The Effects of Intensive Ski Training on Postural Balance of Athletes

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Abstract

The objective of this study is to observe the effects of intensive ski training as a new set of skills on dynamic and static balance of male and female athletes who receive regular and formal sports education. Athletes who have never skied before but received education at similar sports activities volunteered (Ski training group;12 males, aged: 23,75±2,13 years; 8 females, aged: 22,37±0,91 years, Control group; 11 males, aged : 23,75±2,13 years and 9 females, aged :22,37±0,91 years) to take part in the training program that lasted for 6 consecutive days, 4 hours training and 2 hours free activities a day, totaling to 28 hours. Prior to and after ski training, Techno-body PROKIN 4 (Italy) was applied in order to measure static equilibrium (as eyes opened and closed – 30-second EO, 30-second EC) and dynamic equilibrium (60-second disequilibrium and slalom tests). Static and dynamic balance tests for upright posture were conducted as well as at positions where knees flexion was 135-150 degree. The leg power of participants was measured with a dynamometer. A questionnaire were arranged in order to obtain personal info. The pre- and post-data were compared according to gender and group variables (ski training and control group) using Wilcoxon test. The results obtained through our study indicated that the static and dynamic balance of leg power of male athletes increased dearly when compared with that of female athletes.

Key Words: Postural balance, Ski training, Equilibrium, Athletes

1. Introduction

Postural balance consists of the unification of visual, kinesthetic and vestibular information. In order for balance to be obtained, the visual, vestibular and proprioceptive systems must form an afferent data integration (Vuillerme and Nougier, 2004; Paillard, et al., 2002). The postural control system provides two main functions, the first of which is the voluntary stabilization of walking, sitting and standing and the second of which functions to form the balance automatically by keeping the center of gravity within the field of support in order to prevent the person in question from falling (Shaperd, 2000). During the formation of motor skills, what matters most is the proper balance control being dependant on muscular synergies which minimize the displacement of the center of gravity.

According to the studies conducted in order to evaluate the sportive postural balance, training contributes significantly to the betterment of somato-sensorial motor and sensorial competence which increases postural skills and helps athletes to acquire novel balance skills.

Diverse training programs provide improvements at body compositions as well as betterment at balance skills. Athletes demonstrate a higher level of static and dynamic balance than those who do not do any sports activities. Training sessions involving proprioceptive features enhance both performance and balance control (Perrin et al., 2002). Thus, in relation to this aspect, balance skills acquired through a variety of sports disciplines are different (Davlin, 2004; Perrin et al., 2002). Each sports activity develops postural adaptations peculiar to its own (Sirmen et al., 2008; Erkmen et al., 2007; Bergmann et al., 2002). Balance skills increase as the number of years with sports activities increase (Paillard et al., 2006). The speed and level of learning technical skills goes hand-in-hand with balance skills. Keeping and maintaining the body at balance is of crucial importance in order to learn the movement. It is a must for athletes to keep the body at balance when they instantly change their positions (Altay, 2000). The sport of skiing requires technical skills as well as keeping the body at balance. The objective of this study is to observe the effects of intensive ski training as a new set of skills on dynamic and static balance of male and female athletes who receive regular and formal sports education.

2. Material and Methods

2.1. Participants

Volunteered athletes (Ski training group;12 males; 8 females, Control group; 11 males and 9 females) who received similar training but no ski training before at Physical Education and Sports Department were preferred and took part in this study. They gave their informed consent to the experimental procedure as required by the Helsinki declaration (1964).

2.2. Material

Before the training, the body composition of the athletes (BMI, the percentage of fat, muscle mass) was detected via an X-SCAN equipment. Prior to and after ski training, Techno-body PROKIN 4 (Italy) was applied in order to measure static and dynamic equilibrium. The leg power of participants was measured with a dynamometer. A questionnaire were arranged in order to obtain personal info.

2.3. Procedures

At M.U. Physical Education and Sports Department, athletes who have not received any ski training in their lives participated an intensive training program of Basic Ski Training (of 4 hours training and 2 hours free activities) for 6 days, totaling to 28 hours.

In the ski education module, trainings;
1.st day: Introduction and using the skiing equipment, walking, stepping and slipping forward
2.nd day: Skiing and turning by snowplow technique.
3.rd day: Kick turn and traversing.
4.th day: side slipping and kick turn
5.th day: Skiing bumps and ditches
6.th day: skating, turning to the hill side, stem turns.

