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The effect of alpine skiing training on balance performance

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ABSTRACT

This study was conducted to examine the effect of 5 days (25 hours) of ski training on balance performance for individuals who have never had ski training before. A total of 84 volunteers participated in the study, 42 of them men and 42 of them women without any health problems. After the pre-test balance measurements of the control and experimental group, ski training was given to the experimental group for 5 days in Erciyes Ski Center. One day after ski training was completed, the post-test measurements of the control and experimental groups were made and the results were noted. Biodex Balance System was used for balance measurement in the study. According to the results obtained, static APSI values of the experimental group after ski training were better than before and this difference was significant ($p < 0.05$), dynamic OSI, APSI and MLSI values were better than before and these differences were significant ($p < 0.01$, $p < 0.01$, $p < 0.05$, respectively). These results show that skiing activity can be recommended especially for the development of dynamic balance performance. On the other hand, it seems that ski training contributes more to the static balance performance in the direction of A-P.

Keywords: Alpine, biodex, balance, ski.

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INTRODUCTION

Physical activity is one of the most important elements necessary for the individual to lead a healthy, physical and social life. Physical activities can be done in sports tracks, fitness centers or sports complexes, as well as in ski resorts during the winter season. One of these activities in winter is alpine skiing.

Alpine skiing is one of the most popular winter sports that have been in every Winter Olympic Games since 1936 (Şimşek, 2018). In addition, it is one of the most popular winter activities in which millions of people participate at a recreative level. In alpine skiing, there are different techniques that include different body positions and movements, such as walking, straight skiing, snow plough, parallel or carving skiing.

Alpine skiing has high requirements for physical fitness, muscle strength and balance abilities due to these specific movements or techniques (Ferguson, 2010), but also coordination and sensorimotor performance are also very important in addition to endurance and strength components (Wölfel et al., 2003; Bambach et al., 2008). It is particularly noted that modern skiing technique (carving) has to have a high level of balance due to the shorter skis used by skiers and the wide reclining angles of the body inward during rotation (Raschner et al., 2001).

Balance refers to the body's power to hold its center of mass at the base of support with minimal oscillation or maximum stability (Abbasi et al., 2011; Abbasi et al., 2012; Emery, 2003). The state of balance or staying balanced is divided into static and dynamic depending on the surface being stationary or moving (Spirduso, 1995; Muratlı, 2003). Dynamic balance is defined as the ability to maintain its supported position while driving a determined motion, static balance, and to hold the center of gravity within the support range (Sadeghi et al., 2010). Balance is also expressed in the form of Anterior-Posterior (A-P) and Medial-Lateral (M-L) balance, indicating the change of position of the body's center of

gravity (Şimşek and Arslan, 2019).

Alpine skiing is a sport that requires fine postural control to maintain balance in challenging conditions (Schaff and Hauser, 1989). In alpine skiing, one of the preconditions for optimum rotation is to maintain the central balance position on skis during all turn stages (Loland, 2009); the secondary importance is to position the skis on the edge and to orient them in the desired direction. If this is not appropriate, the skis will probably slide sideways and the skier will lose control over the ski speed and central balance position (Spörri et al., 2012; Cigrovski and Matković, 2015). For this reason, it is necessary to constantly make adjustments in small lateral (M-L) and A-P direction adjustments in response to speed changes, turning radii of skis, terrain or snow conditions (Raschner et al., 2017). A skier can complete his descent without falling as long as he can balance the sum of all forces acting on the center of gravity while sliding (LeMaster, 2010). Otherwise, it may cause the skier not to be in balance and a situation that will fall and increase the risk of injury. Hrysomallis (2007) reported that poor balance skills were significantly associated with increased risk of injury, but Staniszewski et al. (2016) reported that skiing had a positive effect on postural stability, regardless of the level of technical skills of skiers.

Wojtyczek et al. (2014) reported that seven days of recreational alpine skiing activity accounted for significant improvement in women and men. Cigrovski et al. (2017) stated that the balance skills of recreational skiers who participate in at least ten days of skiing activities per year have improved positively. In contrast to these studies, Müller et al. (2011) stated that 12 weeks of alpine skiing (average 28.5 days) did not affect the balance skills of the elderly.

