ORIGINAL ARTICLE

Testing the risk compensation hypothesis for safety helmets in alpine skiing and snowboarding

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Objective: The prevalence of helmet use by alpine skiers and snowboarders was estimated and self-reports on risk taking were assessed to test for potential risk compensation when using helmets in these sports.
Setting: Skiers and snowboarders were observed and interviewed at 34 resorts in the western United States and Canada.
Subjects: Respondents were 1779 adult skiers and snowboarders in the 2003 ski season.
Outcome measures: Observations of helmet use and questions about perceived speed and degree of challenge when not wearing a helmet (helmet wearers) or in previous ski seasons (non-helmet wearers).
Results: Helmet wearers reported that they skied/snowboarded at slower speeds (OR = 0.64, $p<0.05$) and challenged themselves less (OR = 0.76, $p<0.05$) than non-helmet wearers. Adoption of safety helmets in 2003 (23%) continued to increase over 2002 (OR = 0.46, $p<0.05$) and 2001 (OR = 0.84, $p<0.05$).
Conclusions: No evidence of risk compensation among helmet wearers was found. Decisions to wear helmets may be part of a risk reduction orientation. Helmet use continues to trend upwards but adoption may be slowing.

Evidence supporting the protective value of safety helmets in sports now includes skiing and snowboarding.[1–8] Yet, within the snow sports industry, the debate continues about whether the benefits of safety helmets are offset because they encourage increased levels of risk taking. This form of risk compensation, based on the hypothesis that safety appliances instill a false sense of security in their users, causing them to engage in offsetting behaviors that exceed their normal level of acceptable risk, continues to be debated in the literature as well.[9–13] Thus, some industry principals allege that skiers and snowboarders wearing safety helmets take greater chances than they would if they were not wearing one.

Other studies, however, show that perceptions of risk may actually prompt the use of safety devices.[14–16] Advanced skiers and snowboarders report wearing helmets more frequently than beginners, possibly because they take more risks to begin with than beginners.[17 18] Contrary to the logic of the risk compensation hypothesis, recent case-controlled studies also reported that there were no differences in the severity or circumstances of non-head/non-neck injuries among helmet and non-helmet wearing skiers and snowboarders.[1 2] Research on other sports, such as bicycling, also suggests that risk compensation may not occur for helmets.[19]

Between 2001 and 2003, helmet use was recorded at a sample of ski areas in western North America.[17 18] Surveys in 2001 and 2002 revealed that helmet use increased from 12.1% in 2001 to 19.6% in 2002.[17 18] Analyses of the 2003 survey, reported here, examined reports of risk compensation by helmet and non-helmet wearers to compliment the prior case-controlled studies and described moderators of change in prevalence of helmet use from 2002 to 2003.

METHODS

Study population

Interviewers approached 1786 eligible adults at 34 ski areas in 10 western states and in British Columbia, Canada (see previous publications in this series[17 18] for recruitment procedures and eligibility criteria). The sample ski areas were diverse in location, size, ownership structure, lift ticket prices, and guest characteristics. Ski area employees, guests <18 years of age and guests who could not speak English were ineligible for interviews.

Survey procedure

Using methods described previously,[17 18] face-to-face interviews were performed on chair lifts with a minimum run time of 4 min during two-day periods (one weekend day and one weekday) from mid-January to late March 2003. Teams of trained interviewers conducted interviews at each area (n = 33–69 interviews per area based on the daily guest load).

Interviewers sat on the outside of the chair when possible, interviewing the guest sitting immediately next to them. All interviews began with an introduction and consent statement approved by the institutional review boards of the participating institutions. If the guest initially approached refused, the person sitting next to that guest was queried. Only one interview was completed per lift ride. Interviewers were assigned to chair lifts throughout each ski area; however, more interviews were performed on main lifts. Short chair lifts, which are common on beginner slopes, were omitted because of insufficient run time.

