BRIEF REPORT

Causes of Accidents in Terrain Parks: An Exploratory Factor Analysis of Recreational Freestylers' Views

Luis Carús, PhD

From the University of Zaragoza, Faculty of Health and Sport Sciences, Huesca, Spain.

Objective.—This study examines ski and snowboard terrain park users' views on aspects associated with accidents by identifying and assessing variables that may influence the occurrence of accidents and the resulting injuries.

Methods.—The research was conducted in a major resort in the Spanish Pyrenees, using information gathered from freestyle skiers and snowboarders aged 6 or older. To identify interrelationships among variables and to group the variables belonging to unified concepts, an exploratory factor analysis was performed using varimax rotation.

Results.—The results revealed 5 factors that grouped the measured variables that may influence the occurrence of accidents while freestyling in terrain parks. The park features, conditions of the activity, and the user's personal conditions were found to have the most substantial influence on the freestylers' perceptions.

Conclusions.—Variables identified as components of the main factors of accident risk in terrain parks should be incorporated into resort management communication and policies.

Key words: terrain park, accident factors, freestyler

Introduction

With the consolidation of snowboarding as an alpine discipline in its own right, ski resorts began to develop new man-made features, mainly quarter and half pipes, specifically to attract participants to this new sport. In addition, freestyle skiing became popular in the new features.¹

Their success led resorts to delimit specific areas for freestylers, which was an attempt to address safety issues by reducing accidents caused by collisions between freestylers and other users. Before long, resorts were competing to create the best terrain park, and the vast majority of ski resorts around the world now have a terrain park facility in which features are found that allow a wide range of maneuvers and stunts to be performed.^{1,2}

However, freestyling in terrain parks involves serious safety risks to ski and snowboard freestylers. It has been reported that at least 26.7% of all injuries registered at 2 US ski areas during 5 seasons occurred in terrain parks,

and the increase in the rate of injuries experienced in Québec ski resorts from 1995 to 2000 coincided with an increase in the number of ski areas in which terrain parks were available, suggesting an association between these areas and an increased risk of injuries.^{3,4} Furthermore, specific studies comparing the skiing and snowboarding injuries sustained in terrain parks with injuries on regular slopes suggest that terrain park activities increase the risk of severe injury compared with on-slope activities.^{3,5}

Although epidemiological research allows description of the injury patterns seen in terrain parks, some authors have observed that less is known about the specific risk factors associated with terrain park accidents.^{1,4} Further research is needed to identify these risk factors and to gain a better understanding of the characteristics of potentially effective prevention measures.

The present study attempts to gain insight into the experiences of terrain park users by identifying and assessing the factors that can potentially influence the occurrence of accidents in terrain parks. This study analyzes the views of a sample of freestylers, and investigates the importance they attach to a series of variables that may affect the risks they assume when visiting a terrain park.

Corresponding author: Luis Carús, PhD, Avda. Infantes, 93; 3º Izda. 39005 Santander, Spain (e-mail: carus@unizar.es).

Methods

The data were gathered through a survey performed between December 2010 and April 2011 at the terrain park of a major resort in the Spanish Pyrenees with information provided by a random sample of users aged 6 or older. The surveys were conducted by experienced interviewers who had received specific instruction for the task. A total of 321 valid surveys were obtained for the study. [Table 1](#) presents a profile of the respondents, showing their basic characteristics and personal habits.

To reach a compromise solution between the inclusion of determinant items and a practical length for the questionnaire to be used in the empirical research, the Delphi method was applied to define a list of questions. When the 15 experts who constituted the panel were first contacted, they were asked to submit an account of every variable that they thought, according to the best of their knowledge and professional experience, could influence the occurrence of accidents in terrain parks.

After 2 consultation rounds with the panel of experts, a consensus was reached on the 25 items that were finally included. An 11-point scale, from 0 (not at all important) to 10 (of the utmost significance), was used for the respondents to assess the importance of the items as risk variables, according to their experience.⁶ A description of the questions asked, the distribution of responses, and the standard deviations are shown in [Table 2](#).

