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# The Effects of a Single Bout of Moderate Cycling Exercise During Ramadhan Fasting on Mood States, Short-Term Memory, Sustained Attention and Perceived Exertion among Sedentary University Students

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## ABSTRACT

Ramadhan is the fasting month in the Islamic calendar when consumption of water and food is abstained from. Previous studies of exercising during Ramadhan have shown mixed findings. The aim of this study was to determine the effects of a single bout of moderate cycling exercise during the ritual fasting of Ramadhan on mood states, rating of perceived exertion and short-term memory among physically inactive university students. Participants were 13 healthy male university students, with a mean age of 23.54±3.41 years, height of 170 ±7.02 cm, weight of 66.95±7.40 kg and body mass index (BMI) of 23.33±1.74 $kg.m^{-2}$. Data on mood states, rating of perceived exertion and short-term memory were collected before and after cycling exercise. All of the participants performed cycling exercise at progressively increasing intensities of 45%, 60%, 75% of $VO_{2max}$ for 30 minutes (10 minutes for each intensity) a week before Ramadhan and in the first and fourth week of Ramadhan and 2 weeks after Ramadhan. The results of the mixed factorial ANOVA revealed no significant interactions between sessions across trials. In conclusion, exercise during Ramadhan fasting exhibited no significant effects on mood states, perceived exertion and cognitive performance.

*Keywords:* Mood states, oxygen consumption, perceived exertion, sustained attention

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## INTRODUCTION

Fasting over a period of time is a feature of several religions and it is considered a healthy practice in many cultures and religions. For Muslims, fasting is usually performed during the ninth lunar month

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of the Islamic calendar. During this one-month period, in the month of Ramadhan, Muslims are required to abstain from eating and drinking during daytime hours between dawn to sunset for 28 to 30 consecutive days. In a tropical climate, a daily fasting duration of 12 to 14 hours is common (Sakr, 1975). Within this period, when food and water consumption is abstained from, the effects of physical activity are not immediately known, especially for the general population.

Among athletes, previous studies have revealed mixed findings. On one hand, several studies reported that exercise performance was not affected during Ramadhan fasting compared to the non-Ramadhan fasting season when the same exercises were undertaken (Chaouachi et al., 2009). On the other hand, other studies have reported adverse impacts of Ramadhan fasting on exercise performances (Aziz & Weileen, 2008; Fallah, 2010, Waterhouse, 2010). For instance, Fallah (2010) reported that one day of fasting has no or a small effect on performance. However, 30 consecutive days of fasting affected several performance factors, including cognitive and endurance functions (Fallah, 2010). There are also studies that observed the tendency of Muslim athletes to report an increase in subjective feelings of malaise, lethargy and fatigue during the Ramadhan fasting period. These negative mood states are known to affect athletes' ability to perform at their optimal ability, particularly in high-intensity exercise (Ramadhan, 2002; Roky, Houti, Moussamih, Qotbi, & Aadil, 2004).

For the general population, exercise behaviour is usually slowed down or ceased during Ramadhan. It has been observed that fasting for 30 consecutive days without exercise can result in regression of strength and fitness. Individuals who stop training during Ramadhan fasting often face a relapse with regard to cardiovascular and resistance adaptation. Furthermore, going a month without exercise is equivalent to losing four months of exercise (Noorbhai, 2013). However, Ramadhan and Barac-Nieto (2000) indicated that exercising during Ramadhan provides no negative effects among sedentary individuals.

Mood is an important aspect of psychological health in a person's daily life. It is largely known that mood, especially negative mood, may affect many aspects of individuals' functions of daily living such as decision-making and effort. Roky et al. (2000) observed that during Ramadhan, positive mood tends to decrease and is accompanied by decreased willingness to work. They also observed that the ability to optimally perform physical and mental activities decreased during Ramadhan (Roky et al., 2000). Given the non-specific nature of mood, its potential sources are numerous and nonspecific. It is therefore interesting to observe if exercising during fasting contributes to this effect.

