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The implications of Ramadan fasting for human health and well-being

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Abstract
Islamic Ramadan is a 29–30 day fast in which food, fluids, medications, drugs and smoking are prohibited during the daylight hours which can be extended between 13 and 18 h · day^{-1} depending on the geographical location and season. The majority of health-specific findings related to Ramadan fasting are mixed. The likely causes for these heterogeneous findings lie in the amount of daily time of fasting, number of subjects who smoke, take oral medications, and/or receive intravenous fluids, in the type of food and eating habits and in changes in lifestyle. During Ramadan fasting, glucose homeostasis is maintained by meals taken during night time before dawn and by liver glycogen stores. Changes in serum lipids are variable and depend on the quality and quantity of food intake, physical activity and exercise, and changes in body weight. Compliant, well-controlled type II diabetics may observe Ramadan fasting, but fasting is not recommended for type I, noncompliant, poorly controlled and pregnant diabetics. There are no adverse effects of Ramadan fasting on respiratory and cardiovascular systems, haematologic profile, endocrine, and neuropsychiatric functions. Conclusions: Although Ramadan fasting is safe for all healthy individuals, those with various diseases should consult their physicians and follow medical and scientific recommendations.

Keywords: *Ramadan fasting, health, chronic diseases, exercise*

Introduction

There are many issues to consider when reviewing the effects of Ramadan fasting on health and well-being, including the changes in diet and lifestyle that occur at this time. Although Ramadan lasts for only one month every year, it may be accompanied by significant changes in both energy intake and in the composition of the diet. Superimposed on this is a change in the timing of food and fluid intake, with a relatively long period of abstention from food and fluid intake during the hours of daylight. There is an extensive literature on the effects of Ramadan fasting on various aspects of health and on risk factors for various diseases, but the published effects are often contradictory. This is likely, in part at least, because of the different ways in which Ramadan fasting is practised in different populations, differences in study design (including in particular the timing of sample collection in relation to the last meal), seasonal and climatic differences, and differences in the health, fitness and activity levels of the study populations. In a survey of Saudi families, for example, about two thirds reported gaining weight during Ramadan and about one third reported a decrease in physical activity levels (Bakhotmah, 2011). In a survey of Turkish Muslims, however, daily energy intake was generally less than expenditure during Ramadan (Karaağaoğlu & Yücecan, 2000).

The lifestyle of some Muslims will not change greatly during Ramadan, but for others this is an opportunity for contemplation and spiritual activities while others still will spend much of the night engaging in social activities with friends and family. For this last group, an increase in food intake and a change in the composition of the diet are to be expected. While short term effects on body

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composition and body mass might be expected because of changes in energy intake and physical activity levels, these changes seem unlikely to have long term effects on body mass. Glycaemic control and cardiovascular risk factors will also be strongly influenced by changes in energy balance and body composition, so differences in response might be expected in different populations. Non-nutritional factors may also have a significant impact on the findings. In some groups that have been studied, Ramadan is a time of increased participation in stress-reducing and spiritual activities and a reduction in caffeine and nicotine use (Afifi, 1997). These changes potentially have both short-term and long-term effects on cardiovascular health.

This short review will focus on common causes of morbidity and mortality that are likely to be affected by the changes in diet and lifestyle factors that occur during Ramadan fasting. The review will consider the implications of Ramadan fasting for body mass and obesity, diabetes, cardiovascular health, mental health, level of physical activity and, pregnancy and maternity.

Diabetes

Individuals are exempt from Ramadan fasting if they are suffering from an illness that could be adversely affected by fasting. People diagnosed with diabetes fall into this category and are allowed to refrain from fasting for anything from one day to all 30 days, depending on the condition of their illness.

Islam recommends that fasting Muslims eat a meal before dawn, called ''sohour.'' This is very important for fasting diabetics. Physicians working in Muslim countries and countries with Muslim communities commonly face the difficult task of advising diabetic patients about the safety of fasting, as well as advising patients on the dietary and drug regimens when diabetics decide to fast. It is important for physicians to have an understanding about the effect of Ramadan fasting on the pathophysiology of diabetes mellitus to appropriately judge whether to grant medical permission for Ramadan fasting to a diabetic patient.

