Journal of Sports Physiology and Athletic Conditioning (J.S.P.A.C) 2023; 3 (9): 43-55

Research Article

The Effect of Eight Weeks of Balance pod and Bosu Ball Selected Exercises on Balance of Teenage Futsal with Functional Ankle

Seyed Kazem Mousavi sadati*[1], Isa Abili Khams[1]

1. Department of Physical Education and Sports Sciences, East Tehran Branch, Islamic Azad University, Tehran, Iran.

Received: 16 July 2023
Revised: 21 August 2023
Accepted: 12 September 2023

Abstract

Background: The purpose of this study was to evaluate the effect of eight weeks of balance pod and Bosu ball selective exercises on the balance of teen Futsalist with functional ankle instability.

Materials and Methods: The present study was quasi-experimental with post-test pretest design. The participants of the study were 45 futsal students from the selected high school teams of Tehran cities who were selected according to the inclusion criteria. After homogenization, participants were divided into three groups based on body mass index (15 people in Bosobal training group, 15 people in balance Disc training group and 15 people in control group). After recording the demographic characteristics of the subjects, all subjects were subjected to a static equilibrium (dynamic stroke test) and dynamic equilibrium test (Y balance test). The experimental group received eight-week exercises with Balance pod and bosu ball. However, the subjects in the control group did not have specific training. Finally, all subjects after the end of the training period were tested and the data were analyzed by covariance test at the level of α=0.05.

Results: The results of this study showed that eight weeks of bosu ball exercises and balance pod had a positive and significant effect on both the static equilibrium and the dynamic balance of the subjects (P = 0.001). Also, there was no statistically significant difference between the two groups of the bosu ball exercises and balance pod exercises in the static equilibrium (P = 0.505) and dynamic balance (P = .295).

Conclusion: According to the results of the study, it is suggested that athletes with functional ankle instability, coaches, therapists and science specialists Rehabilitation use balance pod exercises and bosu ball in order of increase static and dynamic balance.

Keywords:
Balance Training, Neuromuscular Training, Balance, Functional Ankle Instability

***Corresponding author:** Seyed Kazem Mosavi Sadati
Address: Department of sport sciences, East Tehran Branch, Islamic Azad University, Tehran , Iran.
Email: drmousavisadati@gmail.com **Tell**: 00982133584911-14
SK MS: 0000-0003-4922-0541

1. Introduction

Functional ankle instability is one of the most common injuries that occur as a result of external ankle sprains along with pain and a feeling of emptiness in the ankle (1, 2). According to Friedman, Freeman, Dean, Hanham (1965), functional instability is a mental sensation that generally occurs after external ankle sprains as a result of proprioceptive, and neuromuscular control damage, and the person repeatedly feels empty in the area. experiences the ankle (3). Mechanical instability is also expressed as joint kinematic limitations, ligament laxity, synovial changes and improper joint mechanics, which can actually be caused independently of functional instabilities. (4, 5). Researchers in this field believe that functional instability is related to defects in proprioception, neuromuscular control, postural control, mechanical instability, and leg muscle weakness, and the ankle has been identified as the most common site of injury in the lower limb (6). One of the balance training methods that has received more attention recently is balance training on unstable surfaces, such as training on Swiss ball, bosu ball and balance pod, tilt boards, balance swings and various balance boards. (4, 5). Griffin (2003) has stated in this regard that training at unstable levels increases muscle activity And through the strengthening of proprioceptive inputs and movement awareness, it leads to an increase in central dynamic stability and better posture control, and has a special effect on improving the performance of athletes and preventing sports injuries (9) Two of these unstable surfaces are bosu ball and balance pod, which are used in this research. These balls are basically in the shape of a balanced half ball that has a stable side (smooth) and an unstable side (round). In the type of balance pod model, These balls are accompanied by ridges and protrusions that irritate the contact surface with the floor more (4-6).The opinion of the general researchers is that due to the unstable situation that these balls provide for people, performing balance exercises on these tools significantly stimulates the proprioception of the joints and improves balance (7, 8). Akado (2017) used equipment such as bosu ball, balance pod and wobble board in her intervention program to check the balance of the elderly and showed that 12 weeks of exercise and training with these devices has caused a significant increase in the balance of healthy elderly people (2). Erdem, Akyüz (2017) also investigated the effect of 8 weeks of central stability training and balance training and its related components using bosu ball in 14-15-year-old Turkish football players and have reported that regular football training with central stability and balance exercises significantly improves the balance parameters of basic football skills (10) .However, Chen and et al. (2019) stated that there is little evidence of a reduction in ankle sprains after using balance exercises, and more documents and evidence are still needed to use balance exercises in this regard (13). McKeon, Ingersoll, Kerrigan & et al (2008) have also reported that from the results of the research review, it cannot be concluded with certainty that balance exercises increase the postural control of people with functional ankle instability (14). Considering the conflicting results of the conducted research and the lack of targeted research in this field, these basic questions arise whether 8 weeks of balance exercises with Bosu ball and balance pod on the balance of teenage futsal players suffering from functional instability have a significant effect. And if there is an effect, which tool (Bosu ball or balance pod) has more effective and significant effects on the balance of this group of people.Therefore, in this regard, this research will be conducted with the aim of the effect of eight weeks of selected balance pod and bosu ball exercises on the balance of teenage futsal players suffering from functional ankle instability in Qarchak city.

