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Balance as a Risk Factor for Injury in Recreational Skiing

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ABSTRACT

The objective of this study was to determine the efficiency of intervention based on the analysis of the static and dynamic balance status in order to reduce the probability of skiing injuries in adult beginners. In addition, we also analyzed the incidence of injury during initial training in alpine skiing. The subjects were recreational skiers aged from 20 to 25 years (287 subjects; 214 men and 73 women). The experimental group (E) consisted of 146 subjects out of whom 104 were men and 42 women. The control group (C) was made up of 110 men and 31 women, a total of 141 subjects. Independent variables included data on basic anthropometric measures and balance status parameters that were obtained using the Biodex Balance System. The dependent variables in the study included injury incidence or more specifically: number (frequency) of injuries, injury location (region of the body), and injury severity (mild, severe…). Both groups had a 6-day ski training program. Prior to the program, the E-Group was tested for balance, and the subjects with a relative balance insufficiency were identified. These subjects attended a special ski training program with reduced volume and work intensity (20–30% less intensive than other subjects). The data about subjects' injuries were prospectively obtained. The $\chi 2$ test for independent samples was used for the analysis of the differences in the injury incidence between the E and C-Group, 18.5% of subjects from the E-Group suffered minor injuries as well as 24.8% of subjects from the C-Group. In the E-Group, 1.3% of them suffered serious injuries same as 2.8% of subjects from the C-Group, ($p < 0.05$). Contusions account for the largest number of injuries and they are followed by strains (sprains) and front knee pain. A total of one fracture was recorded in each Group, followed by three dislocations, four lacerations and one brain concussion. Hips/the gluteal region was the most frequently injured locality in minor injuries. There was one fracture of the fist, and in one case a rupture occurred. Dislocations were recorded in the shoulder, and twice in the fingers. The injury incidence is lower than that reported so far (2 to 2.5 injuries in 1000 skiing days). The main reason for this difference is to be found in the level of training, proper equipment control and in the methodological advantages of the study. The data suggest that the experimental program had a significant effect on the reduction of injuries during ski training. The conducted intervention was especially efficient in terms of the reduction of serious injuries. The effects, however, relatively failed to occur in terms of the differential effect of gender of the subjects. The study points to the importance of a precise, complete and quality training in recreational skiing.

Key words: *alpine, recreational skiing, injuries, balance, prevention*

Introduction

Injuries in skiing, especially in recreational skiing are an extremely interesting scientific and professional medical issue. The main reason for this claim is in the popularity of recreational skiing, and it is estimated that there are up to 200 million recreational skiers in the world. Today, skiers ski on better skiing tracks as opposed to the past. This allowed a reduction of some risk factors for injury, but also influenced a rise of some other risk factors. Better ski equipment has led to a reduction in the number of serious injuries such as fractures. For example, in Norway, it became clear that the majority of the decrease relates to a reduction in injuries of the lower extremities, while the incidence of injury of the upper extremities remains relatively unchanged.[1–6] Equilibrium (balance) is the ability to achieve the state of balance by maintaining the center of gravity of the body above the base of the body. Previous research proved that the connection of the state of balance and risk of injury in different sports is not uncommon. It is interesting, however, that the authors have not found any research that links the problem of balance and injury in some of the sports in which balance is one of the most important factors, both of success and injury, such as gymnastics[7] or skiing. Research of this kind would include recreational skiers as this is a population that is in many ways

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is very different from the population of athletes (professional, semi-professional or amateur) who were so far regularly examined. Training, an exercise in balance, is a procedure used in rehabilitation programs that aim to improve the condition of instability of the ankle[8,9]. This procedure proved to be very efficient in terms of recovery after injury. Biodex Balance System SD is a very effective device for testing and practicing balance in static and dynamic form. Risk of falling, the position of the ankle and knee, border stability and stability in demanding positions are tested with this device. As for the exercises, serving for proprioceptive exercises and stability, range of motion exercises as well as exercises for the proper transmission of body weight. The majority of previous studies that have addressed this issue had a retrospective character, and it is known that this approach has a number of limitations when it comes to the reliability of the collected data. Another comparative advantage of the study can be seen in the fact that previous research actually collected the data from medical institutions caring only for the injured skiers [10–12].

