

Effects of small-sided games on oxygen consumption, agility, and focused attention in football

Efeitos dos jogos reduzidos no consumo de oxigênio, agilidade e atenção concentrada no futebol

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ABSTRACT

Objective: The study aimed to analyze the effects of training with games on reduced fields on the maximum oxygen consumption, agility, and focused attention in soccer players. **Methods:** For primary and quantitative research, the sample consisted of 10 male athletes, 16.4 ± 1.5 years old, from a field soccer team. Maximum oxygen uptake was obtained through the Cooper 12-minute run test. To measure agility, the test Little and Williams was used, and to assess the concentrated attention, the Concentrated Attention (CA) test was adopted. The small-sided game training program lasted 12 weeks. The tests were carried out in the first and last week of the research. The level of significance established for all situations was $p < 0.05$. **Results:** There was an improvement in oxygen consumption ($p = 0.012$), in agility with ball ($p = 0.0001$), in agility without ball ($p = 0.003$), and in concentrated attention ($p < 0.001$) after the small-sided game training program. **Conclusion:** Training with small-sided games can positively influence maximum oxygen consumption, agility, and focused attention.

Keywords: soccer; exercise; endurance training; physical fitness; attention.

RESUMO

Objetivo: O objetivo do estudo foi analisar os efeitos do treinamento com jogos em campos reduzidos no consumo máximo de oxigênio, agilidade e atenção concentrada em jogadores de futebol. **Métodos:** Para a pesquisa primária e quantitativa, a amostra foi constituída de 10 atletas do gênero masculino, com idade média de $16,4 \pm 1,5$ anos de uma equipe de futebol de campo. O consumo máximo de oxigênio foi obtido por meio do teste de 12 minutos de Cooper. Para mensurar a agilidade, usou-se o teste de Little e Williams e a atenção concentrada foi avaliada por meio do teste de Atenção Concentrada (AC). O programa de treinamento de jogos reduzidos teve a duração de 12 semanas. Os testes foram realizados na primeira e na última semana da pesquisa. O nível de significância estabelecido para todas as situações foi de $p < 0,05$. **Resultados:** Observou-se uma melhora no consumo de oxigênio ($p = 0,012$), na agilidade com bola ($p = 0,0001$) e na agilidade sem bola ($p = 0,003$) e na atenção concentrada ($p < 0,001$) após o programa de treinamento de jogos reduzidos. **Conclusão:** O treinamento com jogos reduzidos pode influenciar positivamente no consumo máximo de oxigênio, na agilidade e na atenção concentrada.

Palavras-chave: futebol; exercício físico; treino aeróbico; aptidão física; atenção.

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Introduction

Football is a sport that requires interaction between motor, technical, tactical, physiological, and psychological factors [1]. This interrelation of dependency that involves these factors requires means and training methods that work with these variables both in isolation and in combination [2].

Thus, to meet the demand imposed by high-level football, new training methodologies have been used in the teams' daily lives [3]. Among the various methodologies, we highlight the small-sided games, which simulate real game situations in reduced dimensions of the field or with a reduced number of players, which means that all variables related to the sport can be evaluated and subsequently improved [4,5].

The small-sided games improve the aerobic conditioning of the athletes since the reduced field dimensions generate a physical overload, which results in positive adaptations in the maximum oxygen consumption [4]. As it is an unpredictable sport, football also requires some specific variables, such as, for example, agility [6]. The constant changes of directions, accelerations, and decelerations existing during a game, make the coaches seek to work agility in an isolated way so that they can carry out the movements naturally and with greater efficiency during the game [7]. It is also suggested that small-sided games in numerical inferiority can improve concentrated attention. However, few studies analyze attention concentrated in small-sided games in numerical equality [8]. Therefore, what makes this research relevant is the scarcity of studies relating small-sided games in numerical equality to maximum oxygen consumption, agility, and attention focused on football. Thus, the objective of this study was to analyze the effects of the game training program in small fields in a situation of numerical equality in the maximum oxygen consumption, agility, and attention focused on soccer players.

Methods

Type of research and sample characterization

The research is primary, longitudinal, and quantitative. The sample consisted of 10 athletes who regularly attended training and were submitted to game sessions in small fields during the preparatory period. All research subjects were male from a team in the south of Minas Gerais, Brazil, between 15 and 20 years old. The inclusion criteria were athletes playing football for at least 3 years and trained for 3 to 4 days a week for at least 1 hour a day. Exclusion criteria were individuals with history of musculoskeletal injury in the last 6 months. The groups were divided into two training sessions of reduced games, 5 vs. 5 in numerical equality, alternating the offensive with the defensive.

