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Ramadan daily intermittent fasting reduces objectively assessed habitual physical activity among adults

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Abstract

Background: Muslims around the world practice intermittent fasting during the month of Ramadan once each year. We hypothesized that daily physical activity could be impacted due to the inability to refuel and rehydrate in the fasting state. Therefore, this study aimed to determine the effects of Ramadan fasting on daily physical activity in the adult community of Qatar.

Methods: A cohort study design among adults registered with national physical activity community program. Data from a pedometer-based community program was used to extract 3 months of daily step counts before, during, and after Ramadan for the past five years (2015-2019). A survey was conducted among participants to determine fasting practice and other health and environmental factors.

Results: A total of 209 participants completed the survey and provided valid data on physical activity. During Ramadan, the average steps per day decreased significantly ($-385 \pm SE 158$) among participants who fasted ($n=155$) $p=0.046$ and increased ($+731.4 \pm SE 247$) for the non-fasting participants ($n=48$) $p=0.010$.

Conclusion: Fasting during Ramadan impacts the daily physical activity behavior among Muslims. Interventions should focus on creating awareness of the importance of maintenance of adequate physical activity for adults fasting during Ramadan.

Article Summary

- Participants performing religious daily intermittent fasting in Ramadan reduce their daily habitual physical activity.
- Physical activity levels remain low even one month following the month of Ramadan.
- Non fasting participants on other hand increase physical activity during Ramadan.

Introduction

Fasting during the holy month of Ramadan is considered as one of the five fundamental pillars of Islam, thus, an obligatory religious duty for all healthy Muslim adults. Ramadan is based on a lunar calendar where the duration varies between 29 and 30 days. Each year, this month shifts forward around 10 days in a Gregorian calendar. During this month, Muslims refrain from eating and drinking during daylight hours. The fast begins early morning after *Suhoor* (meal taken just before dawn) and ends with *Iftar* (meal taken at sunset)[1]. The duration between *Suhoor* and *Iftar* is the duration of fasting and this can vary based on geographical location and season [2]. For instance, it averages from 14 to 15 hours in the Middle East and up to 20 or 21 hours at higher latitudes (e.g. Scandinavian countries) during summer. This variability in fasting time alters the schedule of other daily living activities that have an impact on human health such as sleep and exercise [3].

Ramadan fasting has captured public attention in recent years due to the recent rise in popularity of daily intermittent fasting as means to improve health and reduce weight [4]. Ramadan fasting has been well documented in scientific literature [5-8] where scientists have investigated the effects of fasting during Ramadan with respect to its impact on an individual's biochemistry (e.g., glucose utilization) [9-12], blood pressure [13], metabolism [14], bodyweight [11, 14], sleep [3, 9, 15] and general health [9, 16]. Much of these existing research considered the challenges of chronic illnesses such as diabetes and hypertension on fasting Muslims or focused on athlete's performance during Ramadan Fasting [17, 18]. Although, there is a strong dose-response relationship with number of step count per day and reduced risk of all-cause mortality [19], the effect of Ramadan fasting on community daily physical activity in the literature is scarce [20, 21].

Some of the few published studies [12, 21] that have addressed the impact of Ramadan on physical activity have used qualitative methods rather than quantitative methods to assess physical activity. Insufficient physical activity is one of the leading risk factors for diabetes, cardiovascular disorders, and their associated mortality [22, 23]. Research indicates that an optimal level / increased physical activity has a beneficial effect both on the disease by reducing blood glucose levels and blood pressure as well as on disease prevention [23, 24]. Moreover, based on international recommendations, an individual should engage in at least 60 minutes of moderate to vigorous intensity physical activity daily for optimum health [23]. And at least 8000 steps/day can be equated to 20 min of moderate activity [25]. The intermittent fasting schedule during Ramadan poses a challenge in meeting this objective because of the lack of immediate external energy supply in a fasting state, inability to refuel, inability to hydrate while fasting [26], and disturbances in the sleep-wake cycles that become shifted/disturbed (e.g., taking daytime naps to make up for sleep loss during the night) [2]. Individuals can utilize non-daylight hours for physical activity but the hours after sundown often involve a busy schedule in which all day-to-day activities are planned. In addition, an increased amount of time is spent during the evening performing religious prayers [22].