Body weight for diabetic patients during Ramadan fasting

A review of the literature shows a controversy about weight changes in diabetic patients during Ramadan. Azizi and Rasouli (1987), Al Nakhi, Al Arouj, Kandari, and Morad (1997), and Athar and Habib (1994) showed a decrease in body weight. Those findings showed similar effects to that of healthy individuals (Ramadan, Mousa, & Telahoun, 1994–1995). Rashed (1992) and Klocker et al. (1997) showed an increase in body weight, while no change in body weight was shown by Laajam (1990) and Sulimani (1991) which again was similar to that of healthy people (Ramadan, 2002; Ramadan & Barac-Nieto, 2000).

Blood glucose changes, energy intake and serum lipid variables during Ramadan fasting in diabetics

Changes in glucose control in most patients showed no significant difference between Ramadan and non-Ramadan months (Azizi, 1996; Laajam, 1990; Mafauzy, Mohammed, Anum, Zulkifli, & Ruhani 1990). This is similar to the responses of healthy individuals (Ramadan & Barac-Nieto 2000). In some patients, serum glucose concentration may fall or rise (Bouguerra et al., 1997; Bagraicik, Yumuk, Damei, & Ozyazar, 1994). This variation may be due to the amount or type of food consumption, frequency of taking medications, engorging at Iftar (after the fast is broken at the end of the day), or a decrease in exercise and physical activities. In most cases, no episodes of acute complications of hypoglycaemia or hyperglycaemia in patients under medical management (Al Nakhi et al., 1997; Davidson 1979; Sulimani, 1991), and only a few cases of biochemical hypoglycaemia without clinical hazards, have been reported (Salman, Abdallah, & Al Howasi, 1992).

In general, Glycated hemoglobin (HbAIC) a type of hemoglobin measured to identify average plasma glucose concentration over time, values show no change or even improvement during Ramadan (Al Hader, Abu-Farsakh, Khatib, & Hassan, 1994; Dehghan, Nafarabadi, Navai, & Azizi 1994). Only two studies have reported slight increases in glycated haemoglobin levels (Belkhadir et al., 1993; Uysal, Erdogan, Sahin, Kamel, & Erdogan 1997). Mafauzy et al. (1990) and Bouguerra et al. (1997) have indicated a decrease in energy intake during Ramadan. Most patients with insulin dependent diabetes mellitus (IDDM, type I) and non-insulin dependent diabetes mellitus (NIDDM, type II) showed no change or a slight decrease in concentrations of total cholesterol and triglyceride (Al Hader et al., 1994; Al Nakhi et al., 1997; Bouguerra et al., 1997; Dehghan et al., 1994; Ewis & Afifi, 1997; Klocker et al., 1997; Khatib, 1997; Uysal et al., 1997). Increase in total cholesterol levels during Ramadan seldom occurs (Laajam, 1990). As in healthy persons (Aldouni et al., 1998; Maislos et al., 1993), a few studies have reported increases in high-density lipoprotein (HDL) cholesterol in diabetics during Ramadan (Dehghan et al., 1994; Khatib, 1997; Uysal et al., 1997).

Recommendations to fasting diabetic patients

In recent years, a better understanding about pathophysiological changes during Ramadan fasting

in diabetic patients has provided a few guidelines on how to advise diabetics who want to fast. Gaborit et al. (2011) showed a wide cross-cultural gap between general practitioners and their patients. They recommended that a systematic advice on treatment adjustment needs to be given. For this reason, they encouraged more sensitive care of these patients and more medical training for physicians. Physicians working with Muslim diabetics should employ appropriate criteria to advise their patients regarding the safety of Ramadan fasting.

Several studies have helped in formulating the suggested criteria in making such a decision (Athar & Habib, 1994; Das, 2011; Ibrahim & Abdulhameed, 2010; Kobeissy, Zantout, & Azar, 2008; Omar & Motala, 1997). Fasting should be forbidden in all poorly-controlled and brittle type I diabetics, those who are not compliant with taking diet, drugs and exercise advice, and poorly controlled type II diabetic patients. Close monitoring of patients with serious complications such as uncontrolled hypertension, pregnant diabetics, patients with diabetic ketoacidosis and unstable angina should be undertaken. Fasting should be allowed for controlled patients who do not have the above complications.