Participants were informed about the risks, benefits and invited to participate in the research. All those involved signed the Free and Informed Consent Term, with

details about all the research procedures. This study meets international standards for experimentation with humans. The project was submitted for appreciation and approved by the Research Ethics Committee of the *Centro Universitário de Itajubá*/Brazil, according to protocol 370.978.

Instruments

To assess body mass and height, a Welmy® scale (Brazil) with a capacity of up to 180 kg and fractions of 100 g was used, with a stadiometer attached [9].

To obtain the heart rate during games in a reduced field, a Polar Electro Oy® cardio-frequency meter, Vantage, Finland [10], was used. Maximum oxygen consumption was measured using the Cooper 12-minute run test performed on a flat track [10,11]. Agility was assessed using the agility test adapted from Little and Williams [12,13].

The concentrated attention test is an instrument that aims to assess the ability to keep attention focused on the activity performed under time pressure. The instrument is approved by the Federal Council of Psychology and consists of 21 lines, each with 21 different stimuli. The subject's task is to locate stimuli equal to the three stimuli presented in a model frame. It can be applied individually or collectively [14].

Procedures

To assess body mass and height, athletes had light clothes and were without shoes. To calculate the Body Mass Index (BMI), the formula: $\text{weight}/\text{height}^2$ (kg/m^2) [9,15] was used.

To control the intensity during games on a reduced field, heart rate data (80-95% HRmax) [16] were used according to the formula: $208 - (07 \times \text{age})$ [17] collected during the 3 training sessions weekly 40-minute sessions in each session for 12 weeks.

In the Cooper 12-minute run test, the subjects covered a 400 m flat track with markings every 50 m, during 12 minutes without interruptions, with a record of the total distance covered in that time interval [10,11]. Agility was obtained by the agility test adapted from Little and Williams, which agility is given by the time athletes spend to cover a distance of 20m, with successive changes of direction every 4 meters, with and without a ball. Two tests were performed, with the shortest time recorded between them [12,13].

The application time of the concentrated attention test was 5 minutes, with attention and cognitive and mental control being evaluated in pressure situations [14].

The athletes were randomly assigned to two groups. In the first moment, the training of 5 vs. 5 players was performed in a numerical equality situation, and in the second moment, the players were alternated in the offensive and defensive situations. The sessions were divided into two stages, each lasting 7 minutes, with a 5-minute recovery interval between them, with the field dimensions used being 10 m x 20 m.

Sample size

The sample was calculated using GPower version 3.1.9.2 (Universität Kiel, Germany). The estimate was based on data from the concentrated attention of the first 6 volunteers (Cohen's $d = 0.86$). It was indicated that 10 individuals were needed for a power of 80% ($1-\beta$), an alpha value of 0.05 (two-tailed), and an allocation ratio of 1.

Statistical analysis

During the research course, we sought to verify whether the small-sided game training program influenced variables, such as maximum oxygen consumption, agility, and focused attention. The data were analyzed quantitatively, through the descriptions of the mean and standard deviation, in addition to the verification of normality by the Shapiro-Wilk test and the symmetry of the data (through the histogram). After the preliminary analysis, it was found that the data are parametric. Thus, the paired Student's t-test was used to verify whether there is a difference between the means.

The percentage variation was calculated between the pre and post-training program ($\Delta\%$). Cohen's formula was used to calculate the effect size [18], and the magnitude threshold was ≤ 0.19 trivial; between 0.20-0.59 small; between 0.60-1.19 moderate; between 1.20-1.99 large; and ≥ 2.00 very large.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 20.0® for Windows (Chicago, IL. USA), and the significance level adopted for all situations was $p < 0.05$.

Results

Table I shows the characteristics of the athletes. The data are described in means and standard deviation (SD).