2.4. Methods

Using a Techno-body PROKIN 4 (Italy) device, a number of tests were conducted to the ski training group and the control group. Static and dynamic balance tests for upright posture were conducted as well as at positions where knees flexion was 135-150 degree. In order to measure static equilibrium as eyes opened and closed (30-second EO, 30-second EC) and to measure dynamic equilibrium, 60-second disequilibrium and slalom tests were conducted. Dynamic balance tests were conducted at level 5 on a scale from 1 to 10, holding side handles as well as in hands-free position.

Figure 1: Slalom test. During this test, the athletes see some objects that they come against. Their purpose is to hit the objects in question and follow the blue ideal line thoroughly.

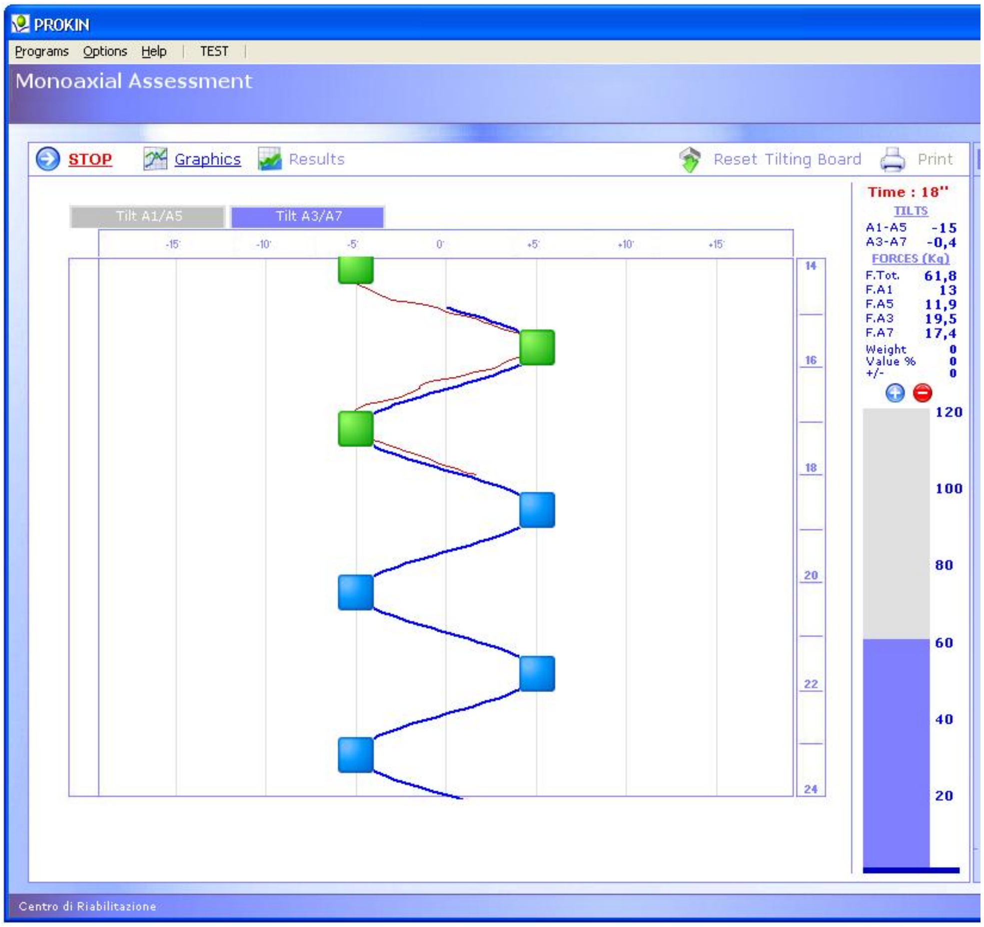


Figure 2: Disequilibrium test. During this test, the athletes see some galleries that they come against. Their purpose is to enter into those galleries and to maintain the tilting board as firm as possible. In this test it's important only to maintain one axis, so you have to harden the force absorbers of the other axis.