Cardiovascular health: Acute effects of Ramadan fasting on cardiovascular events

There have been several studies of the incidence of vascular events during Ramadan, and the majority have concluded that there is not an increased rate of such events during Ramadan, either in patients with established vascular disease or in those with no previous history. A retrospective study of emergency department admissions in Ankara, Turkey, found, in each year of the survey, a lower number of admissions for coronary events during Ramadan than either before or after Ramadan, but the ratio of this population to all patients was not statistically significant between the periods, and the authors concluded that fasting does not increase the risk of acute coronary events (Temizhan, Donderici, Ouz, & Demirbas 1999). Al Suwaidi, Bener, Hajar, and Numan (2004) examined medical records for all hospital admissions in Quataris living in Qatar over a 10 year period from 1991, and separated from the results those admitted for congestive heart failure. A total of 2160 patients were hospitalised for congestive heart failure during this period: the number of hospitalisations for congestive heart failure was not different during the month of Ramadan (208 cases) from the number the preceding month (182 cases) or the following month (198 cases), and the number of fatalities from congestive heart failure was also not different. Bener et al. (2006a,b,c) retrospectively reviewed a 13-year stroke database and studied the data on Muslim patients who were hospitalised with a stroke. The number of hospitalisations for strokes was not significantly different in the month of Ramadan (29 cases), when compared to the month before Ramadan (30 cases) and the month after Ramadan (29 cases). Risk factors for strokes were not significantly different in Ramadan when compared to the month before and after Ramadan. These associated risk factors were hypertension, diabetes mellitus, hypercholesterolaemia, acute myocardial infarction, and congestive heart failure. In a further analysis, Pekdemir, Ersel, Yilmaz, & Uygun (2010) also failed to find any difference in the clinical features of patients admitted to a hospital emergency department during Ramadan or in the number of admissions for specific ailments.

In a prospective study of 465 outpatients with established but stable heart disease who were fasting during the month of Ramadan, (Al Suwaidi et al., 2005) only 19 were hospitalised during the fasting month, and the authors concluded that the effects of fasting on patients with existing and controlled cardiovascular disease were minimal.

In contrast to these findings, Saadatnia, Zare, Fatehi, and Ahmadi (2009) did observe an increased frequency of cerebral venous sinus thrombosis during Ramadan. From 2001 to 2006, the mean number of patients admitted to three neurological centres with cerebral venous sinus thrombosis during the fasting month was higher (5.5 cases) than the mean number of patients during all other non-fasting months (1.95 cases per month).

Although the overall rate of vascular events may not be different during Ramadan, there seem to be some changes in patterns of cardiovascular events occurring over the course of the day. In a prospective study aimed at determining whether Ramadan fasting had any effect on the well-recognised circadian variation in presentation of acute cardiac events, Al Suwaidi et al. (2006) collected data on 1019 patients hospitalised during the study period, of whom 162 were fasting. Fasting patients were less likely to have their symptoms start between 5 and 8 a.m. (11% vs. 19%) and more likely to have symptoms between 5 and 6 p.m. (11% vs. 6%) and 3 and 4 a.m. (11% vs. 7%). These statistically significant changes in the pattern of events over the day while fasting were attributed to the changes in food intake and/or sleep timings. El-Mitwalli, Zaher, and El-Menshawi (2010) also found a significant shift of the circadian pattern of stroke onset time during the month of Ramadan. This observation was based on a study of consecutive stroke patients 1 month before Ramadan and during Ramadan over two successive years. The exact time of stroke onset in both groups was obtained for 507 patients: 262 patients before Ramadan and 245 patients during Ramadan. The

highest frequency of stroke patients admitted before Ramadan was in the morning between 06:00 and noon, whereas the frequency was higher between noon and 18:00 in the patients admitted during Ramadan.

