboarded</i>	
1st quartile	5.0
2nd quartile	13.3
3rd quartile	23.2
Type of guest	16.6
Destination	22.5
<i>Local</i>	
<i>Type of equipment</i>	
Snowboard	30.6
Skis	17.0
<i>Ski area region</i>	
Colorado	22.4
Southwest	16.5
Northwest	23.2
California	15.0

Table 4 Odds ratios and confidence intervals for the interaction between time and statistically significant ($p < 0.05$) predictors on helmet use (1 = yes; 0 = no) in 2001 and 2002*

Predictor	Estimate	p Value
Gender* time		
(Male-pretest)	0.09	0.06
Proportion of days skied/snowboarded since 1 November		
(4th quartile-pretest)	0.10	0.10
(3rd quartile-pretest)	0.06	0.43
(2nd quartile-pretest)	-0.14	0.12
Self reported ability		
(Intermediate-pretest)	0.14	0.14
(Expert-pretest)	0.15	0.11
Type of equipment* time		
(Snowboard-pretest)	0.04	0.34
Ski area characteristics:		
Ski area region		
(Southwest-pretest)	-0.03	0.77
(Northwest-pretest)	-0.02	0.72
(California-pretest)	0.08	0.29

*Models contain both main effects and interaction terms, though only results for interaction term are displayed.

Hypothesis 2

Hypothesis two was generally supported by the results of the univariate and multivariate logistic regression procedures on the 2002 (tables 1 and 2). Helmet use continued to be most prevalent among more experts, more frequent skiers/snowboarders, and snowboarders (table 3). However, more educated skiers/snowboarders and intermediates no longer were observed to use helmets more frequently than less educated guests and beginners. The univariate analyses showed that helmet use was lower at California ski areas than at Colorado ski areas, among those guests living outside the Rocky Mountain region rather than in that region, and among destination as opposed to local guests. The ski area region continued to be a significant predictor in the multivariate model, suggesting that the difference between California and Colorado was more pronounced in 2002 than 2001. The home residence and destination variables were not included in the multivariate model because a large proportion of guests refused to provide their home zip code.

We ran a regression model replicating the predictors from the 2001 model, which included education rather than region of ski area. In this analysis, education was a significant predictor (trade school or some college *v* high school graduate or less odds ratio 1.40, 95% confidence interval 0.98 to 2.02; college graduate *v* high school graduate or less odds ratio 1.72, 95% confidence interval 1.24 to 2.40). A comparison of the R^2 for the two models (0.117 for the 2002 model; 0.112 for the 2001 model) indicated that the substitution of region of ski area for education in 2002 did not substantially alter the performance of the regression model.

Hypothesis 3

The third hypothesis predicted that groups that in 2001 had a helmet use prevalence exceeding 15%—guests residing in the Rocky Mountain region and Canada, experts, those who skied the largest proportion of days, and snowboarders—would display a greater rate of helmet adoption than their counterparts with lower prevalence of use in 2001. A series of bivariate logistic regression (predictor, time [2001 *v* 2002], predictor \times time) analyses on the combined sample and the predictor by time interaction tested hypothesis 3. These analyses did not support the hypothesis; none of the interactions with time were statistically significant (expert *v* beginner by time estimate 0.15, $p = 0.11$ and intermediate *v* beginner by time estimate 0.14, $p = 0.14$; days skied/snowboarded: fourth quartile of skiing frequency *v* first quartile by time estimate 0.10, $p = 0.10$; third quartile *v* first quartile estimate 0.06, $p = 0.43$; second quartile *v* first quartile by time estimate -0.14 , $p = 0.12$; equipment by time estimate 0.04, $p = 0.34$). In fact, time did not demonstrate a statistically significant interaction with any of the potential univariate predictors of helmet use (table 4).

