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Research Article

Investigating the Effectiveness of an Exercise Protocol for Dynamic Balance in Amateur Female Soccer Players: A Randomized Clinical Trial

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ABSTRACT

Introduction: Women's soccer and preventive training strategies have gained popularity in the last decade; accordingly, this study determines the effectiveness of a dynamic balance exercise protocol in amateur soccer players.

Materials and Methods: A total of 24 females participated in this study and were randomly assigned to a control (n=12) and an experimental group (n=12). The experimental group received a dynamic balance exercise intervention with three weekly sessions for six weeks, while the control group maintained regular training. Balance was assessed before and after by the Y balance test in its anterior, posterior medial, and posterior lateral directions. The data were analyzed through the t-test for independent and related samples.

Results: The analysis of this study shows significant improvements in dynamic balance (P=0.000) in the experimental group after the intervention of the dynamic balance exercise program for six weeks, while in the control group, there were no significant improvements.

Conclusion: Dynamic balance exercise programs can be used to increase the balance of amateur female soccer players.

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Introductions

Women's football is a discipline that demands a unique combination of physical and mental skills; speed, coordination, endurance, and agility are just some of the attributes players develop [1, 2]. However, beyond the sporting aspect, this discipline has been confirmed to be a powerful driver of social change, promoting gender equality and empowering women worldwide. As a contact sport, it entails injuries associated with factors such as age, sex, player level, and prior injuries. Reportedly, women are at higher risk of sustaining knee and ankle injuries [3, 4].

Regarding injuries and the player's level of experience, the risk appears to be heightened among younger players who practice the sport recreationally [5]. Unlike professional athletes, amateur players balance their academic or work responsibilities with their football practice. This dual role results in less exclusive dedication to training, which translates into less specialized physical preparation and limited access to high-quality resources such as sports equipment and technical monitoring [6, 7].

Injury prevention in football is essential for optimizing athletic performance [8]. An injury-free player can train consistently and with greater intensity, leading to continuous improvement in technical and physical skills. Furthermore, avoiding long recovery periods minimizes the loss of physical condition and ensures greater availability for matches. The confidence derived from feeling safe and protected from injuries motivates players to perform at their best, which, in turn, benefits the team [9, 10].

The importance of injury prevention programs for football players has been highlighted in previous research, emphasizing various strategies, such as balance training to improve proprioception, muscle strengthening, core-focused exercises, and specific variations of plyometric drills [11-13]. Balance training through exercises involving diverse positions can modify afferent input and enhance proprioception, yielding positive effects on athletes' equilibrium. Previous studies [14, 15] have demonstrated that this type of training improves balance in basketball players. However, there is limited evidence regarding such training in female football players. Accordingly, this study determines the effectiveness of an exercise protocol for dynamic balance in amateur female football players [16].

Materials and Methods

Study design

The design of this research is a prospective cohort study comprising a sub-analysis of a randomized clinical trial to determine the effectiveness of the exercise protocol for dynamic balance of female soccer players. Measurements were taken before and after the intervention of 24 athletes aged 20 to 23 years, who met the inclusion requirements to subsequently form part of the experimental group (EG) and the control group (CG) whose allocation was randomized to eliminate any bias. This research was executed for 6 weeks from May to June 2024, in compliance with the declaration of Helsinki.

Sampling method

The sampling was intensive to recruit eligible athletes. The population of this research is beginner women footballers who have joined the university football team within the last 8 months and actively participate in training sessions of the soccer team at the Universidad Nacional de Chimborazo between the ages of 20 and 23 years. A total of 40 soccer players were evaluated using a self-informed questionnaire. After the selection process, 24 players who fulfilled all the inclusion criteria were recruited for this research.

Study population and recruitment

The inclusion criteria were as follows: 1) Female soccer players from female teams of the Universidad Nacional de Chimborazo; 2) Athletes between the ages of 18 to 23 years; 3) Subjects free of injuries; 4) Previous experience of at least one year practicing soccer; 5) Having a training frequency twice a week [17]. Meanwhile, the following subjects were excluded: 1) Soccer players with a history of injury in the last six months; 2) Subjects with neurological or vestibular dysfunctions affecting balance control; 3) Athletes with alterations in any of the joints of the lower extremities [15].

The research was socialized in person with the soccer players, and they were also informed of the study through their e-mails and cell phones. All the athletes were freely invited to be part of the research. Individuals interested received written information and it was emphasized that participation before and during the study was voluntary; each player could refuse or withdraw at any time during the study. Finally, before filling out the participation form, the volunteers had to read and understand all the information about the study, complete the form, and register their consent to participate.

