

Assessment of sleep patterns, daytime sleepiness, and chronotype during Ramadan in fasting and nonfasting individuals

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ABSTRACT

Objective: Sleep changes during Ramadan in nonfasting individuals have not been assessed before. We aimed to assess the effect of the attending lifestyle changes during Ramadan on sleep behavior and chronotype in fasting and nonfasting individuals.

Methods: Participants completed predesigned questionnaires to assess sleep patterns, daytime sleepiness, meal habits, and chronotype one week before Ramadan (BL) and during the first week (R1) and third week (R3) of Ramadan 1424 (Hijra) (between October 26 and November 15, 2003). Participants were divided into 3 groups: fasting Saudis (SF), fasting non-Saudis (NSF), and non-fasting non-Saudis (NF). The study was conducted in Riyadh, Kingdom of Saudi Arabia.

Results: Complete data were available on 41 subjects in the SF group, 30 in the NSF, and 30 in the NF group. There was no changes in total sleep time or daytime

sleepiness in all 3 groups. In the fasting groups (SF and NSF), bedtime and wake-up time were delayed significantly at R1 and R3 compared to BL, the frequency of meals decreased significantly during Ramadan, and morningness/eveningness test showed an increase in the evening types during Ramadan. In the NF group, bedtime was delayed significantly during Ramadan, and morningness/eveningness test showed an increase in neither types and reduction in the morning types during Ramadan.

Conclusions: Sleep behavior changes during Ramadan in nonfasting participants indicate that the attendant lifestyle changes during Ramadan have a significant effect on sleep behavior. Factors other than fasting may play an important role in modifying an individual's behavior during Ramadan.

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Ramadan is the month during which Muslims must refrain from eating and drinking from dawn to sunset. Fasting during Ramadan is one of the 5 major rules of Islam. Adults who are ill or traveling and women who are breast-feeding or menstruating are temporarily exempt from complying with these regulations. Ramadan occurs in the ninth month of the lunar (Hijra) calendar, and lasts between 29 and 30 days. The lunar calendar does not correspond to the Gregorian calendar, as

the lunar (Hijra) year contains 354 days, such as the lunar year is 11 days shorter than the year using Gregorian months, and hence Ramadan occurs in different seasons. This results in variations in the duration of the daily fasting time, being longer in summer than in winter, which necessitates the need for documenting the time of dawn and sunset in research related to Ramadan. Ramadan fasting is distinct from regular voluntary or experimental fasting by limiting the period of fasting to daylight

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(dawn to sunset), the month duration of the practice, the fact that the fasting individual is not allowed to drink or smoke during daylight, and the change in the usual circadian pattern of eating, whereby caloric intake increases at night. In a previous study,¹ we investigated sleep patterns, daytime sleepiness, and eating habits in a group of medical students. That study revealed several modifications in circadian rhythms, social activity, and eating habits of fasting individuals during the month of Ramadan. These changes affect the daytime functioning and resulted in increased sleepiness despite no significant changes in the total sleep time (TST). During the month of Ramadan, many people alter their sleeping habits and stay awake most of the night. The pattern of meals changes as well, with 2-3 meals usually taken: breakfast at sunset, dinner after night prayer (1700–2000 hours), and a third meal before dawn (Suhur). Many changes in lifestyle and habits occur during Ramadan, such as the opening of stores and shopping malls until late at night. It is reasonable to assume that these changes in lifestyle affect the sleep patterns, daytime alertness, sleepiness, and chronotype of fasting individuals. We have previously demonstrated¹ the occurrence of a sudden and significant delay in bedtime and wake-up time in fasting individuals during Ramadan without a significant change in TST. Despite getting almost the same amount of sleep before and during Ramadan, the participants felt increased subjective sleepiness during Ramadan and decreased daytime functioning.¹ Even though the subjective perception of daytime sleepiness increased during Ramadan, the times of the day and night when participants felt most sleepy and most alert did not differ between baseline and Ramadan.¹ These findings raise some important questions: does fasting during Ramadan affect the circadian rhythm, biological clock, and daytime alertness of fasting individuals? Roky et al² demonstrated a reduction in subjective alertness during fasting at 0900 hours and an increase at 2300 hours in fasting individuals in Morocco. They also reported an increase in the evening types and a decrease in the morning types of fasting individuals during Ramadan on the Horne and Östberg scale.³ However, the above changes cannot be generalized to all societies and may not be applicable to the population in Saudi Arabia since sleep habits during Ramadan may vary with the climatic situation, cultural backgrounds, and particular customs of each country. While studies in Morocco^{3,4} demonstrated a reduction in TST during Ramadan, we found no change in TST in Saudis.¹ Moreover, an overnight-sleep study under controlled conditions in a sleep laboratory revealed no changes in sleep architecture, subjective daytime sleepiness on the Epworth Sleepiness Scale (ESS), objective daytime sleepiness on the multiple sleep