Effects on blood lipids

The effects or Ramadan fasting on blood lipids has been extensively studied over many years, but the pattern of response and the implications for cardiovascular risk are not entirely clear. In some published studies, there is evidence of an increase in some anti-atherogenic biochemical parameters, including high-density lipoprotein cholesterol (HDL-cholesterol) and apolipoprotein (apo) AI, and a decrease in some atherogenic parameters, including triglycerides total cholesterol (TC), apoprotein B, and low-density lipoprotein cholesterol (LDL-cholesterol) (Akanji, Mojiminiyi, & Abdella, 2000; Aldouni, Ghalim, Benslimane, Lecerf, & Saile, 1997, Aldouni et al., 1998; Furuncuoglu, Karaca, Aras, & Yonem, 2007; Lamine et al., 2006; Maislos et al., 1993; Saleh et al., 2004). In some other studies, however, some of these parameters have remained unchanged or even moved in the opposite direction (Al-Hourani & Atoum, 2007; Barkia et al., 2011; Beltaifa et al., 2002; Khaled, Bendahmane, & Belbraouet, 2006; Ziaee et al., 2006). A few studies have included both fasting participants and non-fasting controls. Afrasiabi, Hassanzadeh, Sattarivand, Nouri, and Mahbood (2003) saw reductions in triglycerides, total cholesterol and LDL-cholesterol in fasting participants with no changes in the control group. Some of the apparent contradictions may be related to the timing of blood sampling in relation to the last meal and to changes in the energy intake and diet composition during the fasting period. Where changes have been observed, these are generally reversed within a few weeks after the end of the Ramadan fast, though some studies have shown that changes may last for at least 3 weeks (Chaouachi et al., 2008) and even 4 weeks after returning to the habitual diet and lifestyle (Barkia et al., 2011).

Effects of fasting on blood pressure

Studies on blood pressure (BP) in both normotensive and hypertensive individuals generally show little or no effect of Ramadan fasting on blood pressure. In a comprehensive study of 99 hypertensive patients before and during Ramadan, Habbal, Azzouzi, Adnan, Tahiri, and Chraibi (1998) found no significant difference between the two measurement periods for systolic or diastolic BP or for the 24 hour mean pressure. Ural et al. (2008) found no difference in blood pressure measured during Ramadan and one month after Ramadan, though there was a small rise in mean arterial pressure while having the morning meal before dawn. Other studies have also seen no effect on blood pressure in healthy individuals (Beltaifa et al., 2002) or in patients with Type II diabetes (M'Guil et al., 2008). In contrast, though, a recent study by Unalacak et al. (2011) observed reductions in both systolic and diastolic blood pressure in both obese patients and a healthy control group after Ramadan fasting. In spite of the balance of evidence from these observational studies, however, there is some epidemiological evidence that might suggest otherwise. Topacoglu et al. (2005) analysed hospital visit frequencies for hypertension and uncomplicated headache and found that these were significantly higher during Ramadan than in non-Ramadan months.

Effects of fasting on other cardiovascular risk factors

Inflammation and oxidative stress are now increasingly recognised as contributors to a range of disease states and a number of markers for cardiovascular risk have been identified (Libby, 2005). The effects of Ramadan fasting on a number of other purported risk factors for cardiovascular diseases, including circulating levels of homocysteine, C-reactive protein and other inflammatory markers, have also been studied, again with conflicting results. Aksungar, Topkaya, and Akyildiz (2007) measured a range of risk factors before, during and after Ramadan in fasting individuals and in a control group who did not fast. They found no significant changes in serum triglycerides, total cholesterol, and LDL levels, but the TC/HDL ratio was decreased during and after Ramadan in both men and women in the fasting group while there were no changes in the non-fasting group. Interleukin-6, C-reactive protein and homocysteine levels were significantly lower during Ramadan in the fasting participants of both genders than the baseline levels measured one week before Ramadan. These authors concluded that Ramadan fasting has some positive effects on the risk factors for cardiovascular diseases such as inflammatory markers, homocysteine, C-reactive protein and the TC/HDL ratio. Unalacak et al. (2011) also found reductions in interleukin-2 (IL-2), interleukin-8 and tumour necrosis factor-alpha (TNF-alpha) after fasting, but they saw no change in C-reactive protein. In contrast, however, in a study of elite judo athletes who continued to train during Ramadan, Chaouachi et al. (2009) found an increase in C-reactive protein levels at the end of Ramadan, but no change in homocysteine levels. In another study of athletes, Chennaoui et al. (2009) also reported an increase in IL-6 levels during Ramadan. In young footballers, however, Maughan et al. (2008) saw a significant

decrease in C-reactive protein during the second week of Ramadan in the fasting and non-fasting groups in samples collected in the morning but not in the afternoon. In the fourth week of Ramadan, C-reactive protein concentration had recovered in the non-fasting group but not in the fasting group. It seems that not only the way in which Ramadan is practised but also the timing of measurement and training status of the subjects may influence the response to fasting.

