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ORIGINAL ARTICLE

Effects of Ramadan fasting on training induced adaptations to a seven-week high-intensity interval exercise programme

Effets du jeûne du Ramadan sur les adaptations induites par un programme de sept semaines d'entraînement à haute intensité par intervalles

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Summary
Objectives. — The purpose of this study was to determine if aerobic and anaerobic training-induced adaptations were compromised as a result of Ramadan fasting.
Methods. — Twenty adolescent males of the Muslim and non-Muslim faith were divided into fasting (FAS, $n = 10$) and non-fasting or control (CON, $n = 10$) groups, respectively. High-intensity interval cycle exercise training was conducted three times per week for seven weeks, with Ramadan fasting falling during training weeks 3 to 6 for the FAS group.
Results. — Both groups significantly improved their peak oxygen uptake (VO_{2peak}; FAS 2.77 ± 0.33 to 3.08 ± 0.22 and CON 2.61 ± 0.22 to 2.89 ± 0.21 L/min) and maximal anaerobic performance (total work during four Wingate bouts; FAS 53.4 ± 5.2 to 57.7 ± 4.8 and CON 47.4 ± 4.5 to 52.0 ± 4.5 kJ) (all $p < 0.05$). There were no significant differences in the magnitude of improvements made between groups, either for aerobic (FAS 0.31 ± 0.28 vs. CON 0.28 ± 0.12 L/min) or anaerobic (FAS 4.3 ± 3.3 vs. CON 4.6 ± 3.4 kJ) performance (all $p > 0.05$). Indices of training intensity (mean heart rate and mean blood lactate) and mean daily energy and fluid intake were not significantly different between groups throughout the study period.
Conclusions. — Aerobic and anaerobic adaptations to seven weeks of training were not compromised by four weeks of intermittent Ramadan fasting, possibly because the overall training intensity and nutrient intake were maintained throughout the Ramadan period.

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Résumé
Objectifs. — Le but de cette étude était de déterminer si les adaptations induites par un entraînement aérobie et anaérobie étaient compromises par le jeûne du Ramadan.
Méthodes. — Vingt adolescents masculins de croyance musulmane et non musulmane ont été répartis respectivement en groupes jeûne (FAS, $n = 10$) et témoin ou sans jeûne (CON, $n = 10$). Les sujets ont été soumis à un entraînement par intervalles de haute intensité sur cycloergomètre trois fois par semaine pendant sept semaines, incluant une période de jeûne du Ramadan au cours des semaines 3 à 6 du programme pour le groupe FAS.
Résultats. — Les sujets des deux groupes ont significativement augmenté leur consommation maximale d'oxygène (VO_{2max} ; FAS de $2{,}77 \pm 0{,}33$ à $3{,}08 \pm 0{,}22$; CON $2{,}61 \pm 0{,}22$ à $2{,}89 \pm 0{,}21$ L/min ; $p < 0{,}05$) et leur performance anaérobie maximale (travail total de quatre tests anaérobie Wingate ; FAS de $53{,}4 \pm 5{,}2$ à $57{,}7 \pm 4{,}8$; CON de $47{,}4 \pm 4{,}5$ à $52{,}0 \pm 4{,}5$ kJ ; $p < 0{,}05$). Aucune différence significative n'a été notée dans l'importance de l'amélioration entre les groupes, tant pour la performance aérobie (FAS $0{,}31 \pm 0{,}28$ vs. CON $0{,}28 \pm 0{,}12$ L/min ; $p > 0{,}05$) qu'anaérobie (FAS $4{,}3 \pm 3{,}3$ vs. CON $4{,}6 \pm 3{,}4$ kJ ; $p > 0{,}05$). Les indices d'intensité d'entraînement (fréquence cardiaque moyenne et concentration moyenne de lactate sanguin) ainsi que les apports énergétiques et liquidiens moyens n'étaient pas significativement différents entre les groupes pendant toute la période de l'étude.
Conclusions. — Les adaptations à un entraînement aérobie et anaérobie de sept semaines n'ont pas été compromises par quatre semaines de jeûne intermittent pour le Ramadan, probablement parce que tant l'intensité globale de l'entraînement que l'apport nutritionnel ont été maintenus pendant toute la période du Ramadan.

1. Introduction

During the Islamic holy month of Ramadan, it is obligatory for all healthy able-bodied Muslims to refrain from drinking and eating from dawn to sunset daily (~ 12—14 hours per day in the equatorial region), for 30 consecutive days. During Ramadan, individuals typically consume only two main meals a day; the first meal is usually consumed prior to the start of the day's fasting, between 04:30 to 05:30 (i.e., sahur meal), and the other at the break of the day's fast, at ~ 19:00 (i.e., iftar meal). Hence Ramadan fasting is not a complete fast and there is no restriction to the amount of food or fluid that can be consumed during the permissible period. In studies where athletes continue to train during the Ramadan month, debate continues on the impact of Ramadan fasting on total nutrient intake with some investigations showing a clear decrease [1,2] whilst others report no compromise in fasted athletes' daily intake [3—5]. If carbohydrate and fluid intake were compromised, reductions in muscle and liver glycogen stores would be likely as would hypohydration [6,7], which could potentially have a negative impact on exercise capacity. In addition, Ramadan fasting is associated with changes in food and fluid intake pattern which can also influence sleep quality, leading to subjective feelings of lethargy, malaise and poor motivation that could impact exercise performance [8—10].

Ramadan fasting has been shown to compromise a number of physiological outcomes including muscular strength and endurance [11], high-intensity exercise performance [12—15], anaerobic power [16,17] and maximal aerobic power [2,18—20]. Similarly, in both elite youth and professional soccer players, Ramadan fasting reduced acute exercise performance tasks including endurance running, agility, all-out short sprints, speed endurance and lower limb power [5,21]. Indeed, more than 70% of the professional players perceived that their performance and training abilities were negatively affected [21]. The current data suggest that acute high intensity exercise performance is likely to be negatively affected during Ramadan fasting [22], although there is also evidence to the contrary [4,16,17,23].

As international sporting competitions occur throughout the year, Muslim athletes may need to train through the Ramadan month to be well-prepared for competitions which may fall during or immediately after the Ramadan period. A concern is whether physiological adaptations to intense training are compromised during Ramadan fasting [22,24]. Although previous studies have monitored subjects' exercise performance prior to, during and following the Ramadan period [1,4,15—17,23], apparently there are no studies where the experimental protocols were specifically-designed to directly examine the effects of Ramadan fasting on training-induced adaptations. Thus, the aim of the present study was to examine the influence of Ramadan fasting on training-induced adaptations to a systematic, progressive exercise-training programme. It is hypothesized that training-induced adaptations would be negatively affected because of Ramadan fasting.

2. Methods

2.1. Subjects

Twenty healthy young male subjects were recruited for the study. Subjects were players who were representing either their college/schools or the local clubs in soccer or basketball. At the time of the study, none of the participants were involved in any systematic fitness training. Due to the nature of Ramadan fasting, it was not possible to randomise the participants into different groups. Volunteers of the