latency test (MSLT), or circadian changes in melatonin level between baseline and Ramadan.⁵ Therefore, the attendant cultural and lifestyle changes during Ramadan could be considered as a potential model affecting sleep patterns in individuals regardless of fasting. If that hypothesis is true, sleep patterns in nonfasting residents of Muslim countries may also be affected during Ramadan. Sleep changes during Ramadan have not been assessed before in nonfasting residents of Muslim countries. This study was carried out to assess the effect of Ramadan and its attendant lifestyle changes on TST, sleep habits, daytime sleepiness, chronotype, and eating habits in both fasting and nonfasting individuals. We hypothesized that the attendant cultural changes during Ramadan will affect sleep patterns in nonfasting individuals to variable degrees.

Methods. This descriptive study with repeated measures in a nonrandom sample of volunteers was conducted during the month preceding Ramadan and the month of Ramadan in the year 1424 Hijra (between October 26 and November 15, 2003). During the study period, dawn (beginning of fasting) was between 0440 and 0450 hours, and sunset (end of fasting) was between 1705 and 1720 hours. The study was approved by the Ethics Committee of the College of Medicine, King Saud University, Riyadh, Kingdom of Saudi Arabia (KSA). Participants in this study were employed healthy nonsmoker volunteers between the ages of 25 and 55 years living in Riyadh, KSA, who were not taking any regular medications and did not drink alcohol. Shift workers and students were excluded. The participants were divided into 3 groups: fasting Saudis (SF), fasting non-Saudis (NSF), and nonfasting non-Saudis (NF). The non-Saudi participants had been resident in Riyadh for less than 5 years. In the month preceding Ramadan working hours started at 0700–0800 hours, and during Ramadan they started at the same time for nonfasting people and were delayed to 0900–1000 hours for fasting people. There were no vacations during the study period. Two weeks before Ramadan, medical students trained in the procedures of the study met the participants and explained the study protocol to them, inquired on the pre-existing chronic illnesses or sleep complaints, and answered the participants' questions. A self-administered questionnaire was designed to be given 3 times: (1) one week before Ramadan (baseline [BL]), (2) during the first week of Ramadan (R1), and (3) during the third week of Ramadan (R3). Each questionnaire contained 29 questions concerning bedtime and wake-up time, naptime and duration, possible factors affecting bedtime, the pattern of meals, and daytime performance. Subjective sleepiness was assessed

using the ESS.⁶ Participants were also asked to complete a daily sleep diary on weekdays. Total sleep time, nap duration, wake-up time, and bedtime were calculated on a daily basis for weekdays, and the mean values were used in our analysis. The above questionnaires were used in a previously published work.¹ A 24-hour time scale was used to assess the time of the day where participants felt most alert and most sleepy.¹ Participants were asked to mark the time period of the day or night when they felt most alert and most sleepy. Chronotype was measured using an abridged version of the Horne and Östberg questionnaire in order to assess morningness/eveningness.⁷ This questionnaire establishes 5 behavioral categories: definitively morning type (score 22–25), moderately morning type (score 18–21), neither type (score 12–17), moderately evening type (score 8–11), and definitively evening type (score 4–7). For the purpose of this study, we adopted classification used by Taillard et al.⁸ that reduces the categories from 5 to 3: morning type (M-type) (score 18–25), neither type (N-type) (score 12–17), and evening type (E-type) (score 4–11).

The participants were asked to monitor their sleep habits and other parameters described in the questionnaire during weekdays, and (according to the timetable set in the study design) to subsequently complete the questionnaire on the last weekday of each week, namely Wednesday (weekends were not evaluated in this study, which is Thursday and Friday). Questionnaires were completed at BL, R1, and R3. Sleep diaries were filled on a daily basis.

Statistical analysis. Data were expressed in the text and tables as mean ± standard error (SE) values. Comparisons among the SF, NSF, and NF groups were performed using one-way analysis of variance (ANOVA). Comparisons among BL, R1, and R3 within each group were performed using one-way

repeated-measures ANOVA for continuous variables. The chi-square test was used for comparison of proportions when comparing BL versus R1 and BL versus R3. Results were considered statistically significant at the $p=0.05$ level. Standard statistical software (Sigma Stat, version 3; SPSS Chicago, Illinois, USA) was used for analyses.