Long-term health consequences

Most of the changes in blood biochemistry and other cardiovascular risk factors that occur during Ramadan are rapidly reversed on return to normal diet, sleep patterns and lifestyle, so long term consequences on morbidity and mortality would not be expected. This expectation appears to be supported by the limited available evidence. A prospective cross-sectional study by Roshi, Kamberi, Goda, and Burazeri (2005) looked at myocardial infarction in Muslims and Christians and found that the occurrence of myocardial infarction among Muslims and Christians in Tirana was similar, suggesting that cardiovascular morbidity is not affected by the religious affiliation of Albanian adults. This in turn suggests that the annual period of fasting has no long term effects on cardiovascular risk.

Pregnancy and maternity

Many female athletes continue to train and compete during pregnancy, even well into the third trimester, and some resume training very soon after giving birth. As Ramadan lasts for one month every year, Ramadan fasting will overlap with pregnancy in three of every four births. Women who have just given birth, or who are breast feeding are generally exempt from fasting, but, while pregnant women may also be exempted, most report observing the fast. Many Muslim women will therefore observe the Ramadan fast during the peri-conception period, during pregnancy and while nursing a young child (Kridli, 2011; Robinson & Raisler, 2005). Pregnant women are generally discouraged from skipping meals or from dieting for weight loss reasons during pregnancy because of the possible consequences of the metabolic changes (especially the development of hypoglycaemia) on the long-term health of the foetus. The available evidence on effects of observance of fasting practices is not entirely consistent. This may be because the evidence base is generally limited: prospective studies are mostly small and may not have sufficient power to detect small effects, while epidemiological surveys often lack detail on the degree to which fasting was actually observed.

A recent comprehensive review has suggested that prenatal exposure to Ramadan in Arab women living in Michigan, USA, results in lower birth weight and that mothers who fast in the first month of gestation have fewer than expected male offspring (Almond & Mazumder, 2011). Based on epidemiological data available from studies of Muslims in Uganda and Iraq, they also showed a 20% higher chance (compared to contemporaneous births to non-Muslim mothers) of disability as adults if the timing of Ramadan coincided with early pregnancy and that the estimated effects are greater for learning disabilities. These results suggest that Ramadan fasting around the time of conception and during pregnancy can have both acute and persistent effects, though these surveys did not have confirmation that women actually observed the fast. This is a particular concern for women who may not be aware that they are pregnant when observing the fast. This concern may be allayed to some degree by the findings of Azizi, Sadeghipour, Siahkolah, and Rezaei-Ghaleh (2004), who reported that fasting during gestation did not adversely affect IQ of children aged 3–13 years whose mothers had fasted during Ramadan while being pregnant. Nevertheless, the lack of any effect on children's IQ has to be considered separately from the long-term adverse effects reported above.

In a study of Turkish women, Kiziltan et al. (2005) found that those who fasted had a lower energy intake and gained less weight than those in a non-fasting control group, but they reported no adverse health outcomes in the fasting group. Mirghani and Hamud (2006) reviewed the case histories of 168 fasted and 156 control pregnant women. A higher incidence of gestational diabetes was observed in the fasted group than in the control group, and induction of labour and Caesarian section rate were both more frequent in women in the fasted group than in the control group. Ziaee et al. (2010) compared records of Iranian women who observed different numbers of fasting days at different stages of pregnancy. Of 189 patients, about one third did not fast, while the mean number of fasting days was 13. In general, they found no association between the number of fasting days and means of weight, height, and head circumference of infants. There was also no significant difference between most pregnancy outcome parameters and fasting at different trimesters. They did, however, find that the relative risk of low weight birth was 1.5 times higher in mothers on fasting at first trimester as compared to non-fasting mothers. In a prospective study of 52 healthy pregnant women in their second or third trimester (25 fasting and 27 non-fasting), however, Moradi (2011) found no differences between the groups in estimated foetal weight or in various growth indices assessed by

Doppler ultrasound. Other studies showing no effect of maternal fasting on foetal growth and development include that of Dikensoy et al. (2009).

