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ORIGINAL ARTICLE

The Effect of Ramadan Fasting on Physical Performances, Mood State and Perceived Exertion in Young Footballers

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Abstract

***Purpose*: This study was designed to assess the effects of Ramadan fasting on the profile of mood state and perceived exertion in young soccer players and aerobic and anaerobic performances during the Yo-Yo, repeated sprint ability (RSA) and the Wingate tests.**

***Methods*: Twenty junior male soccer players completed the Yo-Yo, the RSA, and the Wingate tests on three different occasions: one-week before Ramadan (BR), the second week (SWR) and the fourth week (ER) of Ramadan. The total distance (TD) covered and the estimated maximal aerobic velocity (MAV) during the Yo-Yo test were recorded. During the RSA test, peak power (PP) during each sprint, the percentage of decrement of PP (PD) and total work (Wtotal) were calculated. During the Wingate test, peak (P_{peak}) and mean (P_{mean}) powers and fatigue index (FI) were recorded.**

***Results*: TD and MAV (P=0.01) during the Yo-Yo test and PP (P=0.01, P=0.004, P=0.001, P=0.01, P=0.03 for sprints 1, 2, 3, 4, and 5, respectively) and Wtotal (P=0.02) during the RSA test were significantly higher during BR than ER. Furthermore, muscle fatigue during the RSA test increased significantly from BR to ER (P=0.01). P_{peak} and P_{mean} during the Wingate test decreased significantly from BR to SWR and ER (P<0.0005). FI was higher during SWR (P=0.001) and ER (P<0.0005) than BR. In addition, rating of perceived exertion scores and fatigue estimated by the profile of mood state questionnaire were higher during Ramadan in comparison with BR.**

***Conclusions*: The present study suggests that both aerobic and anaerobic performances during the Yo-Yo, the RSA and the Wingate tests were affected by Ramadan fasting in young soccer players.**

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INTRODUCTION

Ramadan requires Muslims to refrain from eating, drinking, smoking, and having sexual relations from sunrise to sunset [1,2]. Based on the data in the current literature and as reviewed by Waterhouse [2], Chaouachi et al [3], Moughan [4], and Mujika et al [5], the effects of Ramadan intermittent fasting on metabolism, body mass and performance have been the subject of several studies performed over the last three decades,

but the findings have been relatively inconsistent. In this context, although previous studies have failed to observe substantial performance decrements following shorter periods of fasting (11–24 h) [6,7], other investigators concluded that fasting before exercise causes a decrement in performance [8,9,10]. Most of these studies used sedentary or recreationally active individuals who were undertaking exercise tasks at which they were relatively inexperienced. For athletes, previous studies suggest that few aspects of physical fitness are negatively affected, and only modest performance decrements are observed [3,11,12,13,14]. However, the latter studies have been conducted during Ramadan 2006 or 2007.

In view of the fact that the Islamic calendar is lunar, Ramadan can occur at different times of the solar calendar over a 33-year cycle. The fast duration depends on the geographical location and the season of the year, and can be as long as 18 h [1]. Thus, the application of the literature results is limited when the fast duration is longer, especially for the most popular competitive event, e.g the Olympic Games London 2012 (about 16 h of daylight: the Games will run from 27th of July to the 12th of August and Ramadan will begin on the 20th of July and continue until the 18th of August [4]). Recently, in Ramadan 2010, Hamouda et al [15] showed that performances during the Yo-Yo and the repeated sprints ability (RSA) tests were reduced during this month. Zeguini et al [12] suggested that decrements in the players' mood and motivation were likely to be at least partly responsible for the reduction in physical performance. In this context, Roky et al [16] showed that mood and the willingness to work decreased during Ramadan, as do abilities to optimally perform physical and mental activities. These results might be evidenced by the reported increases in the frequencies of road traffic accidents [17].

Furthermore, an exciting issue for sports scientists is the challenge imposed by Ramadan intermittent fast and elite sport. Athletes and coaches need to choose between stopping training, with the inherent risk of inducing detraining effects, reducing the training-load or maintaining usual training loads to avoid any detraining effect (see Mujika et al [5]). For a long time, it has been suggested that alterations imposed by the Ramadan intermittent fast may require a reduction in the training load undertaken by elite Muslim athletes [18]. A marked reduction in the training load allows athletes to reduce the fatigue induced by intense training and improve competition performance. Therefore, it is crucial to investigate if athletes are more exhausted during Ramadan. In fact, decrements in physical function can lead to an increase in perceived exertion and mental stress during training and, more seriously, a raised incidence of injury and illness [18].

