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# Knowledge, beliefs and attitudes of Muslim footballers towards Ramadan fasting during the London 2012 Olympics

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**Abstract:**

**Objectives:**

Muslims observe fasting during the Ramadan month by abstaining from eating and drinking from dawn to sunset. Available literature show that although several studies have been conducted on athletes including footballers to determine the effects of Ramadan fasting in terms of physical fitness and performance, little data is available regarding the knowledge, beliefs and attitudes of athletes specially footballers towards Ramadan fasting during high level competitions. This study assessed the knowledge, beliefs, and attitudes towards Ramadan fasting among football players participating in the London 2012 football tournament.

**Design:** Cross-sectional study.

**Settings:** Team training facility.

**Participants:** 54 Muslim footballers participating in the London Olympics, 2012

**Outcome measures:** Each participant was asked to complete a pre validated structured questionnaire to assess knowledge, beliefs, and attitudes regarding Ramadan fasting and their intention to fast at the London 2012.

**Results:** Out of the participating 54 athletes, 21(39%) reported that they intended to fast during Ramadan, but not on a match day. This attitude differed across three teams interviewed —83%, 15%, and 0%— showing cross-cultural variation. Overall, there was lack of knowledge among footballers (~30% athletes gave incorrect responses) regarding effects of Ramadan fasting on sleep and performance. This knowledge was independent of their decision to fast on non-competition days ($P > 0.05$).

**Conclusion:** This is likely the first study to describe the knowledge, beliefs and attitudes towards Ramadan fasting among athletes participating in a high-level competition. Clear knowledge can minimise

the effects of Ramadan fasting on athletes to ensure optimum performance. The coaches along with the family members and friends with clear knowledge can provide moral support to the players.

**Article summary section:**

**Strengths and limitations of the study:**

- First study to assesses the knowledge, beliefs, and attitudes towards Ramadan fasting among football players
- The participants are professional athletes participating in a high level international competition, Olympic Games.
- Self-reported decision to fast but not the actual practice of Ramadan fasting at the event was collected.
- Performance related outcomes were not assessed.

## Introduction

During the month of Ramadan, a healthy adult Muslim observes fast intermittently by avoiding the intake of fluid and food from dawn to sunset for 30 days. Unlike the Gregorian calendar, the Islamic calendar is lunar based. Hence, Ramadan falls on different dates each year in the Gregorian calendar and can coincide with a major sporting competition. Recently we have witnessed high-level international competitions that took place during Ramadan, such as the London 2012 Summer Olympics and the FIFA (Fédération Internationale de Football Association) World Cup 2014.

Review of available literature regarding the effects of Ramadan show alteration in circadian rhythm, change in sleep (in terms of pattern, architecture and duration) , physiological, metabolic and hormonal changes, fall in blood glucose level, reduced daytime fluid intake (daytime dehydration), fall in body temperature, alteration in psychomotor functioning ( better during morning and worsens as the day progresses), easy fatigue, increased incidence of non-contact and overuse injury in footballers are the common factors involved in performance decrement during Ramadan. [1-8]

Literature on the effects of Ramadan fasting on endurance abilities of athletes during the fasting state is still lacking. Theoretically, an inability to refuel or rehydrate before and during a 90-minute football game could affect physical and mental performance during the game. Maugham et al., stressed the importance of providing guidelines and recommendations in order to maintain sports performance and protect the health of the athletes. [9]

Despite the above mentioned changes during Ramadan, the actual impact of these changes on sports performance remains unclear because of contradicting results obtained from different studies.

According to the F-MARC 2006 Ramadan Fasting study, biochemical, nutritional, subjective well-being and performance variables are not adversely affected in young football players observing Ramadan in a controlled training camp environment. [8] Again another study conducted by Umid Karli *et al*., concluded that if strength-power exercise is performed regularly and daily intake of food, fluid balance and sleeping

time is maintained as before Ramadan, the fasting of Ramadan will not adversely affect anaerobic power, capacity, lactate metabolism during and after high intensity exercise in power athletes.[10]

Contradictory to the above findings, study conducted by Meckel Y and associates indicated that Ramadan fasting can lead to significant decrease in sports performance.[11]

It is well established that with minimal change in sleep pattern and maintenance of training, athletes show little change in anaerobic power or capacity during the month of Ramadan in trained athletes; any increase in tiredness is attributed to inadequate sleep and phase shift in flood intake rather than due to nutritional deficiency. There is no evidence of Ramadan induced impairment of maximal oxygen intake during a traditional progressive test for short duration (10 minutes) however with longer periods of endurance exercise performance deteriorates. Muscle strength (muscle contractile force) is minimally during Ramadan fasting with adequate hydration and training. As such ingestion of carbohydrate rich food with low glycemic index (LGI), does not provide any benefit in terms of metabolism and performance during endurance run performed in Ramadan fasted state in comparison to mixed meal containing equivalent macronutrient, however intake of LGI diet is found to be associated with lesser degree of perceived exertion.[10-19]

Despite this, Muslim athletes have their own sets of knowledge and beliefs towards the effects of Ramadan fasting that translate into their attitudes and practices.

When a sports event occurs during Ramadan, some Muslim athletes will forgo fasting on competition days, whereas others may continue to observe fasting on competition and training days. An athlete's decision whether to fast is affected not only by factors such as knowledge, beliefs, and attitudes but also by the influence of his or her social environment and the level of the competition.

Better management of an athlete's performance during Ramadan fasting requires education intervention. Therefore, this study aimed to take the first step by determining the prevalence of fasting among athletes

in high-level international sporting competition along with the athletes' knowledge, beliefs, and attitudes towards fasting.

## Methods

To assess footballers for this cross-sectional study, we approached the team managers of the national teams representing Muslim majority countries (Egypt, the United Arab Emirates, Senegal, and Morocco) that qualified for the football tournament at the 2012 Summer Olympics in London. Three of the four teams agreed to participate and were labelled as Teams A, B, and C to maintain confidentiality. The inclusion criteria were Muslim footballers who were drafted for the national teams that represented the football competition at the London 2012 Olympics. All players identified as Muslims (n = 54) completed the survey, giving a response rate of 100%.

### *Questionnaire*

For Muslim athletes, fasting during the month of Ramadan during a competition is not a new experience.

To judge the knowledge and attitudes of the players, based on their previous experiences, each athlete completed a structured questionnaire before the tournament and one week prior to the beginning of Ramadan.

The questionnaire was prepared by first author in consultation with co-authors to include parameters of importance and known attitudes and beliefs. It was prepared in English which was then translated in Arabic and French and back translated to English for validation. Validation was done by bilingual co-authors in this study for French and Arabic.

The questionnaire was self administered with assistance from trained interviewer available when needed. The questionnaire was presented in three languages: English, Arabic, and French. The questionnaire included items that assessed a player's knowledge, attitudes, and beliefs concerning fasting which were scored on a five-point Likert scale in which the athletes could answer "strongly agree," "agree," "neutral"

(neither agree nor disagree), "disagree," or "strongly disagree" (Table 1). Athletes also were asked if they planned to fast during Ramadan (they could answer "completely," "only during training/practice," "only on match days," or "never").

We defined "knowledge" as the information and skills acquired by a person through experience or education. Facts and information in a specific field constitute knowledge. We defined "belief" as an opinion that Muslim footballers hold with respect to fasting. We defined "attitude" as the position that football player's hold concerning fasting. The study received ethical approval by the Ethics Council, the institutional review board of Algiers, Algeria.

***Statistical analysis***

All data were coded and analysed using predictive analytics software (IBM SPSS 21.0, IBM Corp., Armonk, NY, USA). Since, each item on the questionnaire was coded on a Likert scale, we used the frequencies and percentages to show the athletes' level of response to each question. Using the chi-square test, we compared the players' intention to fast with other categorical variables (knowledge, attitudes, and beliefs) to determine their association. A value of $P < 0.05$ was considered statistically significant.

**Results**

During the 2012 London Olympic Games, the fasting duration for Ramadan (time span from dawn to sunset) was approximately 17 hours 27 minutes. The atmospheric temperature ranged from 14°C to 21°C.

Of the 54 athletes who completed the questionnaire, 33 (61%) reported that they were not planning to fast at all during the tournament, whereas the remaining 21 athletes (39%) reported that they intended to fast during Ramadan but not on a match day. This reported statistics varied across the teams: A (83%), B (15%), and C (0%). None of the 54 athletes surveyed planned to fast during match days.

Footballers agreed that Ramadan fasting reduces sleep quality (53.7%), sleep time (61.2%), power (77.8%), and concentration during game (69.8%); however, the decision to fast was independent of these

factors. A team coach's preference appeared to be a strong deciding factor in whether the athletes chose to fast. Among the 33 athletes who planned not to fast, 28 (85%) of these athletes stated that their coach did not want them to fast, whereas only 9 (43%) of the 21 athletes who planned to fast stated that their coach did not want them to fast ($P$ = 0.002). Most (n = 37, 68%) athletes thought that, even with proper hydration during *Suhoor* (a predawn meal during intermittent fasting), their performance would be affected as the day progressed.

On the beliefs set of questions about fasting, 44 (81.5%) of the participants agreed or strongly agreed that Ramadan fasting reduces endurance/stamina and 26 (48.2%) agreed or strongly agreed that it reduces mental skills. A high number (n = 46, 85.2%) of participants disagreed or strongly disagreed that fasting can increase their physical skills.

On the attitudes set of questions, 42 (78%) of the participants considered fasting for approximately 17 hours each day as a "burden"; 3 (5.6%) of the participants thought that Ramadan fasting would make them physically stronger, and 6 (11.2%) thought that it would make them mentally stronger. Thirty-nine (72.2%) of the athletes agreed that it was acceptable to skip fasting days during games. Most players (72.2%) preferred that future high-level competitions should not take place during Ramadan. Approximately 40% of the surveyed athletes reported that there was pressure from family and friends to practice Ramadan fasting on all days of the competition.

**Discussion**

For 30 days during the month of Ramadan, Muslims fast from dawn to sunset. This fasting schedule may be particularly challenging, especially for elite-level athletes who participate in international competitions scheduled during Ramadan. To our knowledge, this is the first study to report the prevalence of an intent to practice Ramadan intermittent fasting in an international high-level competition.

Our study found that none of the 54 athletes intended to fast on match days. However, 39% reported that they would fast for noncompetition days (training and rest days). Moreover, there was a huge variation in

how the 3 teams responded to this question (0%, 15%, and 83%), thus suggesting cross-cultural differences in how Ramadan fasting is given importance or how its impact is understood.

According to the available scientific literature, sleep architecture is affected during Ramadan fasting in healthy adult non-athletes, and sleep duration during fasting is decreased in healthy adults ( as well as in professional athletes).[1, 14, 15] In the current study, approximately one-third of the players lacked the knowledge that sleep quality and sleep times are affected during Ramadan (see Table 1). Despite the knowledge of effects of Ramadan fasting on sleep duration and quality, majority of the participants reported they would fast on non-competitive days (see Table 2). This could indicate that players are not aware that effect of fasting can influence sleep pattern in following days.