Although balance skill is a very important aspect of alpine skiing, there are very few studies investigating the effects of alpine skiing on balance skill, and the results of these studies are quite different. For this reason, this study was carried out to examine the effect of 5-day ski training on balance performances for individuals who have never received ski training before.

METHODOLOGY

Study group

A total of 84 people, 42 of them men and 42 of them women, who did not have any health problems (orthopaedic injury etc), participated in this study as volunteers in the Faculty of Sports Sciences of Erciyes University. 42 of the volunteers who participated in the study (21 men, 21 women) were randomly identified as an experimental group and were subjected to 5 days of ski training at Erciyes Ski Center. In the same homogeneity control group, no activity was performed. Volunteers were selected from individuals who had never had ski training before.

Study protocol

The balance measurements (pre-test) of the control and experimental groups before the study were carried out in Erciyes University Faculty of Sport Sciences Laboratory. After the measurements, a total of 5 hours of ski training was given to the experimental group for 5 days in the Erciyes Ski Center, 2.5 hours in the morning (09.30 to 12.00) and 2.5 hours in the afternoon (13.30 to 16.00) in the afternoon. Volunteers stayed in the center of Kayseri (1050 m) and completed their education in Erciyes Ski Center (2200 to 2500 altitude). Ski training, certified by Turkish Ski Federation and was carried out at the same time by working as a ski instructor at Erciyes University experts. One day after ski training was completed, the final test measurements of the control and experimental groups were made and the results were noted.

Height length, body weight and body mass index measurements

An electronic scale with a sensitivity of 0.1 kg was used in the body weight (BW) measurements of the volunteers who participated in the study. Tape measure fixed on the wall was used in length measurements. Measurements were recorded with a sensitivity of 0.1 cm with bare feet. Body mass index (BMI) values of the volunteers were calculated with the formula BW / Height Length^2 and noted in kg/m^2.

Balance measurement

In our study, Biodex Balance System (Biodex, Inc, Shirley, New York) was used for balance measurement. The system has a mobility rating of 1-12, and Level 1 forms the most mobile platform. In the study, static balance measurements were made on the fixed platform and dynamic balance measurements on the mobile platform at the first level.

The balance score obtained shows that posture protection is maintained as it approaches 0, and that posture protection deteriorates as it moves away from 0. Volunteers were told not to move or speak during the measurement. Before the balance measurement, volunteers were given a trial right and then the measurement was carried out. In the static balance measurement, the volunteers' arms were released on the side, while in the dynamic balance (Level 1) measurement, the arms were fixed crosswise to the chest. The balance measurement was made for 30 seconds, and the tests of the volunteers who lost their

balance completely or received support from the edge platform were terminated and the measurements were repeated. As a result of balance measurements, data was obtained from 3 different parameters. These parameters:

- Overall Stability Index (OSI)
- Anterior-Posterior Balance Index (APSI)
- Medial-Lateral Stability Index (MLSI)

Statistical analysis

The data obtained in the study were evaluated in the SPSS 22 package program. The normal distribution indicators of the data were examined using the Kolmogorov-Smirnov test, Q-Q Plots and histogram graphs and it was determined that the data did not match the normal distribution. In statistical analysis of the data, intra-group comparisons were made using the Wilcoxon test and inter-group comparisons were made using the Mann-Whitney U test.

RESEARCH FINDINGS

Table 1 shows the averages of the descriptive information of the experimental and control groups and their comparisons.

Table 2 shows both intra-group and inter-group comparisons of experimental and control groups. According to the results obtained, the static APSI values of the experimental group after ski training were better than before and this difference was significant ($p < 0.05$). The static MLSI value of the control group post-test values was found to be worse than the pre-test results and this difference was significant ($p < 0.05$).

Table 3 shows the comparison of experiment and control groups both within and between groups. According to the obtained results, it was determined that the Dynamic OSI, APSI and MLSI values of the experiment group after skiing training were better than before and these differences were significant ($p < 0.01$, $p < 0.01$, $p < 0.05$ respectively). Dynamic MLSI value of Control group post-test values was found to be better than pre-test results and this difference was significant ($p < 0.05$).