Since a common difficulty for Muslim elite athletes is that the sporting calendar is not modified for religious observances and that competitive events are programmed throughout the annual calendar (e.g. the 2012 Olympics Games) [1], the purpose of this study was to determine the effects of Ramadan fasting on muscle fatigue and physical and mental performances of young soccer players.

METHODS AND SUBJECTS

Participants:

Twenty male soccer players (age: 17.6 ± 0.6 yr; body mass: 71.3 ± 4.8 kg; height: 181.3 ± 5.4 cm) from Tunisian junior football squads, affiliated with professional clubs, volunteered to participate in this study. After receiving a description of the protocol, risks, and benefits of the study, each volunteer provided written informed consent. The study was conducted according to the Declaration of Helsinki and the protocol was fully approved by the Clinical Research Ethics Committee of the National Centre of Medicine and Science of Sports of Tunis (CNMSS) before the commencement of the assessments. The study was carried out in Tunisia during Ramadan 2010 when Ramadan started on the 11th of August and finished on the 10th of September. The length of each fasting day was approximately 15-16h.

The criteria for participant inclusion for this study were as follows: all subjects were nonsmokers and followed Islam devoutly, therefore did not consume alcohol. They were exercising for at least four days a week for an average of 2 h per day.

***Experimental Design*:**

Subjects performed three specific tests (Yo-Yo test, 5 × 6 s RSA test and Wingate tests). All players were already familiar with the testing procedures as it was part of their usual fitness assessment program. The experimental design was developed to have three testing periods: one week before Ramadan (BR), the second week of Ramadan (SWR) and the fourth week of Ramadan (end of Ramadan: ER). At each testing period, the subjects performed three test sessions (TS) with only one test session per day. The TS were performed in the evening between 17:00 and 18:00 h. During each period, subjects completed the POMS questionnaire. Moreover, the rate of perceived exertion (RPE) was determined using the Borg scale [19] after each test. Body mass was measured using an electronic scale (Tanita, Tokyo, Japan).

Rating of Perceived Exertion Scale (RPE):

The RPE scale allows participants to give a subjective exertion rating for the physical task. It consists of a 15-point scale ranging from 6 (very very light) to 20 (very very hard). The RPE scale is a reliable indicator of physical discomfort, has sound psychometric properties and is strongly correlated with several other physiological measures of exertion [14].

Profile of Mood States (POMS):

Subjective mood state was evaluated using the English version of the POMS questionnaire. This is a self-report questionnaire consisting of 65 adjectives designed to assess 6 states (tension, depression, anger, vigor, fatigue, and confusion) [20]. Responses to each item range from 0 to 4, with higher scores indicating more negative mood (0 indicates ‘‘Not at all’’ and 4 indicates ‘‘Extremely’’).

The yo-yo intermittent recovery test:

The Yo-Yo test was performed according to the procedures suggested by Castagna et al [21]. The test consists of 20-m shuttle runs performed at increasing velocities with 10 s of active recovery between runs until exhaustion. Audio cues of the Yo-Yo test were recorded on a CD (www.teknosport.com, Ancona, Italy) and broadcasted using a portable calibrated CD player (Philips, Az1030 CD player, Eindhoven, Holland). The end of the test is considered when the participant twice fails to reach the front line in time or he feels unable to complete another shuttle at the dictated speed. The total distance (TD) covered during the Yo-Yo test level 1 and the estimated maximal aerobic velocity (MAV) (including the last incomplete shuttle) were calculated and stored for further analyses.

Cycling tests:

The RSA and Wingate tests were conducted on a friction-loaded cycle ergometer (Monark 894^{E}, Stockholm, Sweden) interfaced with a microcomputer. The RSA cycle test consisted of 5 × 6 s maximal sprints every 30 s [22] against a constant resistance of 60 g • kg^{-1} of body mass as suggested by Doré et al[23]. During the recovery period (i.e.24 s) between sprints, subjects remained seated on the bicycle and were allowed to follow the countdown. However, the Wingate test consisted of a continuous 30 s maximal sprint against a constant resistance of 87 g/kg^{-1} body mass as proposed by Bar-Or [24].

