

An analysis of the medical review process at the National Outdoor Leadership School

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Abstract

A statistical analysis of the medical review process for admitting students to field courses at the National Outdoor Leadership School (NOLS) was performed. This analysis determined that the group of students with the highest overall student scores (• 4 on a 1 through 5 scale) scored lowest in the psychological counseling and current psychological treatment questions and highest in the athletic ability question on the NOLS medical review form. This indicates that these individuals tended to have little or no history of counseling and psychological treatment and were more likely to be engaged in competitive sports. Canonical discriminant analysis demonstrated that these variables also contributed the most to discriminating mathematically among the 4 possible student outcome score groups, which ranged from the inability to complete a course (evacuation) through highly successful.

Many of the questions on the current NOLS medical form could not be analyzed statistically because they demonstrated no variance among the groups. Though these questions still may have a value for screening purposes, some of these could possibly be reworded for increased sensitivity. Canonical discriminant analysis of six responses on the medical form was 43.7% effective at classifying individuals to outcome groups, and it is likely that this could be more effective with some modifications to the evaluation process.

Admissions personnel in outdoor programs are encouraged to include questions such as those mentioned above in their overall admission procedures and to examine these thoroughly in admissions decisions.

Introduction

The screening of applicants for physical and emotional preparedness for multi-week educational wilderness expeditions is a routine practice for the National Outdoor Leadership School (NOLS) and Outward Bound (OB) [9, 10] and a recommended practice for any provider of wilderness trips. Screening systems have largely been developed at both NOLS and OB based on practical experience, but are not necessarily supported by extensive medical science.

Citation:

Monz, C.A. and T. Schimelpfenig. 1997. An analysis of the medical review process at the National Outdoor Leadership School Wilderness and Environmental Medicine. Vol 8. 9 pages.

Research has been conducted on the screening of applicants with specific medical conditions (including cardiovascular) for general wilderness travel [3,7, 8], trekking in a remote, high altitude area [5] and for participating in scuba diving [11]. There is also information available on evaluating readiness to participate in outdoor sports for people with an orthopedic injury history [3, 6, 7, 8]. However, we know of no research examining the medical limitations of students on field educational courses and whether these factors contribute to overall student performance in post-course evaluations.

At NOLS we medically screen prospective students to:

- determine if they are physically and emotionally suited for a course
- place them on courses suited for their physical abilities, or to deny or delay enrollment
- identify medical conditions or medication use that may become a factor during the course

Medical form screening at NOLS begins with the medical professional who completes the NOLS Medical Form [appendix 1]. The form describes the physical rigors of a NOLS expedition, and asks a series of general questions about medical history. A NOLS admissions staff person, a NOLS field instructor and a medical lay person, review the forms. Follow-up between an admissions officer and the applicant may occur. If necessary, there is a registered nurse on staff available for consultation. Questions beyond the scope of the admissions officer or nurse are forwarded to our physician medical advisor. The majority of the screening occurs in the discussion between the applicant and the admissions officer.

The Gentile study on NOLS [2] says "A history of the specific injury or illness was obtained at the time of the incident for 16% of injuries and 10.5% of illness. Of those individuals who gave a history of the incident 93% had listed this on their medical form. A history existed for 25% of sprain/strain/tendon injuries and 13% of fractures. Ten percent of people developing symptoms of high altitude illness had a history of the illness." This suggested that a review of the screening process was wise.

We undertook this study to examine the efficacy of the NOLS medical review process as a predictor of overall student performance and to determine if preexisting problems as listed on the medical form tend to result in evacuation. We hypothesize that student medical characteristics (both physical and emotional) may be a primary limiting factor governing overall success on expedition field courses and that at least some of these factors could be determined by the current screening process.