2. Materials and Methods

The current research method is a semi-quasi type of research and is applied in terms of purpose which was done with a pre-test and post-test plan. The statistical population of this research was all futsal students of selected high school teams in cities around Tehran. A statistical sample of 45 people (15 people in the bosu ball training group, 15 people in the balance pod training group and 15 people in the control group) who were selected according to the input criteria of this research and based on homogenization based on (body mass index) and divided into the desired groups. In order to select research subjects, the researcher after visiting the volleyball clubs in Tehran, with the consent of the coach, team leaders and the subjects, Performed the initial screening of the subjects from among the desired athletes based on the entry and exit criteria of the research. The inclusion criteria of the research were the absence of any history of surgery or fracture in the lower limb, especially the ankle, the absence of any special heart, neuromuscular diseases and the presence of external sprain of the ankle with a functional cause, the age range of 15 to 18 years, and a history of activity in Futsal team for at least 3 years. exit criteria from the research were non-cooperation of the athlete, causing serious injury during the test execution stages and inability to perform the tests correctly. After selecting the subjects based on the inclusion and exclusion criteria, all the subjects completed the general consent form and the health questionnaire before the research. In order to homogenize people in the considered groups, the subject's anthropometric characteristics including height, weight and body mass index were measured with standard and valid laboratory tools

In the next step, people were homogenized according to body mass index and they were placed in three groups (15 people in bosu ball training group, 15 people in balance pod training group and 15 people in control group). All subjects did the pre-test of balance in two static and dynamic situations (Y dynamic balance test and stork static balance test, according to the methods mentioned below). The pre-test was carried out by observing the necessary conditions such as (considering errors, etc.) and the average record of each person was recorded in different directions. After taking the pre-test, the subjects of the two training bosu ball and balance pod groups (Figure 1), performed selected exercises designed in for 8 weeks (18 sessions, 3 sessions per week). Before the first training session, these exercises were fully and clearly taught to the subjects of each group through a training video. It is important to mention that the training protocols for each group were designed by experts and the demonstration video of these movements was also provided to all subjects (Figure 2).

The subjects of the control group did not have any specific and targeted training on any tool and they just did their normal futsal training. Finally, after completing the exercises (8 weeks), a post-test was taken from the subject under the same conditions as the pre-test.