Before starting each test, subjects performed a pre-test warm-up consisting of 5 min cycling at 84 W, followed by 3 min of rest and then by a 10 s maximal sprint. The first 6 s of the 10 s sprint were used as the criterion score during the subsequent RSA cycle test. Upon completion of the 10 s, subjects rested for 5 min before performing the RSA or the Wingate cycle test.

During the Wingate test, the highest power output (P_{peak}) and the mean power (P_{mean}), corresponding to the ratio between total work done and time to completion (i.e. 30 s), were recorded at the end of the test. The Fatigue Index (i.e. the percentage of decrease in power output) is equal to the difference between the highest (P_{peak}) and lowest power (P_{low}) divided by the highest power [10]:

$$\text{Fatigue Index (FI)} = (P_{peak} - P_{low})/P_{peak}$$

During the RSA test, peak power (PP) during each sprint was calculated. The percentage of decrement (PD) of PP and total work (Wtotal) over the RSA test were also calculated [22].

Statistical Analyses:

All statistical tests were processed using STATISTICA Software (StatSoft, France). Mean and SD (standard deviation) values were calculated for each variable.

Table 1: RPE scores recorded after the three tests during BR, SWR and ER

Parameters	BR		SWR*		ER*		*P* Value
	Mean (SD)	CI	Mean (SD)	CI	Mean (SD)	CI	
RPE Yo-Yo	14.05 (2.28)	13.4-14.8	15.59 (2.58)	14.7-16.8	15.82 (2.84)	14.9-16.9	=0.004
RPE RSA	14.14 (1.52)	13.0-15.0	15.77 (2.25)	14.4-16.7	15.91 (2.35)	14.5-17.0	=.02
RPE Wingate	14.25 (1.16)	13.7-14.8	15.6 (1.79)	14.8-16.4	16.05 (2.01)	15.1-17.0	<0.0005

RPE: Rate of Perceived Exertion; BR: Before Ramadan; SWR: Second Week of Ramadan; ER: End of Ramadan; SD: Standard Deviation; CI: Confidence Interval. * Difference in comparison with BR.

The Shapiro-Wilk *W*-test of normality revealed that the data were normally distributed. Once the assumption of normality was confirmed, parametric tests were performed. A Fisher's one-way analysis of variance (ANOVA) with repeated measures was used to determine the differences between the study periods. The mean confidence interval (CI) was determined at 95%. A probability level of 0.05 was selected as the criterion for statistical significance. Exact *P* values have been given; results given as ''0.000'' in the statistics output have been reported as ''<0.0005''.

RESULTS

RPE scores:

RPE scores after the Yo-Yo, the RSA, and the Wingate tests recorded during BR, SWR, and ER are shown in Table 1. Statistical analysis revealed that RPE scores were significantly higher after the Yo-Yo (*P*=0.008 and *P*=0.004 respectively), the RSA (*P*=0.04 and *P*=0.02 respectively) and the Wingate (*P*<0.0005) tests during the SWR and ER with respect to BR.

Profile of mood states (POMS):

For tension, depression, anger, vigor and confusion, the Ramadan effect was not significant (Table 2). However, the fatigue was higher during the SWR (*P*=0.002) and the ER (*P*<0.0005) with respect to BR (Table 2).

Yo-Yo test performances:

TD and MAV recorded during BR, SWR, and ER are shown in Table 3. The statistical analysis showed a significant decrease of TD and MAV during the ER (*P*=0.01) in comparison with BR. However, there was no significant difference between BR and SWR.