Methods

A stratified-random subsampling procedure was applied to select student records from the years 1992 through 1995. This resulted in random subsamples (nominal N= 30 per group) from each of the following four course evaluation outcome groupings: evacuations; overall score ≤ 2.5 ; overall scores of 3 and 3.5; and overall score ≥ 4 . The overall scores refer to the “final grade” that students receive on their course evaluation and ranges from 1 (poor) through 5 (excellence). Responses from the current NOLS medical review form questions were numerically coded on an ordinal scale for statistical analysis. By applying this numerical scale, we were able to calculate “mean scores” (arithmetic averages) of the responses from each question and apply standard statistical tests. This resulted in one large data set which contained student outcome groups and numerically coded responses for the entire medical questionnaire. In many cases, entire question variables had to be eliminated from the subsequent analysis because they did not distinguish between groups in the data set, in other words, the responses were virtually the same regardless of outcome group. This lack of sensitivity in the measurement instrument will be addressed in the discussion session.

These data were analyzed by several statistical procedures; canonical discriminant analysis (CDA), one-way analysis of variance (ANOVA) and Kruskal-Wallis non-parametric tests. All tests were performed with SPSS statistical software (SPSS, Inc., Chicago, IL., USA). The data matrix was reduced to 6 predictor variables (Table 1) after elimination of those variables as mentioned above. The objective of these numerical approaches was to identify individual and combinations of variables that accounted for the majority of the variation in the grouping variable, i.e., identify those questions on the medical form (if any) that explained most of the variation in student outcome scores.

Results

Initial ANOVA results (Table 1) indicate that the counseling question, current treatment, and athletic ability questions all had a significant effect on outcomes (i.e., P -values less than 0.1), while smoking, height and weight were not significant. This is verified by the Kruskal-Wallis test which gives similar results. This result is also depicted in Figure 1 where a Fishers LSD was performed on individual means within each screening question. Here, students who received ≥ 4 on overall student outcome were significantly lower on the overall scores for counseling and current treatment, and rated significantly higher on the athletic ability than all other groups. There were no significant differences in smoking scores between groups, however.

Table 2, 3 and 4 illustrate results from the canonical discriminant analysis. This is a classic application of this technique, which was performed to determine which variables or combinations of variables help discriminate amongst the 4 groups. Table 2 shows that the first

2 discriminant functions account for 88.74% of the variance in the data set, indicating a reasonably good fit along the first 2 canonical axes. Table 3 shows the correlation between each variable and each discriminant function. An important result here is the relatively high correlation (positive or negative) between athletic ability, current treatment, counseling and canonical function 1 (which accounts for 69% of the variance in the data set). These correlations indicate that these variables are contributing the most to this function and consequently are important in discriminating among the groups.

The usefulness of this approach is perhaps best illustrated by Table 4, which shows how well the discriminant functions can “predict” the classification of individuals based on only the original variables. Here we see that the data can accurately predict the outcomes of 37.5 % of group 1 individuals, 58.3% of group 2, 17.2% of group 5 and 65.4% of group 4 for an overall correct classification rate of 43.69%.

Table 1. Univariate ANOVA and Kruskal-Wallis tests for significance

Variable	ANOVA P	Kruskal-Wallis P
Counseling	.0592	0.077
Current treatment	.0776	0.074
Athletic ability	.0199	0.019
Smoking	.2773	0.274
Height	.5535	
Weight	.8634	

Table 2. Canonical discriminant functions

Fcn	Eigenvalue	% of Cumulative Canon			After Wilks'				
		Var	Pct	Corr	Fcn	Lambda	Chi-square	df	Sig
				: 0.735021	29.862	18	.0388		
1	.2300	68.95	68.95	.4325	: 1.904107	9.778	10	.4601	
2	.0660	19.79	88.74	.2488	: 2.963785	3.578	4	.4661	
3	.0376	11.26	100.00	.1903	:				

Table 3. Pooled within-groups correlations between discriminating variables and canonical discriminant functions

(Variables ordered by size of correlation within function)

	Func 1	Func 2	Func 3
Athletic Ability	.66249*	-.20639	-.07996
Current treatment	-.53269*	.29158	-.05869
Counseling	-.51436*	-.43216	.34322
Height	.24564	.32812*	-.08357

Weight	.13865	.18276*	.15074
Smoking	.03300	.42600	.85232*

* denotes largest absolute correlation between each variable and any discriminant function.