Table 1. Descriptive information.

Parameter	Experiment (n=42)	Control (n=42)	U	p
Age (years)	20.83 ± 3.30	21.67 ± 2.76	724.500	.151
Sports age (years)	8.05 ± 4.90	7.33 ± 4.25	808.500	.510
Height (cm)	171.38 ± 8.78	170.36 ± 8.94	825.500	.613
BW (kg)	67.35 ± 13.01	65.61 ± 11.40	823.500	.601
BMI (kg/m^2)	22.78 ± 3.11	22.47 ± 2.38	857.000	.823

Table 2. Comparison of volunteers' static equilibrium parameters within and between groups.

		Experiment (n=42)	Control (n=42)	U	p
Static OSI	Pre-test	.41 ± .14	.38 ± .17	737.000	.184
	Post-test	.36 ± .12	.40 ± .14	747.000	.216
	p	.076	.186		
Static APSI	Pre-test	.31 ± .12	.29 ± .11	782.000	.351
	Post-test	.26 ± .11	.27 ± .11	812.000	.513
	p	.025*	.629		
Static MLSI	Pre-test	.19 ± .09	.16 ± .10	697.500	.074
	Post-test	.17 ± .09	.20 ± .10	706.000	.095
	p	.419	.016*		

*$p < 0.05$.

DISCUSSION

This study was conducted to investigate the effect of 5 days of alpine skiing activity on static / dynamic balance parameters. According to the results obtained, the static APSI values of the experimental group after ski training were better than their pre-test values and this difference was found to be significant. In the same way, dynamic

Table 3. Comparison of the volunteers' dynamic equilibrium parameters within and between groups.

		Experiment (n = 42)	Control (n = 42)	U	p
Dynamic OSI (Level 1)	Pre-test	4.97 ± 3.79	4.52 ± 3.77	803.000	.480
	Post-test	3.84 ± 3.08	4.14 ± 3.14	843.000	.727
	p	.000**	.135		
Dynamic APSI (Level 1)	Pre-test	3.52 ± 2.78	3.39 ± 2.88	833.000	.661
	Post-test	2.61 ± 2.13	2.97 ± 2.40	817.500	.564
	p	.000**	.173		
Dynamic MLSI (Level 1)	Pre-test	2.74 ± 2.07	2.50 ± 2.06	807.500	.505
	Post-test	2.31 ± 1.93	2.25 ± 1.66	877.500	.968
	p	.014*	.034*		

*p < 0.05, **p < 0.01.

OSI, APSI and MLSI values after ski training were found to be better than their pre-test values and these differences were significant.

Alpine skiing is considered to be a complex sport that includes cardiovascular, neuromuscular and sensorimotor systems, with a high level of physical condition requirement (Kahn et al., 1996; Müller and Schwameder, 2003; Malliou et al., 2004; Krautgasser et al., 2009). Alpine skiing is an activity characterized by a mixture of dynamic and static muscle work (Müller and Schwameder, 2003; Tesch, 1995; Kröll et al., 2010). This activity is also carried out in an extremely challenging and variable environment that requires optimum postural control. Many factors such as track structure, snow conditions, weather, speed change during sliding affect postural control and the individual needs to adapt quickly to this situation in order to provide postural control.

Balance ability is an important cornerstone in alpine skiing activities. Interestingly, however, publications about balance parameters during skiing are relatively rare in the alpine skiing literature (Hébert-Losier et al., 2014). Previous literature has suggested that alpine skiing is a high requirement for postural balance, especially in the A-P direction (Müller et al., 2011). Similar results were obtained to support these claims in the literature. In this study, it was found that static balance parameters were significantly better after APSI ski training (Table 2). In their study, Wojtyczek et al. (2014) stated that female and male participants found significant improvements in the sensory and stability indices after skiing training and performed better in the lateral (M-L) direction. In our study, the best balance performance was determined as static MLSI in parallel with this, but no significant difference was found between the pre-test value. When the results obtained in our study are analysed, it is seen that the best static balance performance after ski training is in MLSI, but the best development is statistically in APSI.

