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ELİT ALP DİSİPLİNİ KAYAKÇILARIN BACAK GÜCÜ ile YARIŞ PERFORMANSLARI ARASINDAKİ İLİŞKİ

"The Relationship Between Leg Strength and Racing Performances Of Elite Alpine Skiers"

Mürşit Ceyhun BİRİNCİ [1] & Seydi Ahmet AĞAOĞLU[2]

RESEARCH ARTİCLE

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Authors Communications
1- (Corresponding Author) Ondokuz Mayıs Üniversitesi, Yaşar Doğu Spor Bilimleri Fakültesi, Beden Eğitimi ve Spor Öğretmenliği Bölümü, SAMSUN, TÜRKİYE.
ceyhun.birinci@omu.edu.tr
https://orcid.org/0000-0002-7258-1217
2- Ondokuz Mayıs Üniversitesi, Yaşar Doğu Spor Bilimleri Fakültesi, Antrenörlük Eğitimi Bölümü, SAMSUN, TÜRKİYE.
ahmetsa@omu.edu.tr
https://orcid.org/0000-0001-8578-3355

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ABSTRACT

Aim: The aim of this study is to examine the relationship between leg strength and racing performance of elite alpine skiers.
Material and Method: The scope of our research consisted of elite alpine skiers (n=33) aged between 16-33, competing in clubs affiliated to the Turkish Ski Federation. National team athletes with a mean age of 21.52±4.62 years and/or 25 male and 8 female skiers skiing in the A1 Ski League voluntarily participated in our study. The leg strength of the participants was determined by performing the Vertical Jump test with the NewTest Powertimer PC 2.0 device.
Results: In our study; in a positive direction between age and jump, leg strength and competition speed; A negative correlation was found between the duration of the competition ($p<0.05$). A positive relationship was found between height, jump and leg strength, and a negative relationship between competition time ($p<0.05$). There was a positive relationship between weight and jump, leg strength and competition speed, and a negative relationship between competition time ($p<0.05$). In the evaluation of leg strength, it was observed that there was a positive significance between leg strength and competition speed ($p<0.05$). In addition, it was determined that there was a negative correlation (r -0.539) and a positive significance ($p<0.05$) between the jump height and leg strength and the duration of the competition.
Conclusion: According to the results of this study, which examined the relationship between leg strength and racing performance of elite alpine skiers; It can be said that leg strength has a positive effect depending on the ski training year, contributes significantly to the race results according to the degree obtained, is effective in the competition speed, and has a great importance in the race performance together with the jump height it shows parallelism.
Keywords: Alpine Ski, Leg Strength, Strength, Speed.

ÖZET

Amaç: Bu çalışmanın amacı, elit alp disiplini kayakçıların bacak gücü ile yarış performansları ilişkisinin incelenmesidir.
Materyal Metot: Araştırmamızın kapsamını 16-33 yaş arasında, Türkiye Kayak Federasyonuna bağlı kulüplerde yarışmakta olan elit alp disiplini kayakçılar (n=33) oluşturmuştur. Çalışmamıza yaş ortalaması 21,52±4,62 olan milli takım sporcusu ve/veya A1 Kayak Liginde kayak yapan 25 erkek 8 kadın kayakçı gönüllü olarak katılmıştır. Katılımcıların bacak gücü NewTest Powertimer PC 2,0 cihazı ile Dikey Sıçrama testi yaptırılarak belirlenmiştir.
Bulgular: Çalışmamızda; yaş ile sıçrama, bacak gücü ve yarışma hızı arasında pozitif yönde; yarışma süresi arasında negatif yönde ilişki bulunmuştur ($p<0,05$). Boy ile sıçrama ve bacak gücü arasında pozitif, yarışma süresi arasında ise negatif yönde ilişki tespit edilmiştir ($p<0,05$). Kilo ile sıçrama, bacak gücü ve yarışma hızı arasında pozitif yönde, yarışma süresi arasında ise negatif yönde ilişki bulunmuştur ($p<0,05$). Bacak gücü ile ilgili yapılan değerlendirmede bacak gücü ve yarışma hızı arasında pozitif yönde anlamlılık olduğu görülmüştür ($p<0,05$). Ayrıca sıçrama yüksekliği ve bacak gücü ile yarışma süresi arasında negatif yönde bir korelasyon (r -0,539) ve pozitif yönde anlamlılık olduğu belirlenmiştir ($p<0,05$).
Sonuç: Elit alp disiplini kayakçıların bacak gücü ile yarış performansı ilişkisinin incelendiği bu çalışmanın sonuçlarına göre; bacak gücünün kayak antrenman yılına bağlı olarak olumlu etkisinin olduğu, elde edilen dereceye göre yarış sonuçlarına önemli katkı sağladığı, yarışma hızında etkili olduğu, paralellik gösterdiği sıçrama yüksekliği ile birlikte yarış performansında büyük bir öneme sahip olduğu söylenebilir.
Anahtar Kelimeler: Alp Didiplini, Bacak Gücü, Güç, Hız.

