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# Effect of 12 weeks of modified FIFA 11+ training on functional factors of male beach soccer players: A Randomized Controlled Trial study

# Efecto de 12 semanas de entrenamiento modificado de FIFA 11+ sobre los factores funcionales de jugadores masculinos de fútbol playa: un estudio de ensayo controlado aleatorio

# Efeito de 12 semanas de treinamento modificado do FIFA 11+ sobre fatores funcionais de jogadores masculinos de futebol de praia: um estudo randomizado e controlado

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## ABSTRACT

The purpose of the study was to investigate the effect of modified FIFA 11+ training on functional factors of beach soccer players. The study is an RCT. Forty subjects divided to two control and exercise groups. functional factors was collected by the Bosco jump test on the force plate. repeated measures ANOVA was used to compare, between groups and the intervention group, as well as the effect of intervention. Statistical analyses were performed using SPSS at the significant level of 0.05. The result showed that Bosco index ($F_{1,38}$ = 42.85, p <0.001), power index ($F_{1,38}$ = 12.33, p = 0.001) and equilibrium index ($F_{1,38}$ = 127.11, p = 0.001) were increased after intervention. The time × group interaction for the Bosco-index was significant. The modified FIFA 11+ which performed in the sand had an effect on functional factors. these exercises are recommended for beach soccer players to improve their performance.
**Keywords:** Prevalence, Injury, FIFA 11+, Beach Soccer, Functional factors.

## RESUMEN

El objetivo del estudio fue investigar el efecto del entrenamiento modificado de FIFA 11+ sobre los factores funcionales de los jugadores de fútbol playa. El estudio es un ECA. Cuarenta sujetos divididos en dos grupos de control y de ejercicio. Los factores funcionales se recogieron mediante el test de salto de Bosco sobre la plataforma

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de fuerza. Se utilizó ANOVA de medidas repetidas para comparar, entre los grupos y el grupo de intervención, así como el efecto de la intervención. Los análisis estadísticos se realizaron utilizando SPSS al nivel significativo de 0.05. El resultado mostró que el índice de Bosco ($F_{1,38}$ = 42.85, p <0.001), el índice de poder ($F_{1,38}$ = 12.33, p = 0.001) y el índice de equilibrio ($F_{1,38}$ = 127.11, p = 0.001) aumentaron después de la intervención. La interacción tiempo × grupo para el índice de Bosco fue significativa. El FIFA 11+ modificado que se desarrolló en la arena influyó en los factores funcionales. Estos ejercicios están recomendados a los jugadores de fútbol playa para mejorar su rendimiento.

**Palabras clave:** Prevalencia, Lesiones, FIFA 11+, Fútbol Playa, Factores funcionales.

**RESUMO**

O objetivo do estudo foi investigar o efeito do treinamento modificado do FIFA 11+ nos fatores funcionais de jogadores de futebol de areia. O estudo é um ECR. Quarenta sujeitos divididos em dois grupos controle e exercício. os fatores funcionais foram coletados pelo teste de salto Bosco na plataforma de força. ANOVA de medidas repetidas foi utilizada para comparar entre os grupos e o grupo intervenção, bem como o efeito da intervenção. As análises estatísticas foram realizadas no SPSS ao nível de significância de 0.05. O resultado mostrou que o índice de Bosco ($F_{1,38}$ = 42.85, p <0.001), índice de potência ($F_{1,38}$ = 12.33, p = 0.001) e índice de equilíbrio ($F_{1,38}$ = 127.11, p = 0.001) aumentaram após a intervenção. A interação tempo x grupo para o índice Bosco foi significativa. O FIFA 11+ modificado que atuou na areia teve efeito nos fatores funcionais. esses exercícios são recomendados para jogadores de futebol de praia melhorarem seu desempenho.

**Palavras chave:** Prevalência, Lesões, FIFA 11+, Futebol de Praia, Fatores funcionais.

## INTRODUCTION

Beach soccer, like regular soccer, is a contact sport and requires physical skills and physical, technical and tactical attributes, which are related to the incidence of injury (Mina et al., 2012). Preventing training program is one of the important factors to prevent injury, which helps improve exercise-related performance and prevent injuries. Designing exercises that increase the ability of the athlete to be less likely to be injured or unsafe is one of the major concerns of the athletes and their coaches (Olsen et al., 2004).