Figure 1 balance pod ball and bosu ball

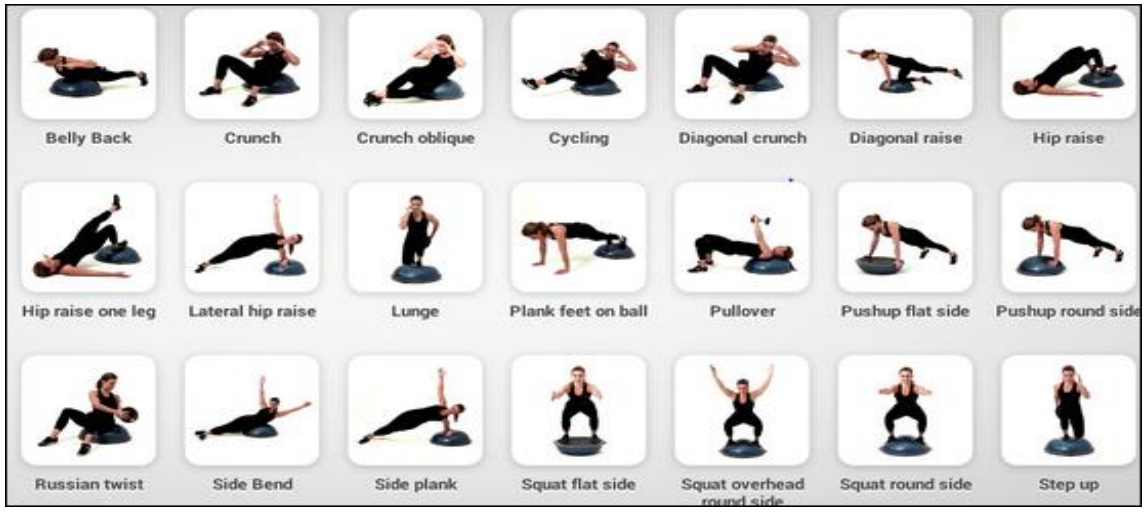

Figure 2 Some movements of bosu ball training protocol

To evaluate the static balance, the stork (Y) test was used. to perform this test, the subject stood on the dominant (superior) leg and placed the toes of the other foot on the knee of the dominant leg while the hands were on the waist. Then the subject raised the heel of the dominant leg with the command "present" and then "go", and while standing on the toes of one foot trying to keep her balance without moving legs or leaving hands behind waist. The test was performed 3 times and the best time was recorded as a score (Figure 3, stork static balance test) (15, 16).

The star test was used to evaluate the dynamic balance. In order to start the dynamic balance test, the actual length of the leg, i.e. from the anterior-superior spine to the inner ankle, was measured in order to normalize the data and compare the subjects. The superior leg was determined using the ball shot test. The subject was asked to measure the leg length lie on the bed lying on the back, then, the distance between the upper anterior cruciate ligament and the distal part of the inner ankle was measured. Each subject and each leg were measured twice and the average was taken; Then the calculated average is used as the foot length size. In this research, the Y balance test was used. The subject stood in the center of the directions and then stood on one leg and performed the reaching action with the other leg and stood on both legs in a natural position and remained in this position for 10 to 15 seconds before making the next attempt. All efforts in one direction must be completed before proceeding to another and it should be done in a clockwise or counterclockwise sequence.

The subject touched the farthest possible point with her toe in each of the designated directions. The distance from the contact point to the center was the reach distance which was measured in centimeters. The following formula (Score = (reach distance)/(body length) ×100) was used to obtain the balance scores in each direction separately (15, 17, 18). Figures 2 and 3 show how the dynamic balance test is performed.

Figure 4 Directions and how to perform the dynamic balance test of the star

Figure 3 How to perform the stork's static balance test

3. Results

Demographic characteristics of participants (Average and standard deviation of age, height, weight, body mass index and leg length) of the three groups are shown in Table 1.

Table 1. Descriptive information about participants' control indicators

group / variable	bosu ball	Disk balance	control
	Average± standard deviation	Average± standard deviation	Average± standard deviation
Number	15	15	15
age (years)	1 ± 16.6	1 ± 17	1 ± 16.4
height (cm)	6 ± 171.1	4 ± 170	3 ± 169.2
weight (kg)	4 ± 58.5	4 ± 58.7	2 ± 59.4
BMI	3 ± 19.8	2 ± 20	3 ± 20.6
leg length (cm)	2 ± 90.4	3 ± 90.8	4 ± 92

As seen in the table above, the participants of the three groups did not differ significantly in terms of age, height and weight.

The average and standard deviation of the variables of static balance and dynamic balance of the three groups of participants in the pre-test and post-test phases are shown in Table 2.