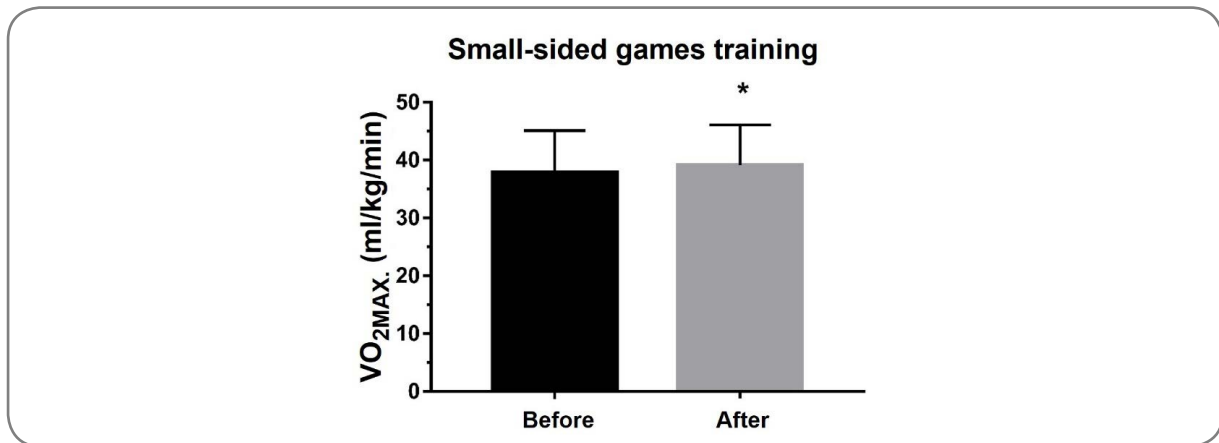
Table I - Sample characterization

Variables	Mean \pm SD
Age (years)	16.4 \pm 1.5
Body mass (kg)	63.3 \pm 6.2
Stature (cm)	170.4 \pm 6.4
BMI (kg/m ²)	21.85 \pm 1.1

BMI = Body mass index

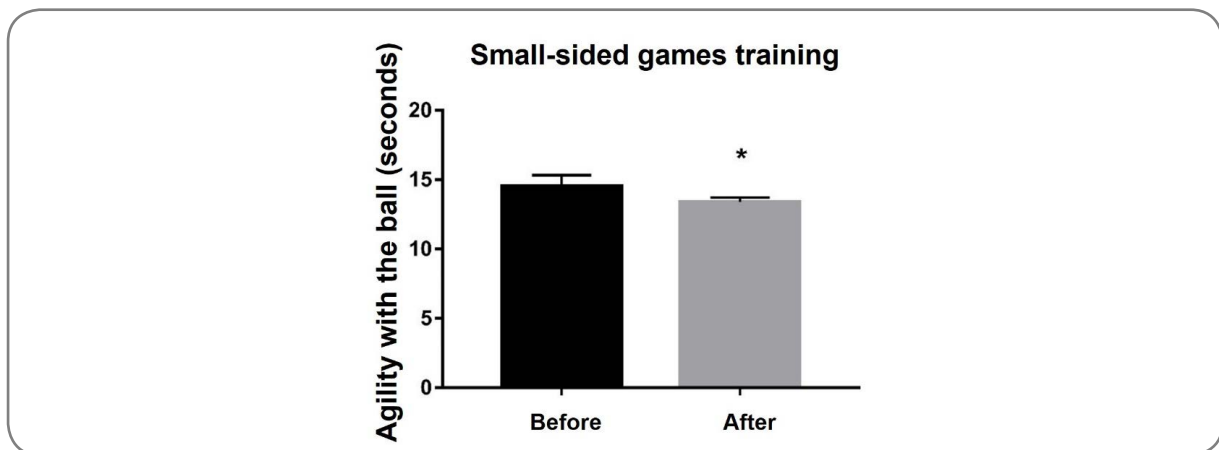
It was observed that the training method significantly influenced the increase in maximum oxygen consumption after the training program, as described in figure 1.

