



Unveiling the Impact of Anaerobic Soccer Training and Small-Sided Games on Soccer Player's Body Composition

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Abstract

Background. While soccer research has concentrated on enhancing physical, technical, tactical, and mental abilities, this study uniquely shifts the focus to body composition, a relatively unexplored area, particularly among amateur soccer players.

Objectives. This study aimed to compare the effects of Anaerobic Soccer Training (AnST) and Small-Sided Games (SSG) on a range of body composition parameters, including body weight (BW), body mass index (BMI), total body water (TBW), body fat mass (BFM), percentage of body fat (PBF), fat-free mass (FFM), and skeletal muscle mass (SMM) in amateur soccer players.

Materials and methods. Thirty amateur soccer players (mean age: 19 ± 0.63 years) were randomly assigned to two groups: AnST ($n = 15$) and SSG ($n = 9$). Both groups underwent a four-week training intervention with three sessions per week. Body composition was assessed before and after the intervention using the INBODY 270 device. Data were analyzed using paired t-tests and independent t-tests for normally distributed variables, while the Wilcoxon test was applied to non-normally distributed data.

Results. The AnST group showed a significant reduction in BFM and PBF compared to the SSG group ($p < 0.05$). Additionally, AnST led to more substantial increases in SMM and TBW ($p < 0.05$), while no marked difference in BW was observed between groups. BMI decreased in both groups due to muscle mass redistribution.

Conclusions. The findings of this study underscore the superiority of AnST over SSG in enhancing body composition parameters, particularly by increasing SMM and reducing BFM. These results provide valuable insights for optimizing soccer training programs at both amateur and professional levels, enlightening coaches, athletes, and other stakeholders in the sports industry.

Keywords: anaerobic soccer training, small sided games, body composition, amateur soccer players.

Introduction

Amateur soccer is a form of sport played by non-professional athletes who do not have contractual obligations and do not compete in major professional leagues (Woods et al., 2023). Although it is played in a more flexible setting compared to professional soccer, players still require

endurance (Wołoszyn, 2019), speed (França et al., 2022), and optimal body composition (Lukaski & Raymond-Pope, 2021). However, traditional training methods often focus on isolated aspects such as physical conditioning, technical skills, or tactical awareness without integrating them comprehensively. This approach is less effective in addressing the complex demands of competition, making it insufficient for achieving optimal performance. A more effective training method is needed to meet these demands, simultaneously incorporating physical and tactical elements (Kusuma et al., 2024).

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A holistic approach is increasingly regarded as more effective, as it integrates physical conditioning and technical skills within a single training program. One widely adopted method is small-sided games (SSG), which involve fewer players, a smaller pitch, and shorter durations than full matches (Castillo et al., 2021). This method emphasizes technical and tactical aspects, as players must make quick decisions in dynamic game situations (Klingner et al., 2022). Another emerging method is anaerobic soccer training (AnST), which is specifically designed to address the demands of repeated sprint efforts that are essential in soccer matches. This training model focuses on high-intensity running distances, sprint frequency, and sprint duration while incorporating technical and tactical components (Kusuma et al., 2025).

Kusuma et al. (2025) reported that a six-week AnST program significantly improved aerobic endurance, sprint speed, and overall physical performance. Similarly, studies by Ouertatani et al. (2022) and Özcan & Şahan (2018) demonstrated that SSG effectively enhances aerobic endurance and game-related skills. While both training methods have been proven to enhance player performance, limited research has specifically examined their impact on body composition parameters. Key metrics such as body weight, body mass index (BMI), total body water (TBW), body fat mass (BFM), and skeletal muscle mass (SMM) have not been comprehensively explored. Since body composition is a crucial component of physical fitness, closely linked to physiological conditions (Li et al., 2022) and athletic performance (Lukaski & Raymond-Pope, 2021), further investigation is warranted. For instance, maintaining an optimal balance between muscle and fat mass can influence speed, strength, and endurance during matches (Lukaski & Raymond-Pope, 2021). Moreover, monitoring body composition provides valuable insights into the effectiveness of training programs (Staśkiewicz et al., 2023). Therefore, it is essential to identify training models that enhance physical and technical performance and contribute to effective body composition management.