RSA test performances:

PP recorded during each sprint at the three periods are shown in Fig. 1. Wtotal and PD recorded during the three experimental sessions are shown in Table 3. The statistical analysis showed that PP were significantly higher during BR than ER in all sprints (*P*=0.01,

Table 2: Mean (SD) effects of Ramadan on mood states

Parameters	BR		SWR		ER	
	Mean (SD)	95%CI	Mean (SD)	95%CI	Mean (SD)	95%CI
Tension	8.08 (0.8)	7.7-8.5	8.18 (0.83)	7.8-8.6	8.13 (0.76)	7.8-8.5
Depression	5.91 (0.96)	5.5-6.4	5.97 (0.81)	5.6-6.3	6.03 (0.74)	5.6-6.4
Anger	9.75 (1.72)	8.9-10.6	10.09 (1.56)	9.4-10.8	10.56 (1.35)	9.9-11.2
Fatigue	5.35 (0.4)	5.2-5.5	5.99 (0.95)	5.5-6.4*	6.57 (1.18)	6.0-7.1‡
Confusion	6.38 (0.66)	6.1-6.7	6.28 (0.82)	5.9-6.7	6.14 (0.95)	5.7-6.6
Vigor	15.22 (0.69)	14.9-15.5	15.12 (0.64)	14.8-15.4	15.09 (0.63)	14.8-15.4

*, ‡: Significant difference in comparison with BR (*P*<0.01 and *P*<0.001 respectively). BR: Before Ramadan; SWR: Second Week of Ramadan; ER: End Ramadan; SD: Standard Deviation; CI: Confidence Interval.

Table 3: Ramadan effects on TD and MAV during the Yo-Yo test

Parameters	BR		SWR		ER	
	Mean (SD)	95%CI	Mean (SD)	95%CI	Mean (SD)	95%CI
TD (m)	1903.64 (516.64)	1674.4-2132.7	1738.18 (555.18)	1492.0-1984.3	1676.36 (564.86)	1425.9-1926.8*
MAV (km · h^{-1})	16.57 (1.38)	16.0-17.2	16.15 (1.44)	15.5-16.8	15.96 (1.5)	15.3-16.6*
Wtotal (W · kg^{-1})	44.16 (2.52)	42.9-45.4	44.28 (2.47)	43.1-45.5	42.49 (3.68)	40.7-44.3*
PD (%)	6.74 (3.34)	5.1-8.4	8.13 (3.03)	6.6-9.6	10.22 (5.23)	7.6-12.8*
P_{peak} (W · kg^{-1})	10.93 (0.92)	10.5-11.4	10.75 (0.93)	10.3-11.2‡	10.73 (0.90)	10.3-11.2‡
P_{mean} (W · kg^{-1})	8.63 (0.56)	8.4-8.9	8.42 (0.57)	8.2-8.7‡	8.38 (0.58)	8.1-8.6‡
FI (%)	38.9 (6.08)	36.1-41.7	41.55 (6.79)	38.4-44.7#	43.35 (7.49)	39.8-46.9‡

*, ‡, #: Significant difference in comparison with BR (P<0.05, P<0.01 and P<0.001 respectively). TD: Total Distance; MAV: Maximal Aerobic Velocity; Wtotal: Total Work; PD: Decrement of Peak Power; P_{peak}: Peak Power; P_{mean}: Mean Power; FI: Fatigue Index; BR: Before Ramadan; SWR: Second Week of Ramadan; ER: End of Ramadan; SD: Standard Deviation; CI: Confidence Interval.

P=0.004, P=0.001, P=0.01 and P=0.03 for sprints 1, 2, 3, 4 and 5, respectively). However, there was no significant difference between BR and SWR. Likewise, Wtotal and PD were significantly affected by Ramadan only during ER. In fact, Wtotal decreased and PD increased significantly from BR to ER (P=0.02 and P=0.01, respectively).

Wingate test performances:

Statistical analysis revealed that P_{peak} and P_{mean} decreased significantly during Ramadan in comparison with BR (P<0.0005) (Table 3). Furthermore, FI increased significantly from BR to SWR (P=0.001) and ER (P<0.0005) (Table 3).

DISCUSSION

While there is much information on selected health, sociological, and physical responses to the Ramadan fasting, there is relatively little information in the literature about exercise in general and athletic