Table 2. Values of investigated variables (average and standard deviation) in the pre-test and post-test stages

group / variable	level	Static balance (second)	Static balance (centimeter)
bosu ball	pre-test	1.9 ± 11.33	5.9 ± 81.60
	post-test	4.1 ± 18.67	4.5 ± 93.53
Disk balance	pre-test	1.5 ± 11.47	4.4 ± 78.27
	post-test	2.2 ± 19.47	2.9 ± 91
control	pre-test	1.9 ± 11.37	6.3 ± 79
	post-test	2.7 ±12.33	1.8 ± 80.80

Table 3. The results of analysis of covariance test for comparing groups in static and dynamic balance variables

Variable	Source of changes	sum of squares	Degrees of freedom	average square	F	significance level
Static balance	Group (bosu ball-control)	279.26	1	279.26	23.54	*0.001
	Group (disk balance - control)	365.95	1	365.95	62.24	*0.001
	Group (balance pod-bosu ball)	5.177	1	5.177	0.456	0.505
Dynamic balance	Group (bosu ball-control)	1031.57	1	1031.57	112.4	*0.001
	Group (disk balance - control)	787.58	1	787.58	134.3	*0.001
	Group (balance pod-bosu ball)	13.28	1	13.28	1.141	0.295

4. Discussion

Part of the results of this research showed that the static and dynamic balance of the participants has significantly improved. In justification of this finding, it can be said that one of the effective and strengthening factors of balance and proprioception is training on unstable surfaces (7).So that the researchers have reported in this regard that balance and sense of proprioception as a result of training on unstable surfaces significantly lead to improvement of balance, and they believe that these exercises increase the mobility of nerve and muscle pathways, more strength, increase balance and a higher sense of proprioception.(12, 13, 19).Since bosu balls have soft and flexible surfaces and it is possible to sit, sleep and stand and perform various movements such as going up and down from it or performing exercises with jumping and leaping in a variable position.Therefore, these balls are also considered as variable and unstable surfaces, and it has very good training effects on static and dynamic balance and proprioceptive stimulation (6).Because in the case of performing exercises on these balls, maintaining the state of balance requires regular use of responses from the visual system, vestibular system, motor sense and hearing system. As a result, the sensory feedback sent from the receptors of the ankle ligaments is sent directly to the cortical and reflex pathways, it causes muscle reaction to be activated for joint dynamic control (2). Also, such exercises on these balls cause interaction between ligament receptors and muscle spindles. This action also has an effective role in joint dynamic control. Therefore, the increase of deep impulses from the joint receptor causes a normal state in the body and an increase in reflex responses. This issue also reduces the possibility of injury to the ankle joint, especially during sports activities or daily activities (20, 21).

Based on the results of the present study, Bosu ball and balance pod exercises have no significant difference on static and dynamic balance, and both can improve static and dynamic balance. So far, there has been no research in this field to compare the results. However, according to the results, it can be concluded that because both types of exercises and tools are similar to each other, and even in the unstable type and the commonality in the type and location of proprioceptive stimulation in the soles of the feet, it is probably one of the main factors in the lack of this The difference is this case (21, 22).Although, more movements were seen in bosu ball training, and it may seem that training on bosu ball is more effective than training on balance pod. But because the balance pod has built-in protrusions. Therefore, there is a possibility that these prominent surfaces lead to increased proprioceptive stimulation and more reflex responses, and as a result of these factors, both training tools are effective in this research. Maintaining a state of dynamic balance requires the regular application of responses from the visual system, the vestibular system, the motor sense, and the auditory system. Dynamic balance disorder may be affected by depth sensory impairment, nerve and muscle control, strength, range of motion, or other issues. People with functional instability not only have poor balance Rather, as a result of this condition, they experience a decrease in proprioception. (24) In the human body, there are three main physiological mechanisms in maintaining balance to inform the body of changes and determine the reactions needed to maintain body position. These mechanisms include visual, vestibular and depth sensory systems (23, 24)