According to the results of a few published studies, the prevalence of beach soccer injuries has been reported up to 44% (Mina et al., 2012; Sharifatpour et al., 2018; 2020). Therefore, the development, modifying and implementation of injury prevention programs is very important (Luig & Henke, 2009). In the last decade, various injury prevention programs such as knee injury program prevention and prevention enhanced performance (PEP) have been studied. Warm-up programs are one of the most common injury prevention programs in various sports, such as soccer (Minonejad et al., 2014). The most common and well-known warm-up training program designed by the FIFA Medical Research and Evaluation Center in collaboration with the Oslo Sports Research and Injury Center and the Santa Monica Center for Sports Medicine and Orthopedics, 11+, is designed to prevent lower limb injuries in soccer players. Most studies have reported the FIFA 11+ prevention programme reduces the top four most prevalent football injuries: hamstring, hip/groin, knee and ankle injury by 60%, 41%, 48% and 32%, respectively (Thorborg et al., 2017).

Although FIFA 11+ is designed for soccer, recent research has suggested that these exercises should be studied in other sports (Rahnama, 2012). Therefore, in some other sports, such as futsal, basketball and handball, this training program was implemented (Abedinzadeh et al., 2017; Gritsanadilok et al., 2013; Longo et al., 2013; Reis et al., 2013; Zein et al., 2017). The results of the implementation of the FIFA 11+ training program in basketball in a RCT study showed that this training program was also effective in preventing injury to professional male basketball players in Italy (Longo et al., 2013). In handball, the modified FIFA 11+ has had positive results in reducing

injuries (13). Implementing the FIFA 11+ training program in the field of futsal has improved physical fitness, technical performance, as well as increased the strength and stability of the core muscles, as well as prevented lower limb injuries (Reis et al., 2013). Due to the similarity of the technical and functional characteristics of football and futsal with beach soccer, and since this exercise program has had a significant effect on reducing injuries. Therefore, this program in beach soccer could probably be effective in preventing and reducing injuries. Generally, to investigate the causes and prevalence of injury, the factors that (in)directly affect the incidence of injury will be considered, such as physical fitness factors or indicators such as Bosco index, power and equilibrium indexes (Zein et al., 2017).

The literature has shown that improving physical fitness factors such as agility, speed, strength, power and endurance improve performance, which is an important factor in preventing injury (Roi et al., 2006). The assessment of fitness factors alone does not provide much information about athletes, especially professional athletes who are usually at the peak of physical fitness. Therefore, it is more appropriate to use performance indicators that provide more details about changes in fitness factors. For example, the power index in the Bosco test is not only a single jump and measuring the height of a jump, it is calculated power based on factors such as time and number of jumps and jump time in consecutive jumps, so it has the ability to calculate the combination and function of various variables that are used to measure and the evaluation of professional athletes has the ability to provide details and specify the changes has been made.

Also, in terms of equilibrium, this index compares the equilibrium function of the upper and lower knee joints. For professional athletes, using this index can be better than a static and dynamic balance test. For that reason, in this study, these functional indicators and their changes following the use of exercise program have been investigated. The Studying these indicators will give us new information.

One of the methods of kinetic and kinematic measurement of functional factors is the Bosco test (Abedinzadeh et al., 2017; Petersen et al., 2005). The Bosco test includes different types of jumps, such as countermovement jump (CMJ), squat jump (SJ) and continuous jumps (CJ). One of the indices for this test is the Bosco index. This index determines the needs of athletes to pay attention to strength or power and speed (Abedinzadeh et al., 2019; Bosco & Riu, 1994; Index, 2015). In a previous study, the effect of two strength training programs on the Bosco index showed that the strength training significantly increased the Bosco index in handball players (Contreras, 2007). Another study also reported a significant relationship between core stability with the CMJ and stated that the pathway of power transmission probably passes through the lateral subsystem of the core muscles. Since the FIFA11+ exercises improve the core muscles, so it changes and increases the Bosco index (Fazl Ers et al., 2015).

Another functional factor is the equilibrium index. Balance training is traditionally used as part of a rehabilitation program from injury. A positive relationship between balance ability, exercise and sports injury risk has been investigated and published. For example, previous studies have shown that poor balance is significantly associated with an increased risk of ankle injuries in various activities (Hrysomallis, 2007). The results also show that balance training alone has significantly reduced ankle recurrence in football, volleyball, and anterior cruciate ligament injuries in male soccer players. In another study, after implementing the modified FIFA 11+ warm-up program, reported a decrease in injury rate and an increase in the equilibrium index obtained from the Bosco test (Abedinzadeh et al., 2017).