Alwasel et al. (2011) have recently provided the first evidence that changes in the lifestyle of pregnant women during Ramadan may affect more than one generation. They compared body size at birth in almost 1000 babies born in a small city in Saudi Arabia. Compared to babies whose mothers were not in utero during Ramadan, boys whose mothers were in mid gestation during Ramadan were significantly longer (by 1.2 cm) while girls had a significantly shorter gestation period. Further studies are needed to confirm these observations on the potential long-term effects of Ramadan fasting in pregnant women.

Ramadan fasting and its impact on physical activity levels

During the holy month of Ramadan, Muslims are encouraged to engage in additional religious pursuits because all good deeds performed during the Ramadan month gain ''extra'' rewards in the afterlife. Many Muslims pursue these practices with such zest that time and opportunities to engage in other activities, such as sports and leisure pursuits, during the Ramadan month may be limited. Several studies have examined the impact of Ramadan fasting Muslims on physical activities in the general Muslim population. The main finding of these studies is that physical activity levels were lowered in the average Muslim (Afifi, 1997; Bahammam, 2003; Soh et al., 2010a; Soh, Soh, Husain, & Salimah, 2010b; Wilson, 2009), although there were exceptions (Al-Hourani & Atoum, 2007; Poh, Zawiah, Ismail, & Henry, 1996). In a group of medical undergraduates from Saudi Arabia, the percentage of students who exercised more than twice per week fell from 24% to less than 10% during the Ramadan month (Bahammam, 2003). However, the use of students as participants limits the study's finding. Another research study, conducted in 107 free-living adult-aged male and female Malaysian Muslims (Soh et al., 2010a, 2010b), monitored the number of steps taken per day (as an index of physical activity level) before, during and after the Ramadan month. The investigators observed that the number of steps per day declined by $\sim$10–13% during Ramadan as compared to before the Ramadan period. The number of steps subsequently increased by $\sim$8% when assessed after Ramadan. These data clearly indicate that fasting Muslims demonstrated a decline in their level of physical activity during Ramadan and these same individuals tended to ''bounce back'' or return to being active after the completion of the Ramadan month.

There are several possible reasons for the observed decrease in the physical activity levels of Muslims during Ramadan. For example, if an individual intends to perform the daily Taraweeh prayers, all other activities e.g., physical exercise or socialising are limited to the daylight hours only. Further, performing physical activities during the day is physically challenging and not necessarily optimal, as the individual would be exercising in a fasted state and under less than ideal physiological conditions (Afifi, 1997; Aziz, Chia, Singh, & Wahid, 2011; Waterhouse, Alabed, Edwards, & Thomas, 2009). Hence it may stand to reason that the adherence to and prioritisation of socio-religious practices during this period can potentially lead to disruptions in the normal daily routine that would reduce the time availability for recreational or physical activities. The altered meal and sleeping times during Ramadan could also lead to a drastic shift in the body's normal circadian rhythm (Waterhouse, 2010). Apparently during the day time, the desire and willingness to engage in any form of physical work is reduced, most likely because of the negative moods and mental state of fasting individuals (Kadri et al., 2000; Roky, Houti, Moussamih, Qotbi, & Aadil, 2004; Waterhouse, 2010). Indeed, a study that surveyed the general behaviour of 750 Turkish Muslims during Ramadan found that 84% of the respondents felt tired or fatigued throughout the day (Karaağaoğlu & Yücecan, 2000). Further, 63% of them also felt sleepy and irritated throughout most of the daytime, with half of them complaining of severe headaches (Karaağaoğlu & Yücecan, 2000). Hence it was not surprising to note that in the previous cited studies by Soh and colleagues (Soh et al., 2010a, 2010b), the participants indicated that poor self-motivation was the primary reason for being less active during Ramadan. Additionally, Ramadan fasting has also been shown, albeit within a laboratory setting, to adversely affect some mental aspects in fasted individuals (Ali & Amir, 1989; Dolu, Yüksek, Sizer, & Alay, 2007; Tian et al., 2011); how this impairment influences the fasted individual's performance in the sporting and working environment is, however, less clear.

