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Level of Overestimation Among Dutch Recreational Skiers: Unskilled Tourists in the Mountains

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Abstract

Objective: To examine the level of overestimation (LO), associated factors, and identify the group of severe overestimators, among recreational skiers. **Design:** Cross-sectional observational study. **Setting:** An intermediate difficulty slope in an artificial snow indoor ski hall, and one in the mountains (Flachau, Austria). **Participants:** Dutch recreational skiers. **Independent Variables:** Participants were asked to rate themselves (SRSS, self-reported skill score). While skiing downhill they were objectively evaluated by 2 expert assessors (OSS, observed skill score). Potential associated factors and predictors for severe overestimation were assessed by a questionnaire. **Main outcome measures:** The LO, calculated by subtracting the OSS from the SRSS, was categorized into "no," "mild," and "severe." Potential differences between these groups were analyzed, and regression analyses were performed to identify the factors associated with severe overestimation. To construct a profile of severe overestimators, the dataset was stratified based on 3 variables. **Results:** Overestimation was largely present (79.8%), and was severe in 32%. The LO decreased toward the more skilled skiers. Severe overestimators were mainly male, skied the least hours per day, were more avoidant, and showed the highest proportions of beginners and slightly advanced skiers. The profile of "severe overestimator" is characterized by physically unprepared males, avoidant for certain weather circumstances. **Conclusions:** Overestimation among recreational Dutch skiers is largely present, particularly among physically unprepared males, avoidant of certain snow and weather conditions. These features may function as a proxy to identify "severe overestimators" in comparable populations. Preventive strategies should focus to increase awareness particularly among these subjects.

Key Words: recreational skiers, injury risk, self-reported skills level, observed skills level, overestimation

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BACKGROUND

Recreational skiing is a popular winter holiday activity. In the Netherlands, about one million Dutch citizens go skiing every year.[1] However, skiing is a moderate risk activity. Compared with other sports, where injury rates vary from 170.000 injuries per year in volleyball[2] to 12.1 injuries per 1000 hours running,[3] studies on skiing report 1 injury per 15.300 skier-days,[4] or 0.98 injuries per 10 000 lift runs,[5] up to approximately 6% among the Dutch skiing population.[6]

Although skiing ability is considered to be one of the major risk factors for injury,[7–9] the evidence is poor, and described associations between skills level and injury severity remain unclear, indicating a possible association, rather than strong evidence: some studies report an increased overall injury risk among the less experienced,[10–12] others among the more experienced.[13] An increased risk for severe injuries has also been reported among the less experienced[14] and the more experienced.[8,15,16]

These differences could be explained by the following:

First, skills level is mainly assessed by self-reportage, which has not only been suggested to be an inaccurate measure for skills level assessment,[17] it even shows a tendency toward overestimation, when compared with an observed skills level assessment.[18] Self-reported skills level assessments, instigated by the lack of use of a validated instrument that more accurately assess skills level[18] or the lack of objective assessments by professional assessors, which is hardly achievable, can explain the differences.

Second, self-reportage does not take into account the Dunning Kruger Effect (DKE),[19] a concept that explains the natural phenomenon in which a low level of knowledge or ability makes it difficult for someone to estimate their real

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The authors declare that the study was performed in accordance with the standards of ethics outlined in the Declaration of Helsinki. The study was ethically approved by the board of Eurocross Assistance. Participants were informed, upon participation, that the data will be used for publication. All participants provided written informed consent.

F. S. Luppino contributed to the conceptualization of the paper, performed the data collection, analyzed the data and wrote the manuscript. M. E. den Hollander-Gijsman provided general and statistical advice, assisted with interpretation, and critically reviewed the manuscript. K. A. Bartlema contributed to the conceptualization of the predictors, based on his clinical experience, and critically reviewed the manuscript. M. van Diepen and F. Dekker actively contributed to the statistical analyses and interpretation of the results, and critically reviewed the manuscript.

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knowledge or ability. Low ability leads to significant overestimation, whereas higher skills lead to a more accurate estimation, or even (marginal) underestimation (see Supplementary Figure 1, Supplemental Digital Content, http://links.lww.com/JSM/A377). Even among other sports, it has been reported before.[20,21]

Among a group of 1500 Dutch recreational skiers,[16] 66% estimated themselves as experienced. The almost-one-million Dutch skiers, report to ski on average 8.6 days a year.[22] It is unlikely that within such a large population, skiing less than 10 days a year can actually result in a level of experienced skier. More likely it is a reflection of the DKE. The presence of the DKE among recreational skiers is also suggested by the findings of Sulheim et al[17] who, based on 5 questions, investigated the correlation between observed and self-reported skiing ability, showing a low-to-fair correlation.