Results. Of the 130 participants who participated in the study, 101 returned complete questionnaires (response rate 77%). There were 41 SF, 30 NSF, and 30 NF participants. The ages of the SF were 32.6 ± 1.5 years, NSF 29.3 ± 1.6 years and NF 31.5 ± 2.3 years. There were no differences between the 3 groups in age, gender, or body mass index (**Table 1**).

Figure 1 shows the TST in all 3 groups at BL, R1, and R3, and **Table 2** summarizes the sleep patterns in the SF group. Compared to BL, bedtime was delayed by approximately 90 minutes at R1 and 120 minutes at R3, and wake-up time was delayed by 120 minutes at R1 and 132 minutes at R3, these differences were statistically significant. However, the TST and the TST plus naptime did not change significantly.

Table 3 summarizes sleep patterns in the NSF group. Compared to BL, bedtime was delayed at R1 by approximately 144 and R3 by 136 minutes, and wake-up time was delayed at R1 by 144 and R3 by 150 minutes. There was no significant difference in the TST and the TST plus naptime between before and during Ramadan.

Table 4 summarizes sleep patterns in the NF group. Compared to BL, bedtime was delayed significantly at R1 by approximately 60 minutes and R3 by approximately 72 minutes and wake-up time was delayed at R1 by 36 minutes and R3 by 54 minutes (the changes were not significant). There was no significant changes in TST. In response to

Table 1 - Comparison of the characteristics of the participants' across the 3 groups.

Group	SF (n=41)	NSF (n=30)	NF (n=30)	p value
Age (years)	32.6 ± 1.5	29.3 ± 1.6	31.5 ± 2.3	NS
Males (%)	25 (61)	17 (56)	19 (64)	NS
BMI (kg/m ²)	23.7 ± 1.01	26.4 ± 1.1	27.6 ± 2.1	NS

SF - fasting Saudis, NSF - fasting non-Saudis, NF - non-fasting non-Saudis, NS - non-significant, BMI - body mass index

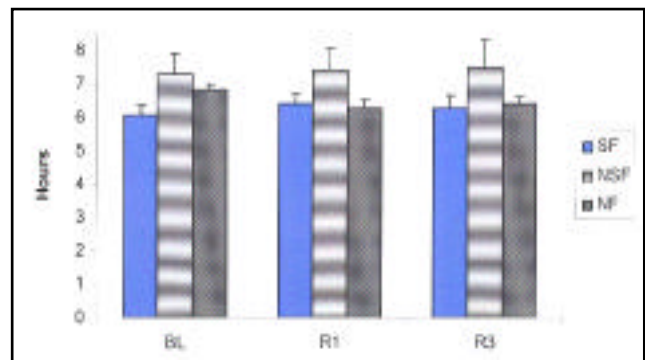


Figure 1 - Total sleep time (in hours) in each group at BL, R1, and R3. SF - fasting Saudis, NSF - fasting non-Saudis, NF - non-fasting non-Saudis, BL - one week before Ramadan, R1 - during the first week of Ramadan, R3 - third week of Ramadan.

Sleep patterns	BL	R1	R3	p value
Bedtime (minute)	00:36 ± 14	02:06 ± 16*	02:36 ± 19*	0.001
Wake-up time (minute)	06:36 ± 13	08:36 ± 8*	08:48 ± 9*	0.001
TST (hours)	6.07 ± 0.3	6.4 ± 0.3	6.3 ± 0.36	0.806
TST + nap (hours)	7.02 ± 0.34	6.9 ± 0.3	7.2 ± 0.35	NS
Time of nap (minute)	15:06 ± 18	16:18 ± 42*	15:18 ± 16	0.04
Duration of nap (minute)	103.4 ± 10.8	97.5 ± 14.4	120.16 ± 22.9	NS
Time of main meal	16:12 ± 38	20:06 ± 37*	19:54 ± 61*	0.001
ESS	4.6 ± 0.47	4.9 ± 0.46	4.5 ± 0.52	NS
Number of meals	2.6 ± 0.7	2.1 ± 0.5*	2.1 ± 0.5*	0.001
Number of cups of tea	2.4 ± 0.25	2.66 ± 0.29	2.55 ± 0.3	NS
Number of cups of coffee	2.5 ± 0.38	2.4 ± 0.35	2.15 ± 0.37	NS

*The difference is statistically significant compared to baseline. TST - total sleep time, ESS - Epworth Sleepiness Scale, SF - fasting Saudis, NS - non-significant, BL - one week before Ramadan, R1 - during the first week of Ramadan, R3 - third week of Ramadan

Table 2 - Comparison of sleep patterns and eating habits between before and during Ramadan among SF participants.