The physical activity of the non-Muslims living in a Muslim country may also be impacted during the month Ramadan, even though they do not fast. Indeed, during Ramadan in some Muslim-majority countries, working hours are shortened (e.g., ≤ 6 hours per workday), which may also impact a non-faster's daily routine (e.g., having more time to do activities that the individual would ordinarily not have time to do).

The main hypothesis of this study is that physical activity during Ramadan will be affected and will impact both fasting and non-fasting individuals living in a Muslim-majority country because of working conditions and/or cultural influences. Therefore, the aim of the current study was to use a quantitative method—pedometry—to determine how physical activity is affected by daily intermittent fasting during the month of Ramadan.

Methods

Study design and population

This is a community-based cohort study which aimed to explore the effect of Ramadan fasting on physical activity assessed by daily steps count per day in Qatar. A total of 209 participants took part in this study (adults aged 18 and above) registered members of the Step into Health (SIH) program during a period of 5 years (2015-2019). Details and program description have been published elsewhere [27]. Participants were excluded if they refused to participate, had invalid physical activity data or in case of incomplete questionnaire (*described below*).

Settings:

This study was conducted in Qatar which has a population of estimated 2.8 million (as of 2019). The pedometry data was collected to represent the Ramadan months for the past 5 years (2015-2019) where Ramadan dates were: June 17 to July 16, June 6 to July 5, May 26 to June 24, May 16 to June 14 and May 5 to June 4, respectively. The usual temperature ranged from 27 degrees Celsius to 41 degrees over the study periods [28]. The usual fasting hours in Qatar lasts around ~14-15 hours each day.

Data collection

Basic demographic information of the study population was extracted from the program database, including age, gender, and nationality. Body Mass Index (BMI) was calculated based on self-reported body weight and height. According to the WHO classification, normal weight was defined as BMI <25, overweight as BMI 25–<30, and obese as BMI ≥ 30 [29]. Other information, such as education, marital status, and religion were gathered later through a questionnaire (*described below*).

Questionnaire

In addition to basic demographic information, the questionnaire included a series of questions related to health status such as smoking habits, diagnosis of any chronic disease (i.e. hypertension, diabetes mellitus, heart disease, allergy, kidney disease, etc.). It also included Ramadan-related questions such as the fasting duration throughout the period 2015-2019, exercise habits, preferred time for exercise, in addition to the influence of Ramadan on levels of physical activity and weight (body mass in kg) change. Participants were also asked about their preferred location for physical activity. The questionnaire was developed in English and was then translated into Arabic. The Arabic version of the questionnaire was back-translated into English to ensure the wording used in English corresponded with cultural context in Arabic and standards used within this population. The questionnaire was anonymous. Participants provided their identification details such as email address and national ID, to enable use to link their responses with the physical activity pedometry data in the SIH system. In order to increase response rate, we had announced that 2 participants who completed the survey will be randomly selected to receive a lucky draw prize (137\$ coupon- Winners were one man and one woman).

Physical activity measurement

Step count was extracted from the SIH web database for three consecutive months (before, during and after the month of Ramadan for each of the Ramadan periods during the past 5 years (2015-2019). Daily habitual physical activity was assessed through Omron HJ-324U pedometer (Omron Healthcare Co., Ltd., Kyoto, Japan) which was used to record the total step count each day. These pedometers were previously validated, and have an absolute percent error of < 3.0% and a coefficient of variation of < 2.1% [30, 31]. Individuals have been uploading their pedometer recordings through an online platform (www.stepintohealth.qa). Daily step counts <500 and above 50,000 per day were considered invalid [28], thus, excluded from analyses. Aerobic step counts are computed separately by the pedometer when a person successively walks >60 steps/min for a duration of at least 10 minutes, as per the definition [28]. To be eligible for inclusion, participant must have provided ≥ 4 days of valid pedometer data during a week (at least 3 weekdays and 1 weekend day) [32].