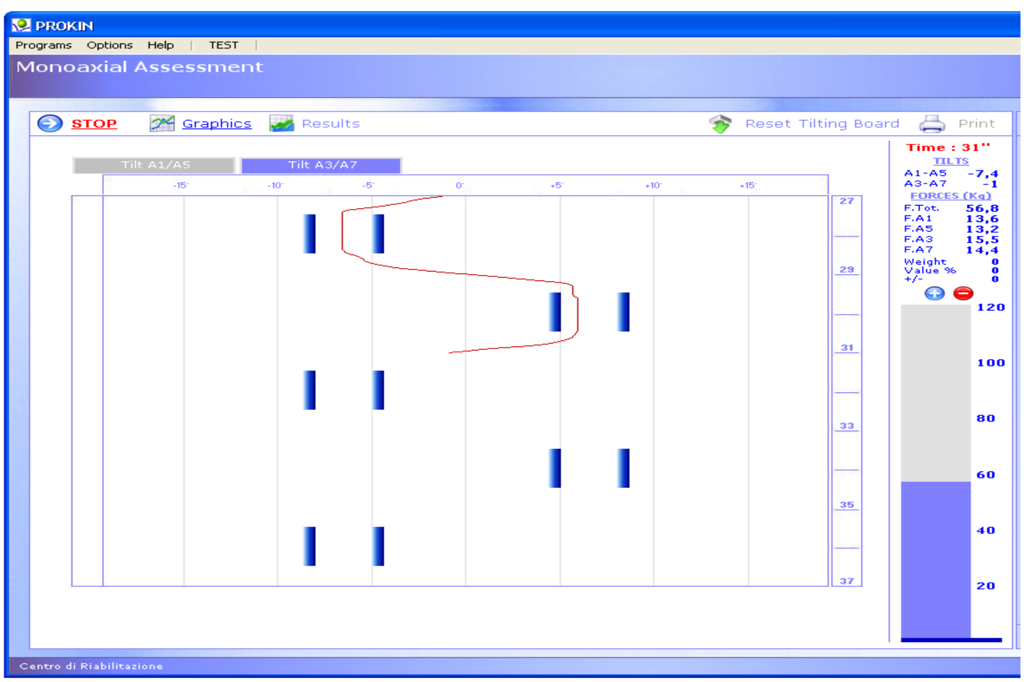
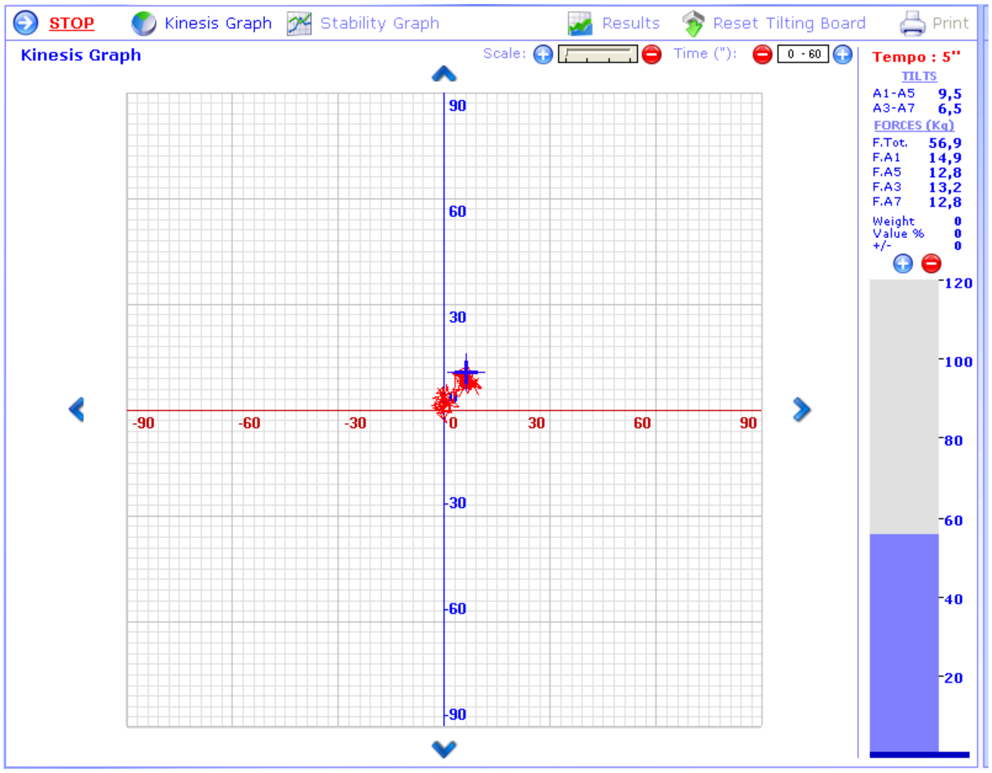


Figure 3: Static balance test. By selecting sequence, the software will calculate the Romberg Test that will be executed between the opened eyes and closed eyes tests.