Outcome assessments

Using individual surveys, each guest's headgear was observed and recorded by the interviewers (ie, wearing a helmet or not). Participants were asked two parallel questions to assess risk compensation. Helmet wearers were asked whether they now skied/snowboarded faster, slower or at about the same speed than in previous seasons when they did not wear a helmet. They were next asked whether they now challenged themselves more, less or about the same than they did when they did not wear a helmet. Guests not wearing helmets were asked whether they now (a) skied/snowboarded faster, slower or at about the same speed and (b) challenged themselves more, less or about the same than when they skied/snowboarded in previous seasons? Guests wearing helmets were asked whether they

wore a helmet in any other type of physical recreation (eg, bicycling) to determine whether helmet use was generalized to other sports.

In addition, interviewers recorded the ski area, chair lift, weather conditions (eg, wind, cloud cover), and gender of the guest. Guests reported the time of day they started skiing/snowboarding, level of expertise (beginner, intermediate, expert), number of days skied/snowboarded in 2002–03, age, ethnicity, education, and home zip/postal code, along with sun protection.[20] Using established procedures,[17 18] the proportion of days skied/snowboarded since 1 November 2002 was calculated and converted to quartiles to represent very frequent, frequent, less frequent, and least frequent skiers/snowboarders. The region of residence was determined as Northeast, Southeast, South Central, North Central, Southwest, Rocky Mountains, Far West and Northwest United States, Canada, and another country.

Statistical analyses

Univariate logistic regression was used to compare helmet and non-helmet wearers on risk behaviors. The answers from both helmet and non-helmet wearing respondents were combined for the speed (faster = more risky) and challenge (challenge more = more risky) questions to test for risk compensation. The association between risk compensation and selected key variables (demographics (age, race, education), other guest characteristics (region of residence, destination versus local guest, level of expertise) equipment (skis or snowboard, proportion of possible days skied), resort features (region)) was tested with univariate logistic regression analyses. Guest characteristics showing significant univariate associations were included in a backwards, stepwise multivariate logistic regression to determine whether they affected risk taking.

The association between helmet use and the selected key variables (including weather variables) in 2003 was tested with a backwards, stepwise multivariate logistic regression model, entering variables first demonstrating univariate relationships with helmet use, as in prior studies in this series.[17 18] Also, data from the three surveys (2001, 2002, 2003) were combined and the interaction of the significant predictors with year was tested to assess whether these characteristics moderated adoption trends over time. An α level of 0.05 was set for statistical significance.

Results

In 2003, 1850 alpine skiers and snowboarders were approached to complete the survey. Removing ineligibles (18 <18 years, 23 employed at the ski area, 14 previously interviewed, and 9 not proficient in English), 1779 (99.6%) eligible guests completed the present 2003 survey, with 7 (0.4%) refusing. This completion rate was similar to the rates obtained in 2001 (98.2%) and 2002 (99.1%). Observations of helmet use were recorded in 1729 surveys.

Among the guests in 2003, 79.5% skied and 20.4% snowboarded; 6.5% reported they were beginners, 51.4% intermediates, and 42.1% experts; 17.1% were 18–25 years, 23.4% were 26–35 years, 24.4% were 36–45 years, 20.3% were 46–55 years, and 14.8% were >55 years. The sample contained 72.8% men and 27.2% women. Education ranged from 9.7% with a high school diploma or less to 19.1% with some trade or college education, and 71.1% with a college degree. By region, 37.2% were interviewed at ski areas in the Rocky Mountains (including Utah), 29.4% in the Far West (ie, California), 23.6% in the Northwest, and 9.8% in the Southwest. Respondents were geographically diverse (Rocky Mountains 26.9%, Far West 30.6%, Southwest 4.7%, Northwest 12.7%, South Central 6.5%, North Central 5.9%, Southeast 5.7%, Northeast 4.4%, Canada 0.9% and 2.6% from a country other than Canada). Guest data from 2001, 2002 and 2003 were combined from the 26 resorts that participated in all 3 years (2737 in 2001; 3144 in 2002; 1312 in 2003 (467 were interviewed at resorts that did not participate in 2001 and 2002)) of the research. Across the 3 years, 80.1% of guests skied and 19.8% snowboarded (0.1% used other equipment), with 5.7% saying they were beginners, 54.5% intermediates, and 39.8% experts. By age, 15.5% were 18–25 years, 24.5% 26–35 years, 27.2% 36–45 years, 19.2% 46–55 years, and 13.6% >55 years. The sample contained 71.6% men and 27.7% women (the sex of 53 (0.7%) respondents sex was not recorded). Education levels varied from 9.5% with a high school diploma or less, 21.6% with some trade or college education, and 68.9% with a college degree. By region, 37.9% were interviewed at ski areas in Colorado and the central Rocky Mountains, 24.5% in California, 27.2% in the Pacific Northwest, and 10.4% in the Southwest. Respondents reported living in the Rocky Mountain region (26.9%), Far West (223.6%), Southwest (5.1%), Northwest (12.9%), South Central (7.1%), North Central (6.8%), Southeast (6.1%), Northeast (5.6%), United States, Canada (3.2%), and other countries (2.7%).