This study aims to bridge this gap by comprehensively evaluating the physiological adaptations of AnST and SSG in amateur soccer players. The novelty of this research lies in its focus on key body composition parameters, including body weight, BMI, TBW, BFM, and SMM. The findings not only contribute significantly to developing soccer training programs at both amateur and professional levels but also offer practical guidance for coaches, athletes, and other stakeholders in the sports industry. This empowers them with actionable knowledge while enriching the existing body of scientific literature in sports science.

Materials and Methods

Study Participants

This study involved 30 amateur soccer players with an average age of 19 ± 0.63 years, a body weight of 62.04 ± 5.49 kg, a height of 165 ± 5.33 cm, and a BMI of 21.75 ± 1.85 kg/m². The participants were randomly assigned to two groups: Group A (AnST), consisting of 15 players, and Group B (SSG), which initially consisted of 15 players. However, during the study, six participants from the SSG group were unable to continue due to illness, leaving a final sample of 9 players in this group.

A detailed overview of the participant characteristics can be found in Table 1. All subjects were verified to have no underlying medical conditions, with health status confirmed through personalized medical interventions where necessary. Before participation, all players provided informed consent after a comprehensive explanation of the study's objectives, potential risks, benefits, and procedures, ensuring their voluntary agreement to undergo the intervention.

Study Organization

This study employed a two-group pre-test and post-test design, comparing anaerobic soccer training (AnST) and small-sided games (SSG). Both groups underwent a pre-test to assess body composition capacity. The first group participated in AnST for four weeks with a frequency of three weekly sessions, while the second group engaged in SSG training with the same duration and frequency. After the four-week intervention, a post-test was conducted to reassess body composition parameters.

Training Program

The first group received the AnST intervention, which combined speed endurance training (SET) and small-sided games (SSG) with a work-to-rest ratio of 1:1. The SSG area was set at 20×20 meters, where each player performed repeated shuttle sprints over distances of 5 meters, 10 meters, and 15 meters before engaging in an SSG session. The total sprint distance per repetition was 60 meters, with estimated sprint times of approximately 2–3 seconds for 5 meters, 4–5 seconds for 10 meters, and 6–7 seconds for 15 meters, summing up to around 15 seconds of sprinting. At the beginning of each session, players completed the 60-meter shuttle sprint before immediately transitioning to a 1-minute SSG focused on ball possession. Following each sprint and SSG sequence, a recovery period equal to the combined duration of the sprint and SSG (approximately 1 minute 15 seconds) was provided, maintaining a 1:1 work-to-rest ratio. This sequence was repeated 10 times, resulting in a total training duration of approximately 25 minutes, including sprinting, SSG, and recovery. Over the entire session, each player completed a total sprint distance of 600 meters (Kusuma et al., 2025). The second group underwent the SSG intervention in a 4v4 format with one neutral player. They aimed to maintain ball possession without any touch limitations for as long as possible. The SSG protocol consisted of four matches, each lasting four minutes, played on a 30×20 -meter field without goalkeepers. Each match was followed by a two-minute passive recovery period. When the ball went out of play, a replacement ball was immediately introduced to ensure continuous play (Bujalance-Moreno et al., 2020).

Body Composition Test

Next, all participants underwent a pre-test body composition assessment using the INBODY 270 device. The measured parameters included body weight (BW), body mass index (BMI), total body water (TBW), body fat mass (BFM), fat-free mass (FFM), percentage of body fat (PBF), and skeletal muscle mass (SMM). This assessment provided detailed insights into the physiological characteristics

of the participants, which are essential for analyzing the effectiveness of the training intervention and monitoring athletic performance with accuracy and consistency. To ensure precise measurements, researchers required participants to remove any jewelry or conductive metal objects in contact with the skin. Before the assessment, their hands and feet were cleaned with alcohol wipes. During the measurement, participants stood on the electrode platform while holding the electrode handles with arms extended at approximately 30°. To minimize potential errors, food, beverages, alcohol, caffeine, and intense physical activity were restricted for at least six hours before testing.