Material and Methods

This study was conducted on a sample of recreational skiers aged 20 to 25 years. The total sample size was 287 respondents, of which 214 were men and 73 were women. The sample was randomly divided into two groups, one of which is the experimental (E) and second the control (C) group. The E-Group had a population of 146 patients, of whom 104 were men and 42 were women. The C-group consisted of 110 men and 31 women that is a total of 141 respondents. The study included only subjects who had no prior skiing experience, in order to exclude the possible effect of skiing experience on the obtained results. Prior to the implementation of the experiment, E-Group was subjected to the test of balance, and on the basis of these measurements and the application of appropriate statistical methods to single subjects who had relatively poor state of equilibrium measures. These respondents were then subjected to a specific intervention that consisted of reducing the amount of work at the ski resort. It was assumed that such interventions will have an impact on the incidence of injury during ski training. C-Group was not tested at the variables for balance, and subjects from this group had a weaker state of equilibrium. The other elements in skiing C and E Groups were carried out in consistent programs. In this way, we could isolate the balance as a parameter to be controlled in the intervention program. This randomized controlled trial was conducted in several major stages.

Generally, the study is divided into two main phases, the implementation of the experiment for the control group and the implementation of the experiment for the experimental group. The control group subjects (C) were enrolled in a six-day ski training program during two seasons. Over the next two seasons the experimental group (E) carried out an identical ski training program. Both programs were identical in terms of the number of hours spent on snow skis (four hours in six days), the venue of the program (Ski Resort Pohorje Slovenia) as well as same instructors and ski curriculum. In this way, the most relevant factors were relatively well- controlled. The difference in the programs of E and C-Groups was in the fact that the subjects from the E-Group were not tested by the Biodex Balance System before starting training. These respondents have attended special ski training program in which the main intervention consisted of reduced volume and intensity of work (20–30% less compared to other respondents). In this way, reduced fatigue consequently allows the relative increase of neuromuscular capacity, adequate contraction of agonist and antagonist muscles, ensures strength and the correct position of the hinge structure and finally-reduces the risk of injury. There were no differences between E and C-Groups in other elements of skiing (length of program, number of hours, methodical procedures, etc.). After ski training, which took place with each generation, the medical data on the etiology of patients' injuries was collected.

Statistical analysis included the analysis of the incidence of injury based on frequencies, descriptive parameters of parametric variables (anthropometric variables and the status of balance) and calculated statistical parameters (mean, standard deviation, etc.). The indices of balance examined are described in Table 1. The intervention groups were identified by means of taxonomic analysis (clustering around a defined number of arithmetic means). We used $\chi 2$ test for independent samples to analyze differences in the incidence of injury between the two groups. The level of significance was set at 95% ($p < 0.05$). The statistical package Statistica for Windows 7.0 and Microsoft Excel 2010 were used for processing data.

TABLE 1

BALANCE VARIABLES EXAMINED AND THEIR ABBREVIATIONS

GID	general dynamic index
API	anterior – posterior index of static balance (deviation from the ideal equilibrium during the balancing test in anterio-posterior direction)
MLISB	midlateral index static balance (deviation from the ideal equilibrium during the balancing test in the mediolateral direction)
GIDB	general index of dynamic balance
IDBF	index of dynamic balance – forward (deviations from the ideal trajectory of leaning forward)
IDBB	index of dynamic balance – back (deviations from the ideal trajectory in the trend towards back)
IDBR	index of dynamic balance – right (deviation from the ideal trajectory in the trend towards the right)
IDBL	index of dynamic balance – left (deviations from the ideal trajectory in the trend towards the left)
IDBFR	index of dynamic balance – front / right (deviation from the ideal trajectory of leaning forward or to the right 45 degrees)
IDBFL	index of dynamic balance – front / left (deviations from the ideal trajectory of leaning forward left or 315 degrees)
IDBBR	index of dynamic balance – back / right (deviation from the ideal trajectory in the trend toward the back right or 135 degrees)
IDBBL	index of dynamic balance – back / left (deviations from the ideal trajectory of leaning forward left or 225 degrees)
TDB	the time required to perform the test characteristic of dynamic equilibrium

Results

Basic descriptive data for anthropometric variables were calculated for both men and women. The results for subjects in the control group were slightly higher for body weight while the values for body mass index were equal in both groups. When comparing data on measures of balance for males in the experimental and control group it became obvious that the groups did not differ significantly in the analyzed measures except in one variable (IDBBL index of dynamic balance – back / left, deviations from the ideal trajectory of leaning forward left or 225 degrees). This variable describes a "failure" when measuring balance in testing limits of stability. However, what is important to note is the fact that regardless of this value there was no significant difference in the degree of general index of dynamic equilibrium, which ultimately means that both groups achieved statistically identical results in tests of balance before starting ski training (Table 2).