Sleep patterns	BL	R1	R3	p value
Bedtime (minute)	23:56 ± 36	02:20 ± 58*	02:12 ± 59*	<0.05
Wake-up time (minute)	07:18 ± 29	09:42 ± 31*	09:48 ± 26*	0.001
TST (hours)	7.3 ± 0.6	7.4 ± 0.65	7.5 ± 0.85	NS
Nap time (minute)	14:18 ± 22	16:36 ± 35*	16:18 ± 56*	<0.05
Nap duration (minutes)	127.5 ± 16.7	117 ± 28.6	141 ± 26.7	NS
TST + nap (hours)	8.5 ± 0.6	8.5 ± 0.55	8.8 ± 0.6	NS
Time of main meal (minute)	14:36 ± 38	17:18 ± 8*	17:30 ± 6*	0.017
ESS	5.1 ± 0.8	5 ± 0.9	5.1 ± 1.02	NS
Number of meals	2.3 ± 0.7	2.1 ± 0.6	2.0 ± 0.5	NS
Number of cups of tea	2.8 ± 0.48	2.86 ± 0.51	2.86 ± 0.55	NS
Number of cups of coffee	1.5 ± 0.34	2 ± 0.58	2 ± 0.58	NS

*The difference is statistically significant compared to baseline. TST - total sleep time, ESS - Epworth Sleepiness Scale, SF - fasting Saudis, NS - non-significant, BL - one week before Ramadan, R1 - during the first week of Ramadan, R3 - third week of Ramadan

Table 3 - Comparison of sleep patterns and eating habits between before and during Ramadan among fasting non-Saudis participants.

Sleep patterns	BL	R1	R3	p value
Bedtime (minute)	22:54 ± 11	23:54 ± 28*	00:06 ± 25*	0.03
Wake-up time (minute)	05:42 ± 8	06:18 ± 28	06:36 ± 24	NS
TST (hours)	6.83 ± 0.17	6.3 ± 0.23	6.4 ± 0.24	NS
TST + nap (hours)	7.04 ± 0.16	6.6 ± 0.19	6.9 ± 0.17	NS
Nap time (minute)	15:12 ± 64	14:24 ± 65	14:06 ± 48	NS
Nap duration (minutes)	49.3 ± 9.1	45.0 ± 10.7	57.5 ± 1.3	NS
Time of main meal	12:48 ± 27	13:00 ± 33	12:58 ± 28	NS
ESS	7 ± 1.06	6.8 ± 1.12	7.8 ± 1.1	NS
Number of meals	2.7 ± 0.6	2.9 ± 3.0	2.8 ± 0.4	NS
Number of cups of tea	1.8 ± 0.23	1.7 ± 0.25	2.1 ± 0.39	NS
Number of cups of coffee	2.08 ± 0.31	2.78 ± 0.49	2.95 ± 0.54	0.07

*The difference is statistically significant compared to baseline. TST - total sleep time, ESS - Epworth Sleepiness Scale, SF - fasting Saudis, NS - non-significant, BL - one week before Ramadan, R1 - during the first week of Ramadan, R3 - third week of Ramadan

Table 4 - Comparison of sleep patterns and eating habits between before and during Ramadan among non-fasting non-Saudis participants.

the question: "Do you feel that you get enough sleep at night? (yes or no)", 45% in SF, 50% in NSF, and 53% in NF subjects reported that they got enough sleep at BL, and none of these percentages changed significantly at R1 and R3. During Ramadan, SF participants who stayed awake after 23:00 hours attributed this to spending time with family at home or outside, spending time with friends, night prayers, and watching TV.

The percentage of individuals who napped during Ramadan did not change significantly during Ramadan in all 3 groups. Although the duration of naps did not change during Ramadan compared to BL in the 3 groups. The nap time was delayed significantly in SF participants at R1 (16:18 hours \pm 42 minutes compared to BL (15:06 hours \pm 18 minutes) and in NSF participants at R1 (16:36 hours \pm 35 minutes) and R3 (16:18 hours \pm 56 minutes) compared to BL (14:18 hours \pm 22 minutes). The naptime did not change in the NF group. Epworth Sleepiness Scale scores did not change significantly during Ramadan as compared to BL among the 3 groups (Tables 2-4). Figures 2a to 2c demonstrate the times of day and night when the participants felt most alert in the 3 groups. The reported times of greatest alertness and greatest sleepiness did not differ between BL and Ramadan in the NF group.