One of the causes of injury in sports where strength-speed activity and jumping are very high, is decreasing performance in power and power-related factors, including the power index. Therefore, it can be said that by improving power, the risk of lower extremity injury can be reduced (Kumar & Kumar, 2005). Although in some sports and situations, power is generally measured using an explosive jump such as a Sargent jump test or vertical jump test, while new research uses sequential explosive-power jumping exercises (Ben Ayed et al., 2020) instead of one single jump; therefore, to evaluate the power, it is better to use consecutive jumps such as Bosco test and Bosco index instead of one explosive jump. Power as an indicator and influential factor in performance that is used in the implementation of most sports skills. The power index as mentioned above is done by performing a Bosco

test and calculating it using force plate's software. Jumps combine factors such as speed and strength, increase the explosive power of muscles and cause explosive-reactive movement (Adams et al., 1992; Redcliffe & Farentinos, 1999).

Jumping exercises as an effective way to increase the muscular strength of athletes has been considered by many coaches and athletes (Suchomel et al., 2018). Jumping and plyometric exercises are parts of the FIFA 11+ training program and include exercises or movements that are performed with the aim of combining absolute strength and speed to create a fast and explosive movement (Brown, 1984). A review study has shown that the combination of squat and plyometric exercises further improves vertical jump height (de Villarreal et al., 2009). Other studies have shown that jumping exercises, including plyometric exercises, increase functional factors such as jumping and power (Bal et al., 2011; Kotzamanidis, 2006; Matavulj et al., 2001). For example, a previous study found that plyometric exercises improved jump performance, as well as increased jump rate, improved flexibility, and speed in female basketball players (Chaudhary, 2010).

Due to the fact that a beach soccer match is played in 3 times of 12 minutes and, in comparison, with regular soccer, power and power index are very important because of heavy attempts in a shorter time and on the sandy field, so this factor can be effective in improving performance and preventing injury. Since physiological factors related to performance and physical fitness are different in beach soccer from football and other sports, these differences should also be observed in the warm-up program, and the exercises of this program should be appropriate to the mechanism of injuries in beach soccer. Therefore, knowledge and familiarity with functional factors related to injury in athletes, especially due to the physical, motor and psychological characteristics of young athletes, is a necessity that has been considered in sports medicine (Roi et al., 2006). Among the beach soccer teams of the Iranian Premier League, the teams of Yazd province were among the top teams in the country, so this study was conducted to investigate the effect of 12 weeks of modified FIFA 11+ training on functional factors of male beach soccer players.