Because no established body of theory was available for a priori assumptions about relationships among the variables—apart from assuming that any measured

Table 2. Questions asked and distribution of responses

<i>How important as a cause of accident in a terrain park is...</i>	<i>Mean</i>	<i>SD</i>
...height of aerals	8.57	1.96
...width of jibs	8.32	1.91
...length of jibs	8.48	1.99
...shape of jibs	8.20	1.93
...launch angles	8.52	1.88
...landing angles	8.31	1.92
...alcohol/drug consumption	4.53	2.64
...previous warm-up	5.20	2.41
...speed	6.97	2.58
...tiredness	5.95	2.53
...type of stunt performed	6.36	2.38
...learning new stunt	7.48	2.27
...skill level	7.17	2.44
...fitness	7.16	2.15
...knowledge of safety rules	6.77	2.33
...attitude (risk-taking, rules observation, etc.)	7.22	2.17
...snow conditions	7.73	2.09
...surface conditions	7.40	2.06
...weather conditions	6.56	2.18
...visibility	6.32	2.35
...crowding	6.84	2.36
...suitability/state of ski/snow boards	5.70	2.52
...suitability/state of ski/snow bindings	6.69	2.40
...suitability/state of ski/snow boots	5.90	2.55
...suitability/state of other gear (goggles, poles, etc.)	4.60	3.10

Table 1. Respondent profile ($n = 321$)

<i>Variable</i>	<i>Response (%)</i>
Modality	
Snowboard	69.16
Ski	30.84
Sex	
Male	78.50
Female	21.50
Age (y)	
6–25	65.11
26–35	20.56
36–45	9.97
>45	4.36
Visiting habits/season	
<5	10.28
5–10	38.32
>10	51.40
Frequency of use of the terrain park	
Occasionally	12.77
Frequently	57.63
Always	29.60

variable may be associated with any factor—the number of factors or the identification of which measured variables would load on which factors were unknown.⁷ In addition, because only the loadings of the measured variables could be used to intuit the factor structure of the data, to identify the interrelationships among the items, and to group those that are part of unified concepts, an exploratory factor analysis was performed on the 25 items using varimax rotation, yielding results that simplify the process of identifying each variable with a single factor.⁸

After determining the underlying structure of the proposed items at an exploratory level, Cronbach's α coefficients were calculated to test the reliability of the analysis. They will generally increase as the intercorrelations among the test items increase, and the process is thus known as an internal consistency estimate of reliability of test scores.⁹

Results

Substantially more than half of the respondents were male (78.5%; $P < .001$), freestyle snowboarders

Table 3. Exploratory factor analysis: rotated components matrix

<i>How important as a cause of accident in a terrain park is...</i>	<i>F1</i>	<i>F2</i>	<i>F3</i>	<i>F4</i>	<i>F5</i>
...height of aerals	.863				
...width of jibs	.819				
...length of jibs	.891				
...shape of jibs	.754				
...launch angles	.617				
...landing angles	.719				
...alcohol/drug consumption		.736			
...previous warm-up		.692			
...speed		.617			
...tiredness		.773			
...type of stunt performed		.663			
...learning new stunt		.553			
...skill level			.778		
...fitness			.631		
...knowledge of safety rules			.536		
...attitude (risk-taking, rule observation, etc.)			.702		
...snow conditions	.480			.562	
...surface conditions	.544			.550	
...weather conditions				.624	
...visibility				.730	
...crowding				.687	
...suitability/state of ski/snow boards					.728
...suitability/state of ski/snow bindings					.597
...suitability/state of ski/snow boots					.762
...suitability/state of other gear (goggles, poles, etc.)					.570
% factor variance	19.51	13.98	12.84	10.99	9.79
% cumulative variance	19.51	33.49	46.33	57.32	67.11

Note: For greater clarity, values less than .45 are not shown.

