COMPARISON OF AEROBIC PERFORMANCE INDICATORS OF SOCCER AND FUTSAL ATHLETES

COMPARAÇÃO DE INDICADORES DE DESEMPENHO AERÓBICO DE ATLETAS DE FUTEBOL E FUTSAL

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ORIGINAL ARTICLE
ARTIGO ORIGINAL
ARTÍCULO ORIGINAL

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ABSTRACT

Soccer and futsal have similar technical movements that are used within different spatial dimensions and game dynamics. The possible physiological differences between players of each sport were unknown. The main purpose of this study was to compare the maximum oxygen uptake (VO_2max) and ventilatory thresholds (VT) of soccer and futsal players. VO_2max and VT of 32 athletes (soccer: n = 15; futsal: n = 17) were obtained by ergospirometry in a progressive treadmill test. VO_2max was similar between groups. VT occurred later and at higher running speeds in the soccer players. The similarities found in VO_2max may be related to the fact that the evaluations were carried out in the pre-season. The fact that the VT was reached later in the soccer players suggests a longer capacity for aerobic exercise and greater resistance to lactate production. Moreover, soccer players appear to be conditioned to withstand increased running times and speeds, until exhaustion. Players of both sports reached the second VT at similar intensities, suggesting no prevalence of anaerobic metabolism. Soccer and futsal players have similar VO_2max, but their VTs occur at different times, and at different running speeds. ***Level of Evidence III; Cross-sectional study.***

Keywords: Soccer; Oxygen consumption; Athletes.

RESUMO

O futebol e o futsal têm movimentos técnicos semelhantes que são utilizados em distintas dimensões espaciais e dinâmicas de jogo. As possíveis diferenças fisiológicas entre as modalidades não foram esclarecidas. O objetivo do presente estudo foi comparar o consumo máximo de oxigênio ($VO_{2máx}$) e os limiares ventilatórios (LV) de atletas de futebol e futsal. O $VO_{2máx}$ e os LV de 32 atletas (futebol: n = 15; futsal: n = 17) foram obtidos por ergoespirometria em teste progressivo de esteira. O $VO_{2máx}$ foi semelhante entre grupos. Os LV ocorreram mais tardiamente e em maiores velocidades nos atletas de futebol. A semelhança encontrada nos valores de $VO_{2máx}$ pode estar relacionada com as avaliações terem sido realizadas em pré-temporada. A obtenção tardia dos LV em atletas de futebol sugere maior permanência em exercício aeróbico e maior resistência à produção de lactato. Além disso, parecem estar condicionados ao fato de suportarem maiores tempos e velocidades de corrida até chegarem à exaustão. Entretanto, ambas as modalidades atingiram o segundo LV em intensidades semelhantes, sugerindo não haver prevalência do metabolismo anaeróbico. Atletas de futebol e futsal apresentam $VO_{2máx}$ similares, embora os LV ocorram em momentos distintos e com diferentes velocidades de corrida. ***Nível de evidência III; Estudo transversal comparativo.***

Descritores: *Futebol; Consumo de oxigênio; Atletas.*

RESUMEN

El fútbol y el futsal tienen movimientos técnicos semejantes que son usados en distintas dimensiones espaciales y dinámicas de juego. Las posibles diferencias fisiológicas entre las modalidades no fueron esclarecidas. El objetivo del presente estudio fue comparar el consumo máximo de oxígeno (VO_2máx) y los umbrales ventilatorios (UV) de atletas de fútbol y futsal. El VO_2máx y los UV de 32 atletas (fútbol: n = 15; futsal: n = 17) fueron obtenidos por ergoespirometría en test progresivo de cinta. El VO_2máx fue semejante entre grupos. Los UV ocurrieron más tardíamente y en mayores velocidades en los atletas de fútbol. La semejanza encontrada en los valores de VO_2máx puede estar relacionada con que las evaluaciones hayan sido realizadas en pretemporada. La obtención tardía de los UV en atletas de fútbol sugiere mayor permanencia en ejercicio aeróbico y mayor resistencia a la producción de lactato. Además, parecen estar condicionados al hecho de soportar mayores tiempos y velocidades de carrera hasta llegar al agotamiento. Entretanto, ambas modalidades alcanzaron el segundo UV en intensidades semejantes, sugiriendo no haber prevalencia del metabolismo anaeróbico. Atletas de fútbol y futsal presentan VO_2máx similares, aunque los UV ocurran en momentos distintos y con diferentes velocidades de carrera. ***Nivel de evidencia III; Estudio transversal comparativo.***