TABLE 2

BALANCE VARIABLES FOR MEN,
INDEPENDENTLY FOR EXPERIMENTAL AND CONTROL GROUP

Men	Experimental		Control		T test
	Mean	SD	Mean	SD	
GID	2.36	1.53	3.20	2.20	–1.52
API	1.64	1.16	2.17	1.37	–1.38
MLISB	1.36	0.92	191	1.53	–1.51
GIDB	19.70	5.80	22.87	8.33	–1.71
IDBF	24.77	10.85	23.55	14.22	0.37
IDBB	27.10	19.88	20.58	13.26	1.51
IDBR	27.83	14.50	27.10	12.43	0.21
IDBL	21.23	10.79	28.90	18.79	–1.94
IDBFR	20.07	8.67	24.81	11.46	–1.82
IDBFL	24.63	10.26	27.00	14.26	–0.74
IDBBR	22.53	11.83	28.06	12.60	–1.76
IDBBL	19.60	8.05	29.45	17.35	–2.82*
TDB	70.53	14.68	63.06	15.49	1.93

Among women in the experimental and control group, there are more significant differences in the indices of balance. Specifically significant differences were found for IDBF (index of dynamic balance – forward, deviations from the ideal trajectory of leaning forward), IDBFR (index of dynamic balance – front / right, deviation from the ideal trajectory of leaning forward or to the right 45 degrees), and TDB (the time required to perform the test characteristic of dynamic equilibrium) (Table 3).

In the experimental group the percentage of uninjured participants was 80%, whereas in the control group this percentage was significantly lower and amounted to 68.8%. In the experimental group, there were a total of 35 minor injuries, while in the control group, the number was as high as 50 injuries, and the number of severe injuries is twice as high in the control group (four severe injuries) than in the experimental group (two severe injuries) (Table 4).

TABLE 3

BALANCE VARIABLES FOR WOMEN,
INDEPENDENTLY FOR EXPERIMENTAL AND CONTROL GROUP

Women	Experimental		Control		T test
	Mean	SD	Mean	SD	
GID	1.01	0.39	1.20	0.37	–1.42
API	0.66	0.24	0.82	0.29	–0.66
MLISB	0.68	0.30	0.61	0.33	–0.58
GIDB	37.76	13.99	31.41	11.27	1.45
IDBF	52.18	16.92	35.18	12.20	–3.36*
IDBB	45.47	25.57	40.18	23.27	0.63
IDBR	35.94	17.02	36.47	17.83	–0.09
IDBL	35.82	16.41	32.94	15.09	0.53
IDBFR	46.29	20.23	31.65	16.99	2.29*
IDBFL	42.06	20.31	37.82	15.20	0.69
IDBBR	41.41	14.90	33.35	19.86	1.34
IDBBL	40.24	20.33	35.18	12.29	0.89
TDB	52.41	7.18	62.76	10.44	–3.37*

TABLE 4

ANALYSIS OF DIFFERENCES IN INJURIES
BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS FOR THE TOTAL SAMPLE OF RESPONDENTS

	Experimental			Control		
	F	%	CI 95%	F	%	CI 95%
Uninjured	117	80.1%	73–86%	97	68.8%	61–77%
Injuries:						
Minor	35			50		
Serious	2			4		

CI 95 % – 95 % confidence interval
F–Frequency
% rate of injury

When the occurrence of different types of injuries was studied in both groups we observed that most injuries were contusions followed by sprains and anterior knee pain. There was one fracture in both groups, three slip injuries, four lacerations, and one concussion (Figure 1). The results showed that 76.9% of men and 69.9% of women in both programs were not injured. 46 men (21.5%) and 21 women (28%) suffered minor injuries. Severe damage was observed in 5 men (2.3%) and one woman (1.3%). The results obtained by $\chi 2$ test for independent samples showed no statistically significant difference between the sexes ($\chi 2 = 2.58$, with 2 degrees of freedom).