Since most sports activities are performed in a dynamic environment. Therefore, the proprioception informs the person about the state of the movement of the joint. And finally, it regulates muscle contractions in order to move the joint and strengthen it. and any factor that reduces depth perception leads to mechanical instability, and finally, it makes the joint susceptible to light blows and damage. Therefore, the information from proprioceptive receptors plays an important role in joint dynamic stability and movement planning for neuromuscular control. Any factor that reduces the accuracy of this sense, it can increase the stress on the joint by disrupting joint stability and make it susceptible to damage. A new theory that has recently been the basis of the work of researchers in the study of movement and balance is the theory of dynamic systems. According to this theory, the ability to maintain and control body position in space, is the result of the interaction of the complex action that occurs between different muscular, skeletal and nervous systems and the importance of each system varies according to the purpose of movement and environmental conditions (6, 23,25,26,27). In this model, the central nervous system is informed about the state of the body's center of gravity in relation to gravity and the conditions of the support surface using the information of the vision system, vestibular system and proprioceptive system. Central nervous system provides the appropriate motor response in the form of pre-programmed movement patterns. It seems that these patterns, due to the teach ability of balance, to be affected by the postures of balance exercises, and these materials and mechanisms can be formed in the execution of exercises with bosu ball ball (2, 23).

It seems exercises performed on balance pod leads to calling more pelvic-lumbar muscles during the activity and these changes will occur in other joints of the body, especially the lower limbs. Based on the opinion of researchers, In general, the effectiveness of exercises on balance requires a response in three movement levels. At the level of the spinal cord, whose main role is to regulate the muscle reflex at this level, the sensory information obtained from the mechanoreceptors of the joint, following the occurrence of balance reflexes, it causes a supportive contraction around the joint and they prevent excessive pressure on the passive factors limiting the movement of the joint (2) At the level of the brain stem, the emergence of balance reflexes helps to control the balance of the body and at the level of higher nerve centers (cerebral cortex and cerebellum), a person consciously tries to control the state of joints and balance of her body with concentration and attention. Control at each of these levels requires sensory information collected from visual, vestibular and bodily sensory systems (2). As a result, these items can also be strengthened by improving the sense of proprioception with balanced implementation. This factor is probably another factor explaining the positive effects of these exercises on the static balance and especially the dynamic balance of the subjects.

Conclusion

According to the results obtained from the present research, it is recommended that athletes, coaches, therapists and rehabilitation science specialists pay attention to performing selected exercises with the help of tools such as balance disc and bosu ball in order to prevent and improve the balance status of athletes with functional instability of the ankle.

Acknowledgements

Hereby, from all the patients and people participating in the present research and their loved ones We are grateful to those who have helped us in this research.

Funding

This study did not have any funds.

Compliance with ethical standards

Conflict of interest None declared.

Ethical approval the research was conducted with regard to the ethical principles.

Informed consent Informed consent was obtained from all participants.

Author contributions

Conceptualization: S.K.M.S., I.A.; Methodology: S.K.M.S., I.A.; Software: S.K.M.S., I.A.; Validation: S.K.M.S., I.A.; Formal analysis S.K.M.S., I.A.; Investigation: S.K.M.S., I.A.; Resources: S.K.M.S., I.A.; Data curation: S.K.M.S., I.A.; Writing - original draft: S.K.M.S., I.A.; Writing - review & editing: S.K.M.S., I.A.; Visualization: S.K.M.S., I.A.; Supervision: S.K.M.S., I.A.; Project administration: S.K.M.S., I.A.; Funding acquisition: S.K.M.S., I.A.;

References

1. Naderi A, Baloochi R, Jabbari F, Eslami R. Comparison between the effects of core stability exercises and neuromuscular exercises on dynamic balance and lower limb function of athletes with functional ankle instability. SJKU 2016; 21 (4) :61-72.URL: http://sjku.muk.ac.ir/article-1-2544-en.html

2. Accardo P. The effect of an exercise Owned balance training intervention program on balance and mobility in community-dwelling older adults. 2017. https://dr.library.brocku.ca/handle/10464/10899 .

3. Freeman MA, Dean MR, Hanham IW. The etiology and prevention of functional instability of the foot. J Bone Joint Surg Br. 1965 Nov;47(4):678-85. PMID: 5846767.

4. Lee AC, Tan LG. The Effectiveness Of Neuromuscular Training Program To Improve Balance Among Female Futsal Players. European Journal of Molecular & Clinical Medicine. 2020;7(2):6060-70. https://www.researchgate.net/publication/346968750_The_Effectiveness_Of_Neuromuscular_Training_Program_To_Improve_Balance_Among_Female_Futsal_Players .