The percentage of SF participants who felt most alert between 20:00 and 22:00 hours increased at R1 and R3 (33.5% and 33.3%) compared to the 8% at BL ($p < 0.01$), and decreased at 08:00-10:00 hours from 55% at BL to 26.6% at R3 ($p = 0.014$). The percentage of NSF participants who felt most alert between 20:00 and 22:00 hours did not vary at R1 and R3 compared to BL. The percentage of participants who exercised regularly (2 or more times per week) did not change during Ramadan compared to BL in the 3 groups (SF: 10.25%, NSF: 21.4%, and NF: 36%). In fact, the same participants who exercised before Ramadan continued to exercise during Ramadan. The average number of meals per day among SF subjects changed significantly from 2.6 ± 0.7 at BL to 2.1 ± 0.5 at R1 and 2.1 ± 0.5 at R3 ($p = 0.001$). Among NSF participants, the average number of meals per day was 2.3 ± 0.7 at BL, 2.1 ± 0.6 at R1 and 2.0 ± 0.5 at R3 (not significant). Among NF participants, the average number of meals per day was 2.7 ± 0.6 at BL, 2.9 ± 3 at R1 and 2.8 ± 0.4 at R3 (not significant). The time of the main meal was significantly delayed during Ramadan in the SF and NSF groups, which reflects that the participants were fasting during daytime. In the SF group, the time of the main meal was delayed from 16:12 hours \pm 38 minutes at BL to 20:06 hours \pm 37 minutes at R1 and 19:54 hours \pm 61 minutes at R3, ($p < 0.001$). In the NSF group, the time of the main

Table 5 - Comparison of chronotype of each group at BL, R1, and R3.

Chronotype	BL %	R1 %	R3 %	p value
SF				
M-types	17	7	9	NS
N-types	56	54	53	NS
E-types	27	38	38	NS
NSF				
M-types	14	11	11	NS
N-types	71	44	44	NS
E-types	14	44	44	0.06
NF				
M-types	74	54	61	NS
N-types	21	40	34	NS
E-types	5	5	5	NS

SF - fasting Saudis, NSF - fasting non-Saudis, NF - non-fasting non-Saudis, BL - one week before Ramadan, R1 - during the first week of Ramadan, R3 - third week of Ramadan, M-type-morning type (score 18-25), N-type - neither type (score 12-17), E-type - evening type (score 4-11)

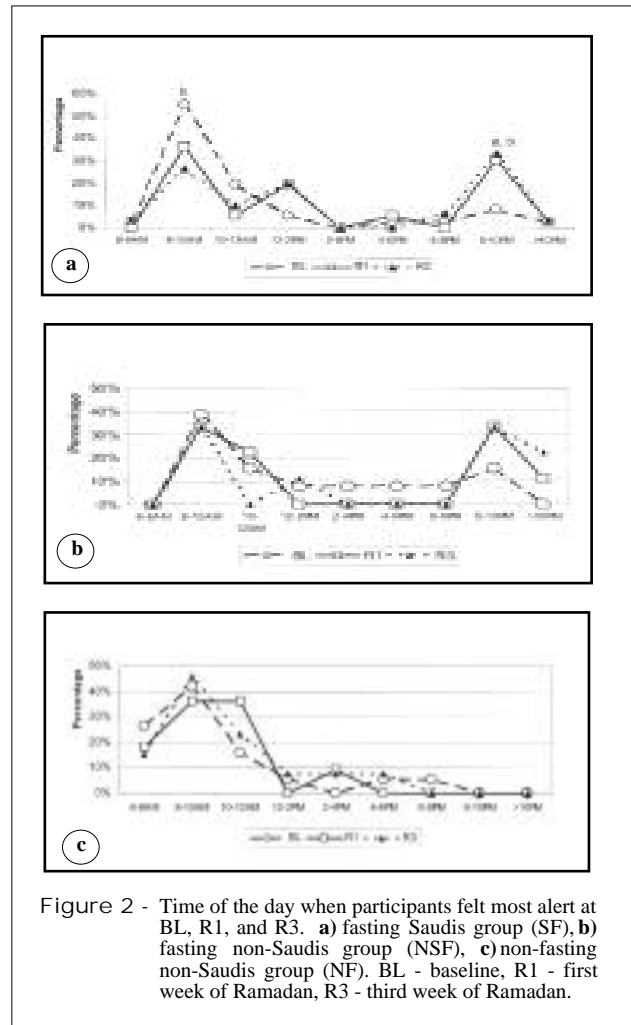


Figure 2 - Time of the day when participants felt most alert at BL, R1, and R3. a) fasting Saudis group (SF), b) fasting non-Saudis group (NSF), c) non-fasting non-Saudis group (NF). BL - baseline, R1 - first week of Ramadan, R3 - third week of Ramadan.