Some studies have reported a decline in sustained attention or rapid responses among athletes during the daytime although sustained attention gradually declines from morning to late afternoon ).[14-16] It must be mentioned that many studies tested the effects of Ramadan intermittent fasting on cognitive function in athletes under resting conditions. [14-17] This is clearly not specific to cognitive function during physical effort. In context to cognitive function, the present study showed that 69.8% of the footballers thought that their concentration reduced in the game while fasting. This view was found to be similar in both groups of fasters on non-competitive days and non-fasters (76.2% vs. 63.6%, p=0.383; Table 2). Even though cognitive function while playing a football game in fasting condition has not been studied, this finding shows that most of the assessed elite football players believed that Ramadan intermittent fasting could have an impact on their “mental” abilities during the games. This view was not associated with their decision to fast on non-competitive days (Table 2).

The importance of being well hydrated before, during, and after strenuous exercise is well established . [9] Particularly, hydrating during exercise will influence thermoregulatory and muscle function as well as maintain hydration status to maximise performance [12] and few hours of fluid deprivation can adversely affect cognitive tasks that rely on speed and accuracy.[13] Of the footballers assessed in the present study,

68.5% agreed or strongly agreed that it would not be possible to engage in games or training in a fasting state despite drinking sufficient water at *Suhoor*. This shows that they are aware of the importance of hydration during play. This may be the critical reason as to why none of the players intend to fast on competitive days.

We found that few participants in our study were under the belief that Ramadan fasting can improve endurance (9.3%), physical skills (13.0%), or mental skills (31.5%). Some players also believed that Ramadan fasting makes them physically and mentally stronger (see Table 1). Others were neutral about many attitude and belief questions. This is possibly because either they do not know and/or because they do not want to take a position, especially if they had to go against their religious belief. Therefore we also see no differences in these attitude and belief items amongst the two groups. For example, among players who reported to fast on non-competitive days, 23.8% believed that Ramadan intermittent fasting can make them weaker day by day as opposed to 69.7% who reported that they do not intend to fast (p=0.001; Table 2).

Footballers who choose not to fast might face disapproval and criticism from family and friends. In this study, approximately 40% of the footballers said their family and friends insisted that they must observe Ramadan fasting on each day. In the context of the players' environment, the team coach's opinion seemed to be of paramount importance. Indeed, the decision to involve a player in a game belongs to him. This was clearly observed in this study, that among the players who intended to fast on non-competitive days, pressure from family and friends was higher and pressure from team coach was lower (P≤0.017; Table 2). The results showed that the participant's decision was more influenced by the coach than family or friends.

Many footballers preferred that such important international competitions not be held during Ramadan, and 72.2% agreed that it is acceptable to make up the fast on another day. This highlights the possibility that some athletes take their fasting decision against their own will, which can decrease their confidence

and morale during the game. As mentioned earlier, the player's decision to fast during a competition is not solely based on his past experiences or beliefs but also current challenges. The responses regarding the practice of Ramadan fasting in this study were likely to be influenced by the footballers' awareness that they would experience Ramadan in London, where the duration of daylight was 17 to 18 h and games were to take place just before sunset in moderate weather conditions. The FIFA World Cup 2014 also witnessed Ramadan month, but this was during knockout stages when only one Muslim team had qualified. During this competition, matches occurred during daylight hours of shorter duration (12 to 13 h) but under conditions of high temperature and humidity.

During the London 2012 tournament, the four teams which represented Muslim majority countries played altogether 14 matches. Only two matches led to victory (14.2%) and six matches ended as draw (42.8%). The limitation of the current study is that exact prevalence of actual practice of Ramadan fasting cannot be determined. It was not possible to access these athletes during the high level competition. Scientific research into the effects of Ramadan intermittent fasting on hydration, nutrition, performance, sleep and general health was recently updated and this bulk of literature continues to grow. [3, 5, 12, 14, 19-20] Athletes, team coach as well as sport organization bodies need to be aware of the recent updated knowledge such that proper education interventions and sports events can be organised to protect the health of the athletes.

**Conclusion**

The present study showed that most participants believed that Ramadan fasting would negatively affect their football match performance. There were cross-cultural differences in how Muslim football players planned to observe Ramadan fasting. Overall, there was a lack of knowledge about the effects of Ramadan fasting in approximately one-third of the surveyed elite footballers, which stresses the importance of education sessions to help players to better manage Ramadan intermittent fasting and sports participation. Furthermore, some players, despite having good knowledge about the influence of Ramadan

fasting on sleep and possibly football performance, still planned to observe fast due to their religious commitment.

Some potential recommendations to reduce the negative effect of Ramadan on athletic performance for players, coaches and authorities include adjustment in event timing (scheduling events during early morning or late at night; although unlikely to be followed in well known tournaments, where majority of the participants are non Muslim), adjustment in sleep pattern (retiring as early as possible after evening meal and taking nap after breakfast or whenever possible in the day time), prevention of hypoglycaemia (by fat metabolism through endurance training with consumption of high fat diet, maintenance of hydration (through high carbohydrate diet to maximize pre game glycogen reserve, intake of salt and water before dawn, avoidance of sweating, activity before event), following appropriate pattern of nutrition like intake of high quality protein following resistance exercise to develop positive nitrogen balance and maintenance of adequate degree of training (to be scheduled around the time of meal) to prevent decline in peak performance but without overreaching as fatigue is a common complain along with loss of body mass. [19-22]

Finally we would like to add that the potential effects of Ramadan fasting and necessary recommendations should be conveyed to players, coaches and family members, so that athletes do not have to take their decisions under duress.

## Footnotes:

**Contributors:**

AF and FM designed and developed the questionnaire. All the authors validated the questionnaire and were involved study design. KC and CH supervised the data collection. AF analyzed and interpreted the data, and wrote the manuscript. All authors have contributed and edited the manuscript and have approved the final manuscript.

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**Competing Interests:** None

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**Conflict of Interest:** None

## References


1. Bahammam AS, Alaseem AM, Alzakri AA, *et al.* The effects of Ramadan fasting on sleep patterns and daytime sleepiness: An objective assessment. *J Res Med Sci* 2013;18:127-31
2. Singh R, Hwa OC, Roy J, *et al*. Subjective Perception of Sports Performance, Training, Sleep and Dietary Patterns of Malaysian Junior Muslim Athletes during Ramadan Intermittent Fasting. *Asian J Sports Med* 2011;2:167-76.
3. Burke LM, King C. Ramadan fasting and the goals of sports nutrition around exercise. *J Sports Sci* 2012;30(Suppl 1):S21-31.
4. Chaouachi A, Coutts AJ, Chamari K, *et al*. Effect of Ramadan intermittent fasting on aerobic and anaerobic performance and perception of fatigue in male elite judo athletes. *J Strength Cond Res* 2009;23:2702-09.
5. Herrera CP. Total sleep time in Muslim football players is reduced during Ramadan: A pilot study on the standardized assessment of subjective sleep-wake patterns in athletes. *J Sports Sci* 2012; 30(Suppl 1):S85-91
6. Iraki L, Bogdan A, Hakkou F, *et al*. Ramadan diet restrictions modify the circadian time structure in humans. A study on plasma gastrin, insulin, glucose, and calcium and on gastric pH. *J Clin Endocrinol Metab* 1997;82:1261-73.
7. Chamari K, Haddad M, Wong del P, *et al*. Injury rates in professional soccer players during Ramadan. *J Sports Sci* 2012;30(Suppl 1):S93-102.
8. Zerguini Y, Dvorak J, Maughan RJ, *et al*. Influence of Ramadan fasting on physiological and performance variables in football players: summary of the F-MARC 2006 Ramadan fasting study. *J Sports Sci* 2008;26(Suppl 3):S3-6.
9. Maughan RJ, Shirreffs SM. Development of hydration strategies to optimize performance for athletes in high-intensity sports and in sports with repeated intense efforts. *Scand J Med Sci Sports* 2010;20(Suppl 2):59-69.
10. Karli U, Guvenc A, Aslan A, *et al*. Influence of Ramadan Fasting on Anaerobic Performance and Recovery Following Short time High Intensity Exercise. *J Sports Sci Med* 2007;6:490-7
11. Meckel Y, Ismaeel A, Eliakim A. The effect of the Ramadan fast on physical performance and dietary habits in adolescent soccer players. *Eur J Appl Physiol* 2008;102:651-7.
12. Maughan RJ, Shirreffs SM. Hydration and performance during Ramadan. *J Sports Sci* 2012;30(Suppl 1):S33-41.
13. Maughan RJ, Zerguini Y, Chalabi H, et al. Ramadan and football. *J Sports Sci* 2012;30(Suppl 1):S1.
14. Petri NM, Dropulic N, Kardum G. Effects of voluntary fluid intake deprivation on mental and psychomotor performance. *Croat Med J* 2012;47:855-61.
15. Roky R, Herrera CP, Ahmed Q. Sleep in athletes and the effects of Ramadan. *J Sports Sci 2012;*30 (Suppl 1): S75-84.
16. Roky R, Iraki L, HajKhlifa R, *et al*. Daytime alertness, mood, psychomotor performances, and oral temperature during Ramadan intermittent fasting. *Ann Nutr Metab 2000;44*:101-7.

17. Tian HH, Aziz AR, Png W, *et al*. Effects of fasting during ramadan month on cognitive function in muslim athletes. *Asian J Sports Med* 2011;2:145-53.
18. Lotfi S, Madani M, Tazi A, *et al*. Variation of cognitive functions and glycemia during physical exercise in Ramadan fasting. *Rev Neurol (Paris)* 2010;166:721-6..
19. Png W, Bhaskaran K, Sinclair AJ, *et al*. Effects of ingesting low glycemic index carbohydrate food for the sahur meal on subjective, metabolic and physiological responses, and endurance performance in Ramadan fasted men. *Int J Food Sci Nutr* 2014;65:629-36.
20. Kirkendall DT, Chaouachi A, Aziz AR, *et al*. Strategies for maintaining fitness and performance during Ramadan. *J Sports Sci* 2012;30(Suppl 1):S103-8
21. Zerguini Y, Ahmed QA, Dvorak, J. The Muslim football player and Ramadan: Current challenges. *J Sports Sci* 2012;30 (Suppl 1):S3-7
22. Shephard RJ. The Impact of Ramadan Observance upon Athletic Performance. *Nutrients* 2012;4:491–505.

**Table 1. Knowledge, beliefs, and attitudes among athletes about Ramadan fasting (n = 54)**

| Item | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|
| **Beliefs** | | | | | |
| Ramadan fasting can reduce my endurance/stamina during game | 3.7 | 5.6 | 9.3 | 46.3 | 35.2 |
| Ramadan fasting will increase my physical skills | 20.4 | 64.8 | 1.9 | 9.3 | 3.7 |
| Ramadan fasting will reduce my mental skills | 9.3 | 22.2 | 20.4 | 38.9 | 9.3 |
| Ramadan fasting will increase my confidence | 3.7 | 20.4 | 22.2 | 37.0 | 16.7 |
| **Knowledge** | | | | | |
| Ramadan fasting will reduce my sleep quality | 16.7 | 22.2 | 7.4 | 40.7 | 13.0 |
| If I am properly hydrated at Suhoor, I can practice game or training without any problem while fasting | 11.1 | 57.4 | 20.4 | 5.6 | 5.6 |
| Ramadan fasting will reduce my concentration during game | 7.5 | 15.1 | 7.5 | 52.8 | 17.0 |
| Ramadan fasting will reduce my sleep time | 13.0 | 22.2 | 3.7 | 51.9 | 9.3 |
| Ramadan fasting can reduce my power during game | 3.7 | 5.6 | 13.0 | 59.3 | 18.5 |
| **Attitudes** | | | | | |
| 17 h of Ramadan fasting in UK can be a challenge | 0 | 5.6 | 16.7 | 46.3 | 31.5 |
| Ramadan fasting will make me physically stronger | 13.0 | 72.2 | 9.3 | 3.7 | 1.9 |
| Ramadan fasting will make me mentally stronger | 7.4 | 57.4 | 24.1 | 5.6 | 5.6 |
| I think it is OK to postpone my Ramadan fasting until after Olympics | 3.7 | 11.1 | 13.0 | 35.2 | 37.0 |
| My family and friends want me to fast in Ramadan | 9.3 | 9.3 | 33.3 | 25.9 | 22.2 |
| It is not a problem for future sports events to take place during Ramadan | 29.6 | 42.6 | 14.8 | 9.3 | 3.7 |
| My coach wants me not to fast in Ramadan | 7.4 | 24.1 | 14.8 | 22.2 | 31.5 |
| Ramadan fasting can make me weaker day by day | 7.4 | 16.7 | 24.1 | 35.2 | 16.7 |

Note: Data are percentages of 54 athletes and may not total to 100% for each item because of rounding.
UK = United Kingdom.