5. Farias SG, Rodrigues M, da Costa SD, Ribeiro de Macedo A, Nogueira-Campos AA, Garcia MAC, Imbiriba LA. Cardiorespiratory and Emotional Responses During Balance Exercises. Res Q Exerc Sport. 2023 Mar;94(1):186-193. doi: 10.1080/02701367.2021.1953691. Epub 2022 Jan 18. PMID: 35040750.

6. Erdem K, Akyüz C. The effect of core and balance training on single-leg sway parameters and well-directed kick of male soccer players. European Journal of Physical Education and Sport Science. 2017. https://oapub.org/edu/index.php/ejep/article/view/1287 .

7. Brown CN, Padua DA, Marshall SW, Guskiewicz KM. Variability of motion in individuals with mechanical or functional ankle instability during a stop jump maneuver. Clin Biomech (Bristol, Avon). 2009 Nov;24(9):762-8. doi: 10.1016/j.clinbiomech.2009.07.001. Epub 2009 Aug 12. PMID: 19679381.

8. Hunt KJ, Lawson P. Acute ankle ligament injuries. Sports injuries of the foot and ankle: Springer; 2019. p. 3-12.https://www.researchgate.net/publication/332387148_Acute_Ankle_Ligament_Injuries.

9. Esmailnia M, Khalkhali Zavieh M, Naeimi SS. Effect of Balance Exercises on Lower Limb Joint Proprioception: Systematic Review. The Scientific Journal of Rehabilitation Medicine. 2017;6(3):266-73. doi: 10.22037/jrm.2017.1100334.

10. Ranjbarzadeh Yamchi F, Letafatkar A, Esmaeilpour S. The Effect of 8 Weeks Virtual Reality Training on Static and Dynamic Balance and Performance in Male Athletes With Functional Ankle Instabilit. PTJ 2021; 11 (1) :45-54

URL: http://ptj.uswr.ac.ir/article-1-443-en.html .

11. Haidary M. Effects of Proprioception Exercises in the Rehabilitation Process of Football Players after Arthroscopic Surgery Anterior Cruciate Ligament (ACL). J Sport Biomech 2017; 3 (2) :15-25

URL: http://biomechanics.iauh.ac.ir/article-1-134-en.html .

12. Etty Griffin LY. Neuromuscular training and injury prevention in sports. Clin Orthop Relat Res. 2003 Apr;(409):53-60. doi: 10.1097/01.blo.0000057788.10364.aa.PMID: 12671485.

13. Chen ET, Borg-Stein J, McInnis KC. Ankle Sprains: Evaluation, Rehabilitation, and Prevention. Curr Sports Med Rep. 2019 Jun;18(6):217-223. doi: 10.1249/JSR.0000000000000603. Erratum in: Curr Sports Med Rep. 2019 Aug;18(8):310. PMID: 31385837.

14. McKeon PO, Ingersoll CD, Kerrigan DC, Saliba E, Bennett BC, Hertel J. Balance training improves function and postural control in those with chronic ankle instability. Med Sci Sports Exerc. 2008 Oct;40(10):1810-9. doi: 10.1249/MSS.0b013e31817e0f92. PMID: 18799992.

15. YAPRAK Y, DELLEKOĞLU B. EVALUATION OF RELATIONSHIP BETWEEN STATIC AND DYNAMIC BALANCE TESTS IN YOUNG. Journal of Physical Education & Sports Science/Beden Egitimi ve Spor Bilimleri Dergisi. 2021;15(2).https://web.p.ebscohost.com/abstract?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=1309386X&AN=152457521&h=NGC%2fcOsoTyrPBCpX4iSjdIKIPQveTIx2tlQHBTW380FPmlCzgbTG%2fA9o8PQq8%2bncy6JewSHjJWvbf7YiY8PjTg%3d%3d&crl=c&resultNs=AdminWebAuth&resultLocal=ErrCrlNotAuth&crlhashurl=login.aspx%3fdirect%3dtrue%26profile%3dehost%26scope%3dsite%26authtype%3dcrawler%26jrnl%3d1309386X%26AN%3d152457521 .

16. Muscat-Inglott M. The Modified Flamingo Test: A Convenient Assessment of Balance for Planning Exercise Interventions with Older Adults. Available at SSRN 3594107. 2020. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3594107 .