Investigation procedure

A total of 24 soccer players comprising the entire sample were randomly assigned into two groups, namely EG and CG. Both groups intervened simultaneously, the average duration of each session was 45 min. The subjects of the experimental group performed a protocol of balance exercises with a frequency of three sessions per week, for six weeks, totaling 18 sessions.

The control group, in contrast, participated in a training program comprising warm-up exercises, strength training, agility drills, sports-specific movements, and stretching exercises, maintaining the same duration, number of sessions, and frequency as the experimental group.

Before the intervention, all participants were verified for informed consent and resocialized about each study procedure. Furthermore, they were informed that they could voluntarily withdraw at any time from the research without giving any reason. To obtain the study results of each group, the athletes underwent the Y balance test, which was initially performed as a test to familiarize each subject with the test to avoid errors that could affect the results. The test was performed at the beginning and the end of the study.

Exercise protocol for balance

The EG underwent the protocol of exercises for balance that was executed during their routine training, this protocol has a duration between 25 and 30 min, adding to the athlete's training proprioceptive training to improve motor coordination in the central nervous system. The protocol is based on the postural change of the athlete by executing various positions as described by Lee et al. [15], a) tandem, b) split squat, c) single leg, d) bilateral jump and landing, e) single leg jump and landing. All exercises increased in difficulty around the time of execution, the degree of effort of each athlete, and the combination of exercises (Figure 1). The protocol was executed gradually in each athlete to increase the proprioceptive effort, a determining factor in obtaining a better balance through sensorimotor integration.

Research measurement instrument

The balance of female soccer players was determined by the Y balance test [15], the athletes had to balance on only one of their lower limbs, while the limb in the air had to try to reach the farthest distance in several directions, namely a) anterior, b) posterolateral, and c) posteromedial (Figure 2). Before taking the official measurements, the subjects performed a pre-test.