Statistical Analysis

This study used the Shapiro-Wilk test to assess whether the data followed a normal distribution. If the results indicated normality, within-group analyses were conducted using a paired t-test. However, the non-parametric Wilcoxon test was applied for analysis if the data were not normally distributed. All statistical analyses were conducted using SPSS software version 29.0

Results

Table 1. Characteristics Subjects

| Characteristics of Research Subjects | AnST (n=15) mean ± SD | SSG (9) mean±SD |
|--------------------------------------|-----------------------|-----------------|
| Age (years) | 19 ± 0.63 | 19 ± 0.72 |
| Body Weight (kg) | 61.86 ± 4.12 | 62.7 ± 6.74 |
| Body Height (cm) | 165 ± 5.33 | 168 ± 5.80 |
| Body Mass Index (kg/m ²) | 22.2 ± 1.79 | 21.5 ± 2.06 |
| BMI Category (n, %) | | |
| Mild Thinnes | 1 (6.7) | 0 |
| Normal | 12 (80) | 8 (88.9) |
| Overweight | 2 (13.3) | 1 (11.1) |
| Basal Metabolic Rate | 1459 ± 81.70 | 1495 ± 112.65 |
| Visceral Fat Level | 4 ± 1.40 | 3 ± 1.74 |

Table 1 provides an overview of the research subjects in the AnST and SSG groups. Both groups had an average age of 19 years, with similar body weight and height of 62.7 kg and 168 cm for the SSG group, slightly higher than the 61.86 kg and 165 cm in the AnST group. For BMI, the AnST group had a mean BMI of 22.2 ± 1.79 kg/m², while the SSG group had a slightly lower average of 21.5 ± 2.06 kg/m². Most participants in both groups fell into the normal BMI category (80 % in AnST and 88.9 % in SSG), though a small percentage in each group was classified as overweight (13.3 % in AnST and 11.1 % in SSG). Only one participant in the AnST group (6.7 %) was categorized as having mild thinness, while none in the SSG group. When looking at BMR, which represents the number of calories the body burns at rest, the SSG group had a slightly higher average (1495 kcal) than the AnST group (1459 kcal). In terms of visceral fat level, which indicates fat stored around internal organs, the AnST group had a level of 4, whereas the SSG group had a slightly lower level of 3.

Table 2. Descriptive Statistics (Mean ± SD) of Body Composition Parameters Pre- and Post-Intervention in AnST and SSG Groups

| Parameter | Group | Pre-test Mean ± SD | Post-test Mean ± SD |
|---------------------------|-------|--------------------|---------------------|
| Body Weight (kg) | AnST | 61.86 ± 4.12 | 61.73 ± 4.07 |
| Body Weight (kg) | SSG | 62.77 ± 6.74 | 62.55 ± 7.55 |
| BMI (kg/m ²) | AnST | 22.26 ± 1.79 | 21.93 ± 1.66 |
| BMI (kg/m ²) | SSG | 21.55 ± 2.06 | 21.44 ± 2.18 |
| Total Body Water (L) | AnST | 36.40 ± 2.79 | 37.00 ± 2.85 |
| Total Body Water (L) | SSG | 37.77 ± 3.86 | 38.55 ± 4.39 |
| Body Fat Mass (kg) | AnST | 11.46 ± 3.56 | 10.53 ± 3.33 |
| Body Fat Mass (kg) | SSG | 10.33 ± 4.06 | 9.22 ± 3.86 |
| Fat-Free Mass (kg) | AnST | 50.06 ± 3.76 | 50.73 ± 3.82 |
| Fat-Free Mass (kg) | SSG | 51.66 ± 5.22 | 52.77 ± 5.97 |
| % Body Fat (PBF) | AnST | 18.46 ± 5.08 | 17.20 ± 1.84 |
| % Body Fat (PBF) | SSG | 16.44 ± 5.07 | 14.88 ± 4.72 |
| Skeletal Muscle Mass (kg) | AnST | 28.00 ± 2.03 | 28.40 ± 2.29 |
| Skeletal Muscle Mass (kg) | SSG | 28.88 ± 3.25 | 29.22 ± 3.70 |