Study size: All participants with valid data on pedometer for a given year, before during and after Ramadan were contacted by email. For a five-year period, eligible number of participants with valid pedometer data was 1306 participants. Of all the participants who were invited, only 209 provided completed questionnaires and were included in the analysis. Participants were divided into two groups: participants who fasted all or most of the days in Ramadan against participants who rarely or did not fast (see questionnaire).

Statistical data analysis:

All data was coded and analyzed using IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp. All data was mostly categorical data and hence presented as counts and percentages. Steps count data was continuous and it was analyzed using linear mixed models to describe time changes in physical activity. Socio-demographic factors and fasting status were considered as fixed factors separately and participant ID was the clustering random variable using unstructured covariance structure for time (before, during and after Ramadan) as repeated measurement. Estimated marginal means \pm standard error was presented and post hoc pairwise differences were reported after Bonferroni adjustment. P-value <0.05 was considered cut-off for statistical significance.

Results

Study participants

Table 1 presents the patients' demographic information of the 209 participants. Most participants were male (75.0%), had a university education (86.6%), were married (88.0%), were non-smokers (80.4%), practiced Islam (74.2%), and healthy (did not have a chronic condition such as high blood pressure, diabetes mellitus, and heart or kidney disease- 71.3%). When asked about preferred location for physical activity, the top responses from participants were parks (57.9%), walking trails (45.5%), neighborhood (33.5%).

According to half (50.2%) of the fasting participants, their activity remained the same during Ramadan and 31.1% reported that their physical activity decreased. The step count of individuals with regard to sex, marital status, weight, and age did not show a significant increase or decrease between groups (fasting individuals and non-fasting individuals) or within each group (before, during and after Ramadan). However, significant differences were observed in step count across reported education levels and fasting status (Table 2).

Among participants who fasted, the average step count decreased significantly during Ramadan (8653 ± 353) compared to before Ramadan (9038 ± 352). Among those who didn't fast, the step count increased significantly during Ramadan (9699.8 ± 404) when compared to before Ramadan (8968 ± 403) (Table 2). There was no effect of Ramadan fasting on aerobic step counts among fasting-as well as non-fasting-individuals.

Figure 1 presents, on a week-by-week basis, the mean step count of the fasting individuals and non-fasting individuals before, during, and after Ramadan. Among those who fasted, the activity level initially fell suddenly with the onset of Ramadan and then increased, but insignificantly. There was a gradual increase during the last two weeks of Ramadan, but this was insignificant. Immediately after Ramadan ended, the step count of the fasting individuals decreased to its lowest level; and not until four weeks after Ramadan, did the step count was recover to what it was pre-Ramadan. Among the non-fasting individuals, the step count increased at the onset of Ramadan and continued to increase to its highest level by the second week of Ramadan; at which point the step count began to decline.

Figure 2. shows the preferred time for physical activity during Ramadan for fasting-and for non-fasting individuals. Most preferred time was evening after *iftar* (38.8%), followed closely by evening before *iftar* (33.5%). Both groups least preferred time for physical activity was afternoon (4.8%). A comparison of fasting individuals with non-fasting individuals revealed that a greater number of those who fasted than those who didn't fast preferred to engage in physical activity in the evening after *iftar* or late night. While those who didn't fast generally preferred early morning. (Figure 2).

Discussion

In this study, physical activity before, during, and after Ramadan was quantitatively measured by using pedometers. Main findings of this study was that, in general, daily physical activity decreased during Ramadan and was still lower after Ramadan in individuals who fasted. Fasting status and education level were the only two identified factors that significantly affected physical activity during Ramadan, with non-fasting individuals performing more steps than fasting individuals during Ramadan.

This study demonstrated that, before Ramadan, individuals with "high school education or less" walked significantly more steps than participants with a "university degree or higher". This difference in step count may be related to the type of work (e.g., more strenuous) commonly engaged in by people with lower levels of education (blue collars) as opposed to jobs which are often "desk-jobs" (white collars) [33].