**Table 2. Association between knowledge, beliefs, and attitudes among athletes about Ramadan fasting with decision to fast in London 2012 Olympic Soccer Tournament**

| | Fast on non-competitive days (n=21) | Not to fast (n=33) | p-value |
|---|---|---|---|
| **Beliefs** | | | |
| Ramadan fasting can reduce my endurance/stamina during game | 17(81.0) | 27(81.8) | 0.936 |
| Ramadan fasting will reduce my physical skills | 19(90.5) | 27(81.8) | 0.383 |
| Ramadan fasting will reduce my mental skills | 10(47.6) | 16(48.5) | 0.951 |
| Ramadan fasting will increase my confidence | 12(57.1) | 17(51.5) | 0.686 |
| **Knowledge** | | | |
| Ramadan fasting will reduce my sleep quality | 17(81.0) | 12(36.4) | 0.001 |
| If I am properly hydrated at Suhoor, I can practice game or training without any problem while fasting? | 0(0.0) | 6(18.2) | 0.071 |
| Ramadan fasting will reduce my concentration during game | 16(76.2) | 21(63.6) | 0.383 |
| Ramadan fasting will reduce my sleep time. | 18(85.7) | 15(45.5) | 0.003 |
| Ramadan fasting can reduce my power during game | 15(71.4) | 27(81.8) | 0.371 |
| **Attitudes**<br>17 h of Ramadan fasting in UK can be a challenge. | 18(85.7) | 24(72.7) | 0.263 |
| Ramadan fasting will make me physically stronger | 1(4.8) | 2(6.1) | 0.839 |
| Ramadan fasting will make me mentally stronger | 0(0.0) | 6(18.2) | 0.071 |
| I think it is OK to postpone my Ramadan fasting until after Olympics | 13(61.9) | 26(78.8) | 0.177 |
| My family and friends want me to fast in Ramadan | 17(81.0) | 9(27.3) | <0.001 |
| It is not a problem for future sports events to take place during Ramadan | 2(9.5) | 5(15.2) | 0.583 |
| Ramadan fasting can make me weaker day by day | 5(23.8) | 23(69.7) | 0.001 |
| My coach wants me not to fast in Ramadan | 7(33.3) | 22(66.7) | 0.017 |

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# Knowledge, beliefs and attitudes of Muslim footballers towards Ramadan fasting during the London 2012 Olympics: a cross-sectional study

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**Keywords:** Football, Ramadan fasting, Knowledge, Attitude, London 2012
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**Abstract:**

**Objectives:**

Muslims observe fasting during the Ramadan month by abstaining from eating and drinking from dawn to sunset. Available literature show that although several studies have been conducted on athletes including footballers to determine the effects of Ramadan fasting in terms of physical fitness and performance, little data is available regarding the knowledge, beliefs and attitudes of athletes specially footballers towards Ramadan fasting during high level competitions. This study assessed the knowledge, beliefs, and attitudes towards Ramadan fasting among football players participating in the London 2012 football tournament.

**Design:** Cross-sectional study.

**Settings:** Team training facility.

**Participants:** 54 Muslim footballers participating in the London Olympics, 2012

**Outcome measures:** Each participant was asked to complete a pre validated structured questionnaire to assess knowledge, beliefs, and attitudes regarding Ramadan fasting and their intention to fast at the London 2012.

**Results:** Out of the participating 54 athletes, 21(39%) reported that they intended to fast during Ramadan, but not on a match day. This attitude differed across three teams interviewed —83%, 15%, and 0%— showing cross-cultural variation. Overall, there was lack of knowledge among footballers (~30% athletes gave incorrect responses) regarding effects of Ramadan fasting on sleep and performance. This knowledge was independent of their decision to fast on non-competition days ($P > 0.05$).

**Conclusion:** This is likely the first study to describe the knowledge, beliefs and attitudes towards Ramadan fasting among athletes from Muslim majority countries participating in a high-level

competition. Clear knowledge can optimise the effects of Ramadan fasting on athletes to ensure optimum performance. The coaches along with the family members and friends with clear knowledge can provide moral support to the players.

**Article summary section:**

**Strengths and limitations of the study:**

- First study to assesses the knowledge, beliefs, and attitudes towards Ramadan fasting among football players
- The participants are professional athletes participating in a high level international competition, Olympic Games.
- Self-reported decision to fast but not the actual practice of Ramadan fasting at the event was collected.
- Performance related outcomes were not assessed.

## Introduction

During the month of Ramadan, a healthy adult Muslim observes fast intermittently by avoiding the intake of fluid and food from dawn to sunset for 30 days. Unlike the Gregorian calendar, the Islamic calendar is lunar based. Hence, Ramadan falls on different dates each year in the Gregorian calendar and can coincide with a major sporting competition. Recently we have witnessed high-level international competitions that took place during Ramadan, such as the London 2012 Summer Olympics,FIFA (Fédération Internationale de Football Association) World Cup 2014 and EURO 2016, for instance.

Review of available literature regarding the effects of Ramadan show alteration in circadian rhythm,[1] change in sleep (in terms of pattern, architecture and duration),[2,3] physiological, metabolic and hormonal changes,[4] fall in blood glucose level,[5] reduced daytime fluid intake (daytime dehydration),[6] fall in body temperature,[7] alteration in psychomotor functioning[8,9] (better during morning and worsens as the day progresses),[7,10] easy fatigue, increased incidence of non-contact and overuse injury in footballers[11] are the common factors involved in performance decrement during Ramadan.

Literature on the effects of Ramadan fasting on endurance abilities of athletes during the fasting state (i.e. daylight period) are few. Theoretically, an inability to refuel or rehydrate before and during a 90-minute football game could affect physical and mental performance during the game. In a group of endurance athletes, rate of perceived exertion (RPE) after endurance running training, was similar among fasters and non fasters alike throughout Ramadan[12] whereas, 3 days intermittent fasting reduced repeated-sprint performance in a lab setting.[13] Moreover, other study confirmed that during fasting state, endurance running performance over 60min is significantly declined. a. Maughan et al., stressed the importance of providing guidelines and recommendations in order to maintain sports performance and protect the health of the athletes.[9]

Despite the above mentioned changes during Ramadan, the actual impact of these changes on sports performance remains unclear because of contradicting results obtained from different studies.[14,15]

According to the F-MARC 2006 Ramadan Fasting study, biochemical, nutritional, subjective well-being and performance variables are not adversely affected in young football players observing Ramadan in a controlled training camp environment.[14] Again another study conducted by Karli *et al*., concluded that if strength-power exercise is performed regularly and daily intake of food, fluid balance and sleeping time is maintained as before Ramadan, the fasting of Ramadan will not adversely affect anaerobic power, capacity, and lactate metabolism during and after high intensity exercise in power athletes.[10]

Contradictory to the above findings, study conducted by Meckel Y and associates indicated that Ramadan fasting can lead to significant decrease in aerobic capacity, speed and jumping performance.[11]

It is well established that with minimal change in sleep pattern and maintenance of training, athletes show little change in anaerobic power or capacity during the month of Ramadan in trained athletes; any increase in tiredness is attributed to inadequate sleep and phase shift in fluid intake rather than due to nutritional deficiency.[2,16,17] There is no evidence of Ramadan induced impairment of maximal oxygen intake during a traditional progressive test for short duration (10 minutes) however with longer periods of endurance exercise performance deteriorates.[18,19]

Despite this, Muslim athletes have their own sets of knowledge and beliefs towards the effects of Ramadan fasting that translate into their attitudes and practices. Partly due to their long Ramadan fasting experience that usually starts from early childhood[20] and partly from their specific individual experiences.

When a sports event occurs during Ramadan, some Muslim athletes will forgo fasting on competition days, whereas others may continue to observe fasting on competition and training days. An athlete's decision whether to fast is affected not only by factors such as knowledge, beliefs, and attitudes but also by the influence of his or her social environment and the level of the competition.

Better management of an athlete's performance during Ramadan fasting requires education intervention. Therefore, this study aimed to take the first step by determining the prevalence of fasting among athletes

in high-level international sporting competition along with the athletes' knowledge, beliefs, and attitudes towards fasting.

## Methods

To assess footballers for this cross-sectional study, we approached the team managers of the national teams representing Muslim majority countries (Egypt, the United Arab Emirates, Senegal, and Morocco) that qualified for the football tournament at the 2012 Summer Olympics in London. Three of the four teams agreed to participate and were labelled as Teams A, B, and C to maintain confidentiality. The inclusion criteria were Muslim footballers who were drafted for the national teams that represented the football competition at the London 2012 Olympics. All players identified as Muslims (n = 54) completed the survey, giving a response rate of 100%.

### *Questionnaire*

To judge the knowledge and attitudes of the players, based on their previous experiences, each athlete completed a structured questionnaire before the tournament and one week prior to the 19th July 2012 (i.e. beginning of Ramadan month).

The questionnaire was prepared by first author in consultation with co-authors to include parameters of importance and known attitudes and beliefs. It was prepared in English which was then translated in Arabic and French and back translated to English for validation. Validation was done by bilingual co-authors in this study for French and Arabic.

The questionnaire was self-administered with assistance from trained interviewer available when needed. The questionnaire was presented in three languages: English, Arabic, and French. The questionnaire included items that assessed a player's knowledge, attitudes, and beliefs concerning fasting which were scored on a five-point Likert scale in which the athletes could answer "strongly agree," "agree," "neutral" (neither agree nor disagree), "disagree," or "strongly disagree" (Table 1). Athletes also were asked if they

planned to fast during Ramadan (they could answer "completely," "only during training/practice," "only on match days," or "never").

We defined "knowledge" as the information and skills acquired by a person through experience or education. Facts and information in a specific field constitute knowledge. We defined "belief" as an opinion that Muslim footballers hold with respect to fasting. We defined "attitude" as the position that football player's hold concerning fasting. The study received ethical approval by the Ethics Council, the institutional review board of Algiers, Algeria.

***Statistical analysis***

All data were coded and analysed using predictive analytics software (IBM SPSS 21.0, IBM Corp., Armonk, NY, USA). Since, each item on the questionnaire was coded on a Likert scale, we used the frequencies and percentages to show the athletes' level of response to each question. Using the chi-square test, we compared the players' intention to fast with other categorical variables (knowledge, attitudes, and beliefs) to determine their association. A value of $P < 0.05$ was considered statistically significant.

