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EFFECTS OF RAMADAN FASTING ON MAXIMAL BENCH PRESS STRENGTH PERFORMANCE IN TRAINED ATHLETES

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This study examined the effects of Ramadan fasting on maximal strength performance (3 sets of bench press exercise at 85% of 1RM with three minutes of passive rest between sets) performed at three different times of the day: 1000h, 1900h and 2200h. There were no significant differences between RAM and CON for the total number of successful bench press repetitions executed over the three sets (1000h: 20.6±1.3 vs. 19.6±1.5; 1900h: 20.7±3.3 vs. 20.7±2.7; and 2200h: 20.9±2.9 vs. 19.2±2.6, respectively, all $P>0.05$). Post-exercise ratings of perceived exertion (Borg's 1-10 scale) were significantly higher in the RAM vs. CON for the 1000h (7.6±0.7 vs. 6.4±1.0; $P<0.017$) and 1900h (7.8±0.8 vs. 6.9±0.6, $P<0.017$), but not for the 2200h (7.0±0.9 vs. 6.4±1.5; $P>0.05$) session. Ramadan fasting has no negative impact on maximal bench strength performance but a greater perceived effort was required to perform the same muscular exercise in the fasted than in the non-fasted state.

1 Introduction

Adult Muslims are obliged to fast daily for 30 days during the religious month of Ramadan, in compliance with one of the five pillars of Islam. During this period, Muslims living in the equatorial region, do not eat nor drink (i.e. total abstinence from food and fluids) from pre-dawn until dusk, for as long as ~13 hrs. Daily meals during Ramadan are consumed at two main sittings, the first at ~0430h to 0530h before the commencement of the day's fast (i.e. the sahur meal), and the second at the breaking of fast at ~1900h (i.e. iftar meal).

Literature evidence suggest that Ramadan fasting has a negative impact on continuous progressive incremental running or cycling to exhaustion and exercise performance during brief (~5.0 to 30.0 s) maximal exercise, albeit there is also evidence to the contrary (see review by Chaouachi *et al.*, 2009*a*). In comparison, studies investigating the effects of Ramadan fasting on exercise strength performance are comparatively sparse. Majority of these studies have used the traditional grip strength as

the criterion measure of strength performance (Afyon & Micoogulari, 2003; Wahid *et al.*, 2009; Waterhouse *et al.*, 2009), and they collectively indicated that Ramadan fasting did not affect maximal grip strength. In contrast, Bigard *et al.* (1998) showed that maximal strength of the elbow and knee extensors decreased significantly by 10-15% when assessed during Ramadan fasting as compared to the pre-Ramadan period. These studies' findings were of limited application because they were restricted to isometric, single-joint-type movement which is markedly different from multi-joints dynamic-type strength.

Thus the aim of the present study was to examine the impact of Ramadan fasting on maximal bench press strength performance performed at three different times of day: 1000h, 1900h and 2200h. The three times of the day were chosen based on feedback from coaches that these are common times that athletes usually perform their training during the day in the Ramadan month (Aziz & Png, 2008).

2 Materials and Methods

2.1. Subjects

Nine male Muslim national athletes from the martial art sport of pencak silat (age: 19±1 yrs; body mass: 71±10 kg) volunteered for the study. All subjects were familiar with the bench press exercise. At the time of study athletes were not involved any form of systematic resistance training. All subjects gave informed consent and the study was given ethical approval by institution ethics committee.

2.2. Experimental Procedure

The study used a repeated measure, cross-over design with each subject completing three sessions before the Ramadan month (Control, CON) and three sessions during the Ramadan month (fasting, RAM); with familiarisation to all procedures performed prior to the actual test sessions. For the RAM condition, trials were conducted between the 2nd and 4th week of Ramadan month to allow habituation to fasting. For the 2200h trial, fasted subjects in the RAM condition would have broken fast and performed the required exercise in the non-fasted state. Subjects maintained their habitual activity and avoided any vigorous activity a day before all trials. Results were not revealed to the subject until the completion of the entire study. All sessions were performed in a thermo-neutral laboratory environment. The study was conducted during the actual Ramadan month where the daily fasting time was between ~0530h to ~1900h, a total fast of 13 hours duration.

One repetition- and three repetition-maximal bench press strength protocol. All exercise sessions were conducted by the same certified strength and conditioning (SC) coach with 10 years of working experience. After a standardised warm-up with a light resistance subjects performed an estimated load that allowed for the completion of 3-5 reps, followed by a 3-min rest. Then a near-maximum load was used that allowed for a

successful 2-3 reps, followed by 2-min rest. The SC coach increased (or decreased) the load progressively until the subject completed one rep with the proper technique. The reliability of this method of 1RM determination in our laboratory is high (ICC=0.97; unpublished data). The final 1RM load was used to calculate the resistance for the 3RM performance trial.

The criterion measure of strength performance used in the study was the total number of successful reps completed in three sets at 85% of 1RM load (with a 3-min rest between sets). The 3RM trials were conducted in a similar manner as in the 1RM trial. Following a standardised warm-up, the appropriate resistance was then loaded and subjects performed the 3RM exercise protocol. No attempt was made to control for the lifts velocity; however subjects were required to use a smooth and controlled motion with minimal pause between repetitions. The SC coach solely determined the validity of each lift.

