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The Effect of Ramadan Fasting on Body Composition and Metabolic Syndrome in Apparently Healthy Men

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Abstract

There are few studies investigating the role of Ramadan fasting on body composition and the characteristics of metabolic syndrome, especially in hot environments. The main aim of the study was to investigate the effect of Ramadan fasting on body composition and the characteristics of metabolic syndrome in apparently healthy men. In a randomized design, 44 college students aged 27.6 ± 5.8 years were selected to participate in the present study. Lifestyle was assessed by a developed questionnaire, body composition was measured using a bioelectrical impedance analyzer, and blood parameters were evaluated by taking a vein blood sample (10 ml) after fasting 10 hr. All measurements were taken 2–3 days before the month of Ramadan, at the end of Week 2 and end of Week 3, and 6 weeks later. The results identified no significant changes in any of the body composition parameters before, during, or after the month of Ramadan. The only significant change in blood parameters was recorded as a positive reduction in low-density lipoprotein (LDL) during the month of Ramadan, compared to before and after Ramadan. No major changes in metabolic syndrome factors were seen except in fasting blood glucose and systolic blood pressure as both factors were slightly but significantly elevated during the month of Ramadan and even after Ramadan, though both of them were within normal levels. This study concludes that Ramadan fasting could be one of the factors that reduce LDL. More studies are needed to clarify the role of Ramadan fasting on different populations such as obese and diabetic patients.

Keywords

Ramadan fasting, men's health, body composition, metabolic syndrome

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The month of Ramadan is a holy month in the Islamic calendar (lunar calendar varies between 29 and 30 days) where Muslims are religiously abstained from having any kind of food or from smoking during the day from dawn to sunset (about 15 hr). During the month of Ramadan, the lifestyle of people changes in Saudi Arabia. People become physically less active during the daytime (before sunset), compared to the nighttime (after sunset). Their diet changes as they break their fasting just after sunset by having a main meal and then they may have two or three meals during the night until daybreak. Moreover, sleep habits may change to be increased during the daytime. All these changes may lead to some changes in some of the physiological parameters including metabolic syndrome as well as body composition (Mansi, 2007; Ramadan, 2002).

Metabolic syndrome has been characterized by three or more of five vital disorders including abdominal adiposity (defined as waist circumference [WC] >102 cm [men] or >88 cm [women]), low levels of high-density lipoprotein cholesterol (HDL-C; <40 mg/dl [men] or <50 mg/dl [women]), high levels of fasting triglyceride

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(TG) concentration >150 mg/dl, high blood pressure >130/85 mmHg, and elevated fasting plasma glucose concentration >100 mg/dl (Felipe et al., 2015).

There are some studies that investigate the effect of Ramadan fasting on body mass (BM) and other physiological variables (Mansi, 2007; Nachvak et al., 2018; Norouzy et al., 2013; Ongsara, Boonpol, Prompalad, & Jeenduang, 2017; Ramadan, 2002). For instance, Mansi (2007) reported that Ramadan fasting may cause reduction in BM and some of the blood parameters such as LDL but not in others such as TG and fasting blood glucose (FG) values (Mansi, 2007). The changes that were identified in some of these studies were impermanent (Leiper & Molla, 2003; Nachvak, et al., 2018). In contrast, other studies did not report significant changes in BM and/or blood parameters (Ramadan, 2002). Most of the literature reviews on the effect of Ramadan fasting in healthy adults focus on BM changes. However, few of the previous studies investigated the effect of lifestyle including physical activity, sedentary time, diet, sleep duration as well as fasting during the month of Ramadan on metabolic syndrome markers and body composition. The present study measures the body composition including body fat (BF), fat-free mass (FFM), and total body water (TBW) using a new generation of the bioelectrical impedance analysis as an objective measure. There is a dearth of studies on the effect of lifestyle and Ramadan fasting on body composition and the characteristics of metabolic syndrome markers in apparently healthy young adults.

Despite results of previous studies, the majority did not investigate the effect of lifestyle and Ramadan fasting in hot and dry environments such as in Saudi Arabia during summer season where the temperature touches 45°C ± 3°C during the day and about 30°C ± 5°C during the night. Moreover, the fasting duration is about 15 hr during the day (from dawn to sunset). More investigation is needed to explore the effects of lifestyle and fasting during Ramadan on body composition and metabolic syndrome markers.

The present study aimed to cover the paucity of studies in this field by investigating the effect of lifestyle and long period of fasting time on body composition and the characteristics of metabolic syndrome in hot and dry environments.

Methods

Subjects

This quasi-experimental—before/after—study was conducted with a randomized design on four different occasions. Forty-four college students aged 27.6 ± 5.8 years were randomly recruited as one group to take part in the sessions (2–3 days before the month of Ramadan [BR], during Ramadan [end of the second week or RW2 and end of the third week or RW3] and 6 weeks later [AR]). All participants were mainly recruited from the King Saud University's students via posters and general e-mails. The sample size of the present study was calculated based on the change in plasma low-density lipoprotein (LDL) level value (mean ± *SD*) observed before and after Ramadan fasting in a previous study (Ziaee et al., 2006), with 95% confidence interval and 80% power of the test. The calculated sample size was 38. The sample size was increased by 10% to avoid withdraw cases; therefore, a total of 44 healthy university students (during summer term) were recruited to take part in the present study. Selection criteria included apparently healthy men within the age range of 18–39 years. Individuals taking medicines that may affect the results, including diabetes, individuals with hypertension, or individuals taking psychological medicine that may affect their behavior or the concentration of the investigated blood parameters were excluded from taking part in the study. All participants were asked to read and sign the consent form before taking part in the study. The present study was conducted during an academic summer semester.

