

Body balance in people practicing snowboarding

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Purpose: While snowboarding, the human body is subjected to many forces and factors affecting balance. It is assumed that practising snowboarding may improve balance, but the evidence from the literature is scarce. Therefore, our study aimed to examine the effect of snowboard training on balance parameters in adults. *Methods:* The study included 34 subjects between 19 to 26 years old (21.4 ± 1.44) – students of the University School of Physical Education in Wrocław. They were divided into 2 equal groups. The first group, the practising group consisted of 17 snowboarders who participated in a 6-day snowboard training. The second group, the control group consisted of 17 individuals who had never practised snowboarding. For the conduct of the study, a FreeMED force plate was used. The following parameters were measured: the length of COP sways, the surface of the COP ellipse, and COP ellipse angle. Tests were performed with eyes closed and open. *Results:* Values of most of the parameters in the practising group decreased insignificantly after 6-day training. Values of parameters in the control group were in most cases insignificantly higher in comparison with the practising group. *Conclusions:* Our findings may suggest that snowboard training has no effect on balance. Further research on larger groups of participants is required. Research methodology should include electromyography, measurement of the moment of muscle force, and kinematic analysis for evaluation movement during real snowboard ride.

Key words: training, winter sports, balance, snowboarding

1. Introduction

Although snowboarding is a young sport discipline, many people practice it recreationally and professionally. While snowboarding, the human body is subjected to many forces and factors affecting balance. Hence, it is assumed that practising snowboarding may improve balance which translates into preventing injuries in this sport and reducing the risk of falls [4], [5], [7]. Only a few articles describing balance in snowboarders have been published. Vernillo et al. [19] claim that snowboarding is a test of physical fitness and technical skills. The more it has been known about physiological and biomechanical demands placed upon snowboarders, the more those skills can be effectively improved. Knowledge of external and muscular forces and energy exchange during practising snowboarding is important for the improvement of

performance and prevention of injuries. Mastering balance, while snowboarding, is a difficult task even on flat terrain. It is even more difficult while sliding on an unstable surface such as a slope on which snowboarders ride, so the snowboarder has to adopt a strictly determined position.

The body balance is defined as the ability to maintain a projection of the centre of mass (COM) within the base of support [23]. Some researchers suggest that the concept of balance is too narrow, so they have introduced a concept of „stability of balance system” [6], [7], [9]. It is additionally associated with the dynamic abilities and properties as well as characteristics of all systems involved in maintaining balance. The ability to maintain balance properly has a significant impact on the development of coordination motor skills [15], [23]. The ability to maintain balance is closely related to the proper functioning of the vestibular apparatus, vision, pro-

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prioceptive sensation and the central nervous system which is responsible for the processing of all stimuli [6], [8]. Balance can be defined statically as the ability to maintain balance with minimal movement and dynamically as the ability to perform the task while maintaining a stable position [17]. Bressel et al. [1] compared static and dynamic balance in gymnasts, footballers and basketball players and demonstrated that basketball players have worse static balance than gymnasts and worse dynamic balance than basketball players. Balance and stability are examined across various sport disciplines, also in swimmers [16]. Many researches evaluate changes in balance parameters in response to various disturbances such as closed eyes and unstable surface [13]. Balance disturbances such as pointing and moving an external point [12] or conscious body sways combined with biofeedback based on showing a movement of the centre of pressure (COP) to study subjects on a computer monitor [11].

Several authors report balance outcomes in snowboarders [10], [13], [14]. The same applies to other quantitative studies of snowboarders. Vernillo et al. [19] analysed available publications on anthropometric parameters (body weight and height), physiologic parameters (oxygen uptake) and biomechanical parameters (power and moment of force of muscles of lower extremities and the spine) in snowboarders [20], [21], [22]. The number of publications is limited. There are 4 publications on examination of height, force and measurement of height, strength and power of a vertical jump in snowboarders [3], [10], 1 publication describing the use of kinematic method [8] and 1 publication presenting an analysis of the activity of muscles of movement in snowboarders [2]. Taking benefits of improving balance such as fewer injuries and lower risk of falls into account, there is a great demand for studies on balance in people practising snowboarding. Therefore, the aim of our study was to examine the effect of 6-day snowboard training on balance parameters in adults.

2. Materials and methods

34 students of the University School of Physical Education in Wrocław participated in the study. Their mean age was 21.4 ± 1.44 years with a range from 19 to 26 years, the mean body height was 173.35 ± 7.81 cm, and the mean body mass was 66.5 ± 8.43 kg. Students were divided into 2 equal groups. The first group – the practising group – consisted of 17 snowboarders

(13 women and 4 men) who participated in a 6-day camp. The second group – the control group – consisted of 17 individuals (9 women and 8 men) who had never practised snowboarding. The camp in which study participants took part was organised in frames of the study course at the Department of Tourism and Recreation. The course included 48 teaching hours of active snowboarding according to a programme for the grade III of technical performance for Instructors and Trainers of Snowboarding. All participants trained for 8 hours with a break (4 hours in the morning and 4 hours in the afternoon) on a slope for 6 days. Balance was evaluated twice in the practising group, before and after the camp, whereas balance parameters in the control group were collected only once, after the snowboarding camp.