INTRODUCTION

Today, sports and exercise are practiced by millions of people to get rid of stress, increase the quality of life and improve body fitness (Taş and ark., 2008). In this sense, skiing has become a widely preferred branch in recent years. At the same time, skiing has increased the importance of its place among competition sports.

It is known that technique and tactics affect success positively in this sport. The ability to improve technique and tactics is closely related to the physical characteristics of the skiers. Especially in the alpine discipline, technical, tactical, and motor features that determine performance should be high level (White and Johnson, 1993). Alpine skiing is a complex sport that requires special skills (Neumary et al., 2003).

In recent years, extremely small details have an important place between winning and losing in sportive competitions. (Bahrke and Morga, 1994). Due to the decisiveness, it plays in achieving success, research on sports and athletes has gained great importance.

In sports branches with anaerobic content, coordination, agility, balance, speed, and power are the most important components (Altınkök and Ölçücü, 2012; Crespo and Miley, 1998). Skiing is a high-level performance sport that includes physical performance features such as balance, agility, speed, power, and strength and is affected by all these parameters (Hazır and Açıkada, 2010; Jovanovic et al., 2011; Little and Williams, 2005). Although balance is not among the first concepts that come to mind when it comes to sports, it has an important place along with agility, which is among the basic features of sports (Altınkök and Ölçücü, 2012; Kejonen, 2002). Lemmink et al. define agility as the ability to change direction quickly while maintaining balance without losing speed (Lemmink et al., 2004). The factor that triggers the change of direction in skiing is that the race gates and the direction changes are planned in advance. Agility is the most basic performance component that determines the quality of a skier's high-speed diversion runs, sudden acceleration, and stopping (Reilly et al., 2000).

Agility and speed of change of direction are planned in advance and developed with sport-specific technical work. The ability to change direction and sudden acceleration is affected by body position. There is a connection between the body position and the force applied, such as the body leaning forward when accelerating, the body straightening when decelerating, and the body moving sideways during vertical displacements. These factors are perfected with training (Young and Farrow, 2006).

Anaerobic performance plays a decisive role in skiing. However, in this determination, the aerobic performance also plays a role as 10% in the slalom race, 20% in the giant slalom race, 40% in the super giant slalom race, and 45% in the downhill race (Bompa & Haff, 2009). Anaerobic performance is affected by many factors. Among these factors, muscle fiber length, leg volume, and muscle mass can be counted as the characteristics that play a decisive role in the power produced by the muscle under anaerobic conditions (Armstrong et al., 2001; De Ste Croix et al., 2001; Dore et al., 2001). Studies have shown that athletes with higher ratios of fast-twitch muscle fiber ratio, muscle mass, muscle cross-sectional area, leg volume, and leg mass have better anaerobic performance (Shephard et al., 1988; Staron et al., 2000).

Since there has not been any study on this subject, it is aimed to examine the effect of leg strength and on race performance of elite alpine skiers.

MATERIAL AND METHOD

Our study includes Alpine skiers (n=33) between the ages of 16 and 33 racer, racing in clubs of Turkish Ski Federation. 25 male and 8 female skiers who were national team athletes and/or skiing in A1 Skiing League with an average age of 21,52±4,62 years participated in our study voluntarily. The purpose of the study was explained one week before the measurements started so that the participants could demonstrate their peak performance during the tests. In addition, information was given about the tests and devices to be applied. The priority criterion was the absence of any leg injury due to the tests to be applied in the persons to be included in the study.

