

The effects of 8 week balance training on the kayaking performance of the beginners

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Abstract

Purpose: To analyze the effects of a special 8-week balance-training program on the static and dynamic balance values and on kayak specific balance values of female candidate athletes who are new to kayaking.

Material: The study included 25 volunteer healthy young women (mean age: 14.92 ±0.39 years, mean weight: 58.47 ±11.28 kg, mean height: 165.68 ±3.84 cm, mean body fat: 27 ± 7.61%); they were randomly divided into two groups as intervention (n=15) and control (n=10). The intervention group had a special 40-minute balance training (10-min warm-up and 30-min proprioceptive exercises) 3 days a week. The control group had their traditional training scheme only (initial 10-min run for warm-up, 40-min ergometer exercise and strength training, 10-min stretching; after 1 month, 10-min warm-up, 4x10-min technical training in water with 5-min rest between sets, technical training in water for 3 km, 20-min stretching). Along with these, both groups had "technical kayak training" 2 days a week. Static and dynamic balance measurements were done with Prokin Tecnobody Isokinetic balance measurement device; kayak-specific balance measurements were done on specially designed kayak prototype and on standard race kayak (K1).

Results: An improvement was found in the static and dynamic balance values of both groups as well as their kayak-specific balance values. It was found that the improvements in static and dynamic balance and especially in kayak-specific balance measured on the prototype kayak (\bar{x} =17.8 -82.4%) and standard race kayak (\bar{x} =36.2) were significantly higher in the intervention group ($p < 0.05$).

Conclusions: It was found that the 8-week-long special balance training had positive effects on kayaking balance performance of the beginners.

Keywords: sprint kayak, balance, balance training, beginners, training aid.

Introduction

Balance is the ability to protect a given posture with minimal movement during fluctuations that are caused by static or dynamic conditions [1]. Good postural stability is important not only for balance, but also for the use of extremities during daily functional activities [2]. Balance has been found to be a risk factor for injuries especially among female athletes [3]. Each sport requires sensorimotor processes at some levels in order to realize the athlete's capabilities to the fullest extent and to protect the neuromuscular system from injury [4]. As described by Zemkova (2014), static balance is important in sports such as shooting and archery whereas dynamic balance performance plays an important role in free style sports such as snowboarding and windsurfing. Likewise, balance in the sitting position is important in canoeing, rowing, and equestrianism [5]. Loss of balance may occur in almost every movement of canoeing or kayaking, which are performed on an unstable surface. The height of the balance level in a sport activity depends on the area of the support base, the position of the center of gravity, and the mass of the individual (body weight) [6].

Various forms of balance exercise emerge as a part of sports education or rehabilitation. However, the improvement achieved after such trainings is only specific for the task at hand [1]. Incorporating balance exercises

into the training programs for athletes from different sports has become a routine practice. The most effective type of balance training and its frequency, intensity, and duration are yet to be determined. It is difficult to create a training model that would be appropriate for every sport discipline, including its characteristics and demands [7]. On the other hand, there is an ongoing debate in the literature about the effect of balance training on the performance, balance improvement, and prevention of injuries of the athletes [8].

Kayaking is a paddle sport that requires a good sitting balance and involves high metabolic demands and challenges related to the balance control system [2, 9]. Paddle sports have two sub-disciplines: canoeing (C) and kayaking (K). Kayaking requires a comprehensive balance and stability training since maintaining a seated position requires a continuous balancing of the irregular sways in the upper part of the body [9] and due to the narrow designs of the flat-water kayaks [10]. In conventional canoeing/kayaking training, 'winter training session' lasts from October to March and consists of three parts, each covering a period of two months. In the first part, aerobic capacity should be increased; the second part should include balance-oriented exercises; and the third part involves the preparations for outdoor training [11].

It may be convenient to board the canoe/kayak on land; boarding in water requires good balance skills at the beginning. A wrong move or loss of balance can lead to

going overboard or hitting the ground. The same is also possible while getting off a canoe/kayak. Having good balance skills is a significant advantage in such situations. It is particularly more difficult for two people to carry out a task synchronously in a two-person canoe/kayak (K2-C2). And so, the role of balance training, the difficulties that may be faced, and possible solutions have been studied through interviews with canoers/kayakers and their coaches to conclude that balance skills are of great importance in canoeing/kayaking. It has been observed that due to the balance problems they have experienced, many of the candidate athletes who started training for this sport and put a great deal of effort during winter technical training off the water were unable to overcome their fear of falling once they boarded the kayak on water. Thus, all of the efforts put in during the season end in vain, resulting in the demise of athletes. Therefore, the aim of this study was to determine the effects of kayak-specific balance training exercises added to beginner athletes' usual winter training program on their general and kayak-specific balance performances in order to prevent the waste of their time, effort, and resources.