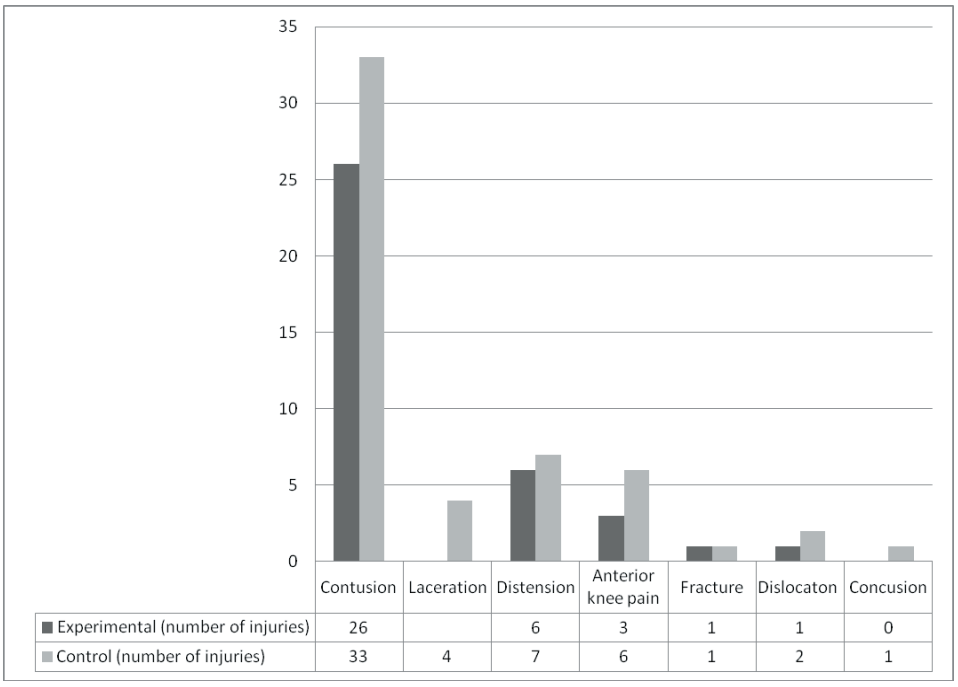

Fig. 1. Types of injuries in the control (c) and experimental (e) group – the total sample of respondents.

The comparison of data on injuries in men and women showed that 76.2 % of men from both programs suffered no injuries (Figure 2). In men, there were 58 minor injuries, while in women this phenomenon was observed in only 27 cases. There were five serious injuries in men and only one in women. These data cannot be expressed in percentages because they describe the number of injuries, rather than the number of injured subjects. In other words, a person can have one or more injuries so percentage is not an appropriate method of expressing the incidence. From the data on the site of injury in men and women, separately given by type of injury it can be seen, that hip/gluteal region is the most frequently injured site when observing minor injuries and it is mainly related to contusions. There is no difference between men and women, although lacerations occur only in men, mainly in the