In contrast to our findings, there was no effect of Ramadan fasting in few studies, when self-reported instruments were used to assess physical activity. For example, Al-Barha and Aljaloud [14] used a self-reported lifestyle questionnaire to ask male participants questions about their habitual daily physical activity levels. They found that the reported activity level (i.e., moderate or vigorous) of the participants in their study did not change significantly before Ramadan, during Ramadan (at weeks 2 and 3), and 6-weeks after Ramadan. Al-Hourani and Atoum [20] examined the activity levels of women before, during, and after Ramadan by using activity diaries. They also found that fasting during Ramadan had no significant effect on physical activity level.

Alsubheen and colleagues [11] examined the activity levels of 15 men during Ramadan by using a physical activity tracker. In their study both fasting and non-fasting did not change their physical activity during Ramadan compared to pre or post Ramadan months. Racinais et al. (2012), compared two months of pre-Ramadan physical activity with Ramadan and post Ramadan months in 11 fasting men and found no significant changes [34]. Although there were shifts in when physical activity was performed during the days of Ramadan, overall energy expenditure did not change. Similar non-significant changes were found in a study involving 16 young teens where energy expenditure during Week 1 and Week 4 of Ramadan was like that of pre and post Ramadan periods [35]. Although these studies used objective measures of physical activity, the small sample size ($n \leq 16$) and absence of control group were inherent in these studies.

In agreement with our study, a recent UK based study showed reduced objective measures of physical activity during Ramadan among individuals that fasted for ~17-18h daily. [36]. While levels of physical activity may decrease during Ramadan, physical activity is expected to be restored to the level recorded before Ramadan after Ramadan [37]. In our study, the non-fasting participants increased physical activity in Ramadan but this was later reduced to baseline values post-Ramadan. However, fasting individuals that decreased their physical activity during Ramadan did not recover one-month post-Ramadan. Regular physical activity is important for health in general, and when integrated with fasting, this results in positive changes to the lipid profile of humans [21].

The data on preferred time to practice physical activity and preferred place for physical activity could explain the reasons why fasting individuals experienced a drop in step count. Lack of available time in evening after *iftar* or late night is a potential factor having led to this observed lower step count.

Other aspects of concern were that most of the fasting participants in this study were under the impression that their physical activity levels remained the same (50.2%) or was not reduced (18.7%) during Ramadan. Also, around 23.2% of the fasting participants preferred to practice physical activity late in the night or in late afternoon / evening just before *Iftar* (33.8%). Both these preferred times are not recommended for doing moderate to vigorous intensity physical activity, because body energy stores are at a lowest nadir after 13-14 hours of fasting and there is no opportunity to drink water and therefore a risk of dehydration [26], especially in hot and humid locations. Naturally, duration of physical activity during this time will be shorter. On the other hand, practicing late night physical activity will jeopardize

duration of night time sleep which is likely to be interrupted by *Suhoor* early morning meal [38]. As a consequence, participants who prefer late night physical activity will be depriving themselves of enough sleep and accumulating sleep debt/deprivation [38, 39]. This will indirectly affect physical activity levels in the consecutive days [40].

The main strength of this study is that objective measures of daily physical activity in the form of step counts was used. This is critical because, based on self-reports, 50% of the fasting participants in this study believed that their physical activity remained the same in Ramadan which is contrary to what pedometer data has revealed. Due to the COVID-19 pandemic at the time of the study, data collection was performed using web survey and through email contact. This gave a relatively low response rate from the participants. The participants of the study were members of a community physical activity program (probably more health conscious) and hence do not represent the general population. Nevertheless, based on the findings it can be expected that daily intermittent fast could potentially have much larger negative influence on daily habitual physical activity in the general population. Although pedometer provides objective measure of physical activity, it cannot provide the timing when the physical activity was performed, and as a result, we were unable to determine at what time of the day do participants engaged in physical activity and whether it was different among fasting and non-fasting individuals. However, in our survey we included questions to enquire preferred time for physical activity among participants during Ramadan.

Conclusions

Daily intermittent Ramadan fasting reduced the daily habitual physical activity among fasting individuals from Qatar. While non fasting individuals increased their physical activity during Ramadan, the fasting individuals reduce their physical activity specially during the first two week. More than half of the fasting individuals were not aware that their physical activity was actually reduced during Ramadan. Interventions should be targeted to promote physical activity both during as well as after Ramadan where physical activity levels begin to gradually recover. The preferred location by the participants parks, and walking trails can be potential targets to conduct physical activity interventions.