Third, studies on this topic may assume linearity, whereas the association could be nonlinear, such as the DKE itself (see Supplementary Figure 1, Supplemental Digital Content, http://links.lww.com/JSM/A377).

The varying results describing the association between skill levels and injury risk can be explained by, and even underline, the theory that not skills levels itself, but overestimation of that level is the major risk factor for injury. This theory also proposes a new lead to apply preventive measures, by identifying who is most prone to overestimation.

To explore the association between overestimation and injury risk, a better understanding of the concept of overestimation, and identification of the group overestimators is needed first.

Our study therefore aimed to first explore the level of overestimation, and second to examine who fits the profile of overestimator, to set a first step toward a better evaluation of the role of overestimation in injury risk.

METHODS

Study Design and Participants

This cross-sectional observational study was based on a sample of 84 Dutch recreational skiers, recruited during 2 days. Based on the observational character, a power calculation was not performed. Before participation, informed consent was given. Participants were first asked to rate themselves (*i.e.*, self-reported skill score, SRSS, from 0 to 10). They also were asked to choose, among a list of 10 descriptions according to the Dutch Ski Federation, which fits them best (see Questionnaire for Participants, Supplemental Digital Content, http://links.lww.com/JSM/A377). Finally, they were asked to descend the appointed slope, of low-to-intermediate difficulty, to not exclude more inexperienced subjects. Their skills were objectively assessed by 2 professional ski-instructors (*i.e.*, observed skill score, OSS), expressed as a score from 0 to 10, and calculated by taking the mean score of both instructors.

In addition, we asked the participants to rank themselves into categories as well (*i.e.*, beginner, slightly advanced, advanced, pro). 18 participants were recruited in a Dutch indoor ski hall with artificial snow, intended to function as a pilot to improve the logistics during the recruitment in the mountains. The others (n = 66), were recruited in Flachau, Austria.

Study design and data assessment were developed in consultation with an expert team.

Measures and Outcomes

The main outcome was the level of overestimation (LO), calculated by subtracting the OSS from the SRSS. The closer the LO is to 0, the more accurate the estimation. A negative LO indicates underestimation.

To assess other relevant characteristics, a questionnaire was developed covering several domains (*i.e.*, gender and age, experience and learning curve (represented by how many hours of lesson one had, the number of years one goes skiing, the number of skiing days a year, and the number of skiing hours per day), avoidant behavior, equipment, and preparation), based on experience of R.M. and J.M. and relevant literature (see Questionnaire for Participants, Supplemental Digital Content, http://links.lww.com/JSM/A377).

The OSS was considered the golden standard, to reflect the actual skill score. It was assessed independently by 2 registered ski-instructors. The mean score was used as the final OSS. For its systematical assessment, we developed an evaluation form (see Evaluation Form, Supplemental Digital Content, http://links.lww.com/JSM/A377), based on the Dutch Ski Federation evaluation methodology.[23] The following technical aspects were evaluated: central balance, inclination of the ski's, shape of the turn, level of parallel skiing, symmetry of movement, level of knee joint flexion, core stability, choice, and control of the speed. The instructors also classified the participants into a ranking category: beginner, slightly advanced, advanced, and pro. After evaluation of the pilot study, the items "level of knee joint flexion" and "technical preparation" were added to the Flachau sample.

Statistical Analyses

All statistical analyses were performed using IBM SPSS Statistics version 26 (IBM, New York, NY).

General sample characteristics were analyzed using means and SD for quantitative variables and numbers and percentages for categorical variables.

To estimate whether the self-reported scale showed a good fit with the observed scores, the association was plotted in a Bland–Altmann plot to investigate the closeness of agreement. To investigate the differences or agreements between instructors, the Cohen's Kappa coefficient was calculated.

To analyze the level of overestimation, the observed and self-reported skill scores were plotted according to the ranking categories. In addition, the sample was split into nonoverestimators, mild, and severe overestimators, calculating the respective proportions. Potential differences between nonoverestimators, mild overestimators, and severe overestimators were investigated with ANOVA analyses for continuous variables and χ^2 test for categorical variables.

To identify which factors are associated with overestimation in general (LO) and specifically with severe overestimation (>1.5 points), we performed univariate regression analyses, and univariate logistic regression analyses, respectively, to support the construction of the overestimators' profile.

Next, we aimed to construct a profile of severe overestimators, as a target group for preventive measures. In light of our limited sample size and to avoid overfitting, we

selected 3 predictors based on literature and expertise. Gender and physical preparation were chosen based on the evidence found in literature.[24–28] "Avoidance of certain weather conditions," such as rain, fog, winter precipitations, or clouded weather, was chosen by expert opinion, because less-experienced skiers tend to avoid less than perfect conditions. We stratified our dataset based on these 3 variables and present the results visually in a tree chart.