The results of agility are shown in figure 2 and figure 3. The small-sided game training program also improved agility with and without a ball in soccer players



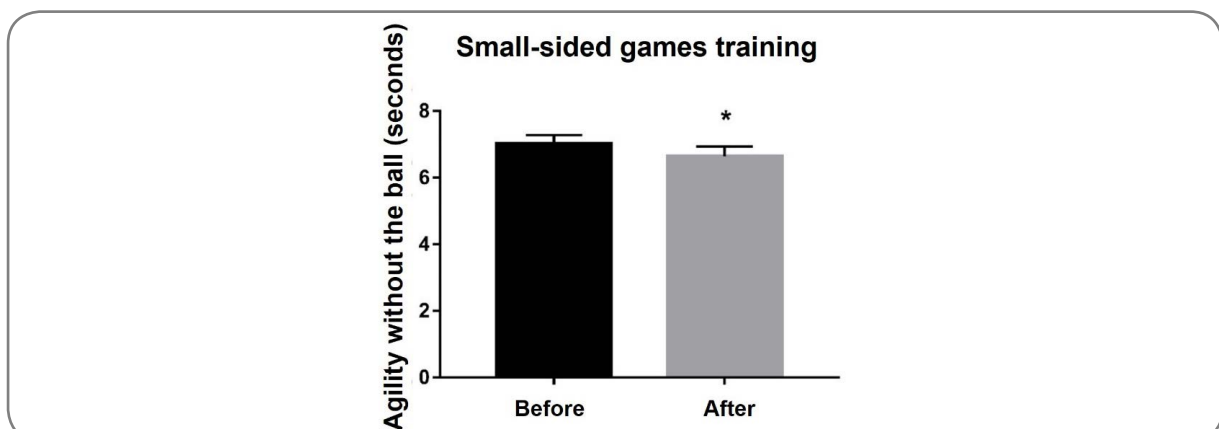
*Significant difference ($p = 0.012$) compared to the assessment before (mean \pm SD = 37.79 ± 7.28 and after (mean \pm SD = 39.16 ± 6.94) of the training period, (effect size = - 0.19 - trivial) and ($\Delta\% = 3.62$); VO_{2max} = maximum oxygen consumption

Figure 1 - Effects of small-sided game training programs on maximum oxygen consumption



*Significant difference ($p < 0.001$) compared to the assessment before (mean \pm SD = 14.50 ± 0.81 and after (mean \pm SD = 13.38 ± 0.32) of the training period, (effect size = 1.81 - large) and ($\Delta\% = -7.72$)

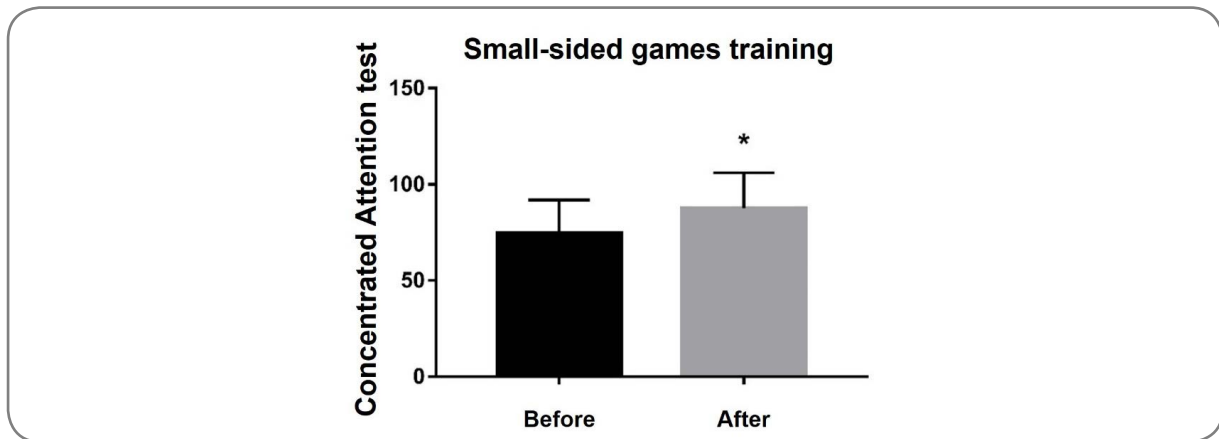
Figure 2 - Effects of small-sided game training programs on ball agility



*Significant difference ($p = 0.0003$) in comparison to the evaluation before (mean \pm SD = 7.00 ± 0.26) and after (mean \pm SD = 6.63 ± 0.29) of the training period, (effect size = 1.34 - large) and ($\Delta\% = -5.28$)

Figure 3 - Effects of small-sided game training programs on agility without a ball

After the small-sided game training program, as described in figure 4, it is observed that the Concentrated Attention Test also showed a significant difference between pre and post-evaluation.