In our research, the following tests were applied respectively. From these tests, the leg strength test (vertical jump) and body composition and hand, foot, and eye preferences measurements were made the day before the race, and times and speeds were taken during the race. The protocols of the tests applied are given below;

Leg strength of the subjects was determined by Vertical Jumping via the NewTest Powertimer PC 2.0 (Newtest 2000, Newtest Oy, Oulu, Finland).

Before the test, each participant was informed in detail about the test administration. The participants were given a 10-minute warm-up period, and they were allowed to warm up in the way they wanted. For the test, participants are given 30 to 60 seconds to recover between each jump in the NewTest protocol, fixed on the ground. They were told to make vertical jumps with a resting period between them (Bayraktar, 2006).

Along with the rest intervals, participants were asked to perform five maximal efforts (five vertical jumps) as recommended by Balčiūnas et al. (2006), and the average of the values exhibited in the five trials was accepted as the ideal value. To adapt and avoid injury, the same test was explained practically before each test, and the test was applied when the participant felt ready. During the whole test, each participant was informed verbally. In each participant's test, the information about the participant was entered into the computer program as specified by the Newtest device, and then the participant was put into practice. For participants who have already prepared for the leg strength test: on the Newtest platform, arms extended by the side of the trunk; The knee joint range of motion was 90o, the hips and chest were flexed, and the knees were asked to jump vertically upwards as much as possible without making any springing movements (Samuel et al., 2008). At this point, it was stated that the knees, hips, and chest should be in extension while jumping in order to reach as high as possible. They were asked to have the same positions during jumping and landing on the platform again. It was stated to the subjects that they should not move forward, backward, or sideways during the jumps throughout the test.

Body mass index (BMI) parameters were taken by using a "Seca" brand measuring device for the body composition of the study participants. It was stated to the subjects that they should go on the device with bare feet, and at the same time, only shorts should be on the subjects during the measurement.

The running time and speeds (i.e., the participant's race degree in seconds) was measured at the race track in the Konaklı region of Erzurum Palandöken Ski Center, where the Winter Universiade 2011 organization was previously held, approved by the International Ski Federation (F.I.S), also which complies with the safety and race committees determined by the Turkish Ski Federation officials. The runway length is approximately 1040m. The starting altitude is 2870m. The arrival altitude is 2515m. The running times and speeds of the subjects were determined with the devices provided by Tag Heuer.

RESULTS

Table 1. *Descriptive Characteristics of Subjects*

	N	Minimum	Maximum	x̄	Ss
Age (Year)	33	14.00	31.00	21.51	4.62
Height (cm)	33	150.00	187.00	169.48	9.53
Weight (kg)	33	41.00	92.00	65.30	13.14
BMI (kg/m^2)	33	17.31	29.07	22.58	3.24
Jump (cm)	33	16.70	43.47	27.96	7.09
Leg Strength (W)	33	1131.00	4285.67	2604.41	828.52
Speed (km/h)	33	44.17	80.11	69.35	8.17
Time (sec)	33	63.58	108.69	74.89	10.69

In Table 1, the descriptive characteristics of the subjects are indicated. Accordingly, the mean age of the subjects participating in the study is 21.52±4.62 years, the mean height is 169.48±9.529 cm, the mean body weight is 65.30±13.13 kg, and the mean body mass index is 22.57±3.24 kg. It was found as /m^2.

Table 2. *The Relationship Between Some Physical Characteristics of the Subjects and the Measured Parameters.*

		Age	Height	Weight	BMI
Jump (cm)	r	0.404	0.500	0.356	0.150
	p	0.020	0.003*	0.042*	0.403
Leg Strength (W)	r	0.534	0.758	0.884	0.662
	p	0.001	0.001*	0.001*	0.001*
Speed (km/h)	r	0.496	0.339	0.409	0.272
	p	0.003	0.054	0.018*	0.126
Time (sec)	r	-0.607	-0.412	-0.411	-0.224
	p	0.000	0.017*	0.017*	0.211

*p<.05

Table 2 presents the relationship between some physical characteristics of the subjects and other measured characteristics. Accordingly, there is a positive relationship between age and jump, leg strength, and competition speed; A negative correlation was found between the duration of the competition (p<0.05). There was a positive relationship between height, jump and leg strength and a negative relationship between competition time (p<0.05). There was a positive relationship between weight and jump, leg strength, and competition speed, and a negative relationship between competition time (p<0.05). There was a positive correlation between BMI and leg strength (p<0.05).