Table 2 shows the mean pre-test and post-test changes for body composition parameters in the AnST and SSG groups. The AnST group experienced a reduction in body weight and BMI, as well as an increase in total body water (TBW), fat-free mass (FFM), and skeletal muscle mass (SMM). Meanwhile, the SSG group also showed reductions in body fat mass (BFM) and percentage body fat (PBF), though with smaller changes compared to the AnST group. Overall, both groups demonstrated reductions in body fat mass and increases in fat-free mass and body water, with more consistent effects observed in the AnST group.

Table 3. Normality test Resultsfor Body Composition in AnST and SSG Groups

| Parameter | Group | Shapiro-Wilk | |
|---------------------------|-------|--------------|-----------|
| | | Pre-test | Post-test |
| Body Weight (kg) | AnST | 0.607 | 0.775 |
| | SSG | 0.171 | 0.162 |
| BMI (kg/m ²) | AnST | 0.304 | 0.077 |
| | SSG | 0.492 | 0.616 |
| Total Body Water (L) | AnST | 0.365 | 0.148 |
| | SSG | 0.654 | 0.441 |
| Body Fat Mass (kg) | AnST | 0.053 | 0.060 |
| | SSG | 0.229 | 0.070 |
| Fat-Free Mass (kg) | AnST | 0.394 | 0.251 |
| | SSG | 0.301 | 0.372 |
| % Body Fat (PBF) | AnST | 0.045* | 0.154 |
| | SSG | 0.108 | 0.039* |
| Skeletal Muscle Mass (kg) | AnST | 0.322 | 0.487 |
| | SSG | 0.404 | 0.409 |

Note: * showed statistically insignificant results (p < 0.05)

Table 4. Paired and Wilcoxon Test Results for Body Composition Changes in AnST and SSG Groups

| Variable | AnST (p-value) | SSG (p-value) | Significant Change in AnST | Significant Change in SSG |
|----------------------------|----------------|---------------|----------------------------|---------------------------|
| Body Weight | > 0.05 | > 0.05 | No | No |
| BMI | 0.019 * | > 0.05 | Yes | No |
| Total Body Water (TBW) | 0.023 * | 0.111 | Yes | No |
| Body Fat Mass (BFM) | < 0.001 * | 0.007 * | Yes | Yes |
| Fat-Free Mass (FFM) | 0.007 * | 0.062 | Yes | No |
| Percentage Body Fat (PBF)† | 0.011 * | 0.018 * | Yes | Yes |
| Skeletal Muscle Mass (SMM) | 0.028 * | > 0.05 | Yes | No |

Note: * indicates a statistically significant result ($p < 0.05$) and † using the Wilcoxon test.