Risk compensation behaviors

In 2003, 23% of the guests (standard error (SE) = 1.01%; 95% confidence interval (CI) 21% to 25%) were observed to be wearing a helmet. When responses from both helmet and non-helmet wearing respondents were combined, approximately one-third of all guests interviewed reported currently engaging in more risky behaviors, with 33.6% skiing/snowboarding faster and 35.7% challenging themselves more. No evidence, however, was found to support the risk compensation hypothesis. Helmet use was not associated with more risky behavior, but rather, less risky behavior: lower speeds (odds ratio (OR) = 0.64, 95% CI 0.49 to 0.82) and less challenge (OR = 0.76, 95% CI 0.60 to 0.97).

Although the use of helmets was not found to predict increased risk taking, several other guest characteristics did. In univariate analyses, it was revealed that snowboarders (OR = 2.71, 95% CI 2.13 to 3.44), younger guests (OR = 0.96, 95% CI 0.95 to 0.97), guests who skied/snowboarded more frequently (4th versus 1st OR = 2.65, 95% CI 1.93 to 3.63; 3rd versus 1st OR = 3.20, 95% CI 2.34 to 4.39; 2nd versus 1st OR = 2.43, 95% CI 1.77 to 3.34), and guests less educated (college versus high school OR = 0.34, 95% CI 0.25 to 0.48; trade versus high school OR = 0.66, 95% CI 0.46 to 0.96) reported skiing/snowboarding at higher speeds than skiers, older guests, guests who skied/snowboarded less frequently and guests more educated. Likewise, beginners (expert versus beginner OR = 0.57, 95% CI 0.37 to 0.86; intermediate versus beginner OR = 0.69, 95% CI 0.46 to 1.04), snowboarders (OR = 2.65, 95% CI 2.09 to 3.37), younger guests (OR = 0.95, 95% CI 0.94 to 0.96), guests who skied/snowboarded more frequently (4th versus 1st OR = 2.00, 95% CI 1.49 to 2.67; 3rd versus 1st OR = 1.95, 95% CI 1.45 to 2.61; 2nd versus 1st OR = 1.57, 95% CI 1.17 to 2.12), and less educated guests (college versus high school OR = 0.30, 95% CI 0.22 to 0.42; trade versus high school OR = 0.59, 95% CI 0.40 to 0.86) reported that they challenged themselves more than guests who were experts, who skied, who were older, who skied/snowboarded less frequently, and who reported more education.

Furthermore, there was no evidence that guests wearing helmets engaged in risk compensation when controlling for the preceding predictors. The relationship between helmet wearing and less risky behavior was strengthened in the adjusted analyses (speed: adjusted OR = 0.51, 95% CI 0.38 to 0.68; challenge: adjusted OR = 0.67, 95% CI 0.50 to 0.88).