To our knowledge, studies on the effects of Ramadhan fasting on selected cognitive and psychological parameters following moderate cycling exercise among the general population such as university students are limited. While many previous

studies focussed on athletes, the present study aimed to determine the effects of progressively increasing exercise intensity during Ramadhan on mood states, perceived exertion and cognitive performance in sedentary university students. It is hypothesised that cycling exercise during fasting has no detrimental effects on measured variables.

## MATERIAL AND METHODS

### Participants

Thirteen male university students participated in this study. Their mean age, height, weight and BMI were 23.54 (3.41), 170 cm (7.02), 66.95 kg (7.40), 23.33 $kg.m^{-2}$ (1.74), respectively. All the participants provided written informed consent. Only healthy Muslim students with previous fasting experience during Ramadhan and had no chronic diseases were included. The Human Research and Ethics Committee of the authors' institutions approved the protocol of the study. The sample size was calculated using the PS software (Dupont & Plummer, 1997). The calculated sample size was 13 participants and this was suffiecient to achieve the specified power, including the estimated dropout rate of 10%.

### Measurement Instruments

Measurement instruments that were used to collect data include a Vmax spectra (Sensormedics, USA) to measure maximum oxygen consumption ($VO_{2max}$) and oxygen uptake during the experimental trials, a telemetric heart-rate monitor (Polar S710 Polar Electro Oy, Finland) to monitor the participants' heart rate and Seca 220/221 measuring rod to measure the standing height and body weight of the participants. Besides, Rating of Perceived Exertion, Digit Span Test, Digit Vigilance Test and Brunel Mood Scale were also used.

Rating of Perceived Exertion (RPE; Borg, 1970) was used to measure the degree of heaviness and strain experienced in physical work as estimated according to a specific rating method. It measures the participant's subjective rating of their strain experience of the extent of stress on the scale of 6 (no exertion), 7 (very , very light), 8-9 (very light), 10-11 (fairly light), 12-13 (somewhat hard), 14-15 (hard), 16-17 (very hard), 18-19 (very, very hard) and 20 (maximal exertion). The participants selected the rating that most closely represented their level of physical workload.

The Digit Span Test (DS; Kaplan et al., 1991) is a subtest from the Wechsler Memory Scale – Third Edition (WMS-III), which is an individually administered battery of learning memory and working memory measures (Attention, concentration, mental control). This task consisted of 15 sets of a sequence of numbers from 0-9 arranged forwards (8 sets) and backwards (7 sets).

The Digit Vigilance Test (DVT; Kelland & Lewis, 1996) is a subtest of Lafayette neuropsychological cognitive batteries that has been widely used with all age groups. The validity and reliability of the DVT have been tested by Kelland and Lewis

(1996) and the result indicates that the DVT possessed high test-retest reliability and adequate convergent and discriminate validity to measure sustained attention.

The Brunel Mood Scale (BRUMS; Terry et al., 2003) is a self-report questionnaire consisting of a 24-item mood scale designed to measure six mood dimensions (tension, depression, anger, vigour, fatigue and confusion). The validity of BRUMS has been previously reported (Terry et al., 2003; Hashim et al., 2010).

## Procedure

The study was designed to have four testing periods: one week before Ramadhan (BR), the end of the first week of Ramadhan (1W), the fourth week of Ramadhan (4W) and two weeks after Ramadhan (AR). During the first visit, subjects were informed of the test protocols and what was required of them. They were asked to provide a signed informed consent form should they decide to participate in the study. Sub=maximal and $VO_{2max}$ tests were conducted prior to the study in order to determine the appropriate exercise intensity for each subject. At each period (i.e. BR, 1W, 4W and AR), the subjects cycled at progressively increasing exercise intensities of 45%, 60% and 75% corresponding to the maximal oxygen consumption value. The test was performed in the afternoon between 2 o'clock and 5 o'clock. BRUMS, the DS and the DVT were administered before and after the subjects performed the cycling exercise. However, RPE was measured at the end of exercise.

