RELATIONSHIP OF KNEE EXTENSION STRENGTH AND ANTHROPOMETRIC VARIABLES TO ALPINE SKI RACING SUCCESS

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INTRODUCTION

A large amount of knee extensor strength is often sited as a requirement for alpine ski racing success.

Several studies have attempted to show a relationship between isometric, isotonic or isokinetic quadriceps strength and ski racing ability. Takashi et al (1992) found that eccentric knee extension and flexion strength may be related to racing success in national caliber athletes. In contrast, Neumayr et al (2003) found no correlation between muscle strength and racing performance in world class athletes. Few studies have examined these types of relationships in recreational athletes.

Tesch (1995) showed ski racing depends heavily on slow forceful eccentric muscle actions. Kues et al (1994) found a strong correlation between slow eccentric contraction strength and isometric contraction strength in muscle testing. The current study examined the relationship between isometric strength of the knee extensors and success in recreational alpine ski racing. In addition, the relationship of several anthropometric measurements to racing ability was also examined.

METHODS

Twenty-two subjects (9 male, 13 female) were selected from an open-entry citizen-type alpine ski race. All subjects were greater then 15 years of age. (Mean 25.6). Heights and weights were obtained for all of the subjects (Means 168.8 cm, 72.4 kg). Segment length measurements were gathered for the dominant leg using a flexible steel tape. The shank of the leg was measured from the lateral malleolus to the head of the fibula. The upper leg was measured from the lateral epicondyle to the greater trochanter. These anatomical structures were found through palpation. Knee joint flexibility was determined with a manual goniometer. The subject stood upright with the anterior surfaces of both legs against a vertical surface. They then independently flexed each knee as far as possible and the knee angle was measured using the greater trochanter and lateral malleolus as aligning landmarks.

Peak isometric knee extension torque was measured at 90 degrees of flexion. The subjects were seated on a bench with an adjustable cuff secured 10 cm below the tibial tuberosity on their dominant leg. This cuff was securely fastened by cable to an OR6-7-2000 (AMTI, Watertown, MA) force platform located behind the subject(Figure 1). The subject's non-restrained leg was also at 90 degrees with the foot resting on the floor. The subjects pushed against the cuff by extending their knee with maximum effort for a period of 5 sec. Data was collected from the force platform and analyzed with an IBM compatible computer using Biosoft 1.0. (AMTI, Watertown, MA)

Ski racing ability was determined using the race times from a 25 gate citizen slalom race.

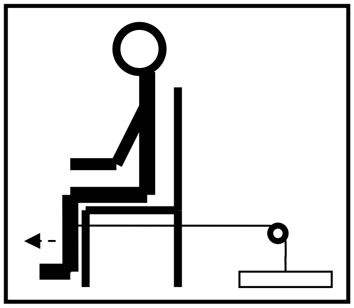

Figure 1. Set-up for measuring isometric knee extension strength

RESULTS AND DISCUSSION

A correlational analysis (SPSS v 11.5) indicated that, for the variables tested, only subject height was significantly correlated to ski racing time ($r = -.561$, $p < 0.01$). Isometric knee extensor strength, knee flexibility, and other anthropometric variables were not significant ($p > 0.05$)

Table 1. Correlation of ski racing time to independent variables (N=22)

Independent Variable	Race Time (sec)	
Age	0.299	
Gender	-0.366	
Height (cm)	-0.561	*
Weight (kg)	-0.120	
Right knee flex (degrees)	-0.297	
Left knee flex (degrees)	-0.279	
Shank length (cm)	-0.332	
Leg length (cm)	-0.318	
Avg. isometric knee strength (N)	-0.221	

* Significant correlation (P < 0.01, 2-tailed)

The data from 16 subjects were randomly chosen from the pool of 22 to form a regression equation. The six remaining subjects were used to cross-validate this equation. Regression analysis was performed (SPSS v 11.5) 20 times using the re-sampling cross-validation technique (Jensen and Kline, 1994). Height was the first variable entering the equation in 17 out of 20 samples with mean multiple r of 0.65. Left knee flexibility, sex, and knee strength entered the equation first one time each.

In recreational alpine ski racing height seems to be an advantage, in contrast to the findings of Piper et al (1987). Taller athletes may be able to put more leverage on the ski, causing them to turn faster. However, isometric knee extension strength was not a factor. Moreover gender, which was also related to height, was not a factor in racing performance.

Table 2. Summary of statistics for predicting ski racing time from 20 regression equations and cross-validations.

	Mean	SD
Development		
Multiple R	0.65	0.121
SEM	4.14	0.947
Beta Coefficients		
Height	-0.428	0.082
Constant	100.9	27.19
Validation		
Correlation	0.49	0.358
Mean Difference	-1.88	5.857
t-value	0.378	0.349

SUMMARY

The major finding of this study was the inability to correlate isometric knee extension strength to racing time in recreational alpine skiers. However, subject height was correlated to racing time.

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