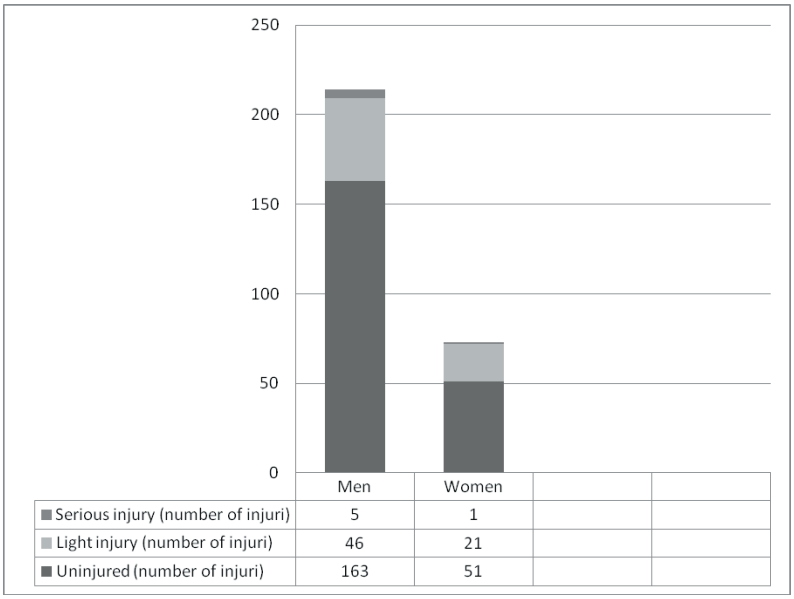

Fig. 2. Number of injured men and women – total sample.

lower leg. Strains occur in both men and women, mainly on the back of the thigh. There was one hand fracture and in one case a rupture of the meniscus which was subsequently diagnosed. Dislocations were observed in the shoulder and twice in fingers (Table 5).

TABLE 5

LOCATIONS AND NUMBER OF INJURIES BY SEX AND GROUP

Injury	Site	Control group		Experimental group	
		Men	Women	Men	Women
		F (%)	F (%)	F (%)	F (%)
Contusions	Hips/Gluteal region	14 (61%)	9 (82%)	7 (44%)	10 (83%)
	Elbow	3 (1.5%)		1 (6%)	1 (8.5%)
	Knee	1 (0.5%)	1 (9%)	2 (12%)	1 (8.5%)
	Shoulder/upper arm	2 (1%)	1 (9%)	4 (24%)	
	Hand	3 (1.5%)		2 (12%)	
Laceration	Lower leg/Calf	4 (80%)			
	Upper arm	1 (20%)			
Strain	Thigh (hamstrings)	4 (80%)	1 (50%)	2 (66%)	1 (100%)
	Shoulder	1 (20%)	1 (50%)	1 (33%)	
Anterior knee pain	Knee	3 (100%)	1 (100%)	3 (100%)	
Fracture	Hand fingers	1 (100%)			
	Meniscus (knee)			1 (100%)	
Dislocation	Hand fingers	1 (50%)		1 (100%)	
	Shoulder	1 (50%)			
Concussion	Head		1 (100%)		

Discussion and Conclusion

There were no ligament injuries found in either the control or experimental group. There were also no injuries of the knee ligament but there were overuse syndromes such as anterior knee pain in both men and women. Specifically, three men and one woman in the control and three men in the experimental group reported anterior knee pain. It was probably an overuse injury but no acute injury. Constant knee bending position and flexion of the knee with the effect of increased power, causing a constant effort, the pressure on the patella and knee ligaments ultimately produce the overuse syndrome, which is reflected as anterior knee pain in the specified number of respondents. It is a direct cause of injury of the ligaments, primarily the medial collateral ligament. The main reason for the absence of this type of injury in our study is the fact that all the respondents in the two groups skied on modern fitted (carving) skis. This factor has already been proven as being preventative in terms of ligament injury in recreational skiers. Thus, the Austrian authors [13–15] demonstrated that the use of carving skis reduces the incidence of knee injuries by 10.5 times compared to the use of conventional flat skis.

In connection with the issue of dislocation among other types of serious injuries, there were two cases in the control group (sprain or strain of ligaments of the wrist and shoulder sprain), and the sprain of metacarpophalangeal joint in the experimental group [16,17]. Last serious injury that is recorded relates to a concussion in one patient in the control group.

In the present study, we tried to answer the questions from previous studies mentioned above, but the study is primarily an attempt to answer the specific question whether a simple intervention strategy that includes an initial analysis of the state of balance in healthy young subjects impacts the reduction in the number of injuries. The intervention consisted of an initial diagnosis of learners with relatively poor balance and continuous monitoring of these participants with continuous load reduction. The physiological background of this approach lies in the interdependence and balance control mechanism of injury. Ability to balance indicates the ability of neuromuscular mechanisms to co-shrink agonists and antagonists and increase the stability of the joints. What is important in this study is the fact that if the initial state of equilibrium is not good enough, neuromuscular mechanisms are more quickly disturbed and the risk of injury of the extension activities further increases. This is precisely the background of the intervention. Specifically, in patients who are initially diagnosed with neuromuscular failure mechanisms which are used for balance, an attempt was made to reduce the total work load, i.e. activities. This according to our research yielded good results. The incidence of injury in all variables is significantly lower in the experimental group than the control group. This was true for a number of minor and serious injuries when the same was observed in the overall sample of men and women as well as when they were reviewed separately by gender.