## Testing Procedures

**Sub-maximal and $VO_{2max}$ test.** Participants performed a sub-maximal exercise testing to establish the relationship between speed/ workload and oxygen uptake. During the test, participants cycled on the ergometer (Lode Groningen BV, Netherlands) starting at the workload of 50 watt and 60 RPM. It was subsequently increased by 30 watt at the end of each 4-minute increment. Following the sub-maximal test, the participants performed the $VO_{2max}$ Test on an electromagnetically braked cycling ergometer (Excalibur Sport, Lord Groningen BV, The Netherlands). The participants started to cycle at workload 50 watt and then at 60 RPM. It was subsequently increased by 15 watt at the end of each 1-minute stage. Expired gas and heart rate were measured throughout the test. Maximal oxygen uptake ($VO_{2max}$ value) was obtained when participants fulfilled the following criteria as suggested by the American College of Sport Medicine (McArdle et al., 2001): (1) Oxygen uptake ($VO_2$) showed a plateau as a small or no increase in $VO_2$ ($\leq$ 2.0 ml/ kg/min) in response to an increase in work rate; (2) Threshold values for post-exercise blood lactate concentration were in excess of 8 mmol/L; (3) A heart rate within 10 beats per minute of age-predicted maximum heart rate; and (4) A respiratory exchange ratio (RER) of 1.1 or above.

To test short-term memory, subjects were asked to replicate the number shown by the test instruments (i.e., DS) on a provided sheet. Sequences of increasing length were administered in both test forms.

For each test form, one point was given if the subject wrote the exact sequence and 0 point was given if the subject made an error in the sequence. The sum of scores from both test forms was used for the total score.

For sustained attention, the task required the subjects to cross out either all of the six (Test Form 1) or all of the nine (Test Form 2) items. The number identified was recorded as the indicator of the level of sustained attention.

For mood states, respondents indicated the extent to which they experienced the feelings described by the 24 mood descriptors such as worried, anxious, furious, bad-tempered, worn out, exhausted, energetic, mixed-up, uncertain, miserable and downhearted using the reference timeframe of "*How do you feel right now?*" The subjects' response was recorded using a 5-point Likert scale of 0 ('Not at all'), 1 ('A little'), 2 ('Moderately'), 3 ('Quite a bite') and 4 ('Extremely').

**Exercise protocol.** Participants performed 30-minute exercise in progressively increasing cycling intensity corresponding to their $VO_{2max}$ on four occasions: (1) week before Ramadhan, (2) first week of Ramadhan, (3) fourth week of Ramadhan, and (4) two weeks after Ramadhan. The participants progressively cycled at exercise intensities of 45%, 60% and 75% of their $VO_{2max}$ for 10 minutes each (Stannard & Thompson, 2008). The intensities were fixed in such an order to avoid sudden exposure to a fixed exercise intensity considering the subjects were fasting. Prior to the start and at the end of the 30 minutes of cycling, mood states and cognitive performance were measured. RPE was measured at the end of the exercise.

**Statistical Analysis**

All statistical tests were processed using IBM SPSS Statistics version 20. Mean and SD (standard deviation) (mean ±SD) values were calculated for all dependent variables. RPE was analysed using repeated measures ANOVA whereas mood states, sustained attention and short-term memory were analysed using 2 (pre and post) x 4 (Before Ramadhan, 1st week, 4th week and after Ramadhan) mixed factorial ANOVA. Statistical significance was set at an Alpha of less than 0.05.

## RESULTS

The descriptive statistics for the primary measures are presented in Table 1. Results of repeated measures ANOVA revealed no significant time effect for RPE. Results of mixed factorial ANOVA revealed a non-significant interaction ($p>0.05$) for any mood state dimensions. Similarly, the results revealed a non-significant interaction for digit span and digit vigilance test 1. However, we observed a significant ($F_{(3,36)}=4.85$, $p<0.05$) interaction in Digit Vigilance Test Form 2. A simple effect test was then performed and the results are presented in Table 2.