**Results**

During the 2012 London Olympic Games, the fasting duration for Ramadan (time span from dawn to sunset) was approximately 17 hours 27 minutes. The atmospheric temperature ranged from 14°C to 21°C.

Of the 54 athletes who completed the questionnaire, 33 (61%) reported that they were not planning to fast at all during the tournament, whereas the remaining 21 athletes (39%) reported that they intended to fast during Ramadan but not on a match day. This reported statistics varied across the teams: A (83%), B (15%), and C (0%). None of the 54 athletes surveyed planned to fast during match days.

Footballers agreed that Ramadan fasting reduces sleep quality (53.7%), sleep time (61.2%), power (77.8%), and concentration during game (69.8%); however, the decision to fast was independent of these factors. A team coach's preference appeared to be a strong deciding factor in whether the athletes chose to

fast. Among the 33 athletes who planned not to fast, 28 (85%) of these athletes stated that their coach did not want them to fast, whereas only 9 (43%) of the 21 athletes who planned to fast stated that their coach did not want them to fast ($P$ = 0.002). Most (n = 37, 68%) athletes thought that, even with proper hydration during *Suhoor* ((The time when the last meal is taken by Muslims prior to dawn in preparation for daily fast)), their performance would be affected as the day progressed.

On the beliefs set of questions about fasting, 44 (81.5%) of the participants agreed or strongly agreed that Ramadan fasting reduces endurance/stamina and 26 (48.2%) agreed or strongly agreed that it reduces mental skills. A high number (n = 46, 85.2%) of participants disagreed or strongly disagreed that fasting can increase their physical skills.

On the attitudes set of questions, 42 (78%) of the participants considered fasting for approximately 17 hours each day as a "burden"; 3 (5.6%) of the participants thought that Ramadan fasting would make them physically stronger, and 6 (11.2%) thought that it would make them mentally stronger. Thirty-nine (72.2%) of the athletes agreed that it was acceptable to skip fasting days during games. Most players (72.2%) preferred that future high-level competitions should not take place during Ramadan. Approximately 40% of the surveyed athletes reported that there was pressure from family and friends to practice Ramadan fasting on all days of the competition.

**Discussion**

For 30 days during the month of Ramadan, Muslims fast from dawn to sunset. This fasting schedule may be particularly challenging, especially for elite-level athletes who participate in international competitions scheduled during Ramadan. To our knowledge, this is the first study to report the prevalence of an intent to practice Ramadan intermittent fasting in an international high-level competition.

Our study found that none of the 54 athletes intended to fast on match days. However, 39% reported that they would fast for noncompetition days (training and rest days). Moreover, there was a huge variation in

how the 3 teams responded to this question (0%, 15%, and 83%), thus suggesting cross-cultural differences in how Ramadan fasting is given importance or how its impact is understood.

According to the available scientific literature, sleep architecture is affected during Ramadan fasting in healthy adult non-athletes, and sleep duration during fasting is decreased in healthy adults [21] as well as in professional athletes.[2] In the current study, approximately one-third of the players lacked the knowledge that sleep quality and sleep times are affected during Ramadan (see Table 1). Despite the knowledge of effects of Ramadan fasting on sleep duration and quality, majority of the participants reported they would fast on non-competitive days (see Table 2). This could indicate that players are not aware that fasting can influence sleep pattern in the following days.

Some studies have reported a decline in sustained attention or rapid responses among athletes during the daytime although sustained attention gradually declines from morning to late afternoon.[7,10] It must be mentioned that many studies tested the effects of Ramadan intermittent fasting on cognitive function in athletes under resting conditions.[7,10,22] This is clearly not specific to cognitive function during physical effort. In context to cognitive function, the present study showed that 69.8% of the footballers thought that their concentration reduced in the game while fasting. This view was found to be similar in both groups of fasters on non-competitive days and non-fasters (76.2% vs. 63.6%, p=0.383; Table 2). Even though cognitive function while playing a football game in fasting condition has not been studied, this finding shows that most of the assessed elite football players believed that Ramadan intermittent fasting could have a negative impact on their "mental" abilities during the games. Though this view was not associated with their decision to fast on non-competitive days (Table 2).

The importance of being well hydrated before, during, and after strenuous exercise is well established. Particularly, hydrating during exercise will influence thermoregulatory and muscle function as well as maintain hydration status to maximise performance [23] and few hours of fluid deprivation can adversely affect cognitive tasks that rely on speed and accuracy.[24] Of the footballers assessed in the present study,

68.5% agreed or strongly agreed that it would not be possible to engage in games or training in a fasting state despite drinking sufficient water at *Suhoor*. This shows that they are aware of the importance of hydration during play. This may be the critical reason as to why none of the players intend to fast on competitive days.

We found that few participants in our study were under the belief that Ramadan fasting can improve endurance (9.3%), physical skills (13.0%), or mental skills (31.5%). Some players also believed that Ramadan fasting makes them physically and mentally stronger (see Table 1). Others were neutral about many attitude and belief questions. This is possibly because either they do not know and/or because they do not want to take a position, especially if they had to go against their religious belief. Therefore we also see no differences in these attitude and belief items amongst the two groups. In a group of Tunisian footballers during Ramadan, reported RPE among fasters and non fasters to the training sessions was comparable despite experiencing similar training loads[25] On another group of young soccer players,[26] aerobic and anaerobic physical performances during Ramadan especially during the last week of fasting was significantly declined. In our study, among players who reported intending to fast on non-competitive days, 23.8% believed that Ramadan intermittent fasting can make them weaker day by day as opposed to 69.7% amongst those who reported that they do not intend to fast (p=0.001; Table 2).

Footballers who choose not to fast might face disapproval and criticism from family and friends. In this study, approximately 40% of the footballers said their family and friends insisted that they must observe Ramadan fasting on each Ramadan day. In the context of the players' environment, the team coach's opinion seemed to be of paramount importance. Indeed, the decision to involve a player in a game belongs to him. It was clearly observed in this study, that among the players who intended to fast on non-competitive days, pressure from family and friends and pressure from team coach were significant factors (P<0.001 and P=0.017; Table 2).

Many footballers preferred that such important international competitions not be held during Ramadan, and 72.2% agreed that it is acceptable to make up the fast on another day. This highlights the possibility that some athletes take their fasting decision against their own will, which can decrease their confidence and morale during the game. As mentioned earlier, the player's decision to fast during a competition is not solely based on his past experiences or beliefs but also current challenges. The responses regarding the practice of Ramadan fasting in this study were likely to be influenced by the footballers' awareness that they would experience Ramadan in London, where the duration of daylight was 17 to 18 h and games were to take place just before sunset in temperate weather conditions. The FIFA World Cup 2014 also coincided with the Ramadan month, but this was during knockout stages when only one Muslim majority country team had qualified. During this competition, matches occurred during daylight hours of shorter duration (12 to 13 h) but under conditions of high temperature and humidity.

During the London 2012 tournament, the four teams which represented Muslim majority countries played altogether 14 matches. Only two matches led to victory (14.2%) and six matches ended as draw (42.8%). The limitation of the current study is that exact prevalence of actual practice of Ramadan fasting in actual competition cannot be determined. Indeed, it was not possible to access these athletes during the high level competition. Although our study had a small sample size of 54 athletes, we were able to recruit 3 of the 4 participating teams in this very high level competition. The practice of Ramadan fasting may vary among other footballers in different settings and events. Therefore prospective studies with larger sample are needed. Scientific research and recommendations into the effects of Ramadan intermittent fasting on hydration, nutrition, performance, sleep and general health was recently updated[2,5,6,11,27] and this bulk of literature continues to grow. Athletes, team coaches as well as sport organization bodies need to be aware of the recent updated knowledge such that proper education interventions and sports events can be organised to protect the health of the athletes. The positive or negative attitudes and beliefs about the effects of Ramadan fasting could play a role as placebo or nocebo effect[28] respectively, and therefore has

a potential to impact performance. It is recommended to evaluate such beliefs in future studies that assess athlete's performance during Ramadan.

**Conclusion**

The present study showed that most participants believed that Ramadan fasting would negatively affect their football match performance. There were cross-cultural differences in how Muslim football players planned to observe Ramadan fasting. Overall, there was a lack of knowledge about the effects of Ramadan fasting in approximately one-third of the surveyed elite footballers, which stresses the importance of education sessions to help players to better manage Ramadan intermittent fasting and sports participation. Furthermore, some players, despite having good knowledge about the influence of Ramadan fasting on sleep and possibly football performance, still planned to observe fast due to their religious commitment.

Some potential recommendations to reduce the negative effect of Ramadan on athletic performance for players, coaches and authorities include adjustment in event timing (scheduling events during early morning or late at night; although unlikely to be followed in well-known tournaments, where majority of the participants are non-Muslims), adjustment in sleep pattern (retiring as early as possible after evening meal and taking nap after breakfast or whenever possible in the day time), prevention of hypoglycaemia (by fat metabolism through endurance training with consumption of high fat diet), maintenance of hydration (through high carbohydrate diet to maximize pre game glycogen reserve, intake of salt and water before dawn, avoidance of sweating, activity at pre-event), following appropriate pattern of nutrition like intake of high quality protein following resistance exercise to develop positive nitrogen balance and maintenance of adequate degree of training (to be scheduled around the time of meal) to prevent decline in peak performance but without overreaching as fatigue is a common complain along with loss of body mass.[19-22] When high level competitions occur during Ramadan, although teams may be able to adhere to some of the above recommendations during training it will not be possible to modify the

settings/schedule on a competition day. Therefore, training programs should be designed to match the competition needs in parallel to Ramadan fasting plan. Finally we would like to add that the potential effects of Ramadan fasting and necessary recommendations should be conveyed to players, coaches and family members, so that athletes do not have to take their decisions under duress.

## Footnotes:

**Contributors:**

AF and FM designed and developed the questionnaire. All the authors validated the questionnaire and were involved study design. KC and CH supervised the data collection. AF analysed and interpreted the data, and wrote the manuscript. All authors have contributed and edited the manuscript and have approved the final manuscript.