Table 4 Classification results

Actual Group	No. of Cases	Predicted Group Membership			
		Evacs	≤ 2.5	3 & 3.5	≥ 4
Group Evacs	24 37.5%	9 29.2%	7 8.3%	2 25.0%	6
Group ≤ 2.5	24 8.3%	2 58.3%	14 12.5%	3 20.8%	5
Group 3 & 3.5	29 10.3%	3 31.0%	9 17.2%	5 41.4%	12
Group ≥ 4	26 3.8%	1 15.4%	4 15.4%	4 65.4%	17

Percent of "grouped" cases correctly classified: 43.69%

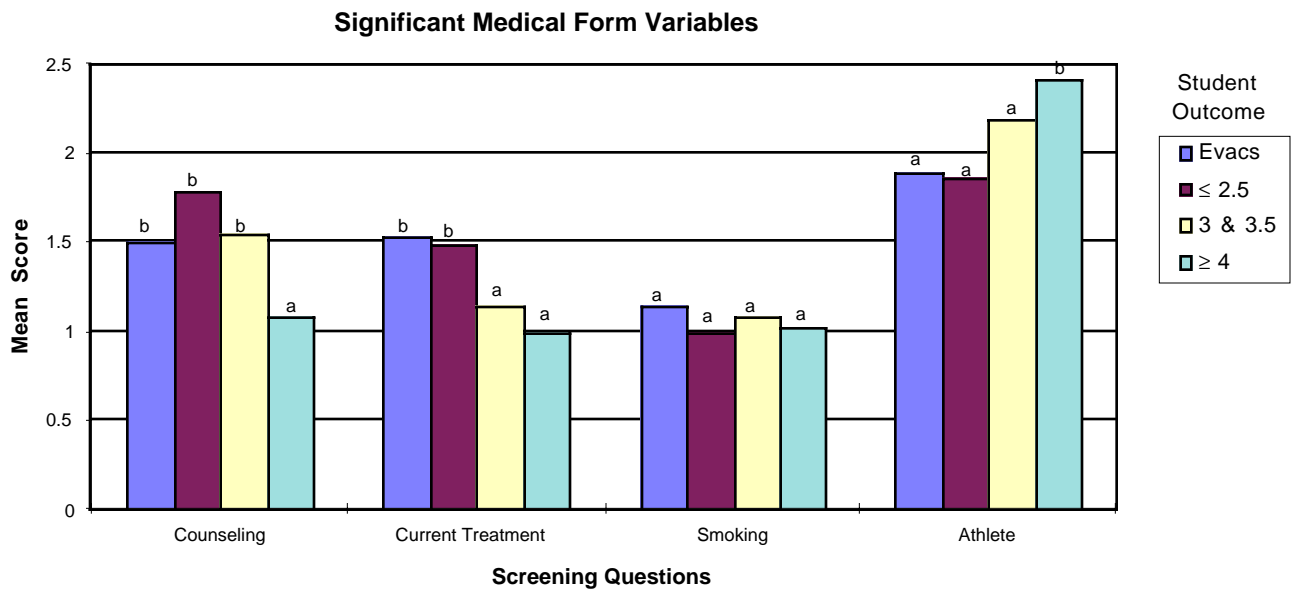


Figure 1. Responses to important medical screening questions by student outcome groups. One -way ANOVA was performed for each "Screening question" and means not followed by the same letter are significantly different using Fischer's LSD at alpha= 0.5.

Discussion

This evaluation of the medical review procedures at NOLS was undertaken as a preliminary examination of this process with the hope of gaining some direction for further study. The medical form that is currently in use was not initially designed for a statistical analysis, and consequentially, many question variables, perhaps some important ones, had to be eliminated as mentioned previously. Moreover, the overall results in the CDA analysis (table 4) were less than optimal (i.e., overall 43.7% correct classification). It is likely that this is due to a lack the

statistical sensitivity in questions analyzed or the omission of one or several important variables because of the lack of between group variation that we observed. Despite these challenges, this analysis does provide a valuable insight to some important characteristics of success on these courses with some degree of accuracy, especially given the original data.