(69.16%; $P < .001$), and between 6 and 25 years of age (65.11%; $P < .001$). The habits of the respondents were noteworthy in that more than half (51.40%; $P < .001$) claimed to visit a ski resort more than 10 times per season, and nearly one third (29.6%; $P < .001$) of those subjects stated that they always used terrain parks.

The results shown in Table 2 indicate that, according to the perceptions of the users, the proposed causes of accident occurrence with higher mean values are related to the design of the features within the terrain parks. Their dimensions, shape, or launch and landing angles obtained mean values greater than 8. In contrast to the aforementioned variables, the importance attached to the consumption of alcohol or drugs or to the suitability or state of other gear (goggles, poles, etc.) as causes of accidents obtained mean values of just slightly greater than 4.

The exploratory factor analysis results, which are presented in Table 3, show that a 5-factor solution was obtained, indicating logical groupings of variables, and explaining 67.11% of the total variance. The reliability

analysis results, which are presented in Table 4, show the values of the Cronbach's α coefficients, which verify the reliability of the scales.⁹

The first 3 factors group the key variables influencing the occurrence of accidents in terrain parks according to the users' perceptions. The first factor, which explains 19.51% of the variance and is the most important for determining the structure of the responses, groups the 6 items related to the design of the jumps and jibs (height of aerals, shape of jibs, etc.). The second factor, which accounts for 13.98% of the variance, groups the

Table 4. Reliability analysis: Cronbach's alpha and correlation

<i>Component</i>	<i>α Coefficient</i>
Features (F1)	.904
Conditions of the user's activity (F2)	.839
User's personal conditions (F3)	.815
Environment (F4)	.852
Gear (F5)	.778

variables related to the different conditions of the user's activity (learning new stunt, speed, etc.), and the third factor, which explains 12.84% of the variance, gathers items related to the user's personal conditions (skill level, fitness, etc.).

The fourth factor refers to the risks related to the environmental conditions, such as snow, surface, or weather conditions, and the fifth factor includes the variables referring to the equipment the freestyler uses (suitability or state of boards, boots, etc.).

Discussion

Prior data have shown that accidents in terrain parks account for a significant proportion of the total number of accidents and result in relatively more severe injuries than accidents on the slopes.³⁻⁵ Therefore, the safety and security of freestylers are important issues for terrain park management.

The results of the exploratory factor analysis reveal that the features—whose variables weigh heavily on faults in the design of the terrain park—the conditions of the user's activity, and the user's personal conditions are perceived as the key components having the most important bearing on accidents. This suggests that ski resorts should invest generously in safety and prevention policies related to the variables that make up these factors.

However, many injured users are prone to blame ski resorts for their accidents instead of taking personal responsibility for preventable, participant-related factors to the accident.¹⁰ Because of this, it is reasonable to assume that the users' perceptions are inherently biased when they assess the design of features much more than the other factors as the main cause of accidents in terrain parks. Further research on the circumstances of actual accidents is needed.

Prior research suggests that it is primarily the nature of the features and the design of terrain parks that leads to severe injury, and most terrain park injuries result from high falls.^{3,4} It seems advisable for resorts to revise and, if needed, to rationalize both of these aspects.

In those resorts in which no special qualifications are required to gain access to the terrain parks or to the dangerous features within them, it seems advisable that safety and communication policies would aim at rationalizing their use by providing the means and guidance necessary for freestylers to identify the difficulty, conditions, and dangers of each particular feature at all times, and of the levels of skill required to use them. Restricting access to particularly hazardous features seems advisable. A very good example of this is the National Ski Areas Association campaign used by most

US ski resorts called "smart style," which emphasizes the proper use of terrain parks.

Lessons could be mandatory before obtaining access to terrain parks because formal instruction focusing on technical jumping and landing skills may reduce injuries.³ Most US ski resorts with larger terrain parks now have "step-up" parks designed for skill building before attempting to use more dangerous features.