For the conduct of the study, a FreeMED force plate (Sensor Medica, Rome, Italy) was used. The sampling rate was 400 Hz. Freestep (v.1.0) software was used to compute and analyze COP data. A person stood for 30 seconds in a relaxed position and 30 seconds in a snowboarder position. Foot positions were marked on the platform so that they were always the same for all subjects. In the relaxed position, knee joints and hips of the person examined were straight. The feet were placed parallel to each other in the distance of 40 cm between their outside edges. The upper extremities were hanging loosely along the torso. In the snowboarder position, knee joints, ankle joints, and hips were flexed to about 30–40 degrees. The feet were positioned shoulder width apart or slightly wider, the angle between long axes of the feet was 30 degrees, and the distance between heel bones was 50 cm. The upper extremities were held in abduction by 20 degrees. The hand was straight. Participants of both groups were instructed to look straight ahead.

The first test was conducted with eyes open and the second with eyes closed. The following parameters were measured: L [mm] – the length of sways designated by COP; S [mm²] – the surface of the ellipse designated by the path of COP, N [deg] – ellipse angle designated by a direction of body movement while maintaining balance in which the most sways were made. The angle of the COP ellipse was defined between the main axis of the ellipse and the vertical line (axis). The same reference axis was used for both “relaxed” and “snowboarder” positions. The COP ellipse area was expressed in mm² and evaluated a dispersion of the COP oscillations of 95% of the sampled positions. Better balance was considered when the values of L and S were lower, and the value of N approached 90 deg.

Statistical analysis was conducted using Statistica software v. 10.0 (StatSoft, Tulsa, OK, USA). Summary values were given as a mean \pm standard deviation of the mean. The Shapiro–Wilk test was used to analyse the distribution of evaluated parameters. For comparison of two groups of variables with a non-normal distribution, the Mann–Whitney *U*-test was used. For comparisons between groups of variables with a normal distribution, Student’s *t*-test for dependent variables was used for the comparison between pre- and post-test variables of the snowboarder group. The Wilcoxon signed-rank test was used in cases when at least one variable had a non-normal distribution. The criteria for statistical significance were set at $p < 0.05$.

3. Results

Values of most of the parameters (10 out of 12 parameters) in the practising group decreased after 6-day training (Table 1, Fig. 1). Statistical comparison of the parameters showed that the differences were not statistically significant ($p < 0.05$).

The parameters in the control group (Table 1) were in most cases higher in comparison with the practising group. The comparison of groups with the Mann–Whitney *U*-test showed that the differences were insignificant ($p < 0.05$).

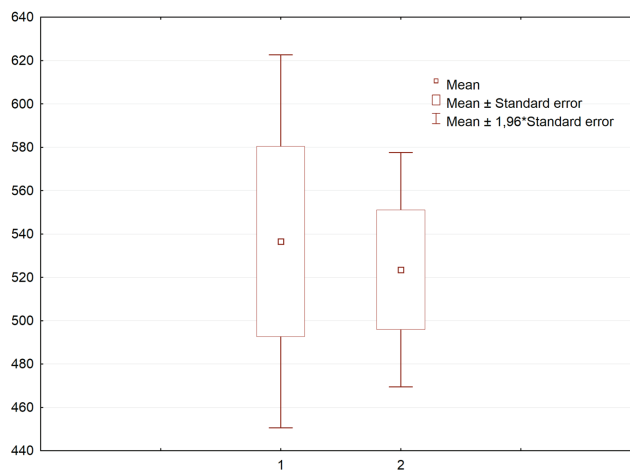


Fig. 1. Length of sways (L [mm]) in the training group before (1) and after the training (2) with eyes closed in a relaxed position

Table 1. Descriptive statistics

		Group B before training (n = 17)				Group B after training (n = 17)			
		Eyes open		Eyes closed		Eyes open		Eyes closed	
		mean \pm SD	M	mean \pm SD	M	mean \pm SD	M	mean \pm SD	M
Relaxed position	L	495 \pm 176 ^N	473	537 \pm 180 ^N	489	↓476 \pm 125 ^N	453	↓524 \pm 114 ^N	518
	S	159 \pm 156	86	141 \pm 148	62	↓125 \pm 231	48	↓111 \pm 117	72
	N	83.8 \pm 43.5 ^N	67	88.8 \pm 46 ^N	70	↓84.1 \pm 43.6	70	↑101 \pm 52.6	129
Snow-boarder position	L	798 \pm 246	792	822 \pm 171 ^N	791	↓765 \pm 192	753	↓788 \pm 211 ^N	810
	S	397 \pm 258 ^N	385	488 \pm 576	329	↑410 \pm 330	338	↓366 \pm 191 ^N	293
	N	109 \pm 54.5	135	93 \pm 56.3	128	↓90.8 \pm 52.2	126	↓87.9 \pm 49.6	62
		Control group (n = 17)							
		Eyes open		Eyes closed					
		mean \pm SD	M	mean \pm SD	M				
Relaxed position	L	↑582 \pm 160 ^N	548	↑658 \pm 247	547				
	S	↑215 \pm 318	74	↑172 \pm 155	128				
	N	↓86.1 \pm 58	56	↑99.8 \pm 51.8	124				
Snow-boarder position	L	↑867 \pm 270 ^N	884	↑823 \pm 256	781				
	S	↑471 \pm 405	272	↓469 \pm 448	327				
	N	↓94.1 \pm 55.2	71	↑74 \pm 52.4 ^N	53				