Table 3. *Comparison of Measured Characteristics by Training Year of Ski*

		n	□	Ss	p	Difference
Jump (cm)	0-5 Year (a)	11	24.82	5.21	0.095	-
	6-10 Year (b)	13	27.82	7.06		
	11-15 Year (c)	2	39.48	5.63		
	+16 Year (d)	7	29.85	7.19		
Leg Strength (W)	0-5 Year (a)	11	2223.69	738.54	0.041	a<d*
	6-10 Year (b)	13	2463.61	789.41		
	11-15 Year (c)	2	3324.16	482.48		
	+16 Year (d)	7	3258.52	697.34		
Speed (km/h)	0-5 Year (a)	11	68.22	6.95	0.465	-
	6-10 Year (b)	13	68.31	9.63		
	11-15 Year (c)	2	75.15	2.80		
	+16 Year (d)	7	71.38	8.24		
Time (sec)	0-5 Year (a)	11	78.70	12.28	0.222	-

	6-10 Year (b)	13	75.56	11.26
	11-15 Year (c)	2	68.46	3.39
	+16 Year (d)	7	69.52	5.28

*p<.05

In Table 3, the analysis of the measured features according to the ski training year is given. Accordingly, in the leg strength parameter, there was a significant difference between those who have been training for over 16 years and those who have been training for 0-5 years in favor of those over 16 years (p<0.05). No significant difference was found between the groups in other characteristics (p>0.05).

Table 4. *Comparison of Measured Properties With Respect to the Obtained Grade*

		n	Average □	Standard Deviation	p	significant difference
Jump (cm)	1st. (a)	3	35,84	2,51	0,074	-
	2nd. (b)	13	28,44	7,57		
	3th. (c)	17	26,20	6,46		
Leg Strength (W)	1st. (a)	3	3654,44	318,12	0,043*	a>c
	2nd. (b)	13	2678,54	775,56		
	3th. (c)	17	2362,43	797,31		
Speed (km/h)	1st. (a)	3	79,35	0,67	0,005*	a>c
	2nd. (b)	13	69,62	9,34		
	3th. (c)	17	67,37	6,71		
Time (sec)	1st. (a)	3	64,07	0,54	0,005*	a<c
	2nd. (b)	13	73,55	11,22		
	3th. (c)	17	77,84	10,07		

*p<.05

Table 4 shows the analysis of the measured features according to the grade. Accordingly, significant differences were found between leg strength, competition speed and competition times, and 1st and 3rd place degrees. (p<0.05). No significant difference was found between the groups in other characteristics (p>0.05).

Table 5. *The Relationship Between Leg Strength And Jump Height And Competition Performances*

		Jump	Leg Strength
Speed	r	0,492	0,540
	p	0,004*	0,001*
Time	r	-0,539	-0,562
	p	0,001*	0,001*

*p<.05

Table 5 presents the analysis of the relationship between leg strength and jump height and competition performances. Accordingly, it was observed that there was a positive correlation between jump height and leg strength, and competition speed (p<0.05). In addition, it was determined that there was a negative correlation and positive significance between the jump height and leg strength and the duration of the competition (p<0.05).

DISCUSSION AND CONCLUSION

Many studies have been carried out in sports that affect or are thought to affect performance.

Balance, leg strength, technical and psychological factors are determinants of performance in alpine skiing. Looking at the literature, we see that while leg strength was the determining factor at first, many factors are also involved in performance today. These components, which are included in recent studies,

have been applied in combinations that can increase performance and their contribution to activity has been investigated.

In this study, it was tried to determine the components that are thought to affect performance or play a role in achieving high performance. By examining the studies in the literature, in addition to leg strength, previously applied research was also evaluated.