meal was delayed from 14:36 hours \pm 38 minutes at BL to 17:18 hours \pm 8 minutes at R1 and 17:30 hours \pm 6 minutes at R3 ($p=0.017$). In the NF group, the time of the main meal did not change significantly: 12:48 hours \pm 27 minutes at BL, 13:00 hours \pm 33 minutes at R1 and 12:58 hours \pm 28 minutes at R3. In the 3 studied groups, there was no significant difference in the consumption of tea or coffee nor in the percentage who drank tea or coffee at BL, R1, and R3.

Table 5 summarizes the chronotype of the 3 groups. In the SF and NSF groups, there was a clear trend toward a decrease in the M-types and an increase in the E-types at R1 and R3 compared to BL but that change did not reach statistical significance. In the NF group, there was a trend toward an increase in N-type and decrease in the M-types at R1 and R3 compared to BL.

DISCUSSION. Changes in sleep behavior during Ramadan have not been thoroughly investigated. While studies using surveys,^{1,3,4} have revealed significant changes in sleep patterns during Ramadan in fasting individuals, studies under controlled conditions and using polysomnographic monitoring have produced conflicting results.^{5,9} Moreover, no comparative studies have assessed the effect of the attendant lifestyle changes on both fasting and nonfasting individuals. This is the first study designed to determine the changes in sleep patterns, eating habits, daytime sleepiness, and chronotype in fasting and nonfasting individuals from different cultures and backgrounds. The wake-up time was delayed in the fasting groups (SF and NSF) but not in the NF group, which reflects the delay in the start of work for fasting individuals during Ramadan. Despite the fact that the time of starting work did not change for NF individuals, bedtime was significantly delayed during Ramadan, which indicates that this group might have been affected by the lifestyle changes taking place at night during Ramadan, such as delayed working hours for stores, shopping malls, and restaurants, and the broadcasting of interesting TV programs until late at night. Even though bedtime was delayed, the TST did not change during Ramadan in the SF and NSF groups due to the delay in the wake-up time. The present findings concur with our previous report¹ but contrast with the findings of Taoudi Benchekroun et al,³ who reported a significant drop in TST during Ramadan, which may reflect the effect of different cultural and lifestyle changes on sleep patterns in different countries as the start of work is delayed for fasting individuals during Ramadan in Saudi Arabia, which allows these people to delay their wake-up time during Ramadan.

The percentage of individuals who napped during Ramadan decreased in all 3 groups, which concurs with the findings reported by Taoudi Benchekroun et al.³

There was a discrepancy between fasting and nonfasting participants regarding eating habits during Ramadan. The time of the main meal did not change in the NF group whereas it was delayed in the SF and NSF groups, reflecting the fact that participants were fasting during the daytime. Most of the participants ate their main meal shortly after breakfast. While the frequency of meals did not change in the NF group, it dropped significantly in SF, which agrees with previous reports.^{1,3,5,10} In fasting participants (SF and NSF), although we found no significant change there was a trend of an increase in the E-types at R1 and R3 compared to BL. This agrees with the findings of Taoudi Benchekroun et al³ who reported similar changes during fasting in fasting Muslims in Morocco. A very interesting finding of the present study is the change in the chronotype of the NF group. There was a trend of an increase in the N-types and decrease in the M-types at R1 and R3 compared to BL which, if found to be significant in future studies may indicate that lifestyle changes during Ramadan also influence residents who do not fast.

The present study confirms previously reported modifications in sleep patterns, chronotype, and eating habits in fasting individuals. Moreover, it provides the first assessment of the above parameters in nonfasting residents of an Islamic country during Ramadan. As sleep behavior has changed during Ramadan in nonfasting individuals, it appears that the attendant lifestyle changes during Ramadan have a significant effect on sleep behavior during the fasting month. Factors other than fasting may play an important role in modifying an individual's behavior during Ramadan. Further studies are needed to identify those factors and explore the effect of each factor on sleep behavior in fasting and nonfasting individuals.

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