Given the previous discussion mentioning beliefs that the morphological-anthropometric structure or the physique of the subjects is an important factor that affects the injury of balance, it should be pointed out that the statistical analysis did not determine the significance of differences between control and experimental groups in body weight (mass), body height and body mass index. Thus, it is clear that there is a need to reduce the burden in patients who are diagnosed before the start of the program to be of weaker balance. However it should be noted that although the intervention significantly influenced and obviously reduced the number of injuries, it had no impact on the reduction of the number of injured subjects. Thus, the total percentage of uninjured subjects in the experimental group was 80% (with a confidence interval 73–86%), whereas the percentage in the control group was approximately 13% lower, where the uninjured accounted for 69% (with a confidence interval of 61 to 77%). It is obvious that this is essentially a smaller difference than in the case of injuries ranging from 30 % for minor to as much as 50% for serious injuries. In both cases, a lower

incidence was observed in the experimental group. At this point it is not possible to completely answer the question about the cause of these differences, but it is very likely that some of the following might be the reasons. First, the injury is repeated on the same person i.e. the injury is not distributed evenly across subjects, but there are subjects who are injured more often and those who experience injuries rarely or not at all. This phenomenon is especially pronounced in men where the difference in the number of injured and the number of injuries is greater than in women, which is probably due to differences in the psychological profiles of men and women. Men are more inclined to search for excitement "sensation seeking" and with such behavior tend to fall more often during skiing and consequently are more likely to injure themselves [18]. On the other hand, women in the event of errors and falls during skiing approach the problem more calmly and seriously, eliminate the error and the motor tasks are more successful. Confirmation of this discussion can be found in studies that study the problem of solving motor tasks by gender [9,19,20].

The difference in the number of injuries between the control and experimental groups is particularly visible in serious injuries. Thus, the control group recorded twice as a many serious injuries than the experimental one. When we add that one of the serious injuries in the experimental group was most likely only recognized during skiing while in fact it had apparently occurred before skiing (meniscus tear in one of the male respondents), it becomes clear that there is a very big difference just in terms of serious injuries. This is particularly important information because serious injuries leave the biggest consequences, and usually patients with them need to be hospitalized to repair, and they significantly reduce or completely limit the patient's ability to work. On the other hand, reducing the number of minor injuries, from a medical point of view is not as important as the effect of the intervention in reducing serious injuries.

As previous studies have shown that women are a more risky group in terms of injuries during recreational skiing[21,22], it is interesting to observe the difference between injured men and women, separately for the control and experimental group. In particular, it is interesting to see whether the experimental program achieved differential effects in terms of reducing injuries in men and women. The results of statistical analysis by gender in the control and the experimental group show no significant impact of gender. In other words, both men and women in the experimental and control group made equal efforts in reducing the number of injuries. This data is actually fairly illogical, since it is known that women are a more risky group than men and accordingly in them we could expect a relatively greater effect. The reason for this should be sought in the approach to the formation of the experimental group. After the experiment, we analyzed the individual members of the group, and it turned out that among subjects diagnosed with weaker balance and who consequently were under special treatment in the experimental program, only a few were women. Specifically, the total sample consisted of approximately 25% women. Under the law of probability in the experimental sample, a group that ran a special treatment (subjects who were diagnosed with weaker balance), the ratio between men and women was 1:4. However, the ratio subsequently found was 1:7. At the beginning of the experiment we did not pay any attention because it was thought that the ratio would level in the next generations with the increasing number of subjects. From this perspective we come to a simple conclusion that men and women differ significantly in the state of balance, while women in both analyzed balance indexes achieved significantly better results than men. Men were therefore recognized as respondents with relatively poorer balance as opposed to women, and this is the reason for the fact that there were no significant differences between genders in terms of injuries, although women are a more risky group in terms of injuries during recreational skiing [21,22]. It may be logical to question such a conclusion when it is obvious that women have better balance, which was also found in other studies[23] and they already have a better ability to maintain balance than men, so why this is not an adequate explanation for a lower number of injuries in the experimental intervention group? Although it sounds logical, this argument has one flaw and that is the fact that women have relatively weaker ligaments and muscle structure than men which consequently means that regardless of better balance women fall more and more often experience injuries since their ligaments and muscular structure are less able to bear the burden.