DISCUSSION

The results of this study demonstrate that helmet use is increasing significantly among skiers and snowboarders. Identical survey procedures conducted at ski areas in western North America in 2001 and 2002 show a statistically significant increase of 7.7% during this single year. The upward trend showed no sign of abating and it may reach a “critical mass” soon in the population that visits ski areas. At that point, according to DIT people should start to overestimate helmet use and helmet adoption should increase at a higher rate.²⁷

Expert and more experienced skiers are still most likely to use helmets. However, the 2002 data suggest that adoption also is becoming more widespread among beginners who now use helmets at the same rate as intermediates. The trend that guests who live and ski in the Rocky Mountain region

have the highest prevalence of helmet use was observed in 2001, too, although it was not part of the multivariate regression model. It may be that more aggressive social marketing campaigns for helmets have been conducted in the Rocky Mountain region than elsewhere. Indeed, an extensive helmet campaign led by neurologist Stewart Levy in Denver provides free helmets in the Denver area through sports stores in Colorado.²⁹ Alternatively, the cold weather pattern in the Rocky Mountains may encourage helmet use as they tend to retain body heat.

Surprisingly, the results showed no support for DIT’s “critical mass” hypothesis. Instead helmet use appeared to be increasing in all groups including those where use was highest in 2001. Perhaps critical mass had not been reached in any group in 2001, although 19.6% prevalence is consistent with theoretical claims that it occurs when prevalence exceeds 15%–20% of a population.²⁷ It is possible that retail marketing campaigns and coverage of helmets in the popular press during 2001 and 2002 influenced all types of skiers and snowboarders to consider wearing them, overshadowing any effect of the critical mass. Alternatively, one year may be an insufficient period of time to adequately test the critical mass hypothesis, thus additional longitudinal data would be desirable.

By 2002 nearly one third of all snowboarders wore safety helmets where only about one sixth of skiers wore helmets. Both groups increased at the same rate from 2001 with snowboarders continuing to lead skiers by over 12%. Prior research suggested that snowboarders are part of a culture that employs helmets in other sports such as skateboarding, inline skating, mountain bicycling, and motor sports whereas skiers may be less likely to have done these sports. This snowboard cohort may have also been the target of more recent intense bicycle helmet safety campaigns as participants in the aforementioned sports.^{30–33}

Finally, the 2002 data continue to show greater helmet use by males than females. Helmets may be perceived as inherently masculine or women may not adopt them because helmets conceal and dishevel female hairstyles.²⁶

As noted in our prior study the issue of recommending and/or requiring ski helmets is a complex one.²⁶ While helmets may afford some degree of protection, the ski industry wants skiers and snowboarders to recognize that helmets may not protect the person from all head injuries, particularly those that occur at high speeds. There is also concern that helmets may increase risk taking among skiers and snowboarders. This risk compensation phenomenon—the practice of taking greater risks when provided with a safety device—has been studied and debated with other types of safety devices.^{34–36} The 2002 data show that experts are about twice as likely to wear helmets than either beginners or intermediates and frequent skiers are nearly 13 times more likely to wear helmets than infrequent skiers. It is possible is

Key points

- Helmet use is increasing in Western North America.
- Helmet use is more prevalent among expert and more frequent skiers and snowboarders rather than beginners, intermediates, or less frequent snowboarders or skiers.
- Helmet use is more prevalent among snowboarders than skiers.
- The fact that expert and frequent skiers are more likely to use helmets suggests that they are recognized by the most knowledgeable participants as a safety device.

that skiers and snowboarders with higher ability and experience wear helmets in order to take more risks (that is, ski or ride faster or on more challenging terrain), consistent with the risk compensation hypothesis. However, it is also possible that, with knowledge and experience, skiers and snowboarders become more aware of the risks inherent in these sports and adopt helmets to reduce them. Future studies should attempt to ascertain the validity of the risk compensation hypothesis by determining if helmet use or other factors are more likely to be associated with risk.

Helmets are becoming more common equipment for a substantial number of skiers and snowboarders. Avid skiers and snowboarders are leading this trend but the prevalence of helmet use is increasing in all groups. Likewise, ongoing media coverage of both helmets and injuries may be contributing to this trend. Data on the safety benefits of helmets in these sports are only just emerging¹⁸ and issues such as risk compensation need to be examined.

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