In our study, 33 elite skiers who continued their active sports life at the A1 league and/or national team level as of 2014 constituted our study group. Leg strength, lateralization, competition time and competition speed were measured on these subjects.

In many studies, it has been seen that physical variables directly affect the physical fitness and performance of the athlete. The physical properties that allow it to move in harmony with the field conditions and the material used should be at the desired level. At the beginning of physical fitness are parameters such as height, body weight, body fat percentage, and body mass index (Kabadayı, 2005; Bostancı, 2009).

Wojtyczek et al., (2014), in their study on 88 alpine skiers, found the mean age of 20.5±0.76 years, Erickson et al., (2013) the mean age of 25 skiers to be 22.6±4.45 years, Todd et al. et al., (2015) found the mean age of 75 skiers to be 18.3±1.1 years. Sievänen et al., (2015), in their study on 13 skiers, found 22.9±1.4 years, Zorko et al.; (2015) stated in their research that the average age of the skiers was 23.33±3.44 years, and the average age of the year was 23.33±3.44 years.

Wojtyczek et al., (2014), in their study of skiers, the average height was found to be 169±7.73 cm, Todd et al., (2015) as 174±8.2 cm, Sievänen et al., (2015) found that it was 182±0.08 cm in male skiers and 169±0.08 cm in female skiers. Zorko et al., (2015) finding the height length of skiers to be 172±0.04 cm in their research, while Brunner et al., (2015) have found it 175.2±8.8 cm in their study. Looking at the studies conducted on skiers, it was found that the weight values of our group were higher in some compared to other research groups, while others were lower (Wojtyczek ve ark., 2014; Sievänen ve ark., 2015; Zorko ve ark., 2015; Brunner ve ark., 2015; Todd ve ark., 2015).

Wojtyczek et al. (2014) conducted a search on 24 female and 54 male skiers and found that the mean BMI of the women was 22±1.86 kg/m2, while the mean BMI of the men was 24±2.26 kg/m2. Todd et al., (2015) researched with 75 elite skiers the mean BMI of the skiers was 22.9±2.2 kg/m2, Sievänen et al., (2015) in their study on 9 male and 4 female skiers, the average BMI of men was 24.76±2.8 kg/m2, women BMI averages 23.11±2.1 kg/m2, Zorko et al., (2015) reported the mean BMI as 21.97±2.5 in their study on skiers.

In our study, it is seen that the age, height, weight and body mass indexes we determined in our elite alpine athletes are similar to the domestic and foreign literature, as well as being in the normative range and between international values.

Sports scientists accept leg strength as an important criterion for revealing skiing performance. Continuity of leg strength is important in building resistance against fatigue. One of the direct methods used to determine leg strength is the vertical jump test Chu, 1992; Masterson and Brown, 1993; Şimşek, 2002).

From the studies in the similar age range; Donti et al. (2014), in their study with artistic and rhythmic gymnasts with official international experience with the Ergojump contact platform, the average leg strength was found to be 49.7±0.8 w/kg in male artistic gymnasts, 40.0±1.3 w/kg in female artistic. Also stated that it was 33.0±9 w/kg in rhythmic gymnasts.

Chamari et al. (2004) determined the leg strength values as 55.1±5.7 w/kg in their study with the vertical jump platform in young elite football players. In the evaluations of Król and Mynarski (2012)

with the KISTLER 9182C force platform device on Polish Junior National Team biathletes, the jump height values were found to be 0.381±0.049 m. Petit et al. (2010) stated that the jump heights of trained physical education students were in the range of 30-40 cm in their study with Optojump. Ruiter et al. (2003) found the jump height to be 0.59±0.03 m in the control group and 0.57±0.05 m in the control group. In studies where reference values are determined; 18-25±2.56 cm with Haynl Elektronik jump mat for jump height (Rogan et al., 2015), Tsubaki et al. (2016) 40.4±12.3 w/kg with Leonardo Mechanography Tounsi et al. (2015) expressed it as 0.28±0.04 m with Optojump in 525 participants.

Considering the studies conducted by means of electronic jumping mat in individuals with anterior cruciate ligament disorders; Laudner et al. (2015), the jump height of individuals with anterior cruciate ligament disorder was 20.3±5.3 cm, while it was 24.9±6.9 cm in healthy individuals in the control group, Caswell et al. (2016) reported the jump height as 16.5±9.3 cm in their study of young American football players who have been playing for two years.