List Of Abbreviations

SIH Step into Health

BMI Body mass index

Declarations

Ethics approval and consent to participate

This study was approved by Qatar Anti-Doping Lab Ethics Committee (Doha, Qatar; approval no: E2017000215). All methods were carried out in accordance with the Declaration of Helsinki. All

participants provided informed consent and were instructed that the data collected is confidential and will only be analyzed for the sole purpose of the study.

Consent for publication

Not applicable because manuscript does not contain data from any individual person.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

AF and ASM conceived the study. AF, ASM, SS, and KC formulated the study design. AF and SS extracted data from Step into Health national physical activity program. AF analysed the data. AF, KC, SS, ASM were involved in interpretation of statistical results. AF wrote the manuscript. AF, KC, SS, MEA, ASM critically revised and edited the manuscript for important scientific content. All authors reviewed and approved the final version of the manuscript.

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Tables

Table 1. Characteristics of the population. N (209)

Variables	N(%)
Nationality	
Qatari	60(28.7)
Non Qatari	149(71.3)
BMI Category	
Normal	55(27.0)
Overweight	85(41.7)
Obese	64(31.4)
Missing	5(2.4)
Gender	
Female	52(24.9)
Male	157(75.1)
Age group	
25-35	20(9.6)
35-45	63(30.1)
45-55	79(37.8)
Above 55	43(20.6)
Missing	4(1.9)
Education level	
High School or lower	26(12.4)
University/Higher	181(86.6)
Missing	2(1.0)
Marital Status	
Single	17(8.1)
Married	184(88.0)
Other	8(3.8)
Smoking status	
Non Smoker	168(80.4)
Current Smoker	13 (6.2)

Past Smoker	28 (13.4)
Religion	
Islam	155(74.2)
Other	48(23.0)
Prefer not to say	6(2.9)
Diagnosed with any chronic disease (HTN, DM, Heart, Kidney)	
Yes	60(28.7)
No	149(71.3)

Table 2. Average number of steps before, during and after Ramadan by various factors.

	Before Ramadan	Ramadan	After Ramadan
Overall	9018.4±344.0	8938.1±344.0	8734.0±343.9
Nationality			
Qatari	9339.2±354.6‡	9345.0±354.0‡	8913.3±354.3*†‡
Non Qatari	8866.8±347.0	8740.8±347.0	8651.1±346.8
Chronic Diseases			
Yes	8252.5±639.9	7960.2±639.9	7935.9±639.9
No	9327.0±405.9	9331.7±406.0	9055.5±405.8
Gender			
Female	8690.9±691.2	8500.2±691.4	8477.2±691.0
Male	9126.8±397.4	9082.0±397.4	8819.5±397.4
Marital Status			
Single	8288.4±1210.5	7971.0±1211.1	7833.6±1210.6
Married	9114.6±367.7	9045.9±367.8	8843.7±367.7
Other	8359.4±1762.7	8503.6±1762.4	8124.3±1760.9
Educational level			
High School or lower	11209.8±973.5‡	10185.1±973.4*	10029.0±973.1*
University/ Higher education	8730.2±368.7	8787.0±368.7	8591.9±368.6
Smoking status			
Non-smoker	8773.4±384.2	8833.6±384.3	8547.7±384.2
Past smoker	10388.1±940.9	9367.0±941.0	9697.5±941.3
Current smoker	9232.7±1378.3	9366.7±1377.5	9066.0±1377.2
BMI group			
Normal	9639.0±665.1	9454.6±665.1	9118.3±664.8
Overweight	8722.3±535.1	8774.7±535.1	8587.9±535.0
Obese	8735.3±617.1	8542.9±617.3	8476.6±617.3
Age group			
25- 35	7324.5±1120.0	6920.3±1121.8	6965.1±1120.8
35 - 45	8821.8±631.2	8903.6±631.1	8657.8±630.9

45 - 55	9475.5±562.1	9145.2±562.2	8854.1±562.1
Above 55	9364.7±761.0	9653.2±760.9	9545.4±761.0
Fasting all (most) days in Ramadan			
Yes	9038.3±352.4	8652.7±352.7*	8659.2±352.8*
No	8968.2±403.4	9699.7±404.9 ^{‡*}	8936.4±406.0 [†]

* significantly different than Before Ramadan (BR)

† significantly different than During Ramadan (R)

‡ significantly higher between categories (Qatari/Non Qatari, education level and fasting status at the same time period)

Figures



Figure 1

Average steps per day, before during and after Ramadan among fasting and non-fasting individuals.