Another finding in the static balance parameters is that the pre-test values of the control group are all better than the experiment group, but when the post-test values are examined, all the values of the experiment group are better. In their study, Wojtyczek et al. (2014) examined the balance performances of 78 university students after 7 days of ski training and found that the balance performance of the intermediate and beginner level participants was better after ski training and that this difference was statistically significant. In a study by Müller et al. (2011), in the weekly reports of the ski instructors, they stated that the skiing skills and postural balance of the subjects increased during the training (28 days in 12 weeks). Saka and Polat (2009) also found that athletes with at least 3 years of alpine skiing experience had better static balance performance than individuals who had never skied before. These results in the literature support the findings in our study.

On the other hand, when dynamic balance parameters are analysed, it is seen that significant improvements occur in all variables of the experiment group. Taube and Gollhofer (2012) emphasized that alpine skiers should quickly compensate for internal and external forces under high dynamic conditions to prevent loss of balance. Therefore, during skiing, the person must constantly monitor and change his/her body position due to different accelerations, different types of terrain and constantly changing friction forces between skis and snow (Müller et al., 2011). This shows us how important the dynamic balance is for this branch (Arslan and Çelenk, 2019).

In the study by Cigrovski et al. (2017), two different balance test results of recreational skiers who participated in alpine skiing for at least 10 days a year and individuals who have never participated in alpine skiing activity were compared. According to the results, no difference was found in one of the balance tests, while in the other balance test, 4 different balance parameters (GYKO Length, GYKO Mean Length Dev, GYKO-ML Length, GYKO-ML Length Dev) were found to be significantly good. In another study, Hydren et al. (2013)

investigated the effects of the one-week high altitude ski training camp (living at 2800 m, skiing up to 3800 m) on the fitness performance of young alpine ski racers and evaluated the balance performance with the Y-Balance test and it showed that balance performance improved after three days of skiing. Therefore, we can say that skiing training affects dynamic balance values more.

From another perspective, Cigrovski et al. (2009) shows that participants who performed better on balance tests achieved better results in learning alpine skiing technique. Similarly, in their study, Malliou et al. (2004) monitored the effect of 14 days of ski training on balance parameters and in addition to ski training, the experiment group underwent a balance study with 20 min ski boots. The study findings found that individuals who received additional balance training were significantly better on the ski skill test. This shows that the relationship between ski training and balance is two-way.

In the control group, it is seen that there is a significant improvement only in the dynamic MLSI variable. Similarly, Müller et al. (2011) found that control group had an improvement in Post-test M-L balance parameters, but this increase was not significant in their studies in which they investigated the effects of alpine skiing on aerobic capacity, strength, power and balance.

Considering the comparisons between the groups, although there was a significant improvement in the experiment group, no significant difference was found between the control group. This situation can be explained as follows: (i) control group's Pre-test values are better than experiment group, (ii) experiment group's Post-test values are better than control group, (iii) experiment group whose balance parameters are worse has developed, but the difference between control group is not opened much. Similarly, Malliou et al. (2004) looked at the effect of 14-day ski training on balance parameters in their study. According to the findings of the study, the performance of both control and experiment groups improved, but no difference was found between the groups.

Wojtyczek et al. (2014) stated that improvements in balance performance can be explained by the help of a series of M-L and A-P exercises during the ski training accompanied by a ski instructor. It can also be thought that ski-specific exercises such as lifting the inner leg while going on the outer ski increase the balance performance.

As a result, it was determined that the Static APSI and Dynamic APSI, OSI and MLSI performances of the volunteers who participated in the five-day (25 hours) ski training study for the faculty of sports sciences improved significantly. These results show that skiing activity can be recommended especially for the improvement of dynamic balance performance. At the same time, we can say that the risk of injury will decrease as the probability of falling will decrease for the individual who develops balance performance. From another point of view, there seems to be a two-way relationship between skiing activity and balance performance. Therefore, improving the balance performances of individuals who will participate in ski basic training can help them perform better.

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