## DISCUSSION

The present study examined the effects of exercising at moderate intensity among inactive male adults. Cessation of exercise during Ramadhan is common, especially

among non-athletes. Complete cessation has been shown to result in a regression of strength and fitness. Individuals who stop training during the Ramadhan fasting often face a relapse with regard to cardiovascular and resistance adaptation. Furthermore, eliminating exercising for a month is equivalent to losing four months of exercise (Noorbhai, 2013). The results of the present study indicated no significant difference in the participants' perceived exertion inany of the testing sessions. The

Table 1
*Descriptive Statistics for Mood States, Rating of Perceived Exertion, Short-Term Memory, and Sustained Attention at Each Testing Period*

| | Testing sessions | Pre-exercise Mean ( SD) | Post-exercise Mean ( SD) |
|---|---|---|---|
| | BR VS 1W | - | 14.77(1.96) |
| RPE | BR VS 4W | - | 15.23( 3.11) |
| | BR VS AR | - | 14.85( 2.67) |
| | 1W VS 4W | - | 14.08(3.15) |
| Tension | 1W VS AR | 2.77(2.49) | 2.38(2.25) |
| | 4W VS AR | 3.15(2.30) | 2.85(2.11) |
| | BR VS 1W | 2.23(1.87) | 2.77(2.38) |
| | BR VS 4W | 1.92(1.89) | 1.92(2.21) |
| Anger | BR VS AR | 1.46(1.27) | 1.77(1.53) |
| | 1W VS 4W | 1.85(2.11) | 1.77(1.73) |
| | 1W VS AR | 1.08(1.32) | 1.62(1.93) |
| | 4W VS AR | 1.54(1.61) | 1.46(1.61) |
| Depression | BR VS 1W | 2.00(1.41) | 2.08(2.25) |
| | BR VS 4W | 1.46(1.80) | 2.08(2.10) |
| | BR VS AR | 1.62(1.50) | 2.15(1.77) |
| | 1W VS 4W | 1.62(1.55) | 1.85(2.03) |
| Fatigue | 1W VS AR | 3.46(2.11) | 4.69(2.59) |
| | 4W VS AR | 4.08(2.29) | 5.69(3.52) |
| | BR VS 1W | 4.69(2.84) | 7.00(2.82) |
| | BR VS 4W | 2.46(1.98) | 2.46(1.98) |
| Vigour | BR VS AR | 9.31(2.09) | 8.69(3.14) |
| | 1W VS 4W | 6.54(3.47) | 6.23(3.11) |
| | 1W VS AR | 6.15(3.97) | 6.08(3.52) |
| | 4W VS AR | 7.38(3.70) | 6.23(3.91) |
| Confusion | BR VS 1W | 3.46(1.39) | 2.38(2.53) |
| | BR VS 4W | 2.62(2.14) | 3.00(1.95) |
| | BR VS AR | 2.15(1.72) | 2.92(2.36) |
| | 1W VS 4W | 2.15(1.46) | 2.46(1.66) |

Table 1 (*continue*)

| | Testing sessions | Pre-exercise Mean ( SD) | Post-exercise Mean ( SD) |
|---|---|---|---|
| DS Memory test | 1W VS AR | 14.46 (2.76) | 14.62 (3.23) |
| | 4W VS AR | 16.62 (2.47) | 17.38 (2.69) |
| | BR VS 1W | 16.77 (2.35) | 18.15 (3.58) |
| | BR VS 4W | 18.31 (2.84) | 19.31 (2.28) |
| DVT1 | BR VS AR | 96.00 (4.66) | 94.00 (5.33) |
| | 1W VS 4W | 95.15 (4.16) | 96.69 (3.59) |
| | 1W VS AR | 95.38 (4.59) | 95.00 (4.88) |
| | 4W VS AR | 94.00 (6.08) | 96.00 (5.66) |
| DVT2 | BR VS 1W | 96.85 (2.38) | 93.54 (4.59) |
| | BR VS 4W | 97.31 (4.40) | 97.69 (3.52) |
| | BR VS AR | 94.62 (4.81) | 97.77 (3.11) |
| | 1W VS 4W | 97.31 (2.96) | 97.46 (4.03) |