Key Points

- Regular participation in balance training practices can improve balance control more efficiently in young female (untrained) candidate athletes who are new to kayaking.
- Special balance training practices significantly improve the kayak-specific balance for beginners and facilitate learning the sport.
- Combining special balance training with the traditional kayak training method increases the overall effect of the training due to the interaction between the two.

Materials and methods

Subjects

The study included 25 healthy female subjects who were between the ages of 14 and 16, had no health problems, had no vestibular disorders such as neurological diseases, dizziness, or loss of balance within the last one year, had no serious complaint with extremities within the last six months, and were not involved in any sports activity. The group was randomly divided into two groups: intervention and control, which were comparable in terms of their physical characteristics ($p > 0.05$) (Table 1).

The approval for the study was obtained from the local ethics committee at Sakarya University (approval #: E.4612-61923333/044). The subjects and their parents/legal guardians were informed about the procedures and

the extent of the study and asked to sign a "Voluntary Participation Form".

Experimental Design

Since bad weather conditions increase the risk of kayak capsize, the study plan was prepared so as to start training in May when the weather and water temperatures begin to improve. In the context of study, pre/post-intervention body composition, and static-dynamic balance measurements were done in the laboratory. While the measurements on the kayak prototype were performed as both before and after the intervention, the kayak-specific dynamic balance measurements on standard racing kayak (K1) were performed after the intervention only since the subjects were new to kayaking. The intervention and control groups began their training program one week after the pre-intervention measurements. The post-intervention measurements were done one week after the end of the training program.

Training Program for Control Group: The control group worked with the training program known as "Traditional Training System": 3-day general endurance and strength training and 2-day technical kayak training per week for 8 weeks and kayak training on water at the end of one month.

Training Program for Intervention Group: Balance training were given as 40-min-long exercise programs 3 days a week for 8 weeks on uneven surfaces, with special balance tools, and with specially designed kayak prototype (Table 2). A "Balance Training Exercise Plan" was prepared for each week; each session included 10-min warm-up and six special balance exercises containing proprioceptive exercises (5 min each) performed in static and dynamic positions for a total of 30 minutes. The training exercises were designed as initial phase (first two weeks), middle phase (third and fourth week), and advanced phase (last four weeks). The intervention group also joined the control group for kayak technical training two days a week.

The kayak-specific dynamic balance training was performed on a wooden kayak prototype that was judged by coaches to adequately mimic the kayak sway and where fall and balance loss can be observed.

In the Balance Training Exercise Plan, special attention was paid to arranging the activities from simple to complex where static exercises were followed by the dynamic exercises, increasing the tempo to the appropriate speed gradually, performing the initial training on a stable surface (flat ground) followed by training under different conditions (on moving, soft, and slippery ground) and

Table 1. Physical characteristics of the intervention and control groups.

	Intervention (n=15)	Control (n=10)	<i>p</i>
Age (year)	15 ±0.3	14.8 ±0.4	0.242
Height (cm)	165.13 ±4.34	166.5 ±2.72	0.364
Weight (kg)	58.04 ±11.3	59.12 ±11.23	0.826
Body Fat %	27.3 ±7.43	26.57 ±7.85	0.819

Table 2. The training program for the intervention group.

Exercise Plan	Content	Equipment
Initial Phase (week 1-2)	Warm-up, static balance exercises with eyes open/shut, glider and flamingo postures, stretching exercises	None
Middle Phase (week 3-4)	Warm-up, static-dynamic balance exercises with eyes open/shut, Y balance exercise, posture exercises on balance pads, stretching exercises	Signs Balance pad Balance board Bosu ball
Advanced Phase (week 5-8)	Warm-up, dynamic balance exercises on fixed and moving surfaces, dynamic balance exercises with balance equipment, special balance exercises on kayak prototype, stretching exercises	Balance board Wobble board Pilates ball Balance pads Wooden kayak prototype

with external stimuli and balance training equipment (bouncing ball, balance ball, kayak prototype, etc.). A 30-second rest period was given after each exercise.