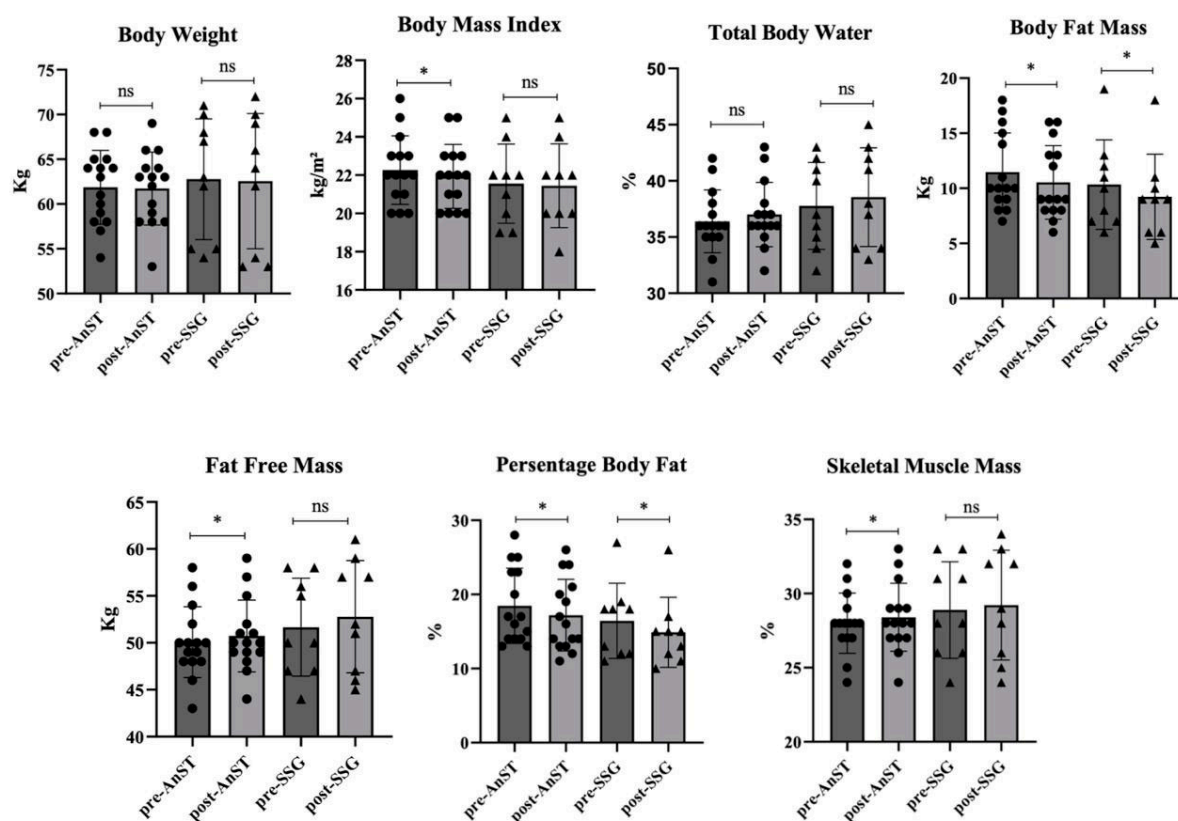


Fig. 1. Effects of Anaerobic Soccer Training (AnST) and Small-Sided Games (SSG) on Body Composition Parameters

The results of the Shapiro-Wilk normality test in table 3 show that most of the data on body composition in both the AnST and SSG groups show normal data distribution as indicated by p values > 0.05 in all pre-test and post-test parameters. However, there are data that are not normally distributed, namely in the pre-test body fat percentage parameter ($p = 0.045$) in the AnST group and the SSG group during the post-test ($p = 0.039$).

Table 4 summarizes the statistical analysis results using paired t-tests to compare pre-test and post-test values of body composition variables in the AnST and SSG groups. The analysis shows which variables experienced significant changes ($p < 0.05$) in each group. Significant improvements were more consistently observed in the AnST group, indicating its greater effectiveness in modifying body composition parameters compared to the SSG group. This is more clearly displayed in Figure 1 below.

Fig. 1 above shows the pre-test and post-test values of various body composition parameters, including body weight, BMI, total body water (TBW), body fat mass (BFM), fat-free mass (FFM), percentage body fat (PBF), and skeletal muscle mass (SMM) for both the AnST and SSG groups. The data highlights the changes in these parameters after the intervention, with significant improvements observed particularly in body fat mass, fat-free mass, and skeletal muscle mass in the AnST group compared to the SSG group.

Discussion

This study aims to compare AnST and SSG training in relation to changes in specific body composition parameters in amateur soccer players. The findings indicate that AnST training is significantly more effective in altering body com-

position. The data show that the AnST group experienced more favorable body composition changes than the SSG group. This difference suggests that high-intensity training, such as AnST, provides a superior physiological stimulus for amateur soccer players. Previous studies have demonstrated that AnST significantly enhances anaerobic capacity in soccer players. The AnST model combines speed endurance training (SET) with soccer-specific exercises (Kusuma et al., 2025). It is highly beneficial for amateur players with limited training time, requiring efficient and practical training.