Note:
DS=Digit span test (memory test) DVT=Digit Vigilance Test (concentration test)
BR=Before Ramadhan 1W=1st Week of Ramadhan
4W=4th Week of Ramadhan AR=After Ramadhan

Table 2
*The Pairwise Difference in Sustained Attention Scores Across Measurement Sessions*

| Variable | Time | Trials | Mean difference (95% CI) | Std. Error | *P* -value |
|---|---|---|---|---|---|
| DVT 2 | Before Exercise | BR VS 1W | -0.46 (-3.292,2.369) | 1.299 | 0.729 |
| | | BR VS 4W | 2.23 (-0.987,5.449) | 1.477 | 0.157 |
| | | BR VS AR | -0.46 (-2.607,1.684) | 0.985 | 0.648 |
| | | 1W VS 4W | 2.69 (-0.059,5.444) | 1.263 | 0.054 |
| | | 1W VS AR | 0.000 (-1.796,1.796) | 0.824 | 1.000 |
| | | 4W VS AR | -2.69* (-4.932,-0.453) | 1.028 | **0.022** |
| | After Exercise | BR VS 1W | -4.15* (-7.535,-0.773) | 1.552 | **0.020** |
| | | BR VS 4W | -4.23* (-7.141,-1.321) | 1.336 | **0.008** |
| | | BR VS AR | -3.92* (-7.106,-0.740) | 1.461 | **0.020** |
| | | 1W VS 4W | -0.07 (-2.818,2.664) | 1.258 | 0.952 |
| | | 1W VS AR | 0.23 (-2.658,3.120) | 1.326 | 0.865 |
| | | 4W VS AR | 0.30 (-1.528,2.144) | 0.843 | 0.721 |

Note:
DVT2=Digit Vigilance Test (concentration test) BR=Before Ramadhan
1W=1st Week of Ramadhan 4W=4th Week of Ramadhan
AR=After Ramadhan

absence of significant differences in this variable before, during and after Ramadhan indicates that exercise during fasting was not perceived to be stressful by the participants. Despite these non-significant differences, the pattern of the data indicated an increase in perceived exertion during Ramadhan compared to during a non-fasting period. It was especially higher at the beginning of Ramadhan. Understandably, participants were in the early process of adapting to the non-consumption of food and water.

As mentioned, mood is an important aspect of psychological health in a person's daily life and may affect many aspects of an individual's daily routine such as decision-making and physical effort. The results here indicated no changes in mood states after exercising before, during and after Ramadhan fasting. Despite these non-significant differences, a pattern of decline in positive mood (vigour) and an increase in negative mood (fatigue) during Ramadhan was compared. This pattern corroborated with the increase in perceived exertion observed following exercise during fasting. An implication that can be drawn from this specific finding is for the exercisers to maintain their level of exercise intensity or adhere to a moderate level of exercise intensity during fasting instead of ceasing exercise altogether.

Roky et al. (2000) observed a decrease in mental ability following exercise during fasting in one of their studies. Contrary to Roky et al.'s (2000) finding, our finding suggests that exercise during Ramadhan has no influence on cognitive functions, particularly sustained attention and short-term memory. In fact, it was observed that exercising at moderate intensity enhances attention. However, because this was observed in only one of the test components (i.e., Form 2 of DVT), further studies are indeed needed to confirm the generalisability of this finding.

When interpreting the findings of this study, the limitations should be taken into consideration. Specifically, our study was limited in terms of the sample size, which was relatively small and the study was conducted among university students aged 20 to 30 years old; thus, the findings may be limited to this age group. Furthermore, the participants' activities between trials were not controlled and that may have affected the results. Further studies involving sedentary individuals are indeed required to confirm the effects of exercising during Ramadhan on this population. To conclude, a single bout of sub-maximal exercise during Ramadhan fasting was significantly associated with increased sustained attention but did not significantly influence the students' memory and showed no adverse impact on mood changes and cardiovascular strain. Thus, exercise at moderate intensity during Ramadhan can be performed without any adverse effect on the measured variables.

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