RESULTS

Level of Overestimation and Differences Between Overestimation Categories

Sample characteristics and comparison between the 3 LO categories are presented in Table 1. Approximately 57% of the sample was male, 79.8% was adult. In one case, information about age was missing. The items "level of knee joint flexion" and "technical preparation" are missing for the pilot sample, because these were added after the evaluation of the pilot. The mean number of lessons was 69.1 hours, the mean experience was 15 years, with a mean number of 8.6 skiing days a year, and 5.7 hours a day. Forty two point nine percentage stated to know the rules on the slopes and 9.5% prepared themselves physically.

Comparing the number of skiing days a year, men skied on average 9.8 days, compared with 6.6 days among females ($P = 0.04$).

Cohen Kappa value for the instructors' OSS was 0.76. The scores between the 2 instructors differed 0.5 points in 16.7% of the cases, 1 point or more in 4.8% of the cases, whereas agreement was found in 78.6% of the cases. A scatter plot of the observed scores of both assessors is shown in the Supplemental Digital Content (see Supplementary Figure 2, http://links.lww.com/JSM/A377).

The Bland–Altmann plot (Figure 1) showed that the limits of agreement for the SRSS and the OSS were not met, indicating a significant difference between the 2. 78.6% of all cases overestimated their skill level, with a mean level of 1.1 points (SD = 1.0). Most participants ranked themselves as "advanced" (69.0%), whereas in the observed ranking, the largest group was "slightly advanced" (53.6%). The mean level of overestimation for each observed ranking categories (Figure 2) showed that the LO decreased with the increase of skill category.

Comparison between the 3 LO categories shows significant differences between the groups regarding gender, OSS, ranking category, skiing hours per day, avoidance of certain snow and weather conditions, and every technical skill. The group of severe overestimators scores the lowest OSS, skis the least hours a day, shows the most avoidance of weather and snow conditions, and has the lowest score for each technical skill. Comparison between observed ranking categories, showed comparable results: significant differences were found across ranking categories for gender, age, number of years skiing, days a year and hours a day, physical preparation, avoidance of certain slopes, black slopes, and certain weather conditions. Severe overestimation was found in all beginners (n = 4), in 21 slightly advanced (46.7%), in 2 advanced (11.1%), and in none of the pro's (0.0%).

Variables Associated With Overestimation

Linear regression analyses (Table 2) show gender and avoidance of weather conditions to be associated with an increase in LO, whereas adult age and hours of skiing per day decrease it. The logistic regression analyses (Table 3) show the number of skiing hours a day to reduce the odds to be a severe overestimator, whereas avoidance of weather and snow increase them.

Interestingly, "avoidance of weather conditions" was significantly associated with the level of overestimation and the probability to be a severe overestimator, confirming its value for risk stratification.

Profile of Severe Overestimators

In our sample, among the men who did not physically prepare themselves and avoided certain weather conditions (n = 11), 8 were severe overestimators (72.7%). Among females, the proportion of severe overestimators within the subgroup who did not physically prepared themselves and avoided certain weather conditions was 66.7% (4 of 6). All proportions of the stratification subgroups are presented in the tree chart (Figure 3).

DISCUSSION

Our study shows that, among a sample of 84 Dutch recreational skiers, overestimation was present in approximately 80% of the cases. In 32%, the overestimation was severe. Severe overestimators were mainly male, showed the lowest number of skiing hours per day, were more avoidant, and showed the highest proportions of beginners and slightly advanced, compared with mild or nonoverestimators. The LO followed the pattern of the DKE, showing a decrease of overestimation toward the more skilled categories. The "severe overestimator" is characterized by males, who do not physically prepare themselves and avoid certain weather circumstances.

For a good interpretation of the results, it is important to understand that the discrepancy between self-reported and observed skills lie at the base of the concept of overestimation and are underlined by the Bland–Altmann plot, which shows that the limits of agreement were not met, among this population. Overestimation among skiers has been described before,[29] reporting overestimation to be present among less-experienced individuals, although its level was not described. Our results, in line with Bailley's study, support the initial hypothesis that overestimation is present among our sample of recreational skiers. Although the finding that the LO followed the DKE pattern, along with the finding that self-reported skill score is an inaccurate measure for the OSS,[18] do not form a causal association, they add to the idea that not skills level per se, but overestimation may be an important risk factor for injury. This study can therefore be considered as the groundwork for future studies that aim to examine the association between LO and injury rates.