This study is very different from previous studies that dealt with the problem of balance and various interventions that attempted to reduce the number and severity of injuries in sport activities[9,22]. Previous studies generally studied the effects of different training programs implemented to improve the quality of proprioceptive mechanisms responsible for maintaining balance, which later had a positive effect in terms of reducing the number of injuries that occur in athletes. It should however be noted that this was examined in: (I) competitive athletes grades rather than recreational athletes, (II) interventions carried out in the period before the beginning of the skiing season (the preparatory period). Such interventions are certainly useful, but in the research conducted here such approach was not feasible considering that it was done on recreational athletes who do not have such professional attitude toward sport and the intervention strategy of the kind is difficult to perform. If such intervention had been feasible in this study, it would have been almost impossible to design such an intervention that could be repeated in real terms (recreational skiing). Therefore, it is very encouraging that the experimental group recorded a smaller number of obvious injuries than the control group. Also, it was a very simple intervention that did not demand a lengthy treatment but only the initial examination of the state of balance and specifically tailored ski training. In the experimental group, when men and women are considered together, 18.5 % experienced a minor injury while the number of minor injuries in the control group slightly increased and was

28.4%. A significantly greater difference is evident in the case of serious injuries. Specifically, serious injury was observed in 1.3% of patients from the experimental group, whereas in the control group it was recorded at 2.8%. Given that the differences are statistically significant we may be talking about a significantly higher number of injured people in the control group, when considering both men and women. When comparing only men, we find significant differences between the groups. It is obvious from the data on the number of respondents who were not injured. In the experimental group, 81.7% of respondents suffered no injury, while in the control group this percentage is 70.9%. 16.3% of respondents from the experimental group suffered minor injury (or multiple minor injuries) in comparison to 26.4% of respondents of the control group. Finally, in the control group, 2.7% of patients suffered serious injuries while in the experimental group only 2% of respondents suffered serious injuries. The data indicate that the subjects in the experimental group were significantly less prone to injuries than subjects from the control group. In particular, even when excluding severe injuries in the experimental group, in the control group, there were 11 people who have suffered a severe injury (35.5% of respondents), while in the experimental group this percentage is considerably lower (23.8% of 10 respondents). It should however be borne in mind that this value does not refer to repeated injury.

Considering the injuries in the total sample, largest number of them accounted for contusions, followed by sprains and anterior knee pain. There was one fracture in the experimental and control group, three slip injuries, four lacerations, and one concussion. Contusions predominate in men, followed by sprains, lacerations (which are recorded only in the control group), anterior knee pain, and sprains. One fracture was recorded. In women, there was less of a variety of injuries than in men. In this subsample, the highest frequency was found for contusions, which are followed by strains. One anterior knee pain and one concussion were reported. According to body regions, the hip/gluteal region was the most commonly injured site in terms of minor injuries and it is mainly related to contusions. There is no difference between men and women, but lacerations occur only in men, mainly in the lower leg. Strains occur in both men and women, mainly on the back of the thigh. One fracture occurred on the hand, and in one case it was a rupture of the meniscus, which was subsequently diagnosed. Dislocations were observed in the shoulder and twice on fingers. The data on injuries through standard methodology that involves calculating the number of injuries per 1000 skiing days are significantly smaller than the data presented so far. We can say that the experimental program contributed to a reduction in the number of injuries that occur in ski training. The intervention was particularly effective in reducing the number of serious injuries, but the incidence of minor injuries was significantly lower in the control than in the experimental group. The effects, however, are relatively absent in terms of differential impacts by gender. We can thus say with some certainty that we missed the expected effect of the intervention among women participants of the program. Although the subjects of the experimental group had a significantly lower incidence of injury than subjects in the control group, the effect of reducing injuries could have been higher. At this point it is clear that it was an error in the initial identification of balance, where all respondents (men and women) were treated as one sample.