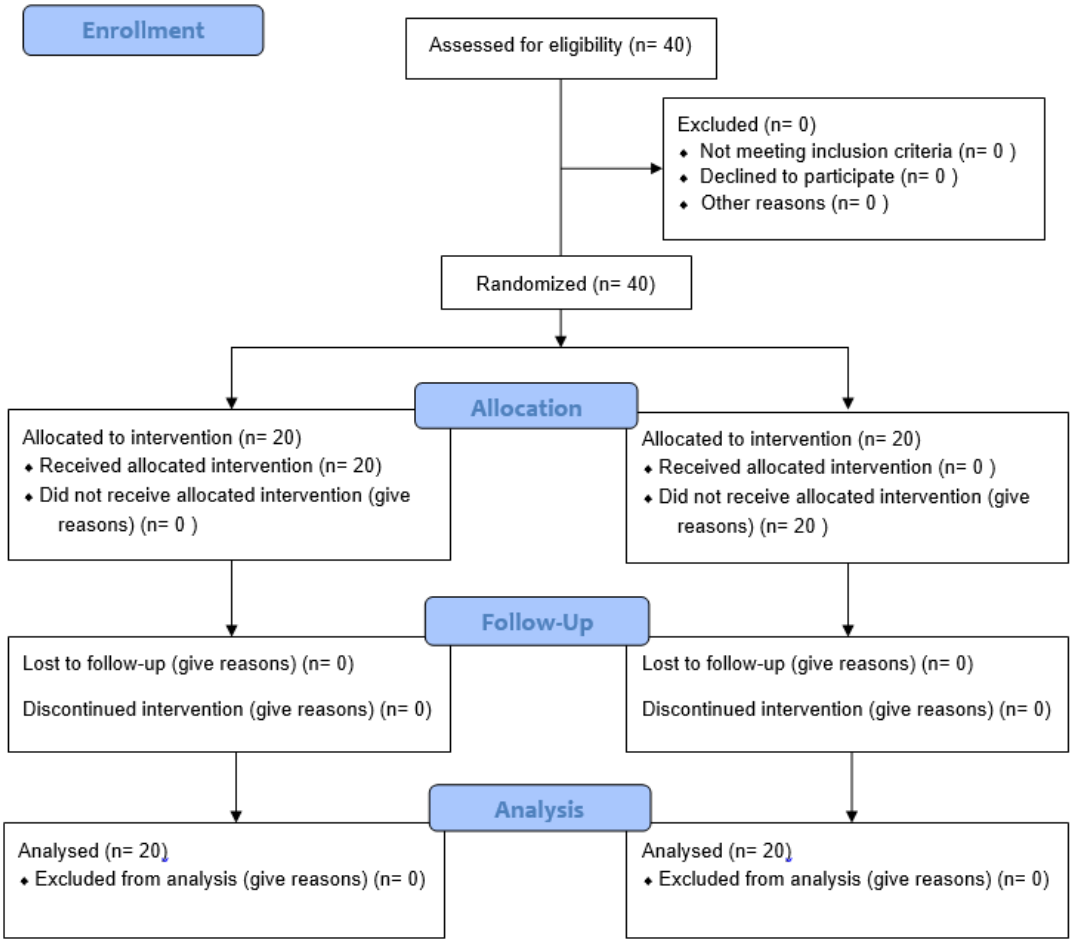
## MATERIALS AND METHODS

### *Participants*

The sample size was determined by power calculation performed with G*Power v.3.1.9.2 (Faul et al., 2009), using the following input parameters: mean anticipated effect size for a comparison between two dependent means extracted from Abedinzadeh et al. 2017 for our indices (f = 0.33-0.50), statistical power $1-\beta = 0.80$ and $\alpha = 0.05$. Based on these calculations, the target sample size determined for the present study was 20 ($1-\beta = 1.616$). Forty male beach soccer players aged between 18 and 25 years (age: 24.98 ± 2.59 years, height: 178.6 ± 1.45 cm, weight = 78.5 ± 2.35 kg, experience time: 7.68 ± 1.33 years), from GolsaPoosh and Ifa teams of Yazd province (Iran) were part of the study. The subjects are divided to two clusters, then by cluster randomization indicated as control and exercise groups. The inclusion criteria were as follows: (i) having at least one year of experience in the country's premier league. Exclusion criteria were as follows: (i) having a history of previous injury, and (ii) absence of more than three sessions in training. The study was designed according to the ethical criteria of the Declaration of Helsinki (Association, 2013) and the ethical standards in sport and exercise science research (Harriss et al., 2019) . The study was approved by the Ethics Committee of Yazd University, in accordance with the Declaration of Helsinki, which establishes the fundamental ethical principles for research on human subjects and all athletes were informed of the risks and benefits inherent in the study before signing the Informed Consent Form. The permission of the ethics committee for this research was obtained from the ethics committee for the research of Yazd University (IR.YAZD.REC.1398.009). In addition, this study was registered as a randomized clinical trial after checking by CONSORT checklist at Iran Clinical Trial Center and received the trial code (IRCT20180827040887N2). Selection, blindness and eligibility of subjects according to the CONSORT checklist have been controlled (Figure 1).

**Figure 1**

*CONSORT Flow Diagram of subject*




*Instruments*

Data related to functional factors were collected by performing the Bosco test and using the Quattro Jump AD9290 force plate made by the Swiss company Kistler (Hägglund et al., 2005). This portable force plate has high validity and reliability (r = 0.97) compared to the fixed force plate (Kavehei & Rajabi, 2014). The Bosco test includes different types of jumps, such as Countermovement Jump (CMJ), squat jump from 90 degree (SJ) and Continuous Jump (CJ). The number of jumps is between 3 and 5 jumps and for Continuous jumps is between 15 and 60 seconds (Table 1). High validity and reliability have been reported for the Bosco test. One study reported the test-retest rate on the 30-second Bosco jump (ICC = 0.94) to determine the mean jump height (ICC = 0.98) (Dal Pupo et al., 2014). The Bosco Protocol evaluates different types of «Squat Jump», «Countermovement Jump» and «Continuous Jump»:

**Table 1**

*Abbreviations and descriptions of Bosco test jumps*

| Abbreviation | Jump type | Number | Description |
|---|---|---|---|
| **SJ** | (Squat Jump) | 3 | Single jump starting from knees bent at 90 degrees |
| **SJbw** | (Squat Jump + Body Weight) | 3 | Squat jump with additional Body Weight load of up to one body weight |
| **CMJ** | (Countermovement Jump) | 3 | Single jump starting with movement straight legs with a natural Jump flexion before takeoff |
| **CJbref** | (Continuous Jump Bent Legs) | 5 | Series of jumps with bent Jump Bent knees, used as reference to compare with CJb (30 s) |
| **CJs** | (Cont. Jump straight leg) | 5 | Series of jumps with straight leg straight knees |
| **CJb** | (Cont. Jump Bent Legs) | 30 s | Series of 30 second jumping with bent knees |