To place our results in a larger context, although not supported by our findings, we would like to address a few considerations and speculations. First, to address the topic of overestimation, a good interpretation is needed first, which, to our knowledge, is lacking. A difference between a self-reported 7.0 and an observed 6.9 has no practical relevance. In contrast, the difference between a self-reported 7.0 and an observed 5.5, may have. More important than the presence of overestimation per se, is its (expected) impact, for which our expert team

TABLE 1. Sample Characteristics and Variables, by Level of Overestimation

	Total Sample n = 84 (% or Mean, SD)	No Overestimation (% or Mean, SD) n = 18	Overestimation up to 1.5 Points (% or Mean, SD) n = 39	Overestimation > 1.5 Points (% or Mean, SD) n = 27	*P*
Gender					
Male	48 (57.1%)	5 (10.4%)	25 (52.1%)	18 (37.5%)	**0.02**
Female	36 (42.9%)	13 (36.1%)	14 (38.9%)	9 (25.0%)	
Age	34.9 (15.2)	37.6 (12.4)	33.1 (14.9)	35.9 (17.5)	0.54
Missing	1 (1.2%)	0 (0.0%)	0 (0.0%)	1 (100.0%)	0.26
0-18	16 (19.0%)	1 (6.3%)	8 (50.0%)	7 (43.8%)	
18+	67 (79.8%)	17 (25.4%)	31 (46.3%)	19 (28.4%)	
Self-reported score (form 1-10)	7.1 (1.0)	7.1 (0.9)	7.2 (1.0)	7.0 (1.2)	0.72
Self-reported ranking (categories)					
Beginner	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0.45
Slightly advanced	14 (16.7%)	2 (14.3%)	6 (42.9%)	6 (42.9%)	
Advanced	58 (69.0%)	14 (24.1%)	29 (50.0%)	15 (25.9%)	
Pro	12 (14.3%)	2 (83.3%)	4 (33.3%)	6 (50.0%)	
Observed score (from 1 to 10)	6.0 (1.4)	7.4 (0.8)	6.2 (1.0)	4.8 (1.2)	**<0.001**
Observed ranking (categories)					**<0.001**
Beginner (n = 4)	4 (4.8%)	0 (0.0%)	0 (0.0%)	4 (100.0%)	
Slightly advanced (n = 50)	45 (53.6%)	2 (4.4%)	22 (48.9%)	21 (46.7%)	
Advanced (n = 27)	32 (38.1%)	13 (40.6%)	17 (53.1%)	2 (6.3%)	
Pro (n = 3)	3 (3.6%)	3 (100.0%)	0 (0.0%)	0 (0.0%)	
Overestimation (yes)	66 (78.6%)	—	—	—	
Level of overestimation	1.1 (1.0)	—	—	—	
Lesson, number of hours	69.1 (69.8)	65.8 (87.0)	63.3 (68.9)	79.7 (59.2)	0.63
Experience					
Years	15.3 (11.3)	14.9 (11.9)	16.4 (11.5)	13.9 (10.9)	0.67
Skiing days per year	8.6 (6.8)	10.6 (12.9)	8.3 (4.2)	7.3 (3.2)	0.29
Hours per day	5.7 (1.1)	5.8 (1.0)	6.0 (1.0)	5.3 (1.3)	**0.04**
Knows the rules					
Yes	36 (42.9%)	10 (27.8%)	16 (44.4%)	10 (27.8%)	0.45
No	48 (57.1%)	8 (16.7%)	23 (47.9%)	17 (35.4%)	
Physical preparation					
Yes	8 (9.5%)	4 (50.0%)	3 (37.5%)	1 (12.5%)	0.10
No	76 (90.5%)	14 (18.4%)	36 (47.4%)	26 (34.2%)	
Technical preparation (Flachau sample only)					
Missing (pilot sample)	18 (21.4%)	4 (22.2%)	12 (66.7%)	2 (11.1%)	0.44
Yes (% of Flachau sample)	2 (2.4%)	1 (50.0%)	1 (50.0%)	0 (0.0%)	
No (% of Flachau sample)	64 (97.0%)	13 (20.3%)	26 (40.6%)	25 (39.1%)	
Avoidance (yes)					
Any avoidance	71 (84.5%)	14 (19.7%)	31 (43.7%)	26 (36.6%)	0.12
Certain slopes	32 (38.1%)	6 (18.8%)	13 (40.6%)	13 (40.6%)	0.43
Black slopes	30 (35.7%)	6 (20.0%)	11 (36.7%)	13 (43.3%)	0.12
Certain snow conditions	36 (42.9%)	9 (25.0%)	11 (30.6%)	16 (44.4%)	**0.03**
Icy slopes	28 (33.3%)	8 (28.6%)	9 (32.1%)	11 (39.3%)	0.17
Certain weather conditions	19 (22.6%)	1 (5.3%)	5 (26.3%)	13 (68.4%)	**<0.001**
Fog	4 (4.8%)	0 (0.0%)	1 (25.0%)	3 (75.0%)	0.16
Crowded spots	46 (54.8%)	11 (23.9%)	22 (47.8%)	13 (28.3%)	0.67
Ski boot rental (yes)	5 (6.0%)	0 (0.0%)	4 (80.0%)	1 (20.0%)	0.26