The study points to the importance of accurate, complete and high-quality training programs in recreational skiing. This is because a number of serious injuries could be prevented if the instructions are followed precisely by the ski instructor. Although research has not directly addressed the problem of protective gear while skiing, the results presented here indicate the quality of the ski equipment may contribute to reducing the number of falls. This primarily relates to the quality adjustment of ski bindings and matching them with physical strength and ski knowledge of each skier. This is extremely important information, especially when it is known that for such a procedure it is not necessary to allocate special material resources, nor this approach is time consuming because today almost all ski centers have a licensed ski service and can provide this service without any problems. For the foregoing reasons and based on extensive medical orthopedic practice, the authors propose the creation of educational materials which would include explanations of the etiology of the occurrence of some characteristic ski injuries. This material should be presented to recreational skiers and should thus warn them of the dangers that come due to non-compliance with these suggestions.

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RAVNOTEŽA KAO FAKTOR RIZIKA KOD OZLJEĐIVANJA U REKREATIVNOM SKIJANJU

S A Ž E T A K

Cilj ovog istraživanja bio je utvrditi efikasnost intervencije koja počiva na analizi statusa statičke i dinamičke ravnoteže kako bi se smanjila vjerojatnost ozljeđivanja u skijanju kod odraslih početnika. Pored toga analizirala se i incidencija ozljeđivanja tijekom početne obuke alpskog skijanja. Uzorak ispitanika predstavljali su rekreativni skijaši od 20 do 25 godina (287 ispitanika; 214 muškaraca i 73 žene). Eksperimentalnu skupinu (E) brojilo je ukupno 146 ispitanika, od čega 104 muškarca i 42 žene. Kontrolnu skupinu (C) činilo je 110 muškaraca i 31 žena, to jest ukupno 141 ispitanika. Neovisne varijable uključivale su podatke o osnovnim antropometrijskim mjerama, te parametre stanja ravnoteže koji se dobiju prilikom testiranja na Biodex Balance System-u. Ovisne varijable u istraživanju uključivale su incidenciju ozljeđivanja i to broj (frekvenciju) ozljeda, lokaciju ozljeda (regija tijela) i težinu ozljeda (lake, teške). Obje skupine provodile su 6-dnevni program obuke skijanja. Prije programa, u E skupini testirana je ravnoteža i identificirani su ispitanici s relativnom insuficijencijom ravnoteže. Ovi ispitanici polazili su poseban program obuke skijanja smanjenog opsega i intenziteta rada (20–30% manje u odnosu na ostale ispitanike). Prospektivno su prikupljani podaci o ozljeđivanja ispitanika. Za analizu razlika u incidenciji ozljeđivanja između skupina E i C koristio se $\chi 2$ test za neovisne uzorke. U E skupini 18,5%, a u C skupini 24,8% ispitanika pretrpjelo je laku ozljedu. U E skupini teška ozljeda zabilježena je kod 1,3%, a u K skupini kod 2,8% ispitanika ($p < 0.05$). Najveći broj ozljeda su kontuzije, potom slijede istegnuća i prednja koljenska bol. Zabilježena je po jedna fraktura u eksperimentalnoj i kontrolnoj skupini, ukupno tri iščašenje, četiri laceracije, te jedan potres mozga. Kukovi/glutealna regija najčešće su ozlijeđeni lokalitet kad se promatra lake ozljede Jedna fraktura dogodila se na šaci, a u jednom slučaju radilo se o rupturi. Iščašenja su zabilježena na ramenu i dvaput na prstima šale. Incidencija ozljeđivanja manja je od do sada izvještavnih (2 do 2,5 ozljeda na 1000 skijaških dana). Osnovni razlog za ovu razliku treba tražiti u faktoru treniranosti, pravilnoj kontroli opreme, ali i metodološkim prednostima studije. Podaci ukazuju da je eksperimentalni program značajno utjecao na smanjenje broja ozljeda koje nastaju u obuci skijanja. Provedena intervencija naročito je bila učinkovita u pogledu smanjenja broja teških ozljeda. Učinci su međutim relativno izostali u pogledu diferencijalnog utjecaja po spolu. Istraživanje ukazuje na važnost precizne, potpune i kvalitetne obuke rekreativnog skijanja.