Tests and protocols

Body composition: Body composition of the subjects was evaluated with InBody 270 body composition analyzer (InBody Co. Ltd, Korea).

Balance Tests: Static and dynamic balance measurements were performed with Pro-Kin 252N isokinetic balance measurement device (TecnoBody Srl, Italy). The subjects were tested in their sports outfit after a 50-min warm-up and stretching. Tests started with body sensor attached to chest after the subjects tried the balance platform for about 2-3 minutes; the subjects were given 1-min rest between the test series. The subjects were asked not to use arms for support during the static tests. This position meant to reduce the effect of arms on balance and to prevent distorting the test results by touching the support rail. The subjects were told to limit upper body movements and use only legs throughout the test. The test was cancelled and repeated if a subject could not keep balance throughout the test and was found to touch the instrument or other things with hands or feet.

Static Balance Measurements: The static test was performed on the fixed platform in bipedal stance with eyes open. The subject was asked to look at a fixed spot in front; after reaching balance, the test was initiated by pressing the start button on the computer keyboard and terminated by the computer at the end of the test automatically. In the bipedal stance, the feet were open at shoulder width and equidistant from the origin point, with reference to the lines on the x and y-axis. The subject was asked to keep position during the tests, which lasted for 30 seconds, and allowed to observe their position on a screen. From among the data obtained as a result of the measurements, the ellipse area (EA) and perimeter were evaluated; higher values indicated poor balance, lower values indicated good balance.

Dynamic Balance Measurements: The dynamic test was carried out in bipedal stance. The optimal position was same as in the static balance measurement. The pressure level of the stabilometer for this test was set to difficulty level 5 (out of 50). The test was completed by rotating the platform clockwise 5 times in 60 seconds

to track the circular trajectory on the screen. Shown below the circular trajectory, the track errors (TE) chart displays the distribution of the errors during tracking the trajectory by platform sectors, and the average force variance (AFV) chart displays the distribution of center of gravity by platform sectors. Other parameters obtained as a result of the measurement were the trunk backward-forward standard deviation (TB-FSD), trunk medial-lateral standard deviation (TM-LSD), and trunk total standard deviation (TTSD), the stability index (SI), and the average track error (ATE), which are the data obtained from dynamic balance measurement. The resulting value represents the deviation from the trajectory that the subject was supposed to track. The subject's dynamic balance is good if the average track error is low, and it is poor if the error is high.

Balance Test with Kayak Prototype: The choice of the balance method and measure used in a particular exercise depends on a number of factors. Balance tests with dynamic components may be more sports-specific than static balance tests [12]. In this line, the dynamic balance measurements specific to kayaking were performed on the specially prepared kayak prototype as well as the standard kayak (K1).

The kayak prototype balance test was performed on a wooden kayak prototype that was judged by coaches to adequately mimic the kayak sway and where fall and balance loss can be observed. The subjects were tested in their sports outfits after a 5-min warm-up and stretching. They were asked to take a position on the prototype as they would sit in a kayak, and the test was initiated after trying the prototype a few times. Starting with sitting on the prototype, they were asked to stay in balance without falling while making the movements with the standard paddle for one minute. Touching the ground with any of the hands, feet, or paddle was considered an "error" and the time was stopped. Then the test resumed with the same rules. At the end of one-minute period, the number of falls due to the loss of balance was determined and recorded.

Balance Test with Standard Race Kayak (K1): The test was performed in a standard-size-and-weight race kayak in a way fall and balance loss can be observed. The subjects were tested following a few trials after a 5-min warm-up and stretching in their sports outfits. The

subjects were asked to board the kayak by holding on to the cockpit and take the sitting position. Starting with taking the sitting position in the kayak, they were asked to stay in balance without falling for one minute. Timing started when they took their hands off of the scaffold; each fall was considered an “error”, and the time was stopped. Since getting into kayak requires effort, each subject was given 30-sec rest period three times so as not to influence the results. Then the test resumed with the same rules. At the end of one-minute period, the number of falls due to the loss of balance was determined and recorded. All tests were administered by the same researcher.

Statistical analyses

Statistical procedures were carried out with SPSS 22 (SPSS Inc, USA). The *t* test was used in order to determine the differences between groups, and paired samples *t* test was used in order to determine differences between pre- and post-intervention tests. The significance threshold was set at 0.05.