TABLE 1. Sample Characteristics and Variables, by Level of Overestimation *(Continued)*

	Total Sample n = 84 (% or Mean, SD)	No Overestimation (% or Mean, SD) n = 18	Overestimation up to 1.5 Points (% or Mean, SD) n = 39	Overestimation > 1.5 Points (% or Mean, SD) n = 27	*P*
Technical aspects					
Central balance	5.8 (1.6)	6.9 (1.2)	6.2 (1.2)	4.3 (1.2)	**<0.001**
Inclination of the ski's	5.8 (1.6)	6.9 (1.1)	6.1 (1.3)	4.5 (1.4)	**<0.001**
Form of the curve	6.1 (1.7)	7.5 (0.9)	6.2 (1.5)	4.9 (1.4	**<0.001**
Level of parallel skiing	6.5 (1.7)	7.6 (0.8)	6.8 (1.3)	5.4 (1.9)	**<0.001**
Symmetry of movements	5.4 (1.7)	6.9 (1.2)	5.7 (1.5)	4.1 (1.1)	**<0.001**
Level of knee joint flextion (Flachau sample)	4.6 (1.7)	6.0 (1.8)	4.8 (1.5)	3.7 (1.7)	**<0.001**
Core stability	5.7 (1.8)	7.3 (0.7)	6.0 (1.4)	4.2 (1.5)	**<0.001**
Speed choice and control	6.7 (1.7)	7.9 (0.7)	7.0 (1.4)	5.5 (1.7)	**<0.001**

P <0.05 was considered to be statistically significant.

proposed the above described categorization. Looking at the LO pattern, it strikingly follows the DKE pattern. In addition, the differences between the LO-categories (Table 1) and the ranking categories (described in the results section, not shown) are very similar, indicating that the chosen cut-off scores were adequate. Second, comparison of these overestimation categories, and the linear and logistic regression analyses, showed several variables to be associated with (severe) overestimation. In mild and severe overestimators, males are overrepresented. The male gender has been associated with overestimation of one's abilities, not only among skiers,[30,31] but also for cognitive and general physical tasks.[24,26,28,32,33] This may be attributable to the general tendency of men to have a higher self-esteem and higher self-efficacy beliefs than females,[34] but is additionally supported by the finding that men and women tend to overestimate themselves in tasks stereotypically associated with their gender.[35] In line