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**Competing Interests:** None

**Provenance and peer review:** Not applicable

**Data sharing statement:** No additional data is available

**Conflict of Interest:** None

## References

1. Iraki L, Bogdan A, Hakkou F, Amrani N, Abkari A, Touitou Y. Ramadan diet restrictions modify the circadian time structure in humans. A study on plasma gastrin, insulin, glucose, and calcium and on gastric pH. *J Clin Endocrinol Metab.* 1997;82(4):1261-1273.
2. Roky R, Herrera CP, Ahmed Q. Sleep in athletes and the effects of Ramadan. *J Sports Sci.* 2012;30 Suppl 1:S75-84.
3. BaHammam A, Alrajeh M, Albabtain M, Bahammam S, Sharif M. Circadian pattern of sleep, energy expenditure, and body temperature of young healthy men during the intermittent fasting of Ramadan. *Appetite.* 2010;54(2):426-429.
4. Chaouachi A, Coutts AJ, Wong del P, et al. Haematological, inflammatory, and immunological responses in elite judo athletes maintaining high training loads during Ramadan. *Appl Physiol Nutr Metab.* 2009;34(5):907-915.
5. Burke LM, King C. Ramadan fasting and the goals of sports nutrition around exercise. *J Sports Sci.* 2012;30 Suppl 1:S21-31.
6. Maughan RJ, Shirreffs SM. Hydration and performance during Ramadan. *J Sports Sci.* 2012.
7. Roky R, Iraki L, HajKhlifa R, Lakhdar Ghazal N, Hakkou F. Daytime alertness, mood, psychomotor performances, and oral temperature during Ramadan intermittent fasting. *Ann Nutr Metab.* 2000;44(3):101-107.
8. Chamari K, Briki W, Farooq A, Patrick T, Belfekih T, Herrera CP. Impact of Ramadan intermittent fasting on cognitive function in trained cyclists: a pilot study. *Biol Sport.* 2016;33(1):49-56.
9. Cherif A, Roelands B, Meeusen R, Chamari K. Effects of Intermittent Fasting, Caloric Restriction, and Ramadan Intermittent Fasting on Cognitive Performance at Rest and During Exercise in Adults. *Sports Med.* 2016;46(1):35-47.
10. Tian HH, Aziz AR, Png W, Wahid MF, Yeo D, Constance Png AL. Effects of fasting during ramadan month on cognitive function in muslim athletes. *Asian J Sports Med.* 2011;2(3):145-153.
11. Chamari K, Haddad M, Wong DP, Dellal A, Chaouachi A. Injury rates in professional soccer players during Ramadan. *J Sports Sci.* 2012.
12. Havenetidis K. Exercise Performance and Recovery of Muslim Endurance Athletes During Ramadan Fasting. *International Journal of Sports Science and Coaching* 2015;10(1):51-68.
13. Cherif A, Meeusen R, Farooq A, et al. Three Days of Intermittent Fasting: Repeated-Sprint Performance Decreased by Vertical Stiffness Impairment. *Int J Sports Physiol Perform.* 2016.
14. Zerguini Y, Dvorak J, Maughan RJ, et al. Influence of Ramadan fasting on physiological and performance variables in football players: summary of the F-MARC 2006 Ramadan fasting study. *J Sports Sci.* 2008;26 Suppl 3:S3-6.
15. Karli U, Guvenc A, Aslan A, Hazir T, Acikada C. Influence of Ramadan Fasting on Anaerobic Performance and Recovery Following Short time High Intensity Exercise. *J Sports Sci Med.* 2007;6(4):490-497.
16. Maughan RJ, Zerguini Y, Chalabi H, Dvorak J. Ramadan and football. *J Sports Sci.* 2012;30 Suppl 1:S1.
17. Havenetidis K. Ramadan Fasting and Endurance Running Performance in Army Officer Cadets. *International Review of the Armed Forces Medical Services.* 2011;84:68-72.
18. Aziz AR, Wahid MF, Png W, Jesuvadian CV. Effects of Ramadan fasting on 60 min of endurance running performance in moderately trained men. *Br J Sports Med.* 2010;44(7):516-521.

19. Brisswalter J, Bouhlel E, Falola JM, Abbiss CR, Vallier JM, Hausswirth C. Effects of Ramadan intermittent fasting on middle-distance running performance in well-trained runners. *Clin J Sport Med.* 2011;21(5):422-427.
20. Farooq A, Herrera CP, Almudahka F, Mansour R. A Prospective Study of the Physiological and Neurobehavioral Effects of Ramadan Fasting in Preteen and Teenage Boys. *J Acad Nutr Diet.* 2015;115(6):889-897.
21. Bahammam AS, Alaseem AM, Alzakri AA, Sharif MM. The effects of Ramadan fasting on sleep patterns and daytime sleepiness: An objective assessment. *J Res Med Sci.* 2013;18(2):127-131.
22. Lotfi S, Madani M, Tazi A, Boumahmaza M, Talbi M. [Variation of cognitive functions and glycemia during physical exercise in Ramadan fasting]. *Rev Neurol (Paris).* 2010;166(8-9):721-726.
23. Maughan RJ, Fallah J, Coyle EF. The effects of fasting on metabolism and performance. *Br J Sports Med.* 2010;44(7):490-494.
24. Petri NM, Dropulic N, Kardum G. Effects of voluntary fluid intake deprivation on mental and psychomotor performance. *Croat Med J.* 2006;47(6):855-861.
25. Leiper JB, Watson P, Evans G, Dvorak J. Intensity of a training session during Ramadan in fasting and non-fasting Tunisian youth football players. *J Sports Sci.* 2008;26 Suppl 3:S71-79.
26. Chtourou H, Hammouda O, Souissi H, Chamari K, Chaouachi A, Souissi N. The effect of ramadan fasting on physical performances, mood state and perceived exertion in young footballers. *Asian J Sports Med.* 2011;2(3):177-185.
27. Kirkendall DT, Chaouachi A, Aziz AR, Chamari K. Strategies for maintaining fitness and performance during Ramadan. *J Sports Sci.* 2012.
28. Colloca L, Miller FG. The nocebo effect and its relevance for clinical practice. *Psychosom Med.* 2011;73(7):598-603.

**Table 1. Knowledge, beliefs, and attitudes among athletes about Ramadan fasting (n = 54)**

| Item | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|
| **Beliefs** | | | | | |
| Ramadan fasting can reduce my endurance/stamina during game | 3.7 | 5.6 | 9.3 | 46.3 | 35.2 |
| Ramadan fasting will increase my physical skills | 20.4 | 64.8 | 1.9 | 9.3 | 3.7 |
| Ramadan fasting will reduce my mental skills | 9.3 | 22.2 | 20.4 | 38.9 | 9.3 |
| Ramadan fasting will increase my confidence | 3.7 | 20.4 | 22.2 | 37.0 | 16.7 |
| **Knowledge** | | | | | |
| Ramadan fasting will reduce my sleep quality | 16.7 | 22.2 | 7.4 | 40.7 | 13.0 |
| If I am properly hydrated at Suhoor, I can practice game or training without any problem while fasting | 11.1 | 57.4 | 20.4 | 5.6 | 5.6 |
| Ramadan fasting will reduce my concentration during game | 7.5 | 15.1 | 7.5 | 52.8 | 17.0 |
| Ramadan fasting will reduce my sleep time | 13.0 | 22.2 | 3.7 | 51.9 | 9.3 |
| Ramadan fasting can reduce my power during game | 3.7 | 5.6 | 13.0 | 59.3 | 18.5 |
| **Attitudes** | | | | | |
| 17 h of Ramadan fasting in UK can be a challenge | 0 | 5.6 | 16.7 | 46.3 | 31.5 |
| Ramadan fasting will make me physically stronger | 13.0 | 72.2 | 9.3 | 3.7 | 1.9 |
| Ramadan fasting will make me mentally stronger | 7.4 | 57.4 | 24.1 | 5.6 | 5.6 |
| I think it is OK to postpone my Ramadan fasting until after Olympics | 3.7 | 11.1 | 13.0 | 35.2 | 37.0 |
| My family and friends want me to fast in Ramadan | 9.3 | 9.3 | 33.3 | 25.9 | 22.2 |
| It is not a problem for future sports events to take place during Ramadan | 29.6 | 42.6 | 14.8 | 9.3 | 3.7 |
| My coach wants me not to fast in Ramadan | 7.4 | 24.1 | 14.8 | 22.2 | 31.5 |
| Ramadan fasting can make me weaker day by day | 7.4 | 16.7 | 24.1 | 35.2 | 16.7 |

Note: Data are percentages of 54 athletes and may not total to 100% for each item because of rounding.
UK = United Kingdom.

**Table 2. Association between knowledge, beliefs, and attitudes among athletes about Ramadan fasting with decision to fast in London 2012 Olympic Soccer Tournament**

| | Fast on non-competitive days (n=21) | Not to fast (n=33) | p-value |
|---|---|---|---|
| **Beliefs** | | | |
| Ramadan fasting can reduce my endurance/stamina during game | 17(81.0) | 27(81.8) | 0.936 |
| Ramadan fasting will reduce my physical skills | 19(90.5) | 27(81.8) | 0.383 |
| Ramadan fasting will reduce my mental skills | 10(47.6) | 16(48.5) | 0.951 |
| Ramadan fasting will increase my confidence | 12(57.1) | 17(51.5) | 0.686 |
| **Knowledge** | | | |
| Ramadan fasting will reduce my sleep quality | 17(81.0) | 12(36.4) | 0.001** |
| If I am properly hydrated at Suhoor, I can practice game or training without any problem while fasting? | 0(0.0) | 6(18.2) | 0.071 |
| Ramadan fasting will reduce my concentration during game | 16(76.2) | 21(63.6) | 0.383 |
| Ramadan fasting will reduce my sleep time. | 18(85.7) | 15(45.5) | 0.003** |
| Ramadan fasting can reduce my power during game | 15(71.4) | 27(81.8) | 0.371 |
| **Attitudes** 17 h of Ramadan fasting in UK can be a challenge. | 18(85.7) | 24(72.7) | 0.263 |
| Ramadan fasting will make me physically stronger | 1(4.8) | 2(6.1) | 0.839 |
| Ramadan fasting will make me mentally stronger | 0(0.0) | 6(18.2) | 0.071 |
| I think it is OK to postpone my Ramadan fasting until after Olympics | 13(61.9) | 26(78.8) | 0.177 |
| My family and friends want me to fast in Ramadan | 17(81.0) | 9(27.3) | <0.001*** |
| It is not a problem for future sports events to take place during Ramadan | 2(9.5) | 5(15.2) | 0.583 |
| Ramadan fasting can make me weaker day by day | 5(23.8) | 23(69.7) | 0.001** |
| My coach wants me not to fast in Ramadan | 7(33.3) | 22(66.7) | 0.017* |

* P<0.05, ** P<0.01; ***P<0.001

**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

| Section/Topic | Item # | Recommendation | Reported on page # |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | Page 1 and Page 2 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | Page 1. |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | Pages 5 and 6 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | Page 6 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | Page 6, line of methods |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | Page 6. |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | Page 6. |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | On page 7. Definition of outcome variables were given. |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | On Page 7. |
| Bias | 9 | Describe any efforts to address potential sources of bias | On Page 7 |
| Study size | 10 | Explain how the study size was arrived at | This is not applicable, since we recruited 3 of the 4 teams representing Muslim countries at London 2012. |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and | Pages 7 and 8 |

| | | | |
|---|---|---|---|
| | | why | |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | Pages 7 and 8 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | Pages 7 and 8 |
| | | (*c*) Explain how missing data were addressed | Page 8 |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | Not applicable |
| | | (*e*) Describe any sensitivity analyses | Not applicable |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | All participants eligible completed the study. Page 8 |
| | | (b) Give reasons for non-participation at each stage | Not applicable |
| | | (c) Consider use of a flow diagram | Not essential |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | Page 8 (age of the participants) |
| | | (b) Indicate number of participants with missing data for each variable of interest | (Not applicable) |
| Outcome data | 15* | Report numbers of outcome events or summary measures | Table 1. |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | Table 1. (No confounder were adjusted in Table 2) |
| | | (*b*) Report category boundaries when continuous variables were categorized | Not applicable |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | Not applicable |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | Table 2. The fasters and non fasters groups were compared. |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | Page 9 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | Page 12 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from | Page 12 |

| | | | |
|---|---|---|---|
| | | similar studies, and other relevant evidence | |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | Page 12 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | Page 14 |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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# Knowledge, beliefs and attitudes of Muslim footballers towards Ramadan fasting during the London 2012 Olympics: a cross-sectional study

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# Knowledge, beliefs and attitudes of Muslim footballers towards Ramadan fasting during the London 2012 Olympics: a cross-sectional study

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**Keywords:** Football, Ramadan fasting, Knowledge, Attitude, London 2012
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**Abstract:**

**Objectives:**

Muslims observe fasting during the month of Ramadan by abstaining from eating and drinking from dawn to sunset. Available literature shows that although several studies have been conducted on athletes to determine the effects of Ramadan fasting in terms of physical fitness and performance, little data is available regarding the knowledge, beliefs and attitudes of athletes (particularly footballers) towards Ramadan fasting during high-level competitions. This study explored the knowledge, beliefs, and attitudes towards Ramadan fasting among football players participating in the London 2012 Olympics football tournament.