*Significant difference ($P < 0.001$) compared to the assessment before (mean \pm SD = 74.50 ± 17.36) and after (mean \pm SD = 87.50 ± 18.61) of the training period, (effect size = -0.72 - moderate) and ($\Delta\%$ = 17.44); Percentage (mean before = 50.67 ± 11.81 ; mean after 59.51 ± 12.66)

Figure 4 - Effects of small-sided game training programs on the Concentrated Attention Test

Discussion

The study aimed to analyze the influence of the game training program in reduced fields in a situation of numerical equality in the maximum oxygen consumption, agility and focused attention in soccer athletes. The study's main findings indicate that maximum oxygen consumption, agility with and without a ball, and focused attention increased significantly after the training program.

The result regarding the maximum oxygen consumption in the present study corroborates the results found in the literature. According to Owen [19], four weeks of training with small-sided games in elite soccer athletes promoted an enhancement in maximum oxygen consumption. The training sessions lasted from 45 to 90 minutes, in a 30 x 25 m area, with 3 line players and the goalkeeper in each team. Other studies also confirm that the maximum oxygen consumption shows improvement after training in games with reduced field [3,11]. High-intensity interval training is a feature of small-sided games that can improve VO_{2max} consumption. Peroxisome proliferator-activated receptor gamma coactivator 1-alpha (PGC-1 α) is a protein that contributes to increased mitochondrial density, which makes it an essential organ of aerobic metabolism. High-intensity training stimulates the synthesis of PGC-1 α , which may explain the improvement in aerobic conditioning through reduced games [20,21].

Also, it was evidenced in the present study that the reduced field games significantly improved the athletes' agility. The results obtained in the research coincide with the data available in the literature. It is believed that training with small-sided games has been quite efficient in improving athletes' agility, as it is a training method that requires constant changes of direction, in addition to successive accelerations and decelerations [22]. According to Davies [23], the reduced field games with increased density (5 vs. 5) generate better agility responses performed by the player. A possible explanation for this effect is the combination of more agility events occur

in situations of attack, defense, and without possession of the ball. In this sense, it is suggested that a greater demand for agility be imposed on players due to the reduced and dense spaces, which forces players to consider the relative position adopted by the other opponents within the reduced field space, even before making decisions to move, with or without a ball.

Finally, the focused attention showed a significant difference after the reduced field game training program in numerical equality. The results obtained in the study corroborate the data available in the literature. In the study by Montalvão [8], the training program reduced in numerical inferiority showed a significant difference when comparing a smaller number of players to the collective. Thus, the smaller the number of athletes, the higher the focus on activity and attention, in addition to higher cognitive and mental control in high-pressure situations. According to Ribeiro [24], the incidence of goals is higher at the end of the match, and players may experience decreased concentration due to fatigue.

The study presented a limitation regarding the sample number. Despite meeting the minimum suggested by the sample calculation test, a higher number of volunteers would further strengthen the results, and this limitation can be due to the difficulty of maintaining the volunteers, especially in longitudinal studies.

In terms of practical applications, the present study offers another alternative to physical trainers and soccer coaches since they can physically and technically condition athletes and simultaneously optimize training time.

Conclusion

Conclui-se que o treinamento de jogos reduzidos em situação de igualdade numérica de 5 vs. 5 jogadores melhoram significativamente o consumo máximo de oxigênio e a agilidade dos atletas, bem como a atenção concentrada. Sugere-se para estudos posteriores, a manutenção das dimensões atuais de campo e o trabalho em inferioridade e superioridade numérica, assim como a utilização de metodologias mais complexas e número amostral maior.

Potencial conflito de interesse

Nenhum conflito de interesses com potencial relevante para este artigo foi reportado.

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Authors' contributions

Conception and design of the research: Silva AS, Mereu GP, Oliveira JJ, Montalvão VHS, Silva JAO. **Obtaining data:** Mereu GP, Montalvão VHS. **Analysis and interpretation of data:** Silva AS, Mereu GP, Baganha RJ, Silva JAO. **Statistical analysis:** Silva AS, Mereu GP. **Obtaining financing:** Silva AS, Mereu GP, Montalvão VHS, Lacerda FV. **Writing of the paper:** Silva AS, Mereu GP, Oliveira JJ, Lacerda FV, Silva JAO. **Critical review of the paper for important intellectual content:** Silva AS, Oliveira JJ, Baganha RJ, Lacerda FV, Silva JAO.

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