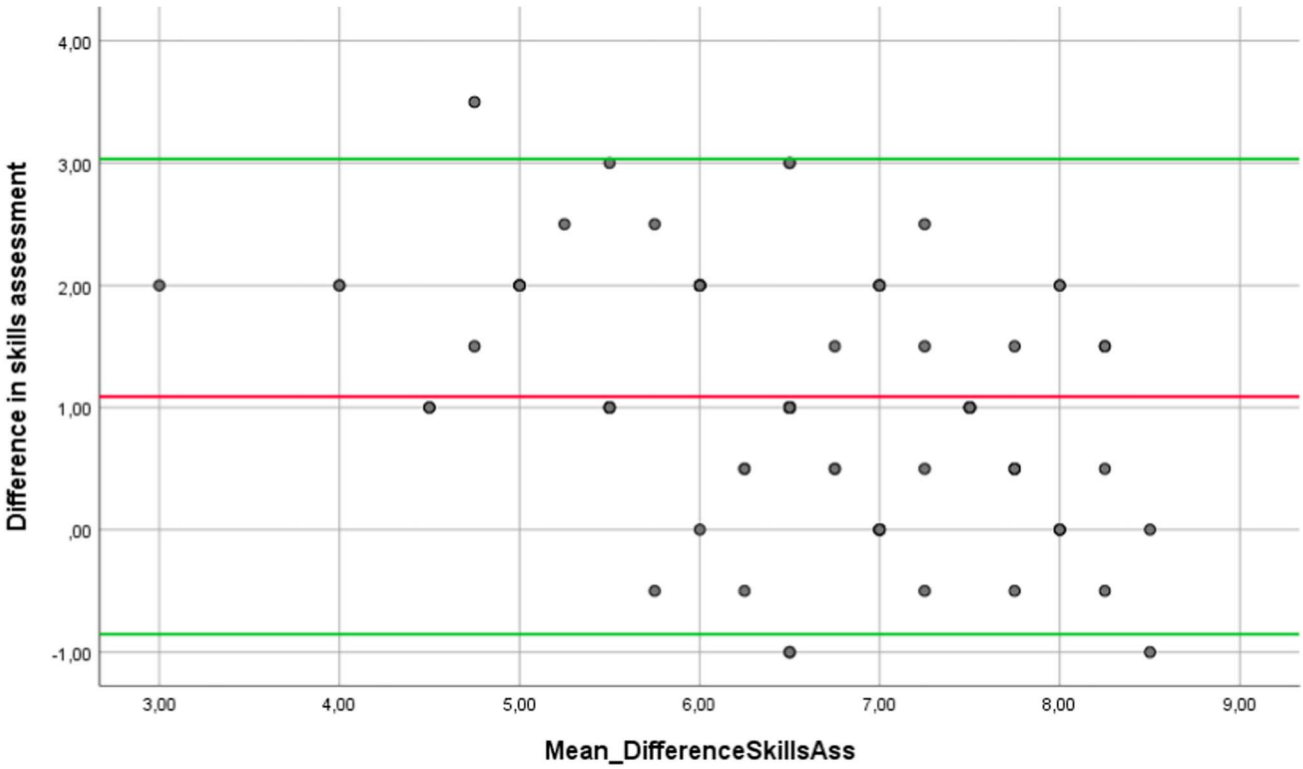

Figure 1. Bland–Altmann plot for self-reported and observed skill score. The red reference line represents the mean difference between SRSS and OSS. Both green lines represent the limits of agreement (+1.96 SD; - 1.96 SD).

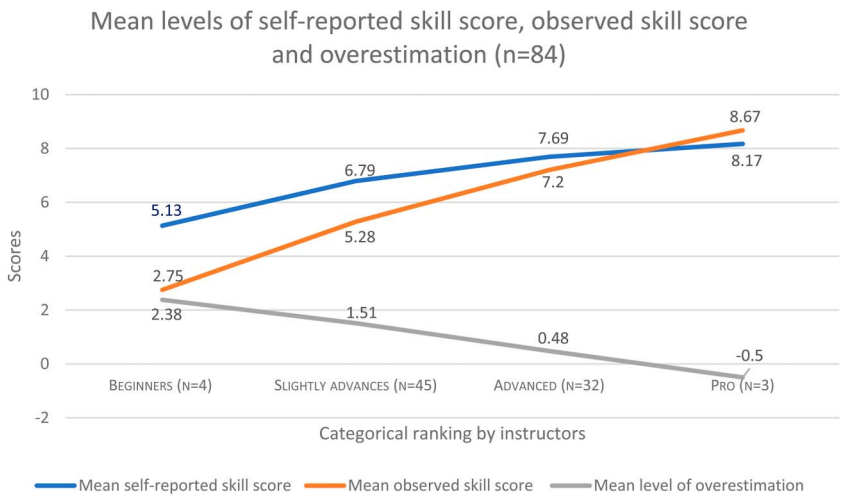

Figure 2. Mean levels of self-reported skill score, observed skill score, and overestimation across observed ranking categories.

with previous findings, in which most Dutch recreational skiers are male,[36] we found our sample to be mainly male. In addition, on average, men ski 9.8 days a year, compared with 6.6 days among females ($P = 0.04$, own results, not shown). The finding that mostly males overestimate themselves, and the possible masculine character of skiing, may explain the finding that a substantial proportion of all overestimators is male. Third, severe overestimators ski the least and show the most avoidance, fitting the DKE philosophy. Practice improves one's ability, and a lot of practice is required to acquire expert performance.[37] How much practice and experience is needed to gain a certain level in skiing, or maintain it, is unclear. However, skiing on average 5.7 hours per day, during 8.6 days a year is not likely to significantly improve one's level. In risk prevention, the number of lessons is not associated with risk decrease.[25] Undoubtfully, lessons add to a better technical skill, but more likely it is experience that will increase ones' skill, as suggested by our findings in linear and logistic regression regarding "hours per day." Fourth, all technical skills were significantly worse among severe overestimators. Of all technical skills, only speed has been described as a risk factor for injury, especially for more severe injuries.[38] However, it is not likely that one single technical skill is attributable for the injury risk. More likely, it is the mismatch between speed and skill that characterizes the injury risk. And fifth, physical strength is not considered to prevent injury per se. However, well-prepared skiers are believed to get more runs with less fatigue, and to be better physically prepared in more demanding or emergency circumstances requiring strength or endurance,[25] even leading to a decreased injury risk among recreational skiers.[27] Although we did not find the lack of