17. ALTINKOK M, SERAN B, KURNAZ M, DEMIR B. INVESTIGATION OF STATIC AND DYNAMIC BALANCE CAPACITY OF 5-9 YEAR-OLD CHILDREN IN GYMNASTICS EDUCATION. ABOUT THIS SPECIAL ISSUE. 2021;12(11):129. https://www.researchgate.net/publication/350063395_INVESTIGATION_OF_STATIC_AND_DYNAMIC_BALANCE_CAPACITY_OF_5-9_YEAR-OLD_CHILDREN_IN_GYMNASTICS_EDUCATION .

18. K.Jothi Prasanna, Z.Ayesha Farvin. Influence of Index Plus and Index Minus Foot on Static and Dynamic Balance among Collegiate Girls. Indian Journal of Forensic Medicine & Toxicology [Internet]. 2021 Mar. 24 [cited 2023 Sep. 14];15(2):178-80. Available from: https://medicopublication.com/index.php/ijfmt/article/view/14299 .

19. Yalfani, A., Ahmadnezhad, L., Gholami Borujeni, B. The Immediate Effect of Balance Training on Ankle Joint Proprioception in Soccer Players. Journal of Paramedical Sciences & Rehabilitation, 2017; 6(3): 36-43. doi: 10.22038/jpsr.2017.14355.1312 .

20. Silva PB, Mrachacz-Kersting N, Oliveira AS, Kersting UG. Effect of wobble board training on movement strategies to maintain equilibrium on unstable surfaces. Hum Mov Sci. 2018 Apr;58:231-238. doi: 10.1016/j.humov.2018.02.006. Epub 2018 Mar 12. PMID: 29499471.

21. Bashir SF, Nuhmani S, Dhall R, Muaidi QI. Effect of core training on dynamic balance and agility among Indian junior tennis players. J Back Musculoskelet Rehabil. 2019;32(2):245-252. doi: 10.3233/BMR-170853. PMID: 30248028.

22. Demir A. COMPARISON OF EFFECT OF BALANCE DISC AND BOSU BALL ON ANKLE DORSIFLEXOR AND PLANTARFLEXOR MUSCLE STRENGTH. European Journal of Physical Education and Sport Science. 2019. https://oapub.org/edu/index.php/ejep/article/view/2543 .

23. İpekoğlu, G. Et Al. (2018) . "DOES BOSU TRAINING AFFECT ON DYNAMIC AND STATIC BALANCE IN ADOLESCENT TAEKWONDO ATHLETES?." KINESIOLOGIA SLOVENICA , vol.24, no.1, pp.5-13. https://avesis.gazi.edu.tr/yayin/fe604063-1462-4c06-abe2-5b5492bbc750/does-bosu-training-affect-on-dynamic-and-static-balance-in-adolescent-taekwondo-athletes .

24. Samadi, H., Rajabi, R., Alizadeh, M. H., Jamshidi, A. Effect of Six Weeks Neuromuscular Training on Dynamic Postural Control and Lower Extremity Function in Male Athletes with Functional Ankle Instability. Studies in Sport Medicine, 2014; 5(14): 73-90. https://smj.ssrc.ac.ir/article_166.html?lang=en .

25. Riyahi Malayeri, S., Nikbakht, H, Gaeini (2014). Serum Chemerin Levels and Insulin Resistance Response to High- Intensity Interval Training in Overweight Men. Bulletin of Environment, Pharmacology and Life Sciences, 3(2), pp. 385-389.

26. Mohammadi, S., Rostamkhani, F., Riyahi Malayeri, S. et al. High-intensity interval training with probiotic supplementation decreases gene expression of NF-κβ and CXCL2 in small intestine of rats with steatosis. Sport Sci Health 18, 491–497 (2022). https://doi.org/10.1007/s11332-021-00829-5.

27. Riyahi Malayeri S, Kaka Abdullah Shirazi S, Behdari R, mousavi Sadati K. Effect of 8-week Swimming training and garlic intake on serum ICAM and VCAM adhesion molecules in male obese rats. . JSSU 2019; 26 (10) :867-878.URL: http://jssu.ssu.ac.ir/article-1-4695-en.html.