L [mm] – length of sways, S [mm²] – ellipse surface, N [deg] – ellipse angle, SD – standard deviation, M – median;
^N parameters with a normal distribution;
 ↓ parameters that improved after the training or are better than in the control group;
 ↑ parameters that worsened after the training or are worse than in the control group.

4. Discussion

In the present analysis, practising snowboarding did not change balance. In the practising group, 10 out of 12 parameters analysed improved after the training. However, the differences were not statistically significant. The results achieved by the control group were in most cases higher in comparison with the practising group but again the differences between groups were insignificant.

Similar studies were conducted by Staniszewski et al. [13]. They evaluated balance of beginner and advanced snowboarders before and after 9-day intensive training. It is noteworthy that they used the same FreeMed platform as the one used in our study. The measurements on an unstable surface were significantly worse in the lateral snowboarder position ($p < 0.01$) in comparison with values of balance parameters achieved in forward stance and demonstrated significant improvement after the training in both groups ($p < 0.05$). The measurement on an unstable surface revealed significantly worse values of parameters obtained in lateral snowboarder position than in a forward stance ($p < 0.01$) and significant improvement in parameters ($p < 0.05$) measured in both groups after the training. On a stable surface, the improvement in balance parameters ($p < 0.05$) was observed only in beginners in snowboarder position. The results reported by Staniszewski et al. are in line with our findings, because we did not obtain statistically significant changes in parameters of balance on a stable surface in subjects riding on a snowboard after the 6-day training. This observation indicates the necessity of continuing the research with a more differentiated level of skills and the surface on which the studies are conducted.

Wojtyczek et al. [18] reported similar findings, but in skiers and on a greater number of subjects. They conducted balance measurements before and after 7-day training on a group of 78 students out of which 43 were beginners. Exercising participants achieved considerably better sensory indicators and stability after 7-day skiing training in comparison to baseline values. Greater changes were observed in the group of beginners.

Unfortunately, there are only a few scientific studies on biomechanics and snowboard physiology. Platzer et al. [10] conducted tests for aerobic capacity, balance, and jumping as well as isokinetic and isometric muscle tests in lower extremities and the spine in 37 snowboarders (21 men and 16 women). Women achieved better results than men. The results indicated that the starting speed and the moment of force of lower extremities and the spine are the most important parameters in subjects practising snowboarding. In

advanced snowboarders, countermovement jump (CMJ) ranged from 23.0 to 37.3 cm in women and from 32.5 to 48.9 cm in men [10], jumping power in professional snowboarders during CMJ was 71.6 ± 3.1 W/kg and during squat jump was 68.5 ± 7.4 W/kg [21], jumping force of CMJ was 26.8 ± 2.8 N/kg [22]. The isometric force of quadriceps femoris in professional snowboarders was described by Vernillo et al. [21] and amounted 680.1 ± 76.8 N [21].

Staniszewski et al. [21] determined the relationship between preferences regarding the choice of the front leg while riding the snowboard and lateralisation during the performance of other activities. They also evaluated dynamic stability in the neutral stance and lateral (left and right) positions. A group of 100 active snowboarders was divided into 2 groups according to declared lateralisation. The moment of force of muscles of lower extremities and body balance was measured. Over 90% of participants declared right side as dominant, but in relation to snowboarding on 66% of them reported the right leg to be dominant. No statistically significant relationship was found between posture on the snowboard and declared dominant side. Significant differences in balance parameters were found between neutral and lateral snowboarder posture [14]. In the present study, only one snowboarder position was examined – neutral, so the lateral snowboarder posture could not be compared.

5. Conclusions

In the present study snowboard training did not change balance. In the practising group, 10 out of 12 parameters improved after training but the differences were not significant. The control group that had never been training snowboarding achieved worse parameters than the practising group, but without significant differences between groups. The topic requires further research on larger groups of participants considering dividing them according to skills into beginner and advanced snowboarders. Research methodology may consider electromyography, the moment of muscle force, a larger number of tests on the stabilographic platform including unstable surface as well as kinematic analysis for evaluation movement during real snowboard ride.

Ethical declaration

The study was approved by the Senate Committee on Research Ethics at University School of Physical Education in Wrocław. All

participants gave their written informed consent for participation in the study.

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