**Design:** Cross-sectional study.

**Settings:** Team training facility.

**Participants:** 54 Muslim footballers participating in the London Olympics, 2012

**Outcome measures:** Each participant was asked to complete a pre-validated structured questionnaire to assess knowledge, beliefs, and attitudes regarding Ramadan fasting and their intention to fast during London 2012.

**Results:** Of the 54 participating athletes, 21(39%) reported that they intended to fast during Ramadan, but not on a match day. This attitude differed across three teams interviewed —83%, 15%, and 0%—showing cross-cultural variation. Overall, there was a lack of knowledge among footballers regarding the effects of Ramadan fasting on sleep and performance around 30% of athletes gave incorrect responses). This knowledge was independent of their decision to fast on non-competition days ($P > 0.05$).

**Conclusion:** This is the first study to describe the knowledge, beliefs and attitudes towards Ramadan fasting among athletes from Muslim-majority countries participating in a high-level competition.

Appropriate knowledge can ensure optimum performance for athletes during Ramadan fasting. Coaches, family members and friends also in possession of this knowledge can provide moral support to the players.

**Article summary section:**

**Strengths and limitations of the study:**

- The first study to assesses the knowledge, beliefs, and attitudes towards Ramadan fasting among football players
- The participants were professional athletes participating in a high-level international competition (Olympic Games).
- Self-reported decisions to fast, but not the actual practice of Ramadan fasting, at the event were collected.
- Performance-related outcomes were not assessed.

## Introduction

During the month of Ramadan, a healthy adult Muslim will observe fasting intermittently by avoiding the intake of fluid and food from dawn to sunset for thirty days. Unlike the Gregorian calendar, the Islamic calendar is lunar-based. Hence, Ramadan falls on different dates each year in the Gregorian calendar and can coincide with a major sporting competition. Recently there have been high-level international competitions which have taken place during Ramadan, such as the London 2012 Summer Olympics, the FIFA (Fédération Internationale de Football Association) World Cup 2014, and EURO 2016.

The available literature regarding the common factors involved in detrimental effects on physical performance during Ramadan has shown alterations in circadian rhythm[1], changes in sleep (in terms of pattern, architecture and duration)[2,3], physiological, metabolic and hormonal changes[4], blood glucose level reduction[5], reduced daytime fluid intake (daytime dehydration)[6], fall in body temperature[7], alteration in psychomotor functioning[8,9] (better during the morning and deteriorating as the day progresses)[7,10], more rapid onset of fatigue, and increased incidence of non-contact and overuse injury in footballers[11].

There is limited literature on the effects of Ramadan fasting on the endurance abilities of athletes during the fasting state (i.e. daylight period). Theoretically, an inability to refuel or rehydrate before and during a 90-minute football game could affect physical and mental performance during the game. In a group of endurance athletes, the rate of perceived exertion (RPE) after endurance-running training was similar among fasters and non-fasters alike throughout Ramadan[12], whereas three days' intermittent fasting reduced repeated-sprint performance in a lab setting[13]. Moreover, another study observed that, during a fasting state, endurance-running performance over 60 minutes is significantly reduced. Maughan et al. (2012) stressed the importance of providing guidelines and recommendations in order to maintain sports performance and to protect the health of athletes[14]. Despite the occurrence of the above-mentioned physiological changes during Ramadan, the direct impact on sports performance remains unclear, largely due to the contradictory results in the current published literature[15,16].

According to the F-MARC 2006 Ramadan Fasting study, biochemical, nutritional, subjective well-being and performance variables are not adversely affected in young football players observing Ramadan in a controlled training-camp environment[15]. Similar results were found in a study conducted by Karli *et al*. (2007), which concluded that if strength–power exercise is performed regularly and daily intake of food, fluid balance and sleeping time are maintained as before Ramadan, fasting will not adversely affect anaerobic power, capacity, and lactate metabolism during and after high-intensity exercise in power athletes[16]. In contrast to these findings, a study conducted by Meckel et al. (2008)[17] found that Ramadan fasting can lead to a significant decrease in aerobic capacity, speed and jumping performance.

It is well established that with a minimal change in sleep pattern and maintenance of training, athletes show little change in anaerobic power or capacity during the month of Ramadan; any increase in tiredness is attributed to inadequate sleep and the phase shift in fluid intake, rather than due to nutritional deficiency[2,14,18]. There is no evidence that Ramadan induces impairment of maximal oxygen intake during a traditional progressive test of short duration (10 minutes); however, performance has been shown to deteriorate with longer periods of endurance exercise[19,20]. Despite existing evidence on the effects of Ramadan fasting, Muslim athletes often have their own knowledge and pre-existing beliefs towards the effects of fasting which translate into their attitudes and practices. This is in part due to their longstanding experience of Ramadan fasting, which usually begins in early childhood[21], and partly from their specific individual experiences.

When a sports event occurs during Ramadan, some Muslim athletes will forgo fasting on competition days, whereas others may continue to observe fasting on competition and training days. An athlete's decision whether to fast is affected not only by factors such as knowledge, beliefs, and attitudes but also by the influence of his or her social environment and the level of the competition.

Better management of an athlete's performance during Ramadan fasting requires educational intervention. Therefore, this study aimed to take the first step by determining the prevalence of fasting among

footballers in a high-level international sporting competition, as well as establishing the athletes' knowledge, beliefs, and attitudes towards fasting.

## Methods

Footballers were recruited to this cross-sectional study by initially approaching team managers of the national teams representing Muslim-majority countries (Egypt, the United Arab Emirates, Senegal, and Morocco) that qualified for the football tournament at the 2012 Summer Olympics in London. Three of the four teams agreed to participate and were labelled as Teams A, B, and C to maintain confidentiality. The inclusion criterion was any Muslim footballers who were drafted for the national teams that were represented in the football competition at the London 2012 Olympics. All players identified as Muslims (n = 54) completed the survey, giving a response rate of 100%.

### *Questionnaire*

To assess the knowledge and attitudes of the players, based on their previous experiences, each athlete completed a structured questionnaire before the tournament and one week prior to 19$^{th}$ July 2012 (i.e. the beginning of Ramadan month).

The questionnaire was designed for the specific purposes of this study and included *a priori* determined parameters of importance and known attitudes and beliefs. It was originally prepared in the English language. The questionnaire was translated into Arabic by a bilingual author (FA) and into French by two bilingual authors (YZ, KC). The authors of this study evaluated the questionnaire for criteria, content and construct validity. This was done to ensure that the wording utilised in the questionnaire was suited to the athletes' cultural context and style of communication without altering the meaning of the questions. The questionnaires were then back translated from Arabic and French to English to ensure consistency across translations.

The questionnaire was self-administered, with assistance provided from a trained interviewer when necessary. The questionnaire was presented in three languages: English, Arabic, and French. The

questionnaire included items that assessed a player's knowledge, attitudes, and beliefs concerning fasting, which were assessed on a five-point Likert scale in which the athletes could answer "strongly agree", "agree", "neutral" (neither agree nor disagree), "disagree", or "strongly disagree" (see supplementary file). Athletes were also asked if they planned to fast during Ramadan (answer options included "completely", "only during training/practice", "only on match days," or "never").

We defined "knowledge" as the information and skills acquired by a person through experience or education. Facts and information in a specific field constitute knowledge. We defined "belief" as an opinion that Muslim footballers held with respect to fasting. We defined "attitude" as the position that football players held concerning fasting. The questionnaire was not scored, but each item was individually assessed. The study received ethical approval by the Ethics Council, the institutional review board of Algiers, Algeria.

***Statistical analysis***

All data were coded and analysed using predictive analytics software (IBM SPSS 21.0, IBM Corp., Armonk, NY, USA). Since each item on the questionnaire was coded on a Likert scale, we used the frequencies and percentages to present the descriptive statistics of the athletes' response to each question. Using the chi-squared test, we compared the players' intention to fast with other categorical variables (knowledge, attitudes, and beliefs) to determine their association. A value of $P<0.05$ was considered statistically significant.

**Results**

During the 2012 London Olympic Games, the fasting duration for Ramadan (timespan from dawn to sunset) was approximately 17 hours 27 minutes. The atmospheric temperature ranged from 14°C to 21°C.

Of the 54 athletes who completed the questionnaire, 33 (61%) reported that they were not planning to fast at all during the tournament, whereas the remaining 21 athletes (39%) reported that they intended to fast

during Ramadan but not on a match day. These statistics varied between the teams: A (83%), B (15%), and C (0%). None of the 54 athletes surveyed planned to fast during match days.

Footballers agreed that Ramadan fasting reduces sleep quality (53.7%), sleep time (61.2%), power (77.8%), and concentration during a game (69.8%); however, the decision to fast was independent of these factors. A team coach's preference appeared to be a strong deciding factor in whether the athletes chose to fast. Among the 33 athletes who planned not to fast, 28 (85%) of these athletes stated that their coach did not want them to fast, whereas only 9 (43%) of the 21 athletes who planned to fast stated that their coach did not want them to fast ($P = 0.002$). Most (n = 37, 68%) athletes thought that even with proper hydration during *Suhoor* (the time when the last meal is taken by Muslims prior to dawn in preparation for daily fast), their performance would be affected as the day progressed.

On the beliefs set of questions about fasting, 44 (81.5%) of the participants agreed or strongly agreed that Ramadan fasting reduces endurance/stamina and 26 (48.2%) agreed or strongly agreed that it reduces mental skills. A high proportion (n = 46, 85.2%) of participants disagreed or strongly disagreed that fasting can increase their physical skills.

On the attitudes set of questions, 42 (78%) of the participants considered fasting for approximately 17 hours each day as a "burden"; 3 (5.6%) of the participants thought that Ramadan fasting would make them physically stronger, and 6 (11.2%) thought that it would make them mentally stronger. Thirty-nine (72.2%) of the athletes agreed that it was acceptable to skip fasting days during games. Most players (72.2%) stated a preference for future high-level competitions to not take place during Ramadan. Approximately 40% of the surveyed athletes reported that there was pressure from family and friends to practise Ramadan fasting on all days of the competition.

## Discussion

For 30 days during the month of Ramadan, Muslims fast from dawn to sunset. This fasting schedule may be particularly challenging, especially for elite-level athletes who participate in international competitions

scheduled during Ramadan. To the authors' knowledge, this is the first study to report the prevalence of intentions to practise Ramadan intermittent fasting during an international high-level competition.