*Procedure*

The present study is a randomized controlled trial (RCT), where two groups voluntarily participated in this study, which was randomly divided into two groups (20 subject in the exercise group and 20 subject in the control group). After the pre-test, the instructor of the warm-up training program was provided to the trainers, coaches and athletes of the selected exercise group. The control group performed routine and general warm-up exercises, and they were not aware of the training of the exercise group. The exercise group performed the FIFA 11+ modified warm-up training program for 12 weeks. In this study, the FIFA 11+ warm-up program was modified by adding balance exercises for the ankle and knee joints on the beach soccer field (Minonejad et al., 2014). This training program was performed for 12 weeks and three sessions per week in three sections and at three different levels in terms of difficulty and intensity of training (simple level, medium level and advanced and intense level) on sandy ground.

The data collection was (force plate) was performed in the biomechanics laboratory of Yazd University. At first, the consent form for participating in the research completed and signed by the subjects. After explaining the implementation process in the pre-test, to collecting the data of functional factors, the tests were performed with the force plate device for the groups. First SJ jump, then SJ with body weight and then CMJ. Each of these jumps was performed 3 times and their average was calculated. After these jumps, five consecutive reference jumps with bent knees and then 5 jumps with straight knees were performed. At the end of 30 consecutive jumps with the knee bent. SJ, SJbw and CMJ jumps were performed by the subjects three times, and their average was used in the analysis. In CJbref and CJs consecutive jumps, five consecutive jumps and in CJb jump, consecutive jumps with bent knees were performed for 30 seconds (Bosco).

*Data Analysis*

The normality distribution of the data was checked and controlled by using Shapiro-Wilk test. To comparison between the groups, as well as the effect of time (within group) and the intervention between time and the groups, two-way repeated measures ANOVA test was used. To investigate the homogeneity of variances, Leven test and the sphericity of covariance were examined by Mauchly test. All statistical analysis were performed by using SPSS software version 25 at a significance level of 0.05.

## RESULTS

In present study, all 40 players from two teams of the Iranian Beach Soccer Premier League participated in this study as a sample. The demographic data of subjects was shown in table 2.

**Table 2**

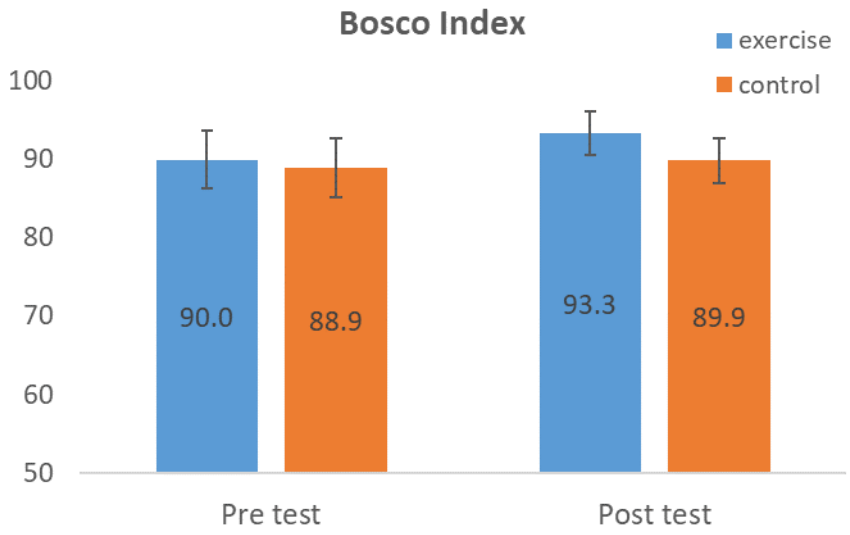
Mean and standard deviation of demographic variables of control and exercise groups

| Variable | Control group (n = 20) | Exercise group (n = 20) |
|---|---|---|
| Age (years) | 23.40 ± 4.90 | 24.17 ± 3.60 |
| Weight (kg) | 74.21 ± 9.16 | 75.67 ± 10.62 |
| Height (cm) | 180.08 ± 4.94 | 178.56 ± 4.64 |
| Game history (years) | 3.75 ± 1.67 | 4.19 ± 2.48 |

There was no significant difference between the two groups in terms of age ($p < 0.12$, $t = 38 = 1.85$). The mean of playing history in beach soccer was not significant between control and exercise groups ($t_{38} = 38.56$, $p < 0.96$).