2.5. Statistical analysis

The mean and standard deviation of test results were calculated pre- and post-training sessions. The pre- and post-training data were compared according to the Wilcoxon test in line with gender and group (ski training group and control group) variables.

3. Results

The data obtained through our study are presented below.

Table 1. The demographic features of the athletes.

	Gender	Age (year)	Sports age (year)	Height (cm)	Wight (kg)	Mass of Body Fat (%)	Lean BodyMAss (kg)	BMI (kg/m^2)
Ski training group	Female N=8	22.37±.91	8.12±2.79	164.33± 5.59	54.93±8.21	23.38±3.96	38.93±3.80	24.61±1.95
	Male N=12	23.75±2.13	10.66±2.34	178.80±8.31	78.97±10.01	22.48±4.61	51.87±51.47	24.61±1.95
Control group	Female N=9	21.88± 2.32	8.56±4.07	163.67±4.36	57.33±4.27	24.34±3.45	39.95±2.19	21.40±1.40
	Male N=11	23.18±2.44	7.82±3.12	180.59±8.28	77±11.34	20.56±5.29	56.45±7.13	23.57±2.89

During static balance evaluations, no significant statistical difference was detected at knees flexion tests at 135-150 degree; hands holding sidebars/hands-free tests; and eyes-open/eyes-closed tests ($p>.05$).

Table 2. Data for standing at upright posture and keeping knee flexion of 135-150 degree (Disequilibrium Distance Medium Error) dynamic balance tests for the control group.

				Disequilibrum Distance Medium Error %		Disequilibrum Distance Medium Error % Keeping knee flexion of 135-150 degree	
Group	Gender	Position	Test	Mean±SD	p	Mean±SD	p
Ski training group	Female n=8	Hold	Pre- test	,19±,27	,043	,028±,03	,026
			Post- test	,022±,031		,01±,01	
		Non-Hold	Pre- test	,45±,54	,025	,1±,07	,161
			Post- test	,12±,15		,06±,07	
	Male n=12	Hold	Pre- test	,27±,33	,010	,02±,03	,731
			Post- test	,03±,05		,01±,03	
		Non-Hold	Pre- test	,85±,47	,003	,57±,42	,023
			Post- test	,36±,31		,21±,17	
Control group	Female n=9	Hold	Pre- test	,36±,32	,859	,04±,04	,865
			Post- test	,36±,31		,37±1,01	
		Non-Hold	Pre- test	2,66±1,67	,314	1,56±1,01	,161
			Post- test	1,91±1,24		1,50±1,47	
	Male n=11	Hold	Pre- test	,30±,44	,959	,03±,05	,500
			Post- test	,31±,36		,03±,05	
		Non-Hold	Pre- test	2,94±1,64	,424	1,48±,93	,563
			Post- test	2,35±1,18		1,68±1,04	

The pre- and post-comparison analyses for the disequilibrium distance medium error percentage values for standing at upright position tests; and the hands holding sidebars/hands-free tests for male and female athletes are quite meaningful ($p<.05$). There has been no statistically significant difference for the control group. The pre- and post-comparison analyses for the disequilibrium distance medium error percentage values for keeping knee flexion of 135-150 degree are quite significant for ski training group with female athletes holding sidebars/male athletes hands-free ($p<.05$). There was no statistically significant difference for the control group with female athletes hands-free and male athletes hands holding sidebars at ski training group for disequilibrium distance medium error percentage values.

Table 3. The slalom dynamic balance values of standing at upright position and keeping knee flexion of 135-150 degree for the ski training group and the control group.