Borg's ratings of perceived exertion (RPE) categorical ratio 1-10 scale which has been shown to be a reliable and valid measure of perception of effort and intensity of exercise during resistance training was used. The subjects were provided with standardised instructions and anchoring procedures during the familiarisation trial. Subjects provided their RPE of the entire session 15 min after the completion of the 3rd set by answering the question: "How was your workout?"

To control for dietary intake, subjects were provided with a standardised pre-packed cooked meals (Fus'zin Palate Catering Pte Ltd, Singapore) for the 24 hours period prior to all testing sessions, based on the following stipulations: carbohydrate 7 g·kg body mass^{-1} per day; (497±73 g) and protein 1.5 g·kg bodymass^{-1} per day (107±15 g). Fluids intake (sports drinks, fruit juice and bottled water) amounted to 4.0 *L* per person were also provided with the food.

All data were analysed using SPSS. The fasting and time-of-day effects were assessed using a 2 x 2 repeated ANOVA, with (RAM, CON) and time-of-day (1000h, 1900h, 2200h) as independent factors. Statistical significance was set at $P<0.05$. If a significant main effect was present, pair-wise comparison was performed to determine its location, accounting for Bonferonni effect ($P<0.05/3=0.017$).

3 Results

There were no statistical significance in the total number of successful reps either for main ($F_{1,8}=2.94$, $P=0.13$), time ($F_{2,16}=0.57$, $P=0.58$), or interaction ($F_{2,16}=1.27$, $P=0.31$) effects (Fig 1). There was however statistical significance in the RPE for main ($F_{1,8}=25.81$, $P=0.001$) and time ($F_{2,16}=4.28$, $P=0.03$), but no interaction ($F_{2,16}=0.81$, $P=0.46$) effects (Fig 2).

4 Discussion

The main finding of the study is that there was no adverse impact of Ramadan fasting on maximal bench press strength performance, as determined by the total number of reps

completed in 3 sets at a load equivalent to 85% 1RM. However, post-exercise RPE data indicate that the maximal performance induced a greater perceived effort on the part of the fasted subjects as compared to the same maximal exercise when subjects were in the non-fasted state.

The strength results contrasted with those reported by Bigard *et al.* (1998). However differences in the subjects' training status (non-training pilots vs. trained athletes), the type of contraction utilised (isometric vs. isotonic), the amount of muscle mass engaged (elbow and quadriceps vs. arms and upper chest) in the movements as well as movements' joints (single vs. multi) between Bigard and present study respectively, may partly help to explain the contrasting results.

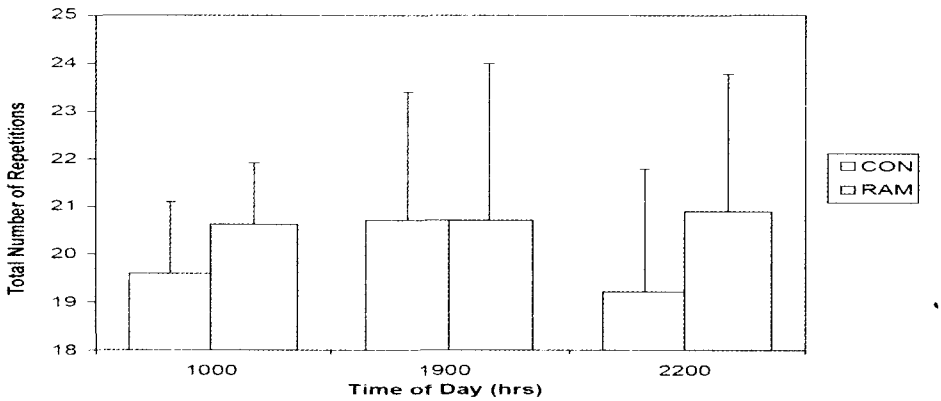

Figure 1. Total number of repetitions in the 3 sets of maximal bench press exercise at three different times of the day during Ramadan (RAM) and Control (CON). There were no significant differences in the total number of repetitions between CON and RAM at the three times of day sessions (all $P > 0.05$).

The post-exercise RPE is well investigated as a marker of exercise intensity during resistance training and there are abundant data showing the close positive relationship and agreement between RPE with many indices of resistance training such as the relative load lifted (as a percentage of 1RM), the number of sets completed, the amount of muscles activated, volume and/ or total work of training, intensity of effort during the lifts and the overall quality of the strength training session (e.g., Day *et al.*, 2004). In this regard, the RPE in the present study serves as a subjective, indirect measure of maximal strength performance. The perception of effort reported by the subjects in the fasted state was higher by almost 1-unit than that in the non-fasted state for the 1000h and 1900h sessions. This indicates that maximal strength exercise during fasting seems to amplify the sensation of physical effort, even though the load lifted remains equivalent. The capacity to maintain high level of exertions during strength training is limited either by fatigue of the working muscles and/or neuromuscular system failure (i.e. within the brain). In accepting the postulations of the central-governor theory (Noakes *et al.*, 2004),

which argues that fatigue operates somewhat independently of the physiological capacity of the muscles, then subjects will reach a self-imposed termination point much earlier in the fasted state compared to the non-fasted state.