The leg strength values obtained from our research were found to be within the normal range for healthy and athletic individuals in the similar age range.

Leg muscles have a very important place in athletes, during exercise and competition, and they play a big role. During exercise, athletes perform thousands of movements and, like other skeletal muscles, leg muscles work intensely. Especially during high-intensity exercise, leg muscles are much more active than at rest. For this reason, leg muscles need a significant amount of metabolic function in order to continue working efficiently. Strong and durable leg muscles can affect exercise capacity; Because leg muscle fatigue is delayed or prevented, continuity in strength is ensured. Thus, the force required by the increased workload will be realized more easily. When the literature on the effects of leg strength is examined;

Wisløff et al. (2004), in their research on 70 international male football players, determined the jump heights as 40.50±5.05 cm in the first measurement with the Bioware brand device, and as 45.35±6.08 cm with the increase in the number of repetitions performed afterwards. They have emphasized that there was a significant increase in jump heights as a result of the exercises.

Again, Lockie et al. (2015) determined the jump height of female athletes with a mean age of 22.67±5.12 years in their study with Swift Performance Equipment as 43.44±3.43 cm. Abidin and Adam (2013), In their study with Takei 5414 jump-DF on 29 male and 25 female martial athletes who participated in Asian university sports games, jump height were detected for women's 42.71±4.96 cm for men it is 62.93±7.34 cm.

Besides these studies, Orr et al. (2016) in their study with the participation of 1021 police officers, they determined the jump height of 863 healthy police officers as 44.0±7.56 cm.

Yanci and Camara (2016) examined the vertical jump performance of 20 male football players with the Quattro Jump brand device and found the jump heights of the football players to be 39.00±6.00 cm.

In the study of Chimera and Kremer (2016), which they carried out manually with a tape measure fixed to the wall on rowers, the jump height of the university rowers was found to be 29.9±7.8 cm, while this value was found to be 27.3±5.2 cm in novice rowers.

Huang et al. (2011) stated that the jump heights of the control group were 39.56±2.23 cm, in A gourp subjects 39.67±1.70 cm and 39.44±2.28 cm in group B subjects in their study on 31 subjects in total with the Motion Analysis Corporation device.

Stafilidis and Tilp (2015) found that their jump height was 41.8±6.3 in their study with Quattro Jump on university students with an average age of 25.5±3.1 years.

Vieira et al., (2015) emphasized in their study with 12 trained male subjects with the AMTI force panel that the jump heights of the subjects they divided into two groups were between 30-46 cm and the control group was between 34-45 cm.

Holmstrup et al., (2016) found jump heights of 0.397±0.05 / 0.413±0.04 in their study on 20 healthy university-aged women with an average age of 18-25 using the Vertec Jump device.

In the study of Imai and Kaneoka (2016), which they applied to 55 football players with an average age of 16.3±0.5 years, using the Multi Jump Tester, they found the jump heights to be 37.82±4.77.

In our study, the reason for the significant increase between leg strength and jump height; We see that this is due to the fact that the leg muscles are used quite frequently as a sport branch of Alpine Skiing and that the trainings for this branch are constantly aimed at strengthening the leg muscles.

In addition, since the jump movement is made with flexors and extensors, which are four important muscle groups in the thigh, and the branch of alpine discipline includes these movements, co-contraction ratio between the extension and flexion muscles explains the statistical significance between jump height and leg strength.

According to the results of the measurements we have made, it has been determined that the Leg Strength value is 2604.41±828.52 w. Leg strength and age, height, weight and body mass index, which are anthropometric values, show statistical significance. In addition, statistical significance was determined between leg strength and those who skied for 15 years or more and those who skied for 5 years. Kayak müsabakalarında elde edilen derecelere göre yapılan incelemede, bacak kuvveti ile 1. ve 3. sıra değerleri arasında anlamlı bir fark bulunmuştur. While it was determined that there was a negative correlation and statistical significance between leg strength and competition time, there was a positive correlation and statistical significance between leg strength and competition speed.

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