Descriptores: *Fútbol; Consumo de oxígeno; Atletas.*

DOI: http://dx.doi.org/10.1590/1517-8692202026062019_0015 Article received on 06/22/2019 accepted on 08/19/2020

INTRODUCTION

Soccer is a field sport with various movements and movement patterns required from players (e.g. shorts and long sprints, walking and running slowly, accelerations with rapid decelerations, changes in direction, jumps, kicks, and confrontations).[1,2] Futsal is similar to soccer, but it is played on a smaller court, with fewer players, uses a smaller ball, and allows for constant and unlimited substitutions.[3-6] Futsal is a dynamic and intense sport that requires many movements within short periods.[3,5,7]

Various studies have compared the physiological characteristics of soccer and futsal players.[5,7-11] Maximum oxygen uptake (VO_2max) and ventilatory threshold (VT) are two characteristics that are commonly used to measure athletes' fitness. VO_2max is an indicator of the highest oxygen uptake (VO_2) per unit of time that an individual can capture, transport and use at the cellular level.[8] VT is an indicator of lactate production and includes a first and second threshold.[12] VO_2max is a determinant factor for aerobic capacity[13] and is considered the gold standard for assessing aerobic fitness. VO_2max seems to be a determinant in soccer performance,[13,14] but not as much in futsal performance.[5] The literature contains contradictory data, where studies have found higher VO_2max in soccer,[7] or futsal players,[5] and have also observed similarities.[8,10] These different outcomes can be attributed to factors ranging from different evaluation periods during the season, level of competitiveness and evaluation protocols.

VT is a measure of endurance performance. The first VT threshold (VT_1) corresponds to the start of blood lactate accumulation, and the second threshold (VT_2) to the moment when lactate production exceeds its removal.[9] Studies comparing VTs of soccer and futsal players[5,8-10] have related VT to VO_2 at the time of VT_2,[5,9] and the percentage of VO_2max during VT_2 (%VO_2maxVT_2).[9,15] Soccer players reached %VO_2maxVT_2 between 76.6 and 90.3% and futsal players between 65 and 77%,[9] demonstrating that VT_2 occurred at different exercise intensities.[10] The percentage of VO_2max during VT_1 (%VO_2maxVT_1) is rarely reported in the literature[16,17] even though it is an indicator of aerobic metabolism[16] that marks the beginning of lactate accumulation.[18] Running speed during each VT is also a parameter of exercise intensity[9,18], and when running speed is associated with VO_2max and VT it can provide more information than isolated cardiorespiratory variables.[11,15,19] Studies evaluating running speed during VT_1 (speedVT_1),[9] and VT_2 (speedVT_2)[5,8,9] have found contradictory results, where: speedVT_1 was superior in futsal players;[9] speedVT_2 was superior in soccer players, and;[8] speedVT_2 was similar in soccer and futsal players.[9] These contradictory outcomes could result from a lack of control in training stage between soccer and futsal players. This study aimed to compare the VO_2max and VT of soccer and futsal players at the same training stage during the start of the preseason. We hypothesized that: 1) soccer players would have higher VO_2max than futsal players;[7] and 2) VT_1 and VT_2 would occur earlier in futsal players than soccer players.[9]

MATERIALS AND METHODS

Participants

This study was approved by the institutional Research Ethics Committee of the University of Santa Cruz do Sul, RS, Brazil (number 1.514.711). All participants read and signed an informed consent form.