Results

A significant decrease was found in post-intervention

bipedal-stance static balance scores EA and perimeter for the subjects in the intervention group ($p<0.05$). No significant differences were found in these variables in the control group (Table 3).

A significant decrease was found in post-intervention dynamic balance scores ATE, AFV, and SI for the subjects in the intervention group ($p<0.05$) (Table 4). Except for the negative change in the TB-FSD (-9.8%), all parameters were improved albeit not significantly. In the control group, however, no significant changes were found in these variables. Similarly, a negative change was found in the TB-FSD (-31.2%) albeit not significant.

A significant decrease was found in both groups' post-training scores on balance test with the kayak prototype ($p<0.05$). Looking at the rate of improvement, it was found that the improvement in the intervention group (82.4%) was almost twice that of the control group (45.5%) (Table 5).

The post-training scores on balance test with the standard race kayak (K1) for the intervention group was found significantly lower than those of the control group ($p<0.05$) (Table 6).

Table 3. Bipedal-stance static balance scores for the two groups before (test) and after (retest) the training program.

Parameters	Groups	Intervention			Control		
		\bar{x}	%	<i>p</i>	\bar{x}	%	<i>p</i>
Ellipse area (mm ²)	Test	419.9±250.49	49	0.012*	536.4±646.64	26.7	0.586
	Retest	214.1±119.73			393.3±419.67		
Perimeter (mm)	Test	520.8±135.01	18.7	0.041*	533.5±293.35	3	0.904
	Retest	423.4±103.29			517.7±253.30		

* $p<0.05$

Table 4. Bipedal-stance dynamic balance scores for the two groups before (test) and after (retest) the training program.

Parameters	Groups	Intervention			Control		
		\bar{x}	%	<i>P</i>	\bar{x}	%	<i>P</i>
ATE	Test	22.3±7.95	34.1	0.013*	26.7±10.36	19.5	0.238
	Retest	14.7±7.24			21.5±7.38		
TB-FSD	Test	2.0±1.06	-9.8	0.658	1.9±1.24	-31.2	0.311
	Retest	2.2±1.27			2.4±1.10		
AFV	Test	3.1±4.38	83.6	0.042*	3.4±8.42	35.4	0.701
	Retest	0.5±0.33			2.2±3.93		
TM-LSD	Test	5.9±3.39	14.6	0.463	3.7±2.47	3.1	0.908
	Retest	5.1±2.73			3.8±1.61		
SI	Test	0.9±0.36	28	0.037*	1.0±0.31	9.1	0.652
	Retest	0.7±0.26			1.1±0.49		
TTSD	Test	6.4±3.30	8.9	0.618	4.3±2.57	3.4	0.894
	Retest	5.8±2.67			4.4±1.91		

* $p<0.05$

Table 5. Kayak prototype balance test scores for the two groups before (test) and after (retest) the training program.

Groups		\bar{x}	p	Change (%)
Intervention Group	Test	17.8±1.47	0.000*	82.4
	Retest	3.9±0.96		
Control Group	Test	18.1±2.18	0.000*	45.5
	Retest	9±2.18		

*($p < 0.05$)

Table 6. Difference between the standard kayak balance test scores of the two groups after the training program.

	N	\bar{x}	P
Intervention Group	15	36.2±4.55	0.049*
Control Group	10	41.1±5.84	

*($p < 0.05$)

Discussion

A previous study of special balance training for the beginners of kayaking was not found in the accessible literature. Existing studies have generally focused on preventing sports injuries [8,13], rehabilitation [2,9], improving the performance of elite athletes (14–16), and the biomechanical analysis of the sports of canoeing/kayaking in order to improve performance [17,18].

This study aimed to analyze the effects of a special 8-week balance-training program on the static, dynamic, and kayak-specific balance values of female candidate athletes who are new to kayaking. The results supported the original hypothesis that regular participation in balance training exercises improves the balance control in young woman who are new to kayaking and facilitates learning the sport and that combining special balance training with the traditional kayak training increases the overall effect of the training.