It is also important to determine whether the influence of Ramadan fasting on physical activity levels in the adult populations was similarly observed in the younger population. An early study showed no difference in levels of activity in boys and girls (between 10–13 years old), even though the boys spent significantly more time praying (Poh et al., 1996). However, in a more recent survey on a sample from the same country, Wilson (2009), showed a decrease of 32% in the number of steps taken per day during Ramadan compared to during non-Ramadan period in school-going boys and girls aged 13–18 years old. It is interesting to speculate on the reason

for the observed decline in the level of physical activity in this younger group given the unlikelihood that this group of youngsters would be pursuing the additional religious activities with the same zest as that of the adult-aged population. This would then suggest that other factors associated with Ramadan fasting *per se*, such as the general feelings of lethargy, malaise and mood swings during the daytime, rather than the lack of time, are perhaps the dominant reason for the avoidance and/or decline in the participation of physical activities during the Ramadan month.

These observations of a negative influence of Ramadan fasting in the physical activity levels of the general Muslim population, however, need to be considered in relation to previous studies that had their fasted participants engage in exercise. Ramadan and colleagues (Ramadan, Telahoun, Al-Zaid, & Barac-Nieto, 1999) examined the exercise responses to cycling at 100 W for 6–8 min in two different groups of fasted Muslims (Active vs. Sedentary). The Active group maintained an exercise regimen consisting of 30–60 min of jogging or brisk walking, 3–5 times $\cdot$ week^{-1} (performed after dusk in the non-fasted state) throughout the Ramadan month. The Sedentary group did not perform any regular exercise during Ramadan. At the end of the Ramadan month, there was a substantial decline in mean exercise HR during the same submaximal cycle test in the Active group as compared to the Sedentary group. Also, the Active group demonstrated a relatively better hydration status throughout Ramadan. This study revealed that being moderately active during Ramadan helped to maintain or even gain some fitness adaptations, and that fasted individuals who are active seemed to cope better with Ramadan fasting. This is further supported by recent studies on two groups of physically active men; one group who performed their fasting regimen and the other group who did not (Trabelsi et al., 2011, 2012). The former group lowered their body mass and body fat percentage and elevated their high-density lipoprotein cholesterol to a greater extent than the group who were active but did not fast (Trabelsi et al., 2011, 2012). Collectively, these findings clearly indicate that Muslims should endeavour to be physically active whilst fasting.

In summary, the pursuit of religious practices as well as circadian rhythm perturbations that are associated with Ramadan fasting such as perceived feelings of subjective fatigue, sleepiness, thirst and/or even mood swings, can lead to a significant lowering of physical activity levels in Muslim individuals. Fortunately, however, being physically active during Ramadan can help the individual to maintain his or her level of conditioning as well as to cope better with the intermittent fasting.

Emergency and road accidents admissions

Emergency admission and hospitalisation

Several studies have been undertaken to investigate the effects of Ramadan on the frequency of admissions to hospital emergency departments. The methodology and reporting of these studies were quite heterogeneous (Table I). Some of them considered several years of admission and included large samples, but others included small samples over two or three months. Some studies compared admissions of Muslim patients to non-Muslims for the same period, while most compared admission of Muslim patients for several months including Ramadan. Concerning the periods of the study, most of these studies compared the rate of admission during Ramadan to the rate before and after Ramadan, while others considered only Ramadan and after-Ramadan periods.

Some retrospective studies have demonstrated that no significant differences were found in the rate of admission of general emergency (Langford, Ishaque, Fothergill, & Touquet, 1994; Pekdemir et al., 2010), of peptic ulcer perforation (Bener et al., 2006b) and of urinary stone colic (Al-Hadramy, 1997). Also, it was reported that the rate of hospitalisation for congestive heart failure (Al Suwaidi et al., 2004) and

Table I. Emergency admissions or hospitalisations.

Study	Sample	Study duration	Admission during Ramadan
Abdolreza, 2011 (Iran)	610	3 months	increase
Herrag, 2010, (Morocco)	250 to 500 per day	1 year	increase
Pekdemir, 2010 (Turkey)	2000	–	no change
Bener, 2006 (UAE)	470	10 years	no change
Bener, 2006 (Qatar)	1590	4 years	no change
Topacoglu, 2005 (Turkey)	–	4 years	increase
Göçmen, 2004 (Turkey)	1,408	4 years	increase
Al Suwaidi, 2004 (Qatar)	20,856	10 years	no change
Parrilla Ruiz, 2003 (Spain)	213	3 months	increase
Temizhan, 1999 (Turkey)	–	6 years	decrease
Al-Hadramy, 1997 (SA)	–	3 years	no change
Langford, 1994 (UK)	386 Muslims 8893 non-Muslims		increase

Table II. Road accidents admissions.