**Figure 2**

*Mean of Bosco index in pre-test and post-test of control and exercise groups.*




As can be seen in Figure 2, the average Bosco index in the exercise group after 12 weeks of training indicates an increasing in the post-test.

**Table 2**

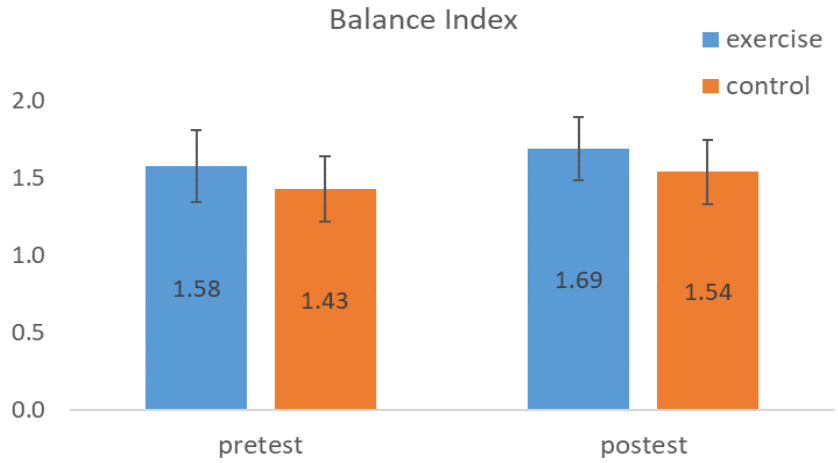
*Results of ANOVA test between and within group effect*

| Variable | Groups | Control | Experiment | Time | Groups | time × group |
|---|---|---|---|---|---|---|
| Bosco index | Pre-test<br>Post-test | 88.93 ± 3.82<br>89.86 ± 2.85 | 89.97 ± 3.63<br>93.28 ± 2.79 | 0.031 | <0.001 | 0.004 |
| Balance index | Pre-test<br>Post-test | 1.50 ± 0.20<br>1.52 ± 0.21 | 1.56 ± 0.22<br>1.73 ± 0.18 | 0.041 | <0.001 | 0.73 |
| Power index | Pre-test<br>Post-test | 21.64 ± 3.01<br>22.85 ± 2.75 | 22.89 ± 2.67<br>25.04 ± 2.13 | 0.007 | 0.001 | 0.18 |

The results of within group analysis show that the effect of time on the Bosco index was significant ($F_{1, 38} = 42.85$, $p < 0.001$) that means Bosco index has significantly increased in the exercise group after 12 weeks of training (ES = 0.58). In terms of group differences, at the post-time Bosco index for exercise group was 93.28 which compared to the control group (89.86) have significant difference ($F_{1, 38} = 5.04$, $p = 0.031$). More important the time × group interaction was significant ($F_{1, 35} = 9.44$, $p = 0.004$).

**Figure 3**

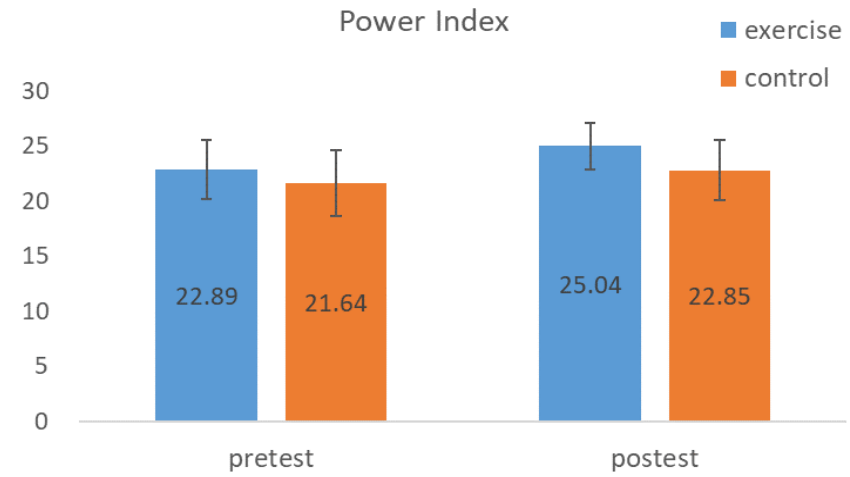
*Balance index in the control and exercise group.*




After 12 weeks of training there is an increasing of the balance index at the post-test in exercise group (Figure 3). Analysis of variance in effect of time shows that the balance index in the exercise group had a significant increase after the implementation of the training protocol ($F_{1, 38} = 67.23$, $p < 0.001$), and the effect size of ES = 0.32. Also, between groups differences was significant according to analysis of variance ($F_{1, 38} = 4.45$, $p = 0.041$).