TABLE 2. Univariate Linear Regression Analyses for all Potential Predictors, With Level of Overestimation (LO) as Dependent Variable (Self-Reported Minus Observed Skill Score)

Factor	Beta	95% Confidence Interval	*P*
Self-reported score	0.008	−0.203 to 0.219	0.94
Sex (female = 0; male = 1)	0.472	0.047 to 0.897	**0.03**
Age (years)	−0.002	−0.016 to 0.12	0.73
Age volw/kind (child = 0; adult = 1)	−0.618	−1.033 to - 0.204	**0.004**
Age cut-off 36 yrs (1= <36; 2 = >= 36)	−0.246	−0.657 to 0.164	0.23
Yers experience	0.001	−0.018 to 0.021	0.89
Days a year	−0.030	−0.061 to 0.001	*0.06*
Hours per day	−0.248	−0.439 to −0.057	**0.01**
Hours lessons	−0.001	−0.002 to 0.005	0.37
Knows the rules	−0.278	−0.771 to 0.155	0.20
Physical preparation	−0.651	−1.375 to 0.072	*0.07*
Avoidance certain slopes	0.159	−0.286 to 0.603	0.48
Avoidance any weather conditions (no = 0; yes = 1)	0.769	0.280 to 1.258	**0.002**
Avoidance any snow conditions (no = 0; yes = 1)	0.135	−0.301 to 0.572	0.54
Ski boot rental	−0.308	−1.220 to 0.605	0.50

$P < 0.05$ was considered to be statistically significant.
$P \geq 0.05$ and < 0.10 was considered a trend.

TABLE 3. Univariate Logistic Regression Analyses for all Potential Predictors, With Severe Overestimation (>1.5 Points) as Dependent Variable

Factor	Odda Ratio	95% Confidence Interval	*P*
Self-reported score	0.847	0.542-1.321	0.46
Sex (female = 0; male = 1)	1.800	0.693–4.674	0.22
Age (years)	1.006	0.976-1.037	0.71
Age volw/kind	0.191	0.024-1.507	0.11
Age cut-off 36 yrs (1= <36; 2 = >= 36)	1.179	0.489– 2.840	0.71
Years experience	0.983	0.940-1.027	0.43
Days a year	0.935	0.822-1.063	0.30
Hours per day	0.568	0.357-0.902	**0.02**
Hours lessons	1.003	0.997-1.010	0.34
Knows the rules	0.701	0.274– 1.794	0.46
Physical preparation	0.275	0.032 –2.354	0.24
Avoidance certain slopes	1.857	0.730-4.728	0.19
Avoidance any weather conditions (no = 0; yes = 1)	7.893	2.540-24.526	**<0.001**
Avoidance any snow conditions (no = 0; yes = 1)	2.691	1.050– 6.895	**0.04**
Ski boot rental	0.510	0.054- 4.792	0.56

P <0.05 was considered to be statistically significant.

physical preparation to be different across overestimation categories, neglecting its importance is commonly believed to fit more inexperienced skiers.

Despite lacking evidence of an association between LO and increased injury rates, the profile of severe overestimator is valuable, because it offers possibilities for preventive strategies. Both gender, lack of physical preparation and avoidance of weather conditions, can act as it proxies, as suggested by our results, and supported by the experience of our expert team member R.M. Males who avoid certain weather conditions and do not physically prepare themselves, could be—in that light—subject of awareness campaigns.

Strengths and Limitations

Our study has some limitations. The most important is the sample size. A replication of our study with a larger sample would improve the power of the results, also allowing more in depth analyses, such as multivariate analyses to better identify predictors for overestimation. Also it may allow to examine the role of age, as