Hence assuming that RPE reflects, at least in part, the fasted subject's central nervous system responses, this suggests that whilst the maximal strength performance during a short exercise effort in the fasted state is not negatively affected, it may be argued that the level of effort is however not sustainable over a longer exercise duration. This view is supported by previous observations that single, short-duration all-out maximal exercises such as vertical jump and sprint were not adversely affected but yet in contrast, repeated continuous jumping for 30 s which requires maximal sustainable effort was markedly impaired in the same well- trained athletes (Chaouachi *et al.*, 2009*b*).

An implication of this finding is that during a typical maximal strength training session which typically involves 3-6 sets of 4-8 exercises, where the need to sustain maximal voluntary contractions over a longer period is imperative, it might then be argued that Ramadan fasting could lead to the early onset of "central" fatigue and this could affect the exercise performance quality or quantity during the later part of the session.

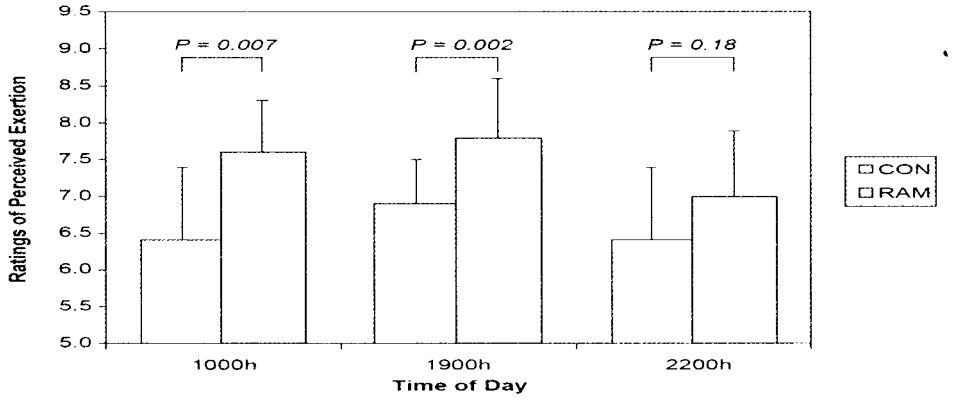

Figure 2. Ratings of perceived exertion after performing 3 sets of maximal bench press strength exercise at three different times of the day during Ramadan (RAM) and Control (CON). *significantly different between RAM and CON, $P < 0.017$. Note: Subjects performed their 2200h trial during RAM in the non-fasted state.

The underlying mechanism(s) which can explain the higher RPE reported by subjects in the fasted state is/are speculative at this point. The present study's very short-duration (~8 min) exercise protocol is not likely to lead to a substrate depletion within the muscles but it may be that the fasted subjects have had to be more reliant on anaerobic metabolism to perform the maximal exercise and this could have resulted in greater metabolic acidosis within the muscles leading to a higher post-exercise RPE response. This view is partially supported by the fact that fat oxidation tends to be the predominant fuel during exercise, even at high intensities, in the fasted state (Aziz & Png, 2008). Also,

perhaps the chronic daily fasting regimen resulted in a lower power output per muscle fibre contraction, similar to that occurred during acute prolonged fasting (Henriksson, 1990), and therefore in order to maintain the same tension development, a greater firing frequency from the higher center command is needed. It should also be highlighted that the above neuromuscular effects could further be exacerbated by the fact that the fasted subjects were exercising in the acute hypohydrated state.

Psycho-physiological factors can also influence the physical state of subjects undergoing fasting; which can affect RPE. Previous studies indicated that Ramadan fasted individuals reported an overall increased in perceptual fatigue, even at rest (Chaouachi *et al.*, 2009*a*). Moreover, subjects in the present study were not blinded to the intervention of fasting and may be "anticipating" the bout of maximal exercise. Such anticipation may lead to neural changes such as increased HR, ventilation, blood pressure, etc., that could have influenced the subjects' brain-perceptual regions.

In conclusion, the results of this study showed that Ramadan fasting did not have a deleterious effect on maximal bench press strength performance *per se*, although fasted subjects perceived their effort to be substantially greater when the same exercise was performed during the daytime.

5 Practical Applications

Ramadan fasted subjects rated their perceived exercise effort to be substantially greater than in the non-fasted state, whilst performing *only* 3 sets of maximal bench press exercise. This suggest that Ramadan fasting may have a negative psycho-physiological influence which could manifest into a poorer quality of performance if session is extended further to 6-8 different exercises, which is typical of a strength session. Coaches and athletes may need to implement strategies to ameliorate the deleterious psycho-physiological effects of the daytime fast during sustained maximal efforts. Based on the present study, one strategy could be to conduct maximal strength session in the evenings after the day' fast. Other plausible strategies include extending the passive rest duration between sets and possibly limit the training session to execution of the 2-3 most critical exercises.

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