It is understandable that most of the questions on the medical form did not assist in discriminating amongst the 4 possible outcome groups because many of these questions are simple yes or no answers. This does not imply that these questions are of no value, since they may be of help in screening out individuals who should not be participating in courses, but instead that they are of little use in helping predict success of admitted students. It is possible that some modifications to the form, such as using a Likert (ordinal) scale for some questions, would increase resolution for these questions, and also the questions contained in this analysis.

The relationship between overall outcomes and the counseling, current treatment and athletic ability scores is significant and should be considered strongly for further analysis. These factors contribute the most to the modest ability that the discriminant analysis has to predict the overall student outcome (Table 3 and 4). The height, weight and smoking factors increase accuracy of the discriminant analysis substantially (from 34.9% in initial analysis runs to the 43.7% in Table 4), but play a lesser role as indicated by the correlations (Table 3) and the ANOVA results (Table 1). Our analysis is reasonably successful at predicting the most successful students (65.7% correctly classified) but much less accurate at determining the other outcomes (Table 4). In fact, little difference was observed between the other groups, i.e., evacuations through “average” performance (Figure 1).

Comparisons of group means for the significant variables (Figure 1) indicate that highly successful students score significantly lower on the counseling and current psychological treatment questions and significantly higher on the athletic ability question. There is no difference between groups on the smoking question, however. This suggests that students who were highly successful tended to be engaged in competitive sports on a regular basis and also had little or no history of counseling or psychological treatment. It is reasonable to assume that athletic students would adapt to the rigors of a wilderness course more easily and consequently be more successful. It is more difficult to interpret the psychological aspects of success as indicated here, and it may also indicate that there might be a possibility of developing certain aspects of the field program to more adequately meet the needs of these students.

Somewhat contrary to previous research [2], we did not find any suggestion that a history of orthopedic injury is a predictor of poor field performance. This does not suggest that these

previous injuries did not pose some difficulty to students while on courses, only that they were not a major factor in overall outcome scores. Also, without conducting actual biomechanical tests on students prior to courses, it is very difficult to quantify the degree to which a previous orthopedic injury is still inhibiting a student in the field.

It is difficult to determine the effectiveness of this screening process without some analysis of those individuals who were either not permitted to take a course or who voluntarily withdrew from the application process. In other words, it is possible that evacuation rates and poor performance scores would be more pronounced with no medical review, but it is not possible to test this with the available data. Further study will help identify additional factors and improve the sensitivity of current questions that function as performance predictors. It is our hope that this process once modified, can remain cost effective and can be administered by people without substantial medical training.

These results may only be relevant for expedition-length educational experiences. We cannot say if they are applicable to the general vacation adventure travel industry, but it is possible that some of the trends observed would be applicable. We do not suggest that a statistical approach should replace the careful review of a student application by trained admissions officers, but instead that this review of available data be utilized as a guide in making admissions decisions.

Conclusions

- To our knowledge no one has tested the medical review systems used by any outdoor program. The system currently in use at NOLS indicates that overall athletic ability, a history of psychological counseling and whether students are currently undergoing psychological treatment are important predictors of overall student success on field courses.
- Improvements to the questions in this review process may help increase sensitivity of this analysis and could highlight additional important factors. Also, it may be important to learn what factors contributed to the “screening out” of perspective students.
- The current review process can predict success but it is less accurate in predicting poor performance (missing over 60% of the evacuations, for example). We must also be careful to not bias our appraisal of non-athletic students or those with history of counseling as it is possible that programmatic changes could allow these students to be more successful.

Acknowledgments

We thank Laura Ordway for her extensive and careful work in compiling and coding the data for this project. Mark Cole, Sharon Kehoe, Drew Leemon and Herbert Ogden, MD provided helpful suggestions for this manuscript. This research was sponsored with funding from the National Outdoor Leadership School's Research Program.

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