Our study found that none of the 54 athletes intended to fast on match days. However, 39% reported that they would fast for noncompetition days (training and rest days). Moreover, there was a substantial variation in how the three teams responded to this question (0%, 15%, and 83%), thus suggesting cross-cultural differences in the importance assigned to Ramadan fasting or in how its impact is understood.

According to the available scientific literature, sleep architecture is affected during Ramadan fasting in healthy adult non-athletes and sleep duration during fasting is decreased in healthy adults[22], as well as in professional athletes[2]. In the current study, approximately one-third of the players lacked the knowledge that sleep quality and sleep times are affected during Ramadan (see Table 1). Despite the knowledge of effects of Ramadan fasting on sleep duration and quality, the majority of the participants reported that they would fast on non-competition days (see Table 2). This could indicate that players are not aware that fasting can influence sleep patterns during the subsequent days.

Some studies have reported a decline in sustained attention or rapid responses among athletes during the daytime, although sustained attention gradually declines from morning to late afternoon[7,10]. Many studies have tested the effects of Ramadan intermittent fasting on cognitive function in athletes under resting conditions[7,10,23], however, this is clearly not specific to cognitive function during physical effort. In relation to cognitive function, the present study showed that 69.8% of the footballers thought that their concentration was reduced during a game while fasting. This view was found to be similar in both groups of non-fasters and fasters on non-competitive days (63.6% vs. 76.2%, $p$=0.383; Table 2). Despite the lack of evidence relating to cognitive function while playing a football game in a fasting condition, this finding shows that most of the assessed elite football players in this study believed that Ramadan intermittent fasting could have a negative impact on their "mental" abilities during games. However, this view was not associated with their decision to fast on non-competitive days (Table 2).

The importance of being well-hydrated before, during, and after strenuous exercise is well established. In particular, hydrating during exercise will influence thermoregulatory and muscle function as well as maintain hydration status to maximise performance[24]. Only a few hours of fluid deprivation can adversely affect cognitive tasks that rely on speed and accuracy[25]. Of the footballers assessed in the present study, 68.5% agreed or strongly agreed that it would not be possible to engage in games or training in a fasting state, despite drinking sufficient water at *Suhoor*. This shows that they are aware of the importance of hydration whilst playing. This may be the critical reason as to why none of the players intend to fast on competitive days.

We found that few participants in our study were under the belief that Ramadan fasting can improve endurance (9.3%), physical skills (13.0%), or mental skills (31.5%). Some players also believed that Ramadan fasting makes them physically and mentally stronger (see Table 1). Others were neutral about many attitude and belief questions. This neutrality may be as a result of a lack of knowledge on the topic area and/or because they do not want to take a position, especially if this meant going against their religious beliefs. We observed no differences in these attitude and belief items between the two groups.

In a study of Tunisian footballers during Ramadan, reported RPE among fasters and non-fasters at training sessions was comparable, despite their experiencing similar training loads[26]. In another study of young soccer players, aerobic and anaerobic physical performances during Ramadan, particularly during the last week of fasting, was significantly diminished[27]. In our study, among players who reported intending to fast on non-competitive days, 23.8% believed that Ramadan intermittent fasting could make them weaker day by day, as opposed to 69.7% amongst those who reported that they did not intend to fast ($p$=0.001; Table 2).

Footballers who choose not to fast might face disapproval and criticism from family and friends. In this study, approximately 40% of the footballers said that their family and friends insisted that they must observe Ramadan fasting on each Ramadan day. In the context of the players' environment, the team

coach's opinion seemed to be of paramount importance. Indeed, the decision whether or not to involve a player in a game is in his hands. It was clearly observed in this study that among the players who intended to fast on non-competitive days, pressure from family and friends and pressure from the team coach were significant factors ($P<0.001$ and $P=0.017$; Table 2).

Many footballers stated a preference for important international competitions not to be held during Ramadan, and 72.2% agreed that it is acceptable to make up the fast on another day. This highlights the possibility that some athletes take their fasting decision against their own will, which could decrease their confidence and morale during the game. As previously mentioned, a player's decision to fast during a competition is not solely based on his past experiences or beliefs, but also on current challenges. The responses regarding the practice of Ramadan fasting in this study were likely to be influenced by the footballers' awareness that they would experience Ramadan in London, where the duration of daylight was 17 to 18 hours and games were to take place just before sunset in temperate weather conditions. The FIFA World Cup 2014 also coincided with the Ramadan month, but this was during knockout stages when only one Muslim majority country team had qualified. During this competition, matches occurred during daylight hours of shorter duration (12 to 13 hours), but under conditions of high temperature and humidity.

During the London 2012 tournament, the four teams which represented Muslim-majority countries played 14 matches altogether. Only two matches led to victory (14.2%) and six matches ended as a draw (42.8%).

The main limitation of this study is that the exact prevalence of those practising fasting during Ramadan on training or competitions days could not be determined. For practical reasons it was not possible to access these athletes during the high-level competition. Although our study had a relatively small sample size of 54 athletes, we were able to recruit three of the four participating teams representing Muslim countries in this high-level competition. The practice of Ramadan fasting may vary among other

footballers in different settings and events. The results of the current study regarding the prevalence of Ramadan fasting cannot be generalised to all Muslim athlete populations from different countries, as our results suggests a cultural influence. To assess this more fully, larger prospective studies are required.

There is an increase in scientific research and recommendations into the effects of Ramadan intermittent fasting on hydration, nutrition, performance, sleep and general health[2,5,6,11,28]. Athletes as well as team coaches and sport organization bodies need to be aware of the recent updated knowledge, such that proper educational interventions and sports events can be organised to ensure that the health of athletes is protected. The positive or negative attitudes and beliefs about the effects of Ramadan fasting could play a psychological role as a placebo or nocebo effect[29], and thus potentially impact on performance. This requires further exploration in future studies to assess the performance of athletes during Ramadan.

**Conclusion**

The present study found that most participants believed that Ramadan fasting would negatively affect their football match performance. There were cross-cultural differences in how Muslim football players planned to observe Ramadan fasting. Overall, there was a lack of knowledge about the effects of Ramadan fasting in approximately one-third of the surveyed elite footballers, which stresses the importance of education sessions to help players to better manage Ramadan intermittent fasting and sports participation. Furthermore, some players, despite having good knowledge about the influence of Ramadan fasting on sleep, and potentially on football performance, still intended to observe fasting due to their religious commitment.

Some potential recommendations to reduce the negative effect of Ramadan on athletic performance for players, coaches and authorities include adjustment of event timing (scheduling events during early morning or late at night; although this is unlikely to be followed in well-known tournaments, where the majority of the participants are non-Muslims), adjustment in sleep pattern (retiring as early as possible after the evening meal and taking a nap after breakfast or whenever possible during the day), prevention

of hypoglycaemia (by fat metabolism through endurance training, with consumption of a high-fat diet), maintenance of hydration (through a high carbohydrate diet to maximize pre-game glycogen reserve, intake of salt and water before dawn, avoidance of sweating and activity pre-event), following an appropriate pattern of nutrition (such as increasing the intake of high-quality protein following resistance exercise, to develop a positive nitrogen balance to prevent a decline in peak performance [19-22]). When high-level competitions occur during Ramadan, although teams may be able to adhere to some of the above recommendations during training, it will not be possible to modify the settings/schedule on a competition day. Therefore, training programs should be designed to match the competition needs in parallel with a Ramadan fasting plan. A particularly pertinent point to emerge from this study is the importance of the education of players, coaches and family members about the physiological and psychological effects of Ramadan fasting and the provision of appropriate evidence-based recommendations to ensure optimal performance whilst still upholding religious and cultural beliefs.

## Footnotes:

**Contributors:**

AF and FM designed and developed the questionnaire. All the authors validated the questionnaire and were involved in the study design. KC and CH supervised the data collection. AF analysed and interpreted the data, and wrote the manuscript. All authors have contributed to and edited the manuscript and have approved the final manuscript.

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**Competing Interests:** None declared

**Provenance and peer review:** Not applicable

**Data sharing statement:** No additional data is available

**Conflict of Interest:** None

## References


1. Iraki L, Bogdan A, Hakkou F, Amrani N, Abkari A, Touitou Y. Ramadan diet restrictions modify the circadian time structure in humans. A study on plasma gastrin, insulin, glucose, and calcium and on gastric pH. *J Clin Endocrinol Metab.* 1997;82(4):1261-1273.
2. Roky R, Herrera CP, Ahmed Q. Sleep in athletes and the effects of Ramadan. *J Sports Sci.* 2012;30 Suppl 1:S75-84.
3. BaHammam A, Alrajeh M, Albabtain M, Bahammam S, Sharif M. Circadian pattern of sleep, energy expenditure, and body temperature of young healthy men during the intermittent fasting of Ramadan. *Appetite.* 2010;54(2):426-429.
4. Chaouachi A, Coutts AJ, Wong del P, et al. Haematological, inflammatory, and immunological responses in elite judo athletes maintaining high training loads during Ramadan. *Appl Physiol Nutr Metab.* 2009;34(5):907-915.
5. Burke LM, King C. Ramadan fasting and the goals of sports nutrition around exercise. *J Sports Sci.* 2012;30 Suppl 1:S21-31.
6. Maughan RJ, Shirreffs SM. Hydration and performance during Ramadan. *J Sports Sci.* 2012.
7. Roky R, Iraki L, HajKhlifa R, Lakhdar Ghazal N, Hakkou F. Daytime alertness, mood, psychomotor performances, and oral temperature during Ramadan intermittent fasting. *Ann Nutr Metab.* 2000;44(3):101-107.
8. Chamari K, Briki W, Farooq A, Patrick T, Belfekih T, Herrera CP. Impact of Ramadan intermittent fasting on cognitive function in trained cyclists: a pilot study. *Biol Sport.* 2016;33(1):49-56.
9. Cherif A, Roelands B, Meeusen R, Chamari K. Effects of Intermittent Fasting, Caloric Restriction, and Ramadan Intermittent Fasting on Cognitive Performance at Rest and During Exercise in Adults. *Sports Med.* 2016;46(1):35-47.
10. Tian HH, Aziz AR, Png W, Wahid MF, Yeo D, Constance Png AL. Effects of fasting during ramadan month on cognitive function in muslim athletes. *Asian J Sports Med.* 2011;2(3):145-153.
11. Chamari K, Haddad M, Wong DP, Dellal A, Chaouachi A. Injury rates in professional soccer players during Ramadan. *J Sports Sci.* 2012.
12. Havenetidis K. Exercise Performance and Recovery of Muslim Endurance Athletes During Ramadan Fasting. *International Journal of Sports Science and Coaching* 2015;10(1):51-68.
13. Cherif A, Meeusen R, Farooq A, et al. Three Days of Intermittent Fasting: Repeated-Sprint Performance Decreased by Vertical Stiffness Impairment. *Int J Sports Physiol Perform.* 2016.
14. Maughan RJ, Zerguini Y, Chalabi H, Dvorak J. Ramadan and football. *J Sports Sci.* 2012;30 Suppl 1:S1.
15. Zerguini Y, Dvorak J, Maughan RJ, et al. Influence of Ramadan fasting on physiological and performance variables in football players: summary of the F-MARC 2006 Ramadan fasting study. *J Sports Sci.* 2008;26 Suppl 3:S3-6.
16. Karli U, Guvenc A, Aslan A, Hazir T, Acikada C. Influence of Ramadan Fasting on Anaerobic Performance and Recovery Following Short time High Intensity Exercise. *J Sports Sci Med.* 2007;6(4):490-497.
17. Meckel Y, Ismaeel A, Eliakim A. The effect of the Ramadan fast on physical performance and dietary habits in adolescent soccer players. *Eur J Appl Physiol.* 2008;102(6):651-657.
18. Havenetidis K. Ramadan Fasting and Endurance Running Performance in Army Officer Cadets. *International Review of the Armed Forces Medical Services.* 2011;84:68-72.
19. Aziz AR, Wahid MF, Png W, Jesuvadian CV. Effects of Ramadan fasting on 60 min of endurance running performance in moderately trained men. *Br J Sports Med.* 2010;44(7):516-521.