Group	Gender	Position	Test	Caught up Objectives in Slalom		Perimeter Error in Slalom		Caught up Objectives in Slalom Keeping knee flexion of 135-150 degree		Perimeter Error in Slalom Keeping knee flexion of 135-150 degree	
				Mean±SD	p	Mean±SD	p	Mean±SD	p	Mean±SD	p
Ski training group	Female n=8	Hold	Pre-test	29,5±3,02	,014	24,06±27,64	,028	31±2,76	,715	29,71±29,26	,161
			Post-test	31,25±2,49		15,26±13,50		31,13±3,04		20,35±22,33	
		Non-Hold	Pre-test	25,38±3,58	,067	41,71±24,51	,327	27,5±3,3	,105	38,59±23,27	,093
			Post-test	27,63±3,02		36,99±18,47		29,75±2,60		26,89±16,68	
	Male n=12	Hold	Pre-test	29,75±2,80	,005	19,68±18,64	,099	31,92±,99	,066	17,73±20,96	,937
			Post-test	32,42±,67		10,25±7,86		32,5±,67		13,68±8,23	
		Non-Hold	Pre-test	23,92±3,8	,003	66,58±39,37	,019	26,75±3,84	,003	54,49±28,59	,002
			Post-test	28,83±3,88		42,46±15,55		29,67±2,39		30,9417±9,34	
Control group	Female n=9	Hold	Pre-test	29,22±1,39	,156	27,94±20,01	,139	31,67±1,73	,480	18,07±10,86	,515
			Post-test	29,67±6,69		17,1±13,23		32,11±,93		19,39±8,36	
		Non-Hold	Pre-test	20,56±4,03	,440	125,06±64,36	,441	23±5	,373	121,67±70,95	,214
			Post-test	22,11±5,62		118,29±66,09		24,89±4,37		95,24±49,56	
	Male n=11	Hold	Pre-test	29±4	,190	24,60±12,70	,110	31±2,57	,088	17,84±9,37	,929
			Post-test	30,91±1,14		16,81±6,94		32,09±1,14		19,32±14,27	
		Non-Hold	Pre-test	18,64±3,38	,503	194,02±93,43	,213	21,55±5,03	,798	163,83±58,47	,477
			Post-test	19,64±5,5		166,15±97,3		22±4,58		148,54±59	

The pre- and post-comparison analyses for the standing at upright posture perimeter error slalom values are quite significant for ski training group with female athletes holding sidebars/male athletes hands-free (p<.05). There was no statistically significant difference between pre- and post-test results for the control group with female athletes hands-free and male athletes with hands holding sidebars. The pre- and post-comparison analyses for knee flexion at 135-150 degree perimeter error slalom values are quite significant for ski training group with male athletes in hands-free position (p<.05). There was no statistically significant difference between perimeter error in slalom pre- and post-test results for the control group with female athletes hands-free and hands holding sidebars as well as male athletes with hands-free and hands holding sidebars.

Table 4. Leg power values for ski training and control group.

Group	Gender	Test	Leg Dinamometer Mean±SD	Leg Dinamometer p
Ski training group	Female n=8	Pre- test Post- test	133,88±16,99 152,44±19,89	,012
	Male n=12	Pre- test Post- test	210,13±38,46 229,67±41,06	,008
Control group	Female n=9	Pre- test Post- test	155,83±38,71 154,28±35,3	,953
	Male n=11	Pre- test Post- test	402,82±571,7 231,14±35,11	,965

The pre- and post-comparison analyses for leg power values are statistically quite significant for ski training group of both male and female athletes (p<.05). There was no statistically significant difference between the values obtained for male and female athletes in the control group. The leg power of both male and female athletes increased after they received the ski training program.

4. Discussion

Skiing is a kind of sport where keeping the balance plays a crucial role. Thus, during our study, the effects of intensive ski training on dynamic and static balance as a new set of skills of male and female athletes receiving regular and formal sports training were scrutinized. Each sport has its own peculiar way of balance development pattern. Bergman et al. (2002) studied the static balance of surfers' and sedentaries' with their eyes open and closed. It was demonstrated that surfers had better results at anterior-posterior balance when compared with those doing no sports at all. It was also determined that surfers were able to partly transfer their static postural control function and also able to develop specific balance models.