Study	Sample	Study duration	Admission during Ramadan
Herrag, 2010, (Morocco)	250 to 500 per day	1 year	decrease
Khammash, 2006 (Jordan)	228	3 months	decrease
Langford, 1994 (UK)	386 Muslims 8893 non-Muslims		no change
Shanks, 1994 (SA)	361	1 year	increase
Bener, 1992 (UAE)	1197	1 year	increase

for asthma (Bener et al., 2006a,c) did not change during Ramadan.

However, in contrast to these findings, more recent studies demonstrated that there was an increase in the rate of emergency consultations for abdominal pain (Parrilla Ruiz, Cárdenas Cruz, Vargas Ortega, & Cárdenas Cruz, 2003), for peptic ulcer perforation (Göçmen et al., 2004), for hypertension and uncomplicated headache (Topacoglu et al., 2005), and for several chronic pathologies, especially diabetes mellitus complicated by acidosis or hypoglycaemia, severe asthma exacerbations, severe hypertension, thrombo-arteriopathyobliterans and acute ischaemia (Herrag, Lahmiti, & Alaoui Yazidi, 2010), and for renal colic (Abdolreza et al., 2011).

Road accidents

Two previous studies have shown that the admissions for road accidents increased during Ramadan (Table II). This result was reported in an emergency department in the United Arab Emirates (Bener, Absood, Achan, & Sankaran-Kutty, 1992) and in a Saudi hospital (Shanks, Ansari, & Al-Kalai, 1994). However, Langford et al. (1994) reported in an emergency hospital in London that the accident-related attendances among Muslims were not significantly different compared to non-Muslims and to the attendances before Ramadan, although a slight increase in the number of admissions was reported during Ramadan in the Muslims group.

More recently, Herrag et al. (2010) reported in large sample study (250 to 500 admissions per day) from an emergency department in Morocco that not only did road accidents decrease during Ramadan but there was also a reduction in accidents related to alcohol intake (trauma, aggression) as well as the number of emergencies due to aggression and violence. The same decrease was observed by Khammash and Al-Shouha (2006) in a hospital in Jordan.

Thus, the potential negative effects of the decrease in alertness and mood during Ramadan (Roky et al., 2003, Roky, Iraki, HajKhlifa, Lakhdar Ghazal, & Hakkou, 2000) on road accidents could be compensated by the alcohol withdrawal and the reduced working hours usually practised during Ramadan.

Summary and conclusions

People who have an illness or medical condition of any kind that makes fasting injurious to their health are exempt from fasting. They must fast later when they are healthy to compensate for the missed days of fasting.

Fasting during the month of Ramadan provides an opportunity for health professionals to promote health improvement among fasting individuals by offering lifestyle advice on topics such as diet, sports and exercise, and smoking cessation.

The literature on the effects of Ramadan fasting on various aspects of health and on risk factors for various diseases is diverse and often contradictory. This is likely, in part at least, because of the different ways in which Ramadan fasting is practised in different populations, differences in study design, seasonal and climatic differences, and differences in the health, fitness and activity levels of the study populations.

Those with poorly controlled diabetes and those injecting insulin are advised not to fast, as the potential risk to health, both in the short and long term, of not taking insulin is too great. People who have their diabetes under control using tablets should ensure that they visit their physicians prior to Ramadan, in order to discuss any possible changes to their drug regimen that would facilitate a safe fast. It is highly advisable that fasting diabetics, especially athletes, regularly self-monitor their blood glucose.

There is not an increased rate of the incidence of vascular events during Ramadan, either in patients with established vascular disease or in those with no previous history.

The Ramadan month has not been shown to affect the physical training response or the fitness level of athletes nor does it appear to have any negative effect on the activity and the health of fasting individuals. Those who are physically active during the month of Ramadan appear to cope better than physically inactive individuals.

Ramadan fasting therefore appears to have no serious adverse health consequences on athletes and the general public, or a detrimental effect on athletic performance when proper advice is followed.

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