The results of this study indicate that although BMI decreased, body weight remained stable after AnST and SSG training interventions. This stability can be attributed to increased muscle mass occurring concurrently with a reduction in fat mass. High-intensity training, such as HIIT and anaerobic exercises, has been shown to effectively stimulate muscle hypertrophy through the activation of the anabolic mTOR (mammalian target of rapamycin) pathway without causing significant weight loss (Biglari et al., 2020; Uemichi et al., 2021). This adaptation not only increases muscle volume but also enhances muscle tissue structure. Additionally, previous research Atakan et al. (2022) has highlighted that HIIT's excess post-exercise oxygen consumption (EPOC) effect contributes to fat reduction while preserving muscle mass. Consequently, the observed changes in body composition reflect a redistribution of muscle and fat mass rather than overall weight loss. Increased muscle mass may also contribute to improved bone density and body fluid volume, which help maintain a stable body weight despite changes in body fat percentage (Tomlinson et al., 2019). Therefore, decreasing BMI without significant weight loss can positively indicate successful training adaptation, reflecting improvements in body composition quality.

The results also indicate that AnST and SSG training did not reduce total body water (TBW); an increase was observed following the interventions. This increase can be linked to physiological adaptations to high-intensity training. Previous studies have reported that anaerobic and HIIT training can increase blood plasma volume through plasma expansion mechanisms, improving body hydration (Nelson et al., 2023). Other physiological adaptations, such as increased muscle glycogen storage, may also play a role in TBW elevation. Glycogen in muscles can bind large amounts of water, thereby increasing total body fluid volume without causing noticeable changes in body weight (Shiose et al., 2022). Metabolic adaptations during high-intensity training interventions may also enhance fluid retention as part of the body's recovery and thermoregulation processes.

This study found that AnST was more effective in reducing body fat than SSG. The study examined overall body fat and analyzed body fat mass, body fat percentage, and fat-free mass. High-intensity AnST training burns more calories and sustains fat metabolism for longer due to the excess post-exercise oxygen consumption (EPOC) effect (Atakan et al., 2022; Jiang et al., 2024). High-intensity activities also enhance metabolic efficiency and stimulate aerobic and anaerobic systems, leading to more optimal energy utilization from fat stores (Chatterjee, 2023; Falk Neto & Kennedy, 2019). This results in reductions in body fat mass and body fat percentage. Consistent with previous studies, high-intensity training over three weeks has been shown to reduce body fat by -1.6% (Lee et al., 2020).

Furthermore, anaerobic training within the AnST model stimulates muscle growth and significantly increases fat-free mass (Benito et al., 2020). In contrast, SSG training does not always maintain consistently high intensity due to irregular rest periods and variability in gameplay. Factors such as smaller playing areas, an emphasis on tactical aspects, and a lack of controlled training load contribute to lower calorie expenditure compared to AnST (Clemente et al., 2021; López-Fernández et al., 2020; Silva et al., 2022). Consequently, reductions in body fat within the SSG group were less substantial than those observed in the AnST intervention. Additionally, players with lower body fat percentages demonstrate greater movement efficiency during matches (Bernal-Orozco et al., 2020).

Another key finding of this study is that AnST is more effective than SSG in increasing skeletal muscle mass. The superior capacity of AnST to stimulate muscle growth is evident. This training model incorporates explosive movements, such as sprinting and changes of direction, which enhance fast-twitch muscle fiber activation. This mechanical stress on muscle fibers triggers hypertrophic adaptations. Enhanced muscle protein synthesis also supports the increase in skeletal muscle mass, which occurs as an anabolic response to high-intensity training interventions (Witard et al., 2022). Research has indicated that anaerobic training improves strength, muscle mass, and overall soccer performance (Pomo Warih Adi et al., 2023).

On the other hand, SSG training does not effectively increase skeletal muscle mass. In SSG sessions, players engage more in tactical gameplay, off-the-ball movements, decision-making, and teamwork (Timmerman et al., 2019). Although some studies have noted that SSG training can improve aerobic endurance and speed (Hůlka & Strniště, 2021), the workload intensity imposed on muscles is not sufficiently high. Moreover, variability in gameplay and unstructured rest periods lead to minimal hypertrophic stimulus, resulting in lower muscle mass gains in SSG training compared to AnST interventions.