Table 1 Multivariate logistic regression model predicting prevalence of helmet use (1 = yes; 0 = no) in 2003

Predictor	Odds ratio (95% CI)
Age	1.02 (1.01 to 1.03)
Equipment (snowboard vs skis)	3.01 (2.16 to 4.19)
Gender (male vs female)	1.50 (1.11 to 2.02)
Education	
Some college vs high school	1.00 (0.59 to 1.69)
College vs high school	1.77 (1.11 to 2.80)
Days skied/snowboarded	
4th quartile vs 1st quartile	9.42 (5.92 to 15.00)
3rd quartile vs 1st quartile	6.72 (4.20 to 10.74)
2nd quartile vs 1st quartile	3.29 (2.01 to 5.38)

Time trends in predictors of helmet use

Once again, certain subgroups of guests had a higher prevalence of helmet use. In the multivariate logistic regression model, helmets were used more by older guests, snowboarders, males, those with college degrees, and those who spent more days skiing/snowboarding than their younger, skiing, female, less educated, and less frequent skiing/snowboarding counterparts in 2003 (table 1).

Models contain both main effects and interaction terms, although only results for interaction terms are displayed in table 3.

The prevalence of helmet use in 2003 was significantly higher than in 2002 (19.8%; OR = 0.46, 95% CI 0.40 to 0.54) and 2001 (12.1%; OR = 0.84, 95% CI 0.73 to 0.96). The interaction of year with each of the statistically significant predictors from the 2003 multivariate analysis model was examined (table 2) and showed that the rate of increase in helmet adoption from 2002 to 2003 was moderated by education and days skied/snowboarded. The increase was significantly smaller among guests with some college education and who skied/snowboarded the most days than those with a high school education and who skied/snowboarded the fewest days (table 3). None of these predictors moderated the increase from 2001 to 2002.

Table 2 Odds ratios and confidence intervals for the interaction between year of survey (2002 vs 2001, 2003 vs 2001) and statistically significant ($p<0.05$) predictors on helmet use (1 = yes; 0 = no)*

Predictor	Estimate	p Value
Age		
2002	−0.01	0.06
2003	0.01	0.12
Equipment snowboard vs skis		
2002	−0.01	0.82
2003	−0.06	0.24
Gender (male vs female)		
2002	−0.06	0.18
2003	0.02	0.77
Education		
Some college vs high school, 2002	−0.04	0.60
College vs high school, 2002	−0.11	0.09
Some college vs high school, 2003	−0.18	0.04
College vs high school, 2003	0.13	0.09
Days skied/snowboarded		
4th quartile vs 1st quartile, 2002	0.01	0.91
3rd quartile vs 1st quartile, 2002	−0.11	0.12
2nd quartile vs 1st quartile, 2002	−0.03	0.75
4th quartile vs 1st quartile, 2003	−0.26	<0.01
3rd quartile vs 1st quartile, 2003	0.06	0.45
2nd quartile vs 1st quartile, 2003	0.18	0.07

Table 3 Prevalence of helmet use (%) in 2001, 2002 and 2003 by education and proportion of days skied/snowboarded

Predictor	2001	2002	2003
Education			
High school graduate or less	6.9	18.5	20.7
Some college education	13.6	20.3	20.4
College graduate	12.5	20.9	24.7
Proportion of days skied or snowboarded			
1st quartile	1.9	5.6	7.1
2nd quartile	5.4	11.3	15.5
3rd quartile	14.6	23.1	31.6
4th quartile	27.6	38.4	38.4

Helmet use in other sports

Three-quarters of guests (75.1%) wearing helmets reported they also wore helmets in at least one other sport, including bicycling (66.1%), skateboarding (3.7%), snowmobiling (6.2%), motor sports other than motorcycling (9.0%), lacrosse, hockey or football (4.0%), or other (17.1%).

Discussion

Adoption of helmets by alpine skiers and snowboarders continues to trend upward, but wearers do not appear to engage in greater risk taking. Instead, far fewer people wearing helmets reported skiing or snowboarding faster than those not wearing them. Similarly, fewer people wearing helmets reported challenging themselves more than those not wearing helmets. The present study found no support for the risk compensation hypothesis; on the contrary, helmeted skiers/snowboarders appear to ski or snowboard more safely than skiers/snowboarders without helmets.