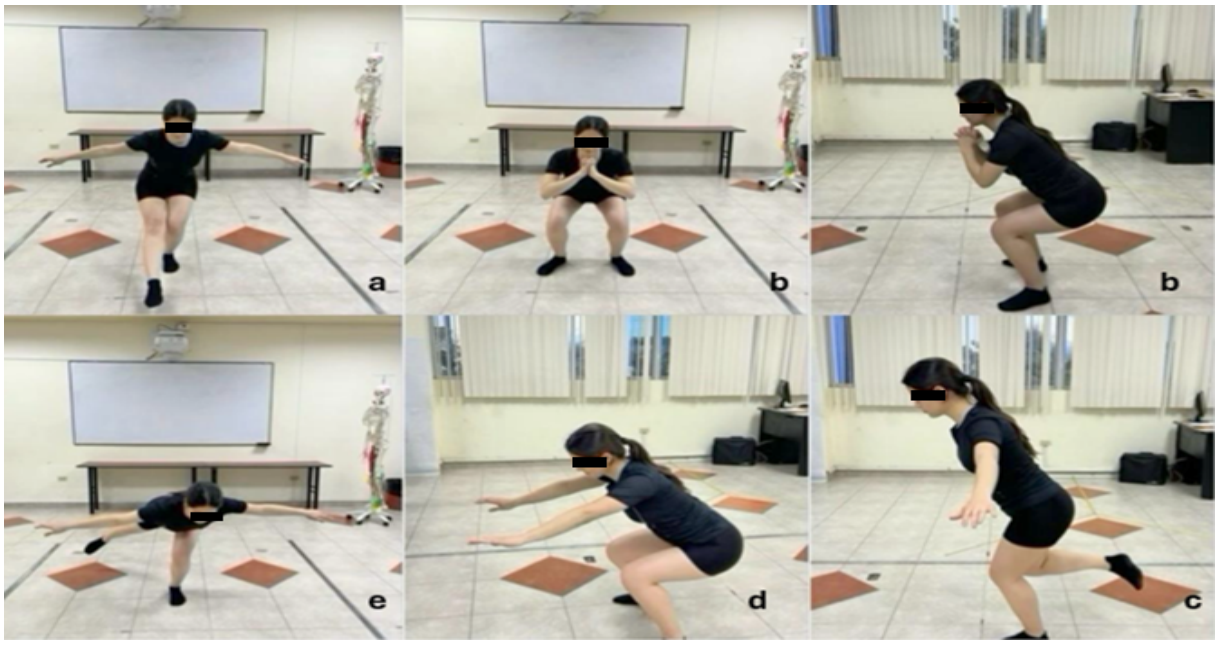

Figure 1. Balance exercises

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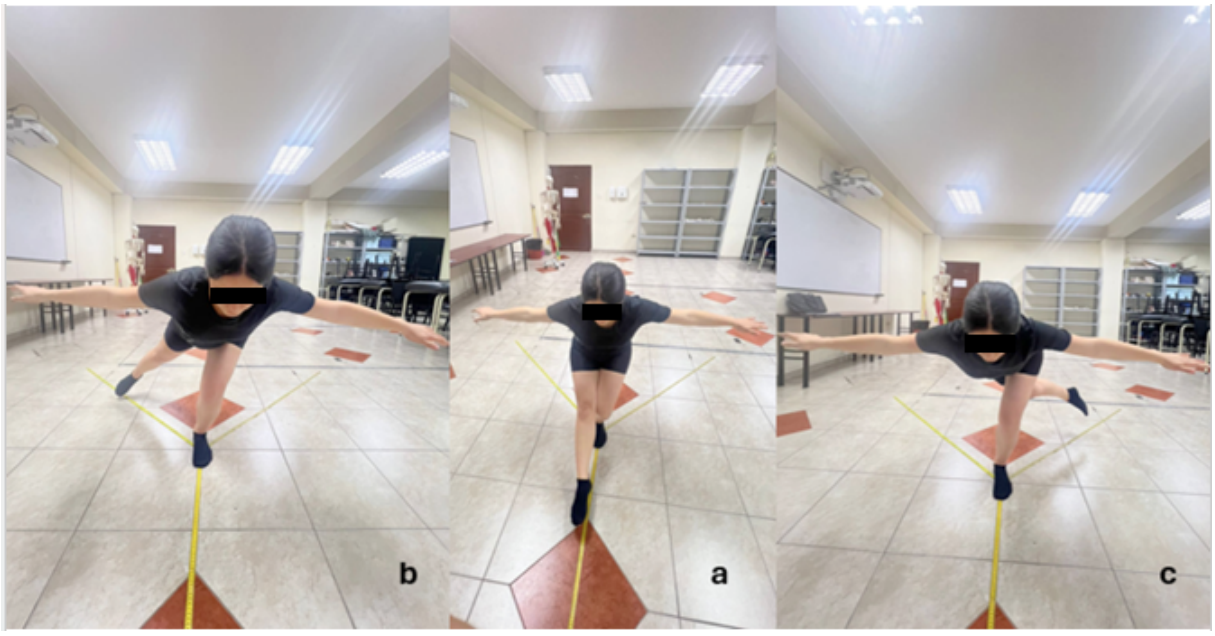

Figure 2. Y Balance test

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Data collection

The subjective and objective data of each athlete were collected through the clinical history. As for the dynamic balance was determined by the Y balance test these data were initially recorded in the Excel program from the Microsoft 365 Office package, for subsequent analysis in the SPSS software, version 29.

Statistical analysis

The measures obtained by the Y balance test were analyzed in SPSS software, version 29 through the t-test for independent samples to compare the difference in the dependent variable between the experimental group and the control group. The t-test for related samples to compare the difference before and after the intervention in the experimental group to determine the effectiveness of the exercise protocol for the dynamic balance of beginner female soccer players. The significance level was predetermined at $P<0.05$.

Results

The demographic data of the participants in this research are characterized by similarity in age, height, and weight, confirming a homogeneous group. The descriptive characteristics of the 24 participants are shown in Table 1.

Table 2 shows the result of the comparison between the control group and the experimental group for dynamic balance in absolute reach before the intervention. The pre-intervention absolute values of dynamic balance in the control group (63.83±8.08 cm) and the experimental group (75.29±6.43 cm) revealed that there was no significant difference, showing that the group was homogeneous before the intervention (P=0.002). The intervention of the experimental group lasted 18 motor training sessions achieving a significant difference with an absolute range (P=0.000) between the control group (64.01±7.85 cm) and the experimental group (81.76±5.39 cm).

The absolute results of the experimental group before 75.29 cm and after the intervention 81.76 cm during 18 motor training sessions show an increase of 6.47 cm. The results of the intervention in the experimental group show a significant improvement in dynamic balance in absolute reach (P=0.000; Table 3).

Discussion

Various authors, such as Benis et al. performed an intervention using body weight neuromuscular exercises for 8 weeks to improve postural control and stability of the lower extremities in female basketball players, with no history of injury. Where neuromuscular warm-up exercises were performed in the experimental group and the control group standard warm-up, the workouts were performed for 8 weeks, and the exercises progressed from a stable to an unstable position to increase lower

Table 1. Demographic data of the experimental and control groups

Variables	Experimental Group (n=12)	Control Group (n=12)
Age (y)	21.33±0.88	21.42±0.69
Height (cm)	155.92±4.64	154.08±4.73
Weight (kg)	59.0±9.06	57.0±4.30

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Table 2. Pre-test and post-test of dynamic balance in the control and experimental groups in absolute range

Stages	Control Group	Experimental Group	P
Pre-test	63.83±8.08	75.29±6.43	0.002
Post-test	64.01±7.85	81.76±5.39	0.000

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Table 3. Pre-test and post-test of dynamic balance in the experimental group in absolute range

Group	Pre-test	Post-test	P
Experimental	75.29±6.43	81.76±5.39	0.000

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extremity strength demand and stability, while the control group performed aerobics, the authors added body weight plyometric exercises to the experimental group to train the core muscles and activate the nervous system concluding that the scores on the Y balance test Postero medial improve in the experimental group, the same author alludes that the program also increases joint awareness and improves postural control [18].