According to the interviewees' perceptions of the variables that make up the second and third factors, it might be advisable for resorts to focus on policies designed to raise the users' awareness of the fact that the better the conditions of the user's activity and the user's personal conditions for performing freestyle activities, the less likely the users are to have an accident; this includes campaigns informing users about the benefits of aspects such as fitness, proper warming-up periods, resting, knowledge of safety rules, or speed control, and for establishing alcohol and drug controls.

In this study, the environmental conditions and gear suitability were perceived to be second in importance to the previous 3 factors, but research on the different ways in which they can potentially influence the occurrence of accidents and the severity of the resulting injuries is extensive. For that reason, ski resorts might provide users with comprehensive information on aspects such as snow and weather conditions, visibility, or the number of other participants in the terrain parks, and might conduct information campaigns to improve freestylers' awareness of the benefits of suitable, well-maintained gear and supervise the protocols followed by the rental services within the sphere of their influence.

Conclusions

According to the views of the participants, the results of this study present a range of dimensions related to accident occurrence that might be considered when creating, maintaining, and managing a terrain park, including the following: the design of the features, conditions of the activity of the user, the user's personal conditions, environmental conditions, and gear suitability. Of these aspects, the risks associated with the features, conditions of the user's activity, and the user's personal conditions were found to have the most significant bearing on the recreational freestylers' perceptions of risk and might be hypothesized as priority objectives for a wide range of possible information and safety policies that could be implemented by resorts.

LIMITATIONS

The study findings and conclusions are limited because the ski resort did not have the means to calculate the

number of terrain park users or the number of freestyle runs taken during the season. Although all the participants claimed to have suffered some sort of accident while freestyling, the data about their characteristics in relation to the variables studied were not recorded, which means that results are based on perceptions alone.

The data are from a single terrain park in 1 country and may not apply to all terrain parks. Although the results may be considered useful to generate new hypotheses, further research is needed to contrast the views of the participant freestylers with the actual circumstances of the individual accidents. This research would furnish ski resort risk managers with valuable information to thoroughly assess the dimensions of the problems to be avoided or solved through their communication and safety policies.

References

1. Langran M. Injuries in terrain/fun parks. Available at: <http://www.ski-injury.com/terrainparks>. Accessed November 15, 2011.
2. Moffat C, McIntosh S, Bringhurst J, Danenhauer K, Gilmore N, Hopkins CL. Terrain park injuries. *West J Emerg Med*. 2009;10:257–262.
3. Brooks MA, Evans MD, Rivara FP. Evaluation of skiing and snowboarding injuries sustained in terrain parks versus traditional slopes. *Inj Prev*. 2010;16:119–122.
4. Goulet C, Hagel B, Hamel D, Lègarè G. Risk factors associated with serious ski patrol-reported injuries sustained by skiers and snowboarders in snow-parks and on other slopes. *Can J Public Health*. 2007;98:402–406.
5. Greve MW, Young DJ, Goss AL, Degutis LC. Skiing and snowboarding head injuries in 2 areas of the United States. *Wilderness Environ Med*. 2009;20:234–238.
6. Linstone HA, Turoff M. *The Delphi Method: Techniques and Applications*. Reading, PA: Addison-Wesley; 1975.
7. Fabrigar LR, Wegener DT, MacCallum RC, Strahan EJ. Evaluating the use of exploratory factor analysis in psychological research. *Psychol Methods*. 1999;4:272–299.
8. Kaiser HF. The varimax criterion for analytic rotation in factor analysis. *Psychometrika*. 1958;23:187–200.
9. Nunnally JC. *Teoría Psicométrica*. México: Editorial Trillas. 1987.
10. Carús Ribalaygua L. Ski accidents and legal responsibility: the Spanish case. *Accid Anal Prev*. 2010;42:468–475.