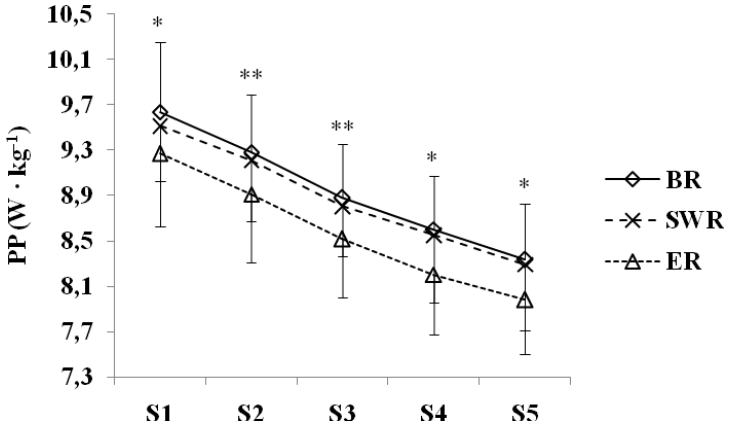

Fig. 1: PP (mean ± SD) recorded during each sprint (sprints 1 (S1), 2 (S2), 3 (S3), 4 (S4) and 5 (S5)) before and during Ramadan.

*, **: Significant difference in comparison with BR (P<0.05 and P<0.01 respectively). BR: Before Ramadan; SWR: Second Week of Ramadan; ER: End Ramadan.

performance in particular. The aim of this investigation was to examine the effect of Ramadan fasting on aerobic and anaerobic performances in young fasting Muslim soccer players. The present results demonstrated that Ramadan fasting affects performance during the Yo-Yo and RSA tests at the end of Ramadan with no changes in the middle of that month. However, performances during the Wingate test decreased at the two periods of testing during Ramadan in comparison with before Ramadan.

To date, there are only a few studies that have examined the effects of Ramadan fasting on physical performance and the results have been inconclusive [1,2,5,15]. The discrepancies between data might be due to several factors such as the duration of fasting, subjects' fitness levels, environment, motivation, changes in sleep patterns and the time-of-day of measurement.

Concerning aerobic performances, in agreement with results of the present study, Sweileh et al [9] reported that VO_2 (oxygen uptake) may decrease significantly over the month of Ramadan and there may be a substantial reduction in maximal oxygen uptake (VO_{2max}) within the first week in sedentary subjects. Bigard et al [25] showed that muscle endurance at 35% and 55% of maximal voluntary contraction (MVC) decreased by 28% and 22%, respectively, by the end of Ramadan in healthy subjects. However, Ramadan[8] reported no adverse effects on sedentary subjects exercising at about 70% of VO_{2max} under thermo-neutral conditions. In athletes, Meckel et al[14] showed that the fast resulted in a significant reduction in aerobic capacity (3000 m run). Likewise, Chennaoui et al [26] showed that maximum aerobic velocity, as determined by the Montreal Track Test Velocity, decreased by 3-4% during Ramadan. However, Chaouachi et al [3] showed that estimated values for maximal aerobic velocity (vVO2max), and VO2max during the Multistage Fitness Test were relatively unchanged during Ramadan in elite judo athletes. Recently, Hamouda et al [15] showed a significant reduced performance during the Yo-Yo intermittent recovery test during Ramadan in young football players.

Fasting prior to exercise may result in greater mobilization of liver glycogen, increased gluconeogenesis and increased use of free fatty acids for fuel during exercise [5]. Although these adjustments may act against a potential reduction in performance by maintaining sufficient blood glucose for intense aerobic muscular activity, it was not surprising to find a significant reduction of performances during the Yo-Yo test in the present study during Ramadan. In fact, it is well known that fasting is associated with catecholamine inhibition and reduced venous return, causing a decrease in the sympathetic tone, which leads to a decrease in blood pressure, heart rate, and cardiac output [27, 28].

Concerning anaerobic performances, the present study's results showed a significant decrease of performances during the RSA and the Wingate tests. Meckel et al [14] showed a decrease in speed endurance measured by 4 × 10 m run time (i.e. an increased sum of the six sprint times and performance decrement during the RSA test). These authors showed a significant mean performance decrement of 9.5% at the end of Ramadan compared to 9.0% before Ramadan. In the present study, PD increased significantly during the ER in comparison with BR (≈7 *vs.* ≈10 %). In addition, Meckel et al [14] showed that the sum of the six sprint times increased from 46.36 s before the beginning of the Ramadan fast to 46.73 s at the end of the month. Likewise, we showed that Wtotal decreased from ≈44 to ≈ 42.5 ($W \cdot kg^{-1}$) at the end of Ramadan. Moreover, in agreement with our findings, Hamouda et al [15] showed a significant decrease in PP during a 5 × 6 s RSA test during Ramadan. These changes may reflect a decreased glycolytic capacity, as well as a slower replenishment of muscle creatine phosphate (CP) stores during the short recovery period between the sprints during the month of Ramadan. During the Wingate test, the results of the present study are in agreement with those of a previous research which showed that P_{peak} and P_{mean} decreased significantly during Ramadan [10]. However, Karli et al [29] showed that power output during the Wingate test didn't change throughout this month. It is possible that the decrease in power during Ramadan may occur because participants are less motivated and less aroused. In fact, individuals tend to prepare for the period of fasting during Ramadan by rising earlier and eating a meal before sunrise [30]. As a result of these, participants would have been suffering from the effects of partial sleep deprivation. Sleep