**Figure 4**

*Power index in the control and exercise group.*



The power calculated during 30 second continues jumping on the force plate. Time effect of the mean power index for exercise group after 12 weeks of training increase significantly ($F_{1, 38} = 12.23$, $p = 0.001$), and the effect size of ES = 0.67. There was a significant difference between control and exercise group at the post-test ($F_{1, 38} = 8.00$, $p = 0.007$).

## DISCUSSION

The present study aimed to examine the effect of 12 weeks of modified FIFA 11+ training on functional factors of 40 male beach soccer players from two professional teams in the country's Premier League. The statistical analysis showed the Bosco index ($p < 0.001$), power index ($p = 0.001$) and equilibrium index ($p < 0.001$) increased significantly at post-test. After implementation of the training protocol, there was a group differences in all indices ($p \leq 0.001$) and time × group interaction only for Bosco index was significant ($p = 0.004$).

The jump of the exercise group improved significantly after 12 weeks of training program. This improvement in the Bosco test jumps, includes squats jump and jumps with extra weight, which these are the components of the Bosco index calculation. This index is calculated by obtaining the amount of jump with body weight divided by the amount of jump with extra weight multiplied by 100. This ratio shows that subject need to train strength or speed. This means that if the number achieved or close to 100, it indicates an increase in strength and the subjects jumps with the extra weight has done as much as body weight jump. If this value is less than 100, it indicates the low power of people who performed the jump. Using this index, we can examine the effect of training on changes in speed and strength of players and determine that the effect of this training program has been more on the speed of players or their strength.

The Bosco index after the training intervention period increased from the average of 89.97 in the pre-test to 93.28 in the post-test and showed a significant difference. Considering that the interaction of time × group was significant, the results of our study demonstrate that the training program performed by the experimental group is more efficient in increasing the Bosco index scores than the one implemented in the control group. Although no study was found for examining the Bosco index in beach soccer, but in other sports, such as handball (Abedinzadeh et al., 2019; Abedinzadeh et al., 2017; Contreras, 2007; Dal Pupo et al., 2014) it has been reported. The increase in this index may be due to jumping and strength training in the warm-up program, as a previous study showed that strength training increases the Bosco index in handball players (Contreras, 2007).

Many coaches and athletes believe that jumping exercises are effective way to increase the muscular strength of athletes (Suchomel et al., 2018). The jump-landing exercises in the second part of this exercise program, possibly by affecting the timing and amount of muscle activity, allow the limbs to be active during various movements and prevent injuries caused by delayed muscle activity. Delayed muscle activity happened by hypo / hyperactivity of muscles and limited range of motion and muscle stiffness (Abedinzadeh et al., 2017). Jump-landing exercises also have core stabilization exercises, and these exercises probably allow the person to have better conditions and result in functional tests by creating postural stability. Core exercises improve the function of the neuromuscular system, leading to optimal movement of the lumbar, pelvic, and hip joints along the functional motor chain, increasing or decreasing acceleration, proper muscle balance, proximal stability, and functional strength(de Andrade Gomes & Pinfildi, 2018). These effects lead to optimal function and increase the strength of the lower limb muscles, which can better stabilize the joints, resulting in better power. Decreased power index, that is power function, in strength-speed and jumping activity, is one of the factors that cause injuries, by improving this index can reduce the risk of lower limb injury (Kumar & Kumar, 2005).

Fazl Ersi et al. (2017) also reported a significant relationship between central stability and CMJ jump and stated that it seems that increasing the strength of the core region can improve the CMJ jump (Fazl Ers et al., 2015). According to McGill's opinion, the central muscles of the body do not produce power by themselves, but during sports activities, they can transfer the power produced in the hip joint to other parts of the body while keeping the trunk stable (McGill, 2010). Since the muscles of the central region of the body improve in 11+ exercises, this

increase in the index could be explained. In addition, the increase in strength due to training and a significant increase of jumps with and without extra weight are the causes of significant changes in the Bosco index. As mentioned, this increase is due to the increase in strength and possibly the effect of strength training in the central part of the body and lower limbs. In this study, two points are emphasized that can be a good reason to improve the Bosco index; First, special warm-up exercises can reduce the number of injuries by increasing and improving factors such as strength, power and balance in the joints and muscles of the thighs, knees, ankles and especially the central area of the body. The second point is, teaching and correcting movement spatially in landing technics after the jump, during the exercise program, which is effective in performance directly and reducing injury indirectly.

