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 (VO2max) and ventilatory thresholds (VT) of soccer and futsal players. VO2max and VT of 32 athletes (soccer: n = 15; futsal: n = 17) were obtained by ergospirometry in a progressive treadmill test. VO2max was similar between groups. VT occurred later and at higher running speeds in the soccer players. The similarities found in VO2max 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 VO2max, but their VTs occur at different times, and at different running speeds. Level of Evidence III; Cross-sectional study.

Keywords: Soccer; Oxygen consumption; Athletes.

RESUMEN

El fútbol y el futsal tienen movimientos técnicos semelhantes 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 (VO2max) y los límites ventilatorios (LV) de atletas de fútbol e futsal. VO2max y LV de 32 atletas (fútbol: n = 15; futsal: n = 17) fueron obtenidos por ergoespirometría en test progresivo de esteira. VO2max fue similar entre grupos. LV ocurrieron más tardíamente y en mayores velocidades en los atletas de fútbol. La semelhanza encontrada nos valores de VO2max puede estar relacionada con las avaluaciones terem sido realizadas en pre-temporada. A obtención tardia dos LV em atletas de fútbol 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 VO2max similares, embora os LV ocorram em momentos distintos e com diferentes velocidades de corrida. Nível de evidência III; Estudo transversal comparativo.

Descritores: Fútbol; Consumo de oxígeno; 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 (VO2max) y los umbrales ventilatorios (UV) de atletas de fútbol e futsal. El VO2max y los UV de 32 atletas (fútbol: n = 15; futsal: n = 17) fueron obtenidos por ergoespirometría en test progresivo de cinta. El VO2max fue semejante entre grupos. Los UV ocurrieron más tardíamente y en mayores velocidades en los atletas de fútbol. La semelhanza encontrada nos valores de VO2max puede estar relacionada con que las evaluaciones hayan sido realizadas en pretemporada. A obtención tardia 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 VO2max similares, aunque los UV ocurran en momentos distintos y con diferentes velocidades de carrera. Nivel de evidencia III; Estudio transversal comparativo.

Descritores: Fútbol; Consumo de oxígeno; Atletas.
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). 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. Futsal is a dynamic and intense sport that requires many movements within short periods.

Various studies have compared the physiological characteristics of soccer and futsal players. Maximum oxygen uptake (VO₂max) and ventilatory threshold (VT) are two characteristics that are commonly used to measure athletes' fitness. VO₂max is an indicator of the highest oxygen uptake (VO₂) per unit of time that an individual can capture, transport, and use at the cellular level. VT is an indicator of lactate production and includes a first and second threshold. VO₂max is a determinant factor for aerobic capacity and is considered the gold standard for assessing aerobic fitness. VO₂max seems to be a determinant in soccer performance, but not as much in futsal performance. The literature contains contradictory data, where studies have found higher VO₂ max in soccer or futsal players, and have also observed similarities. 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 (VT₁) corresponds to the start of blood lactate accumulation, and the second threshold (VT₂) to the moment when lactate production exceeds its removal. Studies comparing VTs of soccer and futsal players have found contrary values, that VO₂max during VT₁ (VT₁) corresponds to the start of blood lactate accumulation, and the second threshold (VT₂) to the moment when lactate production exceeds its removal. Studies comparing VTs of soccer and futsal players have found contradictory results, where: speedVT₁ was superior in futsal players; speedVT₂ was superior in soccer players, and speedVT₃ was similar in soccer and futsal players. These contradictory outcomes could result from a lack of control in training stage between soccer and futsal players. This study aimed to compare the VO₂ max and VT of soccer and futsal players at the same training stage during the start of the pre-season. We hypothesized that: 1) soccer players would have higher VO₂max than futsal players; and 2) VT₁, VT₂, and VT₃ would occur earlier in futsal players than soccer players.

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 VT₂ 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.
This study aimed to compare aerobic performance indicators between soccer and futsal players. No differences were found in VO$_2$max between soccer and futsal players. These results agree with previous studies that controlled for stage of training. Soccer and futsal players may have similar VO$_2$max levels due to the intermittent high-intensity nature of their sports. Contradictory values of VO$_2$max were identified between soccer and futsal players in studies that did not control for stage of training. Kamini, Hojjati and Shamsi found higher VO$_2$max 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. VO$_2$max is linked to the distance covered during a match; thus, soccer players may have better endurance, withstanding longer periods of exercise until exhaustion. On the other hand, Nunes et al. found a higher VO$_2$max 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$_2$max may vary during the season (3-7% lower at the beginning of the season than the end), 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. In our study, futsal players reached VT$_1$ at lower percentages of VO$_2$max, 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. Despite this, VT$_1$, which represents intensity of effort relative to VO$_2$max, 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., 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 was 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$_2$, 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. 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. Contrary to our results, Ribeiro et al. observed a higher speedVT in futsal players (13.3 km/h) than soccer players (11.0 km/h); however, this study did not control for pre-season period (initial and final). Ribeiro et al. 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 2% at each 3-min stage, lasting up to 21 minutes. VT$_1$ represents the respiratory compensation point. We found no differences in %VO$_2$maxVT$_1$ between soccer and futsal players. This is in agreement with the results of Baroni et al., who observed %VO$_2$maxVT$_2$ at similar intensities (soccer = 87.89%; futsal = 88.29%). Nunes et al. found higher %VO$_2$maxVT$_1$ 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. because our evaluations were performed at the beginning of the pre-season, while Nunes et al. did not mention the phase of the pre-season in which players were evaluated. In our study, VT$_1$ was reached earlier (less time) in futsal than soccer players. Leal Junior et al. also found that futsal players reached VT$_1$ earlier (11.4 min) than soccer players (14.0 min), suggesting that soccer players have a greater aerobic capacity. Like Baroni et al., we found that speedVT$_1$ 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, suggesting that soccer players can withstand progressive effort for longer periods until exhaustion.

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. However, the procedures used in this study can be performed with athletes to assess basic physiological parameters (e.g. VO$_2$max and VT), which assist in building highly specific training programs. 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. 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. This would allow us to identify adaptations to physiological parameters caused by training. As well, the inclusion of other physiological markers such as blood lactate, heart rate, and subjective perception of effort could provide additional information about the demands of soccer and futsal and the physiological profiles of players.

In the pre-season phase of the competitive calendar of soccer and futsal, male players have similar VO$_2$max'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.

### Table 2. Cardiorespiratory variables of soccer and futsal players.

|        | Soccer | Futsal | p    |
|--------|--------|--------|------|
| VO$_2$max (ml kg$^{-1}$ min$^{-1}$) | 39.80±6.66 | 36.97±5.84 | 0.219 |
| VO$_2$maxVT$_1$ (%) | 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$_2$maxVT$_2$ (%) | 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$_2$max = maximal oxygen uptake; %VO$_2$maxVT$_1$ = percentage of VO$_2$max at first ventilatory threshold VT$_1$; %VO$_2$maxVT$_2$ = percentage of VO$_2$max at second ventilatory threshold VT$_2$. * = statistically significant differences between groups (p<0.05).
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