Study participants were State level male soccer and futsal players who met the inclusion criteria: a) aged 18 to 30 years old; b) no musculoskeletal injuries; c) no respiratory disorders; and d) no heart disease. Individuals who did not reach VT_2 during testing and those who had difficulties understanding the experimental protocol were excluded from the study. Thirty-two athletes (soccer: n = 15; futsal: n = 17) participated in the study.

The evaluation took place preseason, prior to any soccer or futsal training. During the evaluation period, soccer and futsal players began their preparation to compete in the State championships.

To characterize athletes, body mass and height were measured. Measurements followed Heyward's guidelines using a beam scale (Welmy R110; Welmy SA, Santa Bárbara do Oeste, Brazil).[20]

Assessment of performance indicators

Cardiorespiratory parameters were obtained by ergospirometry during a maximal effort test on a treadmill (Super ATL, Inbramed Ltda., Porto Alegre, RS, Brazil). The Bruce ramp protocol was used, which consists of seven three-minute stages. The starting speed and inclination were 2.7 km/h and 10º, respectively. Each progressive stage involved an increase in speed and inclination of 1.6 km/h and 2º.[21,22] Respiratory gases were measured every 20 seconds by a gas analyzer (VO2000, Aerosport, Medgraphics, St. Paul, Minnesota, USA), which was calibrated before the start of each test within a temperature-controlled environment (20-22ºC). Assessments were performed during the day, with all subjects in a resting state (sitting for five minutes) until the time of the test. The test duration was determined by the athletes' voluntary exhaustion; when the athletes reached their effort limit, the test was immediately interrupted, and the recovery phase began [three minutes of walking on the treadmill at 2.7 km/h without any inclination (0º)].

VO_2max was determined by the VO_2 peak reached during the maximal effort test.[23] It was captured in absolute and relative values, but only relative values were reported. VTs were identified by three experienced evaluators using the visual-graphic method, which consists of observing the behaviour of the VO_2 curve (oxygen consumption over time) and the production of carbon dioxide (VCO_2) during progressive effort. VT_1 was identified when the VCO_2 increased disproportionately to VO_2 (i.e. loss of parallelism), while VT_2 was identified at the time of respiratory compensation or during the disproportionate increase in ventilation compared to VCO_2.[17,23] For VT_1 or VT_2, when the three evaluators identified identical values, that value was adopted. In the case of divergences between evaluators, the median result was chosen.

Each VT was calculated relative to VO_2max (%VO_2maxVT_1; %VO_2maxVT_2), acquisition time of VT (in min),[8,15,24] and running speed on the treadmill (speedVT_1; speedVT_2).[9,24]

Statistical analysis

Descriptive analyses (mean and standard deviation) were performed. The normality of the data was verified by the Shapiro-Wilk test. Between-group comparisons were performed using Student's t-test for independent samples (parametric data), or the Mann-Whitney U test (non-parametric data). All statistical tests were performed using SPSS software (v. 23.0; IBM Corporation, Armonk, New York, NY, USA), with α=0.05.

RESULTS

The characterization of the players is shown in Table 1. Regarding positions, soccer players included a goalkeeper, a full-back, four defenders, four defensive midfielders, three midfielders, and two forwards. Futsal players included two goalkeepers, four defenders, nine wingers, and two pivots. The groups were similar in terms of age and body mass; however, soccer players were taller.

No differences were found in VO_2max and %VO_2maxVT_2 between groups but soccer players had higher %VO_2maxVT_1, VT_1 and VT_2. In addition, futsal players reached both VTs at lower speeds (Table 2).

Table 1. Characterization of groups of players.

	Soccer	Futsal	p
Age (years)	25.60±3.18	26.82±2.92	0.266
Mass (kg)	79.32±7.35	75.76±8.10	0.206
Height (m)	1.77±0.06	1.72±0.05	0.022*

Values expressed as mean and standard deviation (±); * = statistically significant differences between groups (p≤0.05).