deprivation primarily affects the higher cognitive centers of the central nervous system [31], and motivation is a key factor in the validity of tests of anaerobic power and capacity during the Wingate test[24].

Sleep patterns may also influence athletic performance [32,33] and negatively affect mood and mental performance [30]. However, in agreement with Chennaoui et al [26], in the present study there were no differences in tension, depression, anger, vigor, and confusion estimated by the POMS questionnaire. Only fatigue was higher at the end of Ramadan. It has been shown that mood, psychomotor and cognitive functions deteriorate more quickly than physical capabilities and the complexity, duration, and boredom produced by the task can also accelerate this decline [1]. The declined mood and mental activity were suggested as the main reasons for the declines in performance [9,16,17]. In this context, Waterhouse et al[34] observed that during Ramadan, the daytime hours were associated with more fatigue and less physical and mental activity than on control days but that these changes were reversed after sunset, as individuals broke their fast, often in the company of friends/family. In addition the RPE scores were higher during Ramadan. Thus, the increased muscle fatigue during Ramadan (i.e. FI during the Wingate test and PD during the RSA test) could be due to an increase in perceived exertion. The increased perception of fatigue reported during Ramadan is in agreement with previous research that reported an increased sensation of fatigue [3]. The increased RPE score suggests that Ramadan intermittent fast may result in an increased level of fatigue during training and, more seriously, a raised incidence of injury and illness. Indeed, decrements in physical function can lead to an increase in perceived exertion, an earlier onset of fatigue, and hence to an increased risk of injury or illness [18]. Regarding these results of POMS and RPE, in practice, coaches might be advised to adjust training plans during Ramadan to alleviate the increased fatigue. However, care must be taken when adopting such an approach because detraining may occur, particularly with high-level athletes [5].

Studies such as the present one are subject to some limitations. First, all maximal physical tests, such as the Yo-Yo, the repeated sprints, and the Wingate test, require a high level of motivation. However, we have to assume that all soccer players performed at their maximal capacity on all tests. Second, during the present study, soccer players continued to train during Ramadan without calculation of their training load (estimated from RPE scores). In this context, Meckel et al [14] suggested that the decrease in performance was due to the significant decrease in the weekly volume of intense physical activity from 6.4 ± 0.2 h/wk before Ramadan to 4.5 ± 0.1 h/wk during Ramadan. However, in the present study both the training volume and intensity were the same before and during Ramadan; the weekly training program included 5 training sessions averaging a total of ≈8 hours. Future studies might consider the weekly training load before and during Ramadan.

CONCLUSION

In conclusion, the results of the present study suggest that Ramadan negatively affects perceived exertion and physical performances during the Wingate, the Yo-Yo, and the repeated sprint ability tests in young soccer players especially during the last week of fasting. However, for the mood states, only fatigue was higher during Ramadan. Thus from the results of the POMS and RPE, it seems that Muslim soccer players may be at risk of experiencing increased feelings of fatigue during Ramadan which can be an early sign of overreaching or overtraining. For practical consideration, in order to maximize training benefits and avoid overreaching or overtraining during Ramadan, coaches must be advised to properly handle the training program variables (e.g. intensity, frequency, volume) when planning training sessions in the evening. In other words, when planning training sessions later in the day during Ramadan (i.e. in the evening), coaches should reduce the training volume to avoid overreaching or overtraining and to allow their athletes to cope better with the training while following their religious demands. However, it is clear that the detailed nature of the problems involved with training during Ramadan and dealing with them in a manner

based upon a firm body of knowledge requires far more experimental investigations.

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