20. Brisswalter J, Bouhlel E, Falola JM, Abbiss CR, Vallier JM, Hausswirth C. Effects of Ramadan intermittent fasting on middle-distance running performance in well-trained runners. *Clin J Sport Med.* 2011;21(5):422-427.
21. Farooq A, Herrera CP, Almudahka F, Mansour R. A Prospective Study of the Physiological and Neurobehavioral Effects of Ramadan Fasting in Preteen and Teenage Boys. *J Acad Nutr Diet.* 2015;115(6):889-897.
22. Bahammam AS, Alaseem AM, Alzakri AA, Sharif MM. The effects of Ramadan fasting on sleep patterns and daytime sleepiness: An objective assessment. *J Res Med Sci.* 2013;18(2):127-131.
23. Lotfi S, Madani M, Tazi A, Boumahmaza M, Talbi M. [Variation of cognitive functions and glycemia during physical exercise in Ramadan fasting]. *Rev Neurol (Paris).* 2010;166(8-9):721-726.
24. Maughan RJ, Fallah J, Coyle EF. The effects of fasting on metabolism and performance. *Br J Sports Med.* 2010;44(7):490-494.
25. Petri NM, Dropulic N, Kardum G. Effects of voluntary fluid intake deprivation on mental and psychomotor performance. *Croat Med J.* 2006;47(6):855-861.
26. Leiper JB, Watson P, Evans G, Dvorak J. Intensity of a training session during Ramadan in fasting and non-fasting Tunisian youth football players. *J Sports Sci.* 2008;26 Suppl 3:S71-79.
27. Chtourou H, Hammouda O, Souissi H, Chamari K, Chaouachi A, Souissi N. The effect of ramadan fasting on physical performances, mood state and perceived exertion in young footballers. *Asian J Sports Med.* 2011;2(3):177-185.
28. Kirkendall DT, Chaouachi A, Aziz AR, Chamari K. Strategies for maintaining fitness and performance during Ramadan. *J Sports Sci.* 2012.
29. Colloca L, Miller FG. The nocebo effect and its relevance for clinical practice. *Psychosom Med.* 2011;73(7):598-603.

**Table 1. Knowledge, beliefs, and attitudes among athletes about Ramadan fasting (n = 54)**

| Item | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|
| **Beliefs** | | | | | |
| Ramadan fasting can reduce my endurance/stamina during a game | 3.7 | 5.6 | 9.3 | 46.3 | 35.2 |
| Ramadan fasting will increase my physical skills | 20.4 | 64.8 | 1.9 | 9.3 | 3.7 |
| Ramadan fasting will reduce my mental skills | 9.3 | 22.2 | 20.4 | 38.9 | 9.3 |
| Ramadan fasting will increase my confidence | 3.7 | 20.4 | 22.2 | 37.0 | 16.7 |
| **Knowledge** | | | | | |
| Ramadan fasting will reduce my sleep quality | 16.7 | 22.2 | 7.4 | 40.7 | 13.0 |
| If I am properly hydrated at Suhoor, I can participate in a game or training without any problem while fasting | 11.1 | 57.4 | 20.4 | 5.6 | 5.6 |
| Ramadan fasting will reduce my concentration during game | 7.5 | 15.1 | 7.5 | 52.8 | 17.0 |
| Ramadan fasting will reduce my sleep time | 13.0 | 22.2 | 3.7 | 51.9 | 9.3 |
| Ramadan fasting can reduce my power during a game | 3.7 | 5.6 | 13.0 | 59.3 | 18.5 |
| **Attitudes** | | | | | |
| 17 h of Ramadan fasting in the UK can be a challenge | 0 | 5.6 | 16.7 | 46.3 | 31.5 |
| Ramadan fasting will make me physically stronger | 13.0 | 72.2 | 9.3 | 3.7 | 1.9 |
| Ramadan fasting will make me mentally stronger | 7.4 | 57.4 | 24.1 | 5.6 | 5.6 |
| I think it is OK to postpone my Ramadan fasting until after the Olympics | 3.7 | 11.1 | 13.0 | 35.2 | 37.0 |
| My family and friends want me to fast in Ramadan | 9.3 | 9.3 | 33.3 | 25.9 | 22.2 |
| It is not a problem for future sports events to take place during Ramadan | 29.6 | 42.6 | 14.8 | 9.3 | 3.7 |
| My coach wants me not to fast in Ramadan | 7.4 | 24.1 | 14.8 | 22.2 | 31.5 |
| Ramadan fasting can make me weaker day by day | 7.4 | 16.7 | 24.1 | 35.2 | 16.7 |

Note: Data are percentages of 54 athletes and may not total to 100% for each item because of rounding.
UK = United Kingdom.

**Table 2. Association between knowledge, beliefs, and attitudes of Ramadan fasting among athletes who did and did not decide to fast during the London 2012 Olympic Football Tournament**

| | Fast on non-competitive days (n=21) | Not to fast (n=33) | p-value |
|---|---|---|---|
| **Beliefs** | | | |
| Ramadan fasting can reduce my endurance/stamina during a game | 17(81.0) | 27(81.8) | 0.936 |
| Ramadan fasting will reduce my physical skills | 19(90.5) | 27(81.8) | 0.383 |
| Ramadan fasting will reduce my mental skills | 10(47.6) | 16(48.5) | 0.951 |
| Ramadan fasting will increase my confidence | 12(57.1) | 17(51.5) | 0.686 |
| **Knowledge** | | | |
| Ramadan fasting will reduce my sleep quality | 17(81.0) | 12(36.4) | 0.001** |
| If I am properly hydrated at Suhoor, I can participate in a game or training without any problem while fasting? | 0(0.0) | 6(18.2) | 0.071 |
| Ramadan fasting will reduce my concentration during game | 16(76.2) | 21(63.6) | 0.383 |
| Ramadan fasting will reduce my sleep time. | 18(85.7) | 15(45.5) | 0.003** |
| Ramadan fasting can reduce my power during a game | 15(71.4) | 27(81.8) | 0.371 |
| **Attitudes**<br>17 h of Ramadan fasting in the UK can be a challenge. | 18(85.7) | 24(72.7) | 0.263 |
| Ramadan fasting will make me physically stronger | 1(4.8) | 2(6.1) | 0.839 |
| Ramadan fasting will make me mentally stronger | 0(0.0) | 6(18.2) | 0.071 |
| I think it is OK to postpone my Ramadan fasting until after the Olympics | 13(61.9) | 26(78.8) | 0.177 |
| My family and friends want me to fast in Ramadan | 17(81.0) | 9(27.3) | <0.001*** |
| It is not a problem for future sports events to take place during Ramadan | 2(9.5) | 5(15.2) | 0.583 |
| Ramadan fasting can make me weaker day by day | 5(23.8) | 23(69.7) | 0.001** |
| My coach wants me not to fast in Ramadan | 7(33.3) | 22(66.7) | 0.017* |

* P<0.05, ** P<0.01; ***P<0.001

| I think…. | Strongly agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Ramadan fasting can reduce my endurance/stamina during game | ① | ② | ③ | ④ | ⑤ |
| Ramadan fasting can make me weaker day by day | ① | ② | ③ | ④ | ⑤ |
| Ramadan fasting will reduce my physical skills | ① | ② | ③ | ④ | ⑤ |
| Ramadan fasting will reduce my sleep quality | ① | ② | ③ | ④ | ⑤ |
| If I am properly hydrated at Suhoor, I can practice game or training without any problem while fasting? | ① | ② | ③ | ④ | ⑤ |
| Ramadan fasting will reduce my concentration during game | ① | ② | ③ | ④ | ⑤ |
| Ramadan fasting will reduce my sleep time. | ① | ② | ③ | ④ | ⑤ |
| Ramadan fasting can reduce my power during game | ① | ② | ③ | ④ | ⑤ |
| Ramadan fasting will reduce my mental skills | ① | ② | ③ | ④ | ⑤ |
| **I believe….** | **Strongly agree** | **Agree** | **Neutral** | **Disagree** | **Strongly Disagree** |
| 17hrs of Ramadan fasting in UK can be a challenge. | ① | ② | ③ | ④ | ⑤ |
| Ramadan fasting will make me mentally stronger | ① | ② | ③ | ④ | ⑤ |
| My family and friends want me to fast in Ramadan | ① | ② | ③ | ④ | ⑤ |
| It is not a problem for future sports events to take place during Ramadan | ① | ② | ③ | ④ | ⑤ |
| Ramadan fasting will increase my confidence | ① | ② | ③ | ④ | ⑤ |
| I think it is OK to postpone my Ramadan fasting until after Olympics | ① | ② | ③ | ④ | ⑤ |
| Ramadan fasting will make me physically stronger | ① | ② | ③ | ④ | ⑤ |
| My coach wants me not to fast in Ramadan | ① | ② | ③ | ④ | ⑤ |

Practice:

Ramadan Fasting
Do you plan to fast during the Ramadan month? ..... [Y/N]
If yes, will you
[1] Fast all days
[2] Skip only on Match days and compensate later
[3] Skip only on Training days and compensate later
[4] Skip on Match or Training days and compensate later

**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

| Section/Topic | Item # | Recommendation | Reported on page # |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | Page 1 and Page 2 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | Page 1. |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | Pages 5 and 6 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | Page 6 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | Page 6, line of methods |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | Page 6. |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | Page 6. |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | On page 7. Definition of outcome variables were given. |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | On Page 7. |
| Bias | 9 | Describe any efforts to address potential sources of bias | On Page 7 |
| Study size | 10 | Explain how the study size was arrived at | This is not applicable, since we recruited 3 of the 4 teams representing Muslim countries at London 2012. |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and | Pages 7 and 8 |

| | | | |
|---|---|---|---|
| | | why | |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | Pages 7 and 8 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | Pages 7 and 8 |
| | | (*c*) Explain how missing data were addressed | Page 8 |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | Not applicable |
| | | (*e*) Describe any sensitivity analyses | Not applicable |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | All participants eligible completed the study. Page 8 |
| | | (b) Give reasons for non-participation at each stage | Not applicable |
| | | (c) Consider use of a flow diagram | Not essential |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | Page 8 (age of the participants) |
| | | (b) Indicate number of participants with missing data for each variable of interest | (Not applicable) |
| Outcome data | 15* | Report numbers of outcome events or summary measures | Table 1. |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | Table 1. (No confounder were adjusted in Table 2) |
| | | (*b*) Report category boundaries when continuous variables were categorized | Not applicable |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | Not applicable |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | Table 2. The fasters and non fasters groups were compared. |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | Page 9 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | Page 12-13 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from | Page 12-13 |

| | | | |
|---|---|---|---|
| | | similar studies, and other relevant evidence | |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | Page 12-13 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | Page 14 |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.