Table 2. Cardiorespiratory variables of soccer and futsal players.

	Soccer	Futsal	p
VO_2max (ml·kg^{-1}·min^{-1})	39.80±6.86	36.97±5,84	0,219
VO_2maxVT_1 (%)	62.81±15.29	50.68±10.64	0.013*
VT_1 (min)	9.15±2.08	5.50±1.02	0.000*
SpeedVT_1 (km/h)	6.44±1.00	4.49±0.68	0.000*
VO_2maxVT_2 (%)	91.65±7.29	86.19±11.72	0.130
VT_2 (min)	15.10±2.61	12.02±1.42	0.000*
SpeedVT_2 (km/h)	8.42±0.73	7.31±0.81	0.001*

Values expressed as mean and standard deviation (±); VO_2max = maximal oxygen uptake; $\%VO_2maxVT_1$ = percentage of VO_2max at first ventilatory threshold; VT_1 = first ventilatory threshold; speedVT_1 = speed during first VT; $\%VO_2maxVT_2$ = percentage of VO_2max at second ventilatory threshold; VT_2 = second ventilatory threshold; speedVT_2 = speed during second VT. * = statistically significant differences between groups (p≤0.05).

DISCUSSION

This study aimed to compare aerobic performance indicators between soccer and futsal players. No differences were found in VO_2max and $\%VO_2maxVT_2$ between groups. Percent VO_2maxVT_1 was lower in futsal players, and their VT occurred sooner and at lower speeds than in soccer players.

VO_2max represents the maximal capacity of oxygen consumption and reflects level of fitness. We found no differences in VO_2max between soccer and futsal players. These results agree with previous studies that controlled for stage of training.[8-10] Soccer and futsal players may have similar VO_2max levels due to the intermittent high-intensity nature of their sports.[4] Contradictory values of VO_2max were identified between soccer and futsal players in studies that did not control for stage of training. Karimi, Hojjati and Shamsi[7] found higher VO_2max values in soccer players (57.42 ml·kg^{-1}·min^{-1}) than futsal players (52.77 ml·kg^{-1}·min^{-1}). According to the authors, this suggests an aerobic predominance in soccer, where the aerobic system is the main source of energy (70 to 90%) during a match/ training.[5,7,10,25] VO_2max is linked to the distance covered during a match; thus, soccer players may have better endurance, withstanding longer periods of exercise until exhaustion.[8] On the other hand, Nunes et al.[5] found a higher VO_2max in futsal players (62.5 ml·kg^{-1}·min^{-1}) than in soccer players (52.1 ml·kg^{-1}·min^{-1}). These authors attributed their results to the different training methods, levels of competitiveness and number of competitions between players. Therefore, the level of competitiveness of the teams may have influenced the results, as the futsal team in their study competed nationally while the soccer team competed at the state level. Since VO_2max may vary during the season (3-7% lower at the beginning of the season than the end),[13] it is important to consider evaluation period, periodization of training, and level of competitiveness of players when different sports are compared.

VT_1 refers to the beginning of lactate accumulation during physical effort.[18] In our study, futsal players reached VT_1 at lower percentages of VO_2max, and it occurred earlier and at lower speeds than in soccer players, suggesting earlier lactate production in futsal players. This may result from greater participation of anaerobic glycolytic metabolism in futsal players, while aerobic metabolism is still their main source of energy.[16] Despite this, VT_1, which represents intensity of effort relative to VO_2max, was lower in futsal than in soccer players and futsal players had a longer interval between VT_1 and VT_2. According to Wilke et al.,[17] intensity is divided into three zones: below VT_1 (low intensity), between VT_1 and VT_2 (moderate intensity), and above VT_2 (high intensity). It is reported that futsal players expend 73% of a training session below VT_1, 20% between the VT_1 and VT_2 and 7% above VT_2.[17], while soccer players cover approximately 11 km in a match, with 3% and 5% of a training session spent sprinting and running at high-intensity effort, respectively.[26] Therefore, it is expected that futsal players have higher speeds during VT, since speedVT is highly correlated to the ability to perform repeated high-intensity sprints over time.[24] Contrary to our results, Ribeiro et al.[9] observed a higher speedVT_1 in futsal players (13.3 km/h) than soccer players (11.0 km/h); however, this study did not control for preseason period (initial and final). Ribeiro et al.[9] also adopted a more intense ramp protocol with an increase in speed of 1 km/h every minute, where testing lasted between 8-12 minutes, while we adopted a longer protocol (i.e. Bruce protocol) with increases in speed and inclination of 1.6 km/h and 2º at each 3-min stage, lasting up to 21 minutes.