This study demonstrates that AnST interventions are more effective than SSG in reducing body fat and increasing total body water and skeletal muscle mass. While body weight remained stable, BMI decreased. However, several factors may influence these training outcomes. The primary differences between the two methods lie in training variations, key focus areas, and rest periods. AnST emphasizes high-intensity interval training, such as maximal sprinting, which enhances explosive strength and anaerobic endurance.

In contrast, SSG emphasizes gameplay's technical and tactical aspects while improving aerobic capacity through small-sided match simulations. Furthermore, the effectiveness of both methods is influenced by external factors such as dietary habits, sleep quality, and stress levels. Without proper monitoring of these factors, the benefits of AnST and SSG training may not be fully reflected in performance outcomes. This study specifically examined athletes who were already physically active outside of the provided interventions. Therefore, future research with a larger sample size and extended intervention duration is necessary to understand better the long-term effects of these training methods and how external factors can be optimized to support enhanced physiological adaptations.

Conclusions

The findings of this study indicate that the group undergoing the AnST intervention was more effective than the SSG group in improving body composition. There was an increase in muscle mass and a reduction in body fat. These findings have important implications in sports, particularly for amateur soccer players with limited time and a less active lifestyle.

Conflict of interest

The authors declare that there is no conflict of interest.

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Виявлення впливу анаеробних тренувань з футболу та ігор неповними складами на композицію тіла футболіста

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 4 табл., 1 рис., 32 джерела.

Історія питання. У той час як дослідження у галузі футболу зосереджені на покращенні фізичних, технічних, тактичних та ментальних здібностей, у представлений науковій праці зміщено акцент виключно на композицію тіла, що є відносно недослідженою сферою, особливо серед футболістів-аматорів.

Мета дослідження. Мета цього дослідження полягала у порівнянні впливу анаеробних тренувань з футболу (АТФ) та ігор неповними складами (ІНС) на низку параметрів композиції тіла, включаючи масу тіла (МТ), індекс маси тіла (ІМТ), загальну кількість води в організмі (ЗКВО), жирову масу тіла (ЖМТ), відсоток жирової маси тіла (ВЖМТ), безжирову масу (БЖМ) та масу скелетних м'язів (МСМ) у футболістів-аматорів.

Матеріали та методи. Тридцять футболістів-аматорів (середній вік: $19 \pm 0,63$ роки) було розподілено за методом рандомізації на дві групи: АТФ ($n = 15$) та ІНС ($n = 9$). Обидві групи пройшли чотиритижневий курс тренування з трьома сесіями на тиждень. На перед- та постінтервенційному етапах дослідження проведено вимірювання показників складу тіла із використанням приладу INBODY 270. Дані було проаналізовано за допомогою парних t-критеріїв та незалежних t-критеріїв для нормально розподілених змінних, а для даних, що не мали нормального розподілу, застосовано критерій Вілкоксона.

Результати. Група АТФ продемонструвала значне зниження показників ЖМТ і ВЖМТ порівняно з групою ІНС ($p < 0,05$). Крім того, анаеробне тренування з футболу призвело до суттєвішого збільшення показників МСМ і ЗКВО ($p < 0,05$), тоді як між групами не спостерігалось істотної різниці в МТ. В обох групах відзначалося зниження показника ІМТ внаслідок перерозподілу м'язової маси.

Висновки. Результати цього дослідження підкреслюють перевагу АТФ над ІНС у поліпшенні параметрів композиції тіла, зокрема через підвищення показників МСМ і зменшення ЖМТ. Представлені результати містять цінну інформацію для оптимізації тренувальних програм з футболу як на аматорському, так і на професійному рівнях, розширюючи обізнаність тренерів, спортсменів та інших зацікавлених осіб у спортивній галузі.

Ключові слова: анаеробне тренування з футболу, ігри неповними складами, композиція тіла, футболісти-аматори.

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