In the beginning, there was no difference between the average static and dynamic balance scores of the intervention and control groups. The control group was engaged in the traditional training program for 8 weeks while the intervention group implemented a mixed training method in the same period. At the end of the 8-week period, there was a significant improvement in the ellipse area (49%) and perimeter (18.7%) parameters in bipedal-stance static balance tests for the intervention group (Table 3), suggesting that the balance training program benefited the subjects. Regular exercise is known to improve static and dynamic balance. In a study of the effects of dynamic and static balance exercises on lower extremities, Suveren et al. (2017) implemented these two exercise programs to two groups 3 days a week for 8 weeks. They found significant improvements in the dynamic and static balance parameters of both groups after the exercises. Together, this study and our study suggest that balance exercises increase muscle stabilization in the lower extremities and improve posture control [19]. Similarly, Kahle and Gribble (2009) found a significant difference between the control group and

the intervention group after implementing 6 weeks of core stability balance exercises with healthy individuals [20]. These results were also consistent with the results of Hrysomallis' (2011) study, which showed that balance training was effective in improving sports performance and motor skills [21].

In the dynamic balance measurements, the ATE, an indicator of dynamic balance, AFV, and SI decreased significantly after the training programs in the intervention group but not in the control group, which suggested a positive effect. This means that the special balance training improved the dynamic balance of the subjects but the traditional training program did not. Similarly, comparison of pre-test post-test scores of the intervention group revealed a 34% improvement in the ATE, while the improvement in the control group was 19.5% (Table 4). Zech et al. (2010) reported that functional balance training was effective in improving static postural sway and dynamic balance [22]. Jamshidi et al. (2017) reported that a 6-week (3 days a week) training program involving backward walking improved the dynamic balance performance in healthy female athletes in high school and suggested that it could be used as a complementary training [23]. Sekendiz et al. implemented endurance, flexibility, and dynamic balance exercises to 21 sedentary women and found significant improvements in the post-test values [24]. Studies have shown that balance exercises are effective in improving the stability, proprioceptive values, and balance parameters [14, 25–27].

Similar to our study, Toube et al. (2007) reported in a study involving both children and adults that the balance training alone could improve performance without the resistance training. These results emphasize that the balance training improves the athletic performance as well as preventing injuries and providing rehabilitation [28].

In most of the sporting activities, the successful execution depends on having the proper posture and the ability to keep balance in this position [19]. In this line, our 8-week balance-training program was found

to significantly improve the static and dynamic balance of subjects in accordance with the literature. Lee et al. (2016) reported that dynamic balance of subacute stroke patients was improved after training for 6 weeks with a virtual reality game based on canoeing [2]. This study shows that improving the static and dynamic balance capabilities may depend on the balance training method used. A few studies about the balance in canoeing/kayaking exist in the literature. In a study comparing the postural stability of 23 young male canoeing and kayaking athletes (10 canoe and 13 kayak athletes) who trained in water for two hours 3 days a week to that of 15 healthy untrained controls, Stambolieva et al. (2012) found that body sways in both groups were significantly less than that of the controls, suggesting that the balance performances specific to canoeing/kayaking naturally improved through training in water [29]. In this context, balance training given to beginners beforehand may improve their canoeing/kayaking performance. In order to observe such effects, we implemented a balance test with a kayak prototype. After the training programs, significant improvements were observed in the dynamic balance values of the intervention group and the control group compared to their baseline values. Remarkably, the rate of improvement in the intervention group (82.4%) was almost twice that of the control (45.5%) (Table 5). This showed that the functional materials used in training programs and developing static and dynamic balance performances had an effect on the balancing skills on the kayak prototype. Similarly, the results of the balance test with the standard racing kayak (K1) revealed significantly

lower average errors in the intervention group after the balance training (Table 6). This suggested that both traditional and mixed training methods were effective in improving balance and that a training method integrating balance exercises to traditional exercises might be more effective in improving the balance skills specific to kayaking.

The nature and environment of movements observed in various sporting activities are known to influence postural adaptation [30]. According to Paillard (2014), each type of training results in different type of specific postural control. Therefore, this study, which integrated kayak-specific balance-training exercises with the traditional training program for the beginner athletes to investigate their effect on general and kayak-specific balance performances, has demonstrated that the sport-specific balance training produces the desired effect. The results suggest a significant improvement due to the balance-training program used in this study.

Conclusions

Balance-training program might be used for athletes intending to start kayaking to improve their balance performances and to help prevent the waste of their time, effort, and resources. Such a program might be recommended for long-term improvement of athletes' performance in all stages of their career as well as in the early stages.

Conflict of interest.

The authors state that there is no conflict of interest.

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