VT_2 represents the respiratory compensation point.[18] We found no differences in $\%VO_2maxVT_2$ between soccer and futsal players. This is in agreement with the results of Baroni et al.,[8] who observed $\%VO_2maxVT_2$ at similar intensities (soccer = 87.89%; futsal = 88.29%). Nunes et al.[5] found higher $\%VO_2maxVT_2$ in futsal players (futsal = 93.9%; soccer = 76%), who reached VT_2 at higher intensities than soccer players. Our results may have been different from Nunes et al.[5] because our evaluations were performed at the beginning of the preseason, while Nunes et al.[5] did not mention the phase of the preseason in which players were evaluated. In our study, VT_2 was reached earlier (less time) in futsal than soccer players. Leal Junior et al.,[10] also found that futsal players reached VT_2 earlier (11.4 min) than soccer players (14.0 min), suggesting that soccer players have a greater aerobic capacity. Like Baroni et al.,[8] we found that speedVT_2 was greater in soccer players than futsal players. Soccer players reached both VTs at higher speeds (equivalent to time/test stage), where VO_2 increases as running speed increases,[27] suggesting that soccer players can withstand progressive effort for longer periods until exhaustion.[8]

Our study had some limitations. Laboratory effort protocols, such as the one used in this study, are not very functional for soccer and futsal, while field tests have good applicability.[28,29] However, the procedures used in this study can be performed with athletes to assess basic physiological parameters (e.g. VO_2max and VT), which assist in building highly specific training programs.[22,29] Participants in our study were not stratified by position, which could have minimized intragroup variation as there are different mechanical and physiological demands for each position.[8,18,30] However, the number of players evaluated did not allow for such stratification. To control these limitations, pre-training and post-training evaluations could be performed, and training routines and game calendars could be monitored.[18] This would allow us to identify adaptations to physiological parameters caused by training.[31] As well, the inclusion of other physiological markers such as blood lactate,[4,15,32] heart rate,[2,5] and subjective perception of effort,[31,33] could provide additional information about the demands of soccer and futsal and the physiological profiles of players.

CONCLUSION

In the preseason phase of the competitive calendar of soccer and futsal, male players have similar VO_2max's and reach their VT at different times and speeds. Different levels of physical effort and physiological adaptations exist for each sport, indicating that training methods should be designed with each sport's specificity in mind.

All authors declare no potential conflict of interest related to this article

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. MHG: substantial contribution to the conception and design of the work, analysis and interpretation of the data, writing the manuscript and preparing the final version of the manuscript; JMG: interpretation of the data, writing the manuscript, critical review of the intellectual content and final approval of the version of the manuscript; ANC: analysis and interpretation of the data, writing the manuscript and critical review of the intellectual content; PN: analysis and interpretation of the data, writing the manuscript and preparing the final version of the manuscript; GGR: substantial contribution to the concept and design of the work, analysis of the data; HHP): substantial contribution to the concept and design of the work, critical review of its intellectual content and final approval of the version of the manuscript. MBR: substantial contribution to the concept and design of the work, interpretation of the data, critical review of its intellectual content and final approval of the version of the manuscript.

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