The literature on the relationship between the risk of injury and muscle strength and balance of women volleyball players reported a significant relationship between the amount of jump and peak torque in knee flexion and extension, as well as dynamic balance (Soylu et al., 2020). In the study Vitale et al. (2018) It was also shown that after the implementation of the FIFA 11+, the static, dynamic balance performance and proprioception of professional football players increased (Vitale et al., 2018). Stephen et al. examined the effect of the 11+ warm-up program on the balance performance of female players among 31 teams and found that the program had a significant effect on the balance performance of young female and adolescent footballers (Steffen et al., 2013). Balance exercises cause a series of neuromuscular adaptations in the human body, which are responsible for improving the sense of depth and balance resulting from exercise (Hrysomallis, 2011). Previous studies have shown that core muscle resistance training, balance, has improved the performance of both legs of football, basketball and volleyball players (Myer et al., 2005). FIFA 11+ training include dynamic balance such as hoping and landing and also core muscle training (i.e. plank exercises) which could explain these improvements.

The balance index consists of a functional structure in the lower limb that includes the three joints, hip, knee and ankle joint, which measures the functional balance of the upper and lower knee and indicates the neuromuscular function of these three joints during the jump. A value greater than or equal to 2.3 ($\geq$ 2.3) indicates a good equilibrium as the neuromuscular function of the whole foot, including the upper and lower extremities, and a value less than 2 (<2) indicates the neuromuscular function of the knee and ankle is weaker than hip. In the present study, the mean of this index was less than 2, which indicates that the neuromuscular function of the knee and ankle was weaker than the hip. A similar result was reported in a study on runners, jumpers, and track and field athletes in 2017 (Zhang et al., 2017).

In the present study, modified FIFA 11+ increased the balance, although the average balance of the players is still less than 2. Possible reasons for improving balance should be synchronizing of large fast twitch and motor units, stimulating the muscle spindles, also reducing the self-controlling effect of the Golgi organs, and increasing the coordination of muscles involved in co-contraction resulting from the jumping part of the exercise program (Docherty et al., 1998). By stimulating the muscle spindles, muscle contraction increases the activity of gamma efferent nerves in the spindles and increasing this sensitivity in the spindles improves the sense of joint position, which has a great effect on joint control (Zebis et al., 2008). Another possible causes of increased equilibrium are performing exercises on the sand, which by reorganizing the nervous-central system and sensory-motor integration will change the motor pulse, change the feedback of the mechanoreceptors and improve proprioceptive and balance (Heidt et al., 2000). On the other hand, activation of proprioceptive receptors, preparation of motor neurons in a group of muscles and joints to perform movement, increase coordination and integration of motor units, co-contraction of synergist muscles and increase inhibition of antagonist muscles can be effective (Cook et al., 2006).

The previous studies support which landing exercises, interval jumping and controlled jump could reduce injuries (Benet-Vigo et al., 2021). Heidt and et al. reported that teaching landing and preprogram landing effect on jumping technics and prevent knee injuries (Heidt et al., 2000). The same study on elite volleyball players showed a decrease in ACL injuries (Ljungqvist et al., 2009). The subjects in the present study were elite beach soccer players who had high technique and physical fitness.

## CONCLUSION

However, after the implementation of this program, they had 3-point improving of the Bosco index that indicated an increased strength of the players, which was effective in the correct performance of the technique, especially in fatigue, which can be a reason to reduce injury. However, these players had little knowledge of basic skills such as jumping and, more importantly, landing techniques. This may be due to a lack of training and practice of basic skills. Since the 11+ exercise protocol including training and correction of jumping and landing movements, a significant improvement in the Bosco index after the intervention can be explained by increasing the skill level. Therefore, it could be recommended that players, even at top and elite levels, teach basic movement and practice. The modified FIFA 11+ should be done by beach soccer players at all skill levels to improve performance and prevent injuries.

## PRACTICAL APPLICATIONS

In general, according to the results of this study, which is one of the first reports in the field of beach soccer in our knowledge, on the results of this study indicated that the modified FIFA 11+ warm-up training program improved performance indicators. The results showed that the FIFA 11+ warm-up training program had a significant effect on the performance indicators of balance, power and Bosco index. Since these exercises include jumping, plyometric and balance training, and proprioceptive exercises and core training, which were performed on the sand field, it can be concluded and recommended for beach soccer players to improve their performance.

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