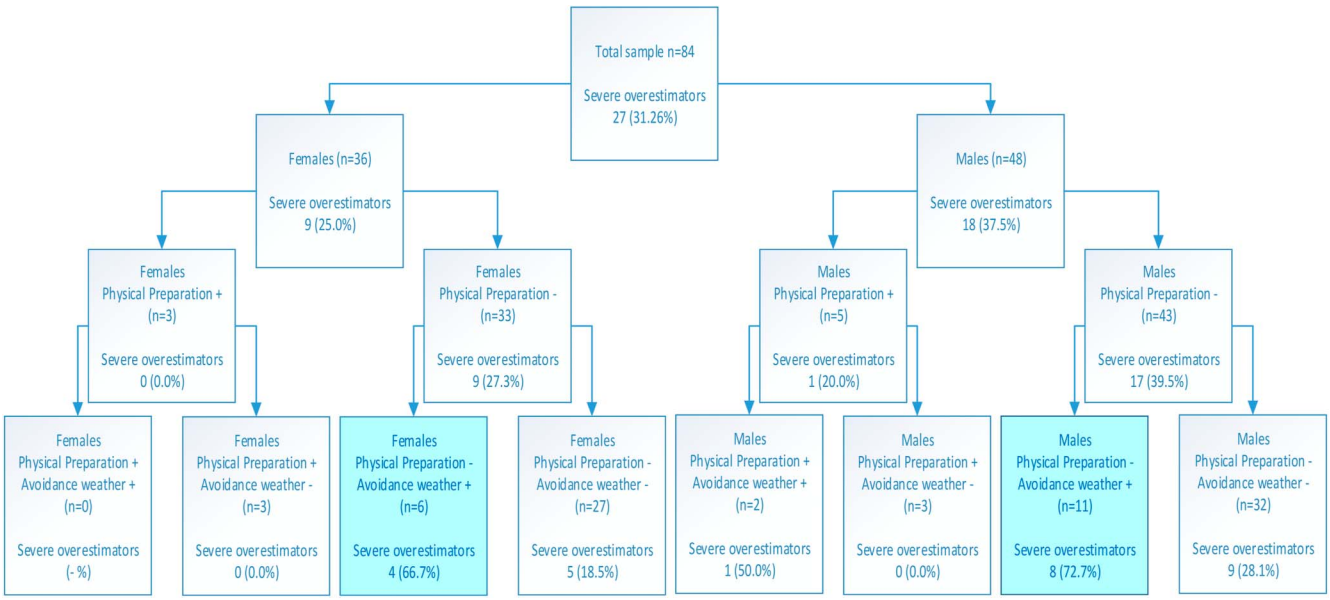

Figure 3. Percentage of overestimation, after stratification. Note: The percentages of severe overestimators are expressed as the proportion of the subgroup.

it was suggested to play a role in overestimation,[28] whereas injury risk is considered to be more elevated among youth and elderly.[7]

For inclusion purposes, we chose a slope of low to intermediate difficulty. The absence of more demanding circumstances could have masked the lack of skill. The actual overestimation may be even more severe than we found. In addition, the pilot study was performed on artificial snow, which in theory could affect the OSS. However, based on the experience of our team expert RM, in contrast to indoor treadmills, the needed technique is most similar to the one used on real slopes.

Replication of the study, adding a second more difficult slope, and using only natural conditions, could help to better analyze the overestimation levels. In addition, because the number of runs per day is a well-known confounder for injury risk, and a commonly used measure to assess injury risk exposure, this variable could also be used as a proxy for experience and learning curve.

Avoidance can be observed as a manifestation of fear or discomfort for certain circumstances. However, it could also reflect a sense of safety and responsibility. We focused on avoidance as a manifestation of lacking skills. This does not do justice to the possibility that avoidance can also stand for competence and realism.

Despite the limitations, our study presents several strengths. First, this is the first study to address the level of overestimation among recreational skiers, thus being a first important step toward a better evaluation of the role of overestimation in injury risk, especially because the group of recreational skiers is numerous. Second, the level of overestimation was assessed objectively and independently by 2 assessors and based on a priori systematically defined items. Third, by subdividing the LO into 3 categories and focusing on "severe overestimation," the subject was approached in a practical way, making the results useful for preventive measures. Fourth, a first evaluation on which profile seems most prone to overestimation, was addressed in our study. Fifth, our findings apply to comparable populations. Even in France, a well-known ski country, urban populations living far away from ski resorts are less inclined to ski frequently, thus forming a comparable population of recreational tourists.

Future Recommendations

A replication of this study with a larger sample is needed to improve the accuracy of the results, giving the possibility to further evaluate the role of overestimation in skiing injuries, and possibly being able to discriminate which overestimation level is associated with the risk for severe injuries. Second, a larger sample could address the question of which factors are associated with overestimation, and whether lack of physical preparation and avoidance of weather circumstances are proxies for the severe overestimators' profile. Third, as overestimation is closely related to actual skills level, it may be helpful to investigate what is needed to transit to a better skill category, in required experience and preparation. And finally, to better examine the interrater reliability, it would be advisable to assess the OSS by more assessors.

CONCLUSIONS

Our study showed that among a group of recreational skiers, overestimation is largely present. Thirty-two percentage showed severe overestimation, especially among males who do not physically prepare themselves and avoid certain weather circumstances. Previously found associations between injury risk and self-reported skills level should be interpreted with caution, given the inaccuracy of self-reportage, and may be in need of correction for overestimation, taking into consideration the DKE-like-pattern. This study forms the groundwork for future studies, aiming to explore the association between injury risk among skiers and overestimation.

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