On trunk stabilization exercises Filipa et al., Granacher et al., Imai et al., and D'souza et al., share programs based on core training or trunk stabilization through different sets of exercises [19-22]. Filipa et al. describe it as an objective to determine whether a neuromuscular training program focused on core stability and strength in the lower extremities would affect the performance of the balance test star exclusion balance test (SEBT). The experiment was performed on 20 non-injured soccer players by applying an 8-week program, due to the intervention in 16 sessions, there was evidence of improvement in the balance score measured with the SEBT, especially in the posterolateral and posteromedial reach, due to better neuromuscular control in the lower extremities [19].

Granacher et al. run a 6-week intervention program comparing core strength training on unstable versus stable surfaces, achieving improvements in balance, coordination, and speed, attributing its cause to the improvement in anticipatory muscle activation which is the basis for functional movements providing stability from the trunk to the lower extremities [20].

Imai et al. similarly performed trunk stabilization exercises and conventional trunk exercises to improve balance and strength, showing that trunk stabilization exercises improve static balance immediately and also sports performance. Adjudicating these improvements in the postero-lateral and posteromedial directions of the SEBT [21].

The primary finding of this study was that a 6-week balance training program, utilizing progressively challenging exercises, proved beneficial by yielding significant improvements in Y balance test measurements. Accordingly, the specific exercise-based intervention had a positive effect on participants' balance compared to the control group, particularly regarding dynamic balance training. Therefore, the literature supports the use of trunk musculature training to improve balance, thus it is often found in a multitude of training to prevent ankle or knee injuries because decreased neuromuscular control of the trunk influences the dynamic stability of the lower extremity during high-speed athletic maneuvers [23].

McKay et al. conducted a treatment to evaluate the relationship between hip strengthening and pain in female runners with iliotibial band syndrome, through assigned groups that used conventional exercise, stretching, or strengthening of the hip muscles, the hypothesis was based on adding progressive complexity to the basic exercises for 8 weeks, the Y balance test was used to measure the differences in the patients, resulting that the stretching and hip training group improved the balance test mentioned in the patients, therefore it is also important to emphasize that functional exercise, including sport-specific movements improves balance and mobility [24].

Lee et al. conducted a six-week study, which, unlike ours, performed perturbations during the execution of the exercises and showed significance when measuring dynamic balance. The author indicates that proprioception is an important factor in maintaining dynamic balance and sensation of the limbs in space, especially necessary in basketball athletes who need a dynamic balance that includes perturbation due to the nature of the game [25].

The present study was developed in female soccer players, a sport that requires constant movement changes and joint stability, so balance training is key to obtaining mechanical advantages and minimizing the overload or injury complexes on the ankle, although this study has focused on improving balance. In the future, it is of interest to project ourselves to the prevention of frequent injuries in women's soccer teams and detect possible predictions of lower body injuries based on balance.

Conclusion

The dynamic balance exercise program executed for six weeks with eighteen sessions promotes a significant improvement of balance in amateur female soccer players. This could contribute to injury prevention protocols; however, it is important to emphasize that more studies are needed that relate balance to the prevention of lower extremity injuries in women.

Study limitations

The study was limited by a small sample size.

Ethical Considerations

Compliance with ethical guidelines

This research was registered in the clinical trial database of the Neurofit ec physical rehabilitation center (CEINF00010) and was approved by the Research Ethics Committee of the comprehensive physical rehabilitation center (N°2/2024 approval date February 11, 2024).

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Authors' contributions

Conceptualization and Supervision: Shirley Mireya Ortiz Pérez and David Marcelo Guevara Hernández; Methodology: Shirley Mireya Ortiz Pérez and David Marcelo Guevara Hernández; Data collection: Shirley Mireya Ortiz Pérez and Fernando Daniel Álvarez Maigualema; Data analysis: Vanessa de los Ángeles Belloso de Noriega and David Marcelo Guevara Hernández; Investigation and Writing: Shirley Mireya Ortiz Pérez and David Marcelo Guevara Hernández.

Conflict of interest

The authors declared no conflict of interest.

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