As a result of their studies regarding the balance performance at a variety of sports, Erkmen et al. (2007) also found out that gymnasts had a higher level of static balance performance when compared with basketball players while having better dynamic balance performance when compared with football players. It was determined that basketball players and football players demonstrate similar characteristics in terms of their balance skills. Sirmen et al. (2008) compared the values of dynamic and static balance of karate-do and water polo athletes. Karate-do athletes were found out to have a better balance pattern towards left backwards when compared with water polo athletes. However, sedentaries were not able to detect any significant difference between the static balance values of water polo and karate-do athletes.

Bressel et al. (2007) conducted researches regarding the static and dynamic balance of female football players, gymnasts and basketball players. No significant differences were detected between the static balance values of gymnasts and football players. Basketball players, however, were observed to have a higher level of static balance when compared to gymnasts and a lower level of dynamic balance when compared with football players.

Vuillerme and Nougier (2004) conducted tests on athletes from a variety of sports (gymnastics, football, handball etc.) while they were tested in three different postural balance; one foot, both feet and one-foot on mat. No significant difference between groups at eyes-open postural balance was detected. However, it was observed that gymnasts demonstrated better results during eyes-closed postural balance measurements. As quite many studies indicate, each and every sport has its own peculiar pattern of balance development. During our study according to the pre- and post-comparison analyses of male and female athletes in the intensive ski training group and control group when holding sidebars/hands free positions with open/closed eyes static balance tests while standing at upright posture and keeping knee flexion at 135-150 degree, it was observed that there was no significant difference although the time of maintaining balance increased and the rate of making errors decreased ($p>.05$). We are of the opinion that balance development shall increase with the increase of training time.

As it was noted in some studies conducted on sportive postural balance, training helps athletes to acquire new sets of skills regarding balance control, and, in relation to this aspect, renders the balance skills different in line with the peculiar features of the sports in question (Davlin, 2004; Perrin et al., 2002; Bressel et al., 2007; Erkmen et al., 2007; Kochanowicz and Kucharska, 2010). Through a number of studies it was revealed that as the number of years of training increase, the ability to control balance is also affected positively (Paillard et al., 2006). However, at some other branches of sports, the number of years of training has no effect at all (Paillard et al., 2002).

In our study, pre- and post-disequilibrium and slalom dynamic values of athletes in the ski training group increased when compared with those in the control group. The dynamic balance of male athletes demonstrated a higher level of balance in comparison to female athletes. In spite of participating in the intensive ski training program for a short time, the dynamic balance skills of the athletes were affected positively.

Lately, there has been a increase in the number of researches conducted to study the balance parameters of athletes (Matsuda et al., 2008; Hrymallis, 2011; Vuillerme and Nouger, 2004; Akan et al., 2008; Sirmen et al. 2008; Bressel, 2007; Paillard et al., 2002, 2006). Although some different results were obtained through these studies, it must be taken into consideration that the mentioned studies were conducted on different branches of sports. A statistically significant difference was reached during our 6-day study for the leg power of male and female athletes who received intensive ski training. There was no change in the control group during the term of our study. Balance and movement control constitute the backbone of skiing for the lower extremity. Especially when the center of gravity gets closer to the ground, dynamic and isometric convulsions occur more which lead to the increase in balance and leg power. We can infer the reason of this situation from the frequent convulsions occurring during ski training as well as continuous dynamic-isometric convulsions.

In researches studying gender effect in balance skills, no standardized results were obtained so far. Perrin et al., (1998) did not detect any gender effect during their research touching on the static and dynamic balance control of judo athletes and dancers. The results of the mentioned study are supported with the research conducted by Kolleger et al. (1992) on the same age group. However, Ekdalh et al. (1989) found out that females demonstrate better balance postures than males. Golomer et al. (1997) put forth with their study conducted on dancers and acrobats that females have better balance values in comparison to males. In our study, however, it was found out that male athletes had higher performance results between pre- and post-tests development when compared with female athletes. The balance of male athletes were more developed then female athletes. While the balance of athletes in the intensive ski training group increased, no significant difference was detected in the control group in terms of dynamic balance development. We can infer from our findings that the reason for the male athletes demonstrating a higher level of balance development is their being more active participants in newly acquired skills and their courageous behavior.

5. Conclusion

Our study clearly indicated that the results obtained through our study indicated that the static and dynamic balance of leg power of male athletes increased dearly when compared with that of female athletes. We firmly believe that with the extension of training time, female athletes shall demonstrate a better level of balance features.

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