The decision to wear a helmet for many skiers/snowboarders may be part of an orientation toward risk reduction. The majority of helmet wearers in 2003 also wore them while participating in other sports, most notably when bicycling. Adopters were also older and more educated than non-adopters. Risk aversion may increase with age, hence older guests may view helmets as a safety innovation worthy of use. Likewise, educated individuals who may engage in more preventive health behaviors in many facets of their lives might also decide to incorporate safety helmets into their prevention strategies. Those who visit resorts more frequently may also be influenced by repeated exposure to industry safety messages and increased exposure to other adopters of helmets that they observe in close proximity.

Snowboarders, who experience more upper-body injuries than skiers,[21–23] may intuitively see helmets as beneficial. Given that they are generally younger and more likely to have participated in athletic endeavors where helmets are the norm (eg, bicycling) they may also be more accustomed to routinely wearing helmets.

Our findings are consistent with earlier case-controlled studies that found no support for risk compensation in snow sports even though they were based on observation and self-report data (which may not reflect actual behavior).[1 2] It is possible that some skiers and snowboarders do engage in more risk taking when wearing helmets, but several studies have reported that such slight changes do not offset the considerable benefits from safety devices.[11 24] One recent study, for example,

showed that the protective value of a helmet was as large in areas where skiing and snowboarding are inherently more risky—that is, in snowboard parks and offpiste (ie, outside groomed runs), than in areas that should pose less risk—that is, groomed runs.[7]

The difference between helmet and non-helmet wearers may also reflect selection biases. Persons who choose to wear helmets when not required to do so may be more cautious by nature. Conversely, those who refuse to wear them may be characteristically less cautious. But, this was not the question studied. We tested the prediction that voluntarily using helmets encourages risk-taking behavior by skiers and snowboarders. This does not appear to be the case, even though our results do not shed light on whether the less cautious would take more risks if required to wear helmets. Likewise, guest characteristics associated with greater risk taking while skiing and snowboarding, such as being younger and less educated, are consistent with risk taking in other areas of health. Finally, the fact that those who either spend more days on the slopes or are beginners report that they engage in more risky behavior is consistent with learning complicated, skill-based sports. Skiing and snowboarding skills are acquired by repetition and progression to more difficult circumstances that require greater mastery. Thus, many guests who are skiing/snowboarding more frequently probably become more skilled, permitting them to ski/snowboard faster and on more difficult terrain while still under control. The same is true for beginners as they work to acquire these skills. However, these results do not indicate whether risk compensation would occur if a ski area required helmets to be worn by everyone.

This analysis of risk compensation had limitations. The self-report measures were open to memory errors and social desirability biases. Studies using methodologies that observe risky behavior or injury reports are needed. However, direct measures also suffer from limitations (eg, difficulty determining causal order and under-reporting).

There was some indication in 2003 that the adoption of helmets by alpine skiers and snowboarders in this sample of largely North Americans was slowing, particularly among those with some education beyond high school who ski and snowboard most frequently. Helmet use among North Americans may also be lagging behind other countries such as Norway, where it was observed in 2002 that 34.6% of skiers and snowboarders were wearing helmets.[7] Studies using direct methodologies that observe risky behavior or employ injury reports are needed. However, direct measures also suffer from limitations (eg, difficulty determining causal order and under-reporting, respectively).

Key points

- Skiers and snowboarders wearing helmets do not appear to take greater risks than non-helmeted skiers and snowboarders.
- Skiers and snowboarders wearing helmets appear to ski more slowly and challenge themselves less than non-helmeted skiers and snowboarders.
- The risk compensation hypothesis does not appear to obtain for safety helmets while skiing and snowboarding.
- Adoption of safety helmets by skiers and snowboarders continues to increase although more slowly than in previous years.

Implications for prevention

Until published studies reveal that snow sport helmets produce risk compensation, there is little reason to presume helmets cause guests to ski or snowboard beyond their abilities and place themselves and others at greater risk of injury. This should provide comfort to industry leaders and injury prevention advocates alike. They should not be reluctant to recommend ski helmets based on fears of risk compensation. Still, the snow sports industry and injury prevention advocates are wise to advise guests who wear helmets that they should wear a proper fitting one and continue to ski and snowboard within their abilities, and to direct safety communication to risk-taking guests—snowboarders, younger guests, guests who visit more frequently, and less educated guests.

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