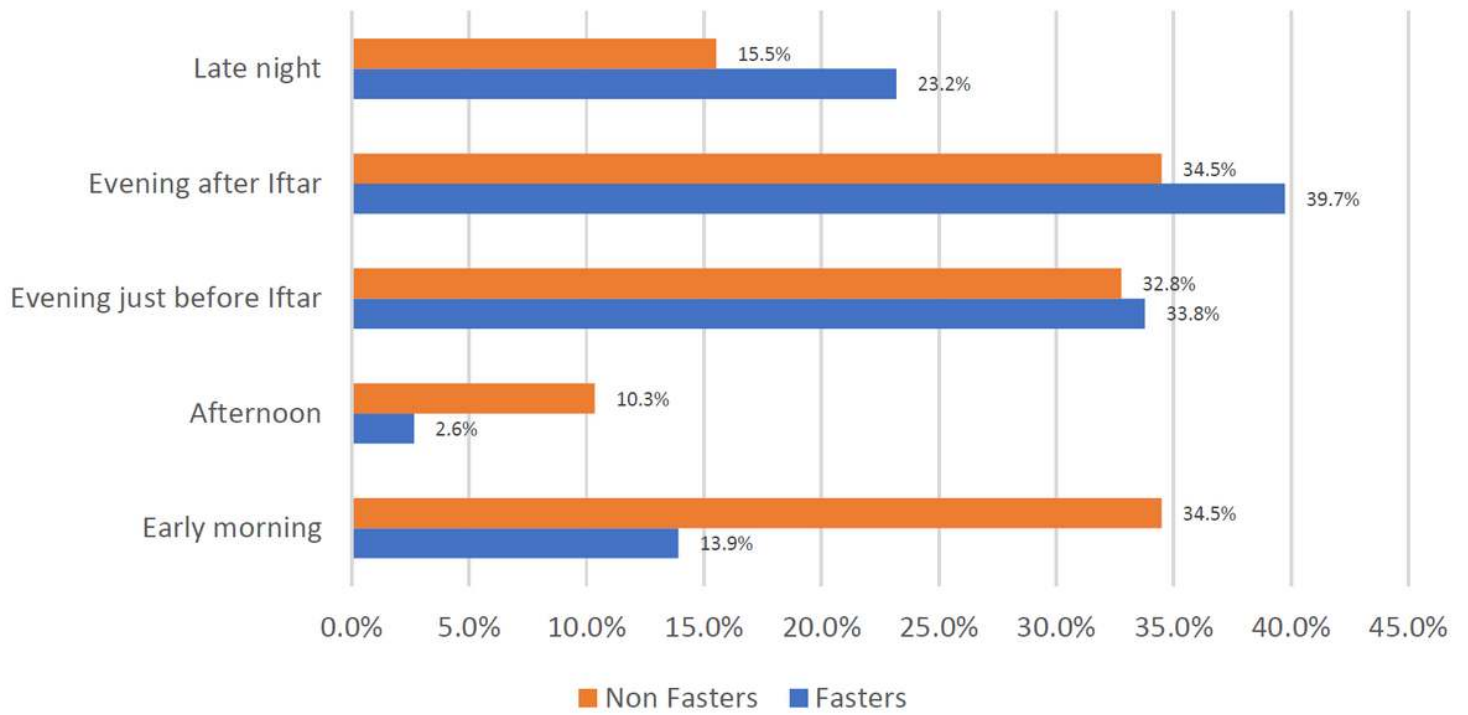


Figure 2

Preferred time for doing physical activity among fasting and non-fasting individuals during Ramadan