Procedures

All participants were asked to attend the laboratory during afternoon on the same day. All procedures of the study were performed consistently as follows:

Lifestyle Assessment

Participants were asked to complete a lifestyle questionnaire. The lifestyle questionnaire has been previously evaluated in terms of validity and repeatability (Al-Hazzaa & Al-Ahmadi, 2003). The lifestyle questionnaire consists of 47 questions divided into three sections; habitual daily physical activity, diet, and sleep status.

Physiological and Lipid Profile

Blood pressure and resting heart rate were measured while seated on a chair. Then, a vein blood sample of 10 ml was taken by a phlebotomist after at least 10 hr of fasting. The blood sample was taken to evaluate total cholesterol (TC), LDL, high-density lipoprotein (HDL), TG, and FG.

Body Composition and Physical Anthropometrics

Physical anthropometrics including height (H; to the nearest 0.5 cm), BM (to the nearest 0.1 kg), and WC (to

Table 1. Body Composition and Physiological Parameters (Mean ± *SD*) for the Four Occasions (BR, RW2, RW3, AR; $n = 44$).

Body composition parameters	Before Ramadan	Ramadan Week 2	Ramadan Week 3	After Ramadan	*F*	*p*
Body mass (kg)	70.0 ± 12.6	69.6 ± 12.4	69.6 ± 12.8	69.9 ± 12.9	0.03	.99
BMI (kg/m^2)	24.5 ± 4.0	24.3 ± 4.0	24.3 ± 3.8	24.3 ± 4.0	0.04	.99
Waist circumference (cm)	82.9 ± 10.9	82.3 ± 10.6	81.8 ± 10.5	81.8 ± 11.0	0.10	.96
Body fat mass (kg)	14.7 ± 6.6	14.0 ± 6.9	13.9 ± 6.8	14.5 ± 6.9	0.13	.94
Body fat (%)	20.2 ± 6.2	19.5 ± 6.7	19.4 ± 6.6	19.7 ± 6.5	0.22	.88
Fat-free mass (kg)	55.3 ± 8.6	55.6 ± 6.9	55.5 ± 7.5	55.8 ± 7.3	0.04	.99
Fat-free mass (%)	79.8 ± 6.2	80.5 ± 9.0	80.6 ± 6.7	80.3 ± 6.5	0.13	.94
Total body water (liter)	40.1 ± 6.0	41.6 ± 6.8	40.5 ± 5.8	40.6 ± 5.4	0.49	.69
Total body water (%)	56.9 ± 7.2	59.0 ± 5.0	59.3 ± 5.3	58.9 ± 5.0	1.56	.20
Resting heart rate bpm	67.3 ± 6.6	67.5 ± 6.8	65.6 ± 5.4	67.3 ± 7.4	0.14	.91
SBP mmHg	109.6 ± 9.0	109.3 ± 7.9	112.5 ± 7.7	114 ± 8.5*	3.31	.02
DBP mmHg	73.9 ± 7.5	76.8 ± 5.3	75.7 ± 5.1	74.0 ± 6.3	0.11	.96

Note. AR = 6 weeks later (after Ramadan); BMI = body mass index; BR = 2–3 days before the month of Ramadan; DBP = diastolic blood pressure; RW2 = end of the second week of Ramadan; RW3 = end of the third week of Ramadan; SBP = systolic blood pressure.
*Significant differences from Ramadan.

the nearest 0.5 cm) were measured, and body mass index (BMI) was calculated using the BMI formula BMI = W (kg)/H (m^2).

Body composition parameters were taken for each participant including fat mass and percentage, FFM and FFM percentage (FFM%), and TBW and TBW percentage (TBW%) using a valid and reliable bioelectrical impedance analyzer (model TANITA BC 418; Jaffrin, 2009).

All measurements were taken on four occasions. The first trial was during BR; the second and third sessions were in RW2 and RW3. The fourth trial was in AR.

Statistical Analysis

Results of the present study were analyzed using the Statistical Package for the Social Sciences 19.0 (SPSS, Chicago, IL). Data was presented as mean ± *SD*. Comparisons between BR, RW2, RW3, and AR were performed using one-way repeated-measures analysis of variance (ANOVA) for all variables. Difference between results was considered statistically significant when $p < .05$. When difference was significant, post hoc testing was performed using post hoc comparison. Pearson correlation coefficient was computed to assess the association between variables.

Results

Forty-four participants with a mean age of 27.6 ± 5.8 years and average H (169.3 ± 6.1 cm) took part in this study. The participants were from different academic levels (undergraduate and postgraduate students).

Body Composition Parameters

The body composition parameters measured during the four occasions (BR, RW2, RW3, AR) are presented as mean ± *SD* in Table 1. Although there is a minor reduction in some of the body composition parameters (BM, BMI, BF, WC) and a slightly increase in other parameters (FFM, TBW), no significant changes were reported in any of the body composition parameters across all assessment occasions (BR, RW2, RW3, AR). The minor changes in body composition parameters were not significant. Table 1 also illustrated that systolic blood pressure (SBP) was elevated slightly but more significantly in AR compared to that in BR and RW2 (BR and RW2 = 109 mmHg vs. AR = 114 mmHg).

Habitual Physical Activity

Physical activity status of the participants was lower than recommended guidelines (moderate to vigorous physical activity >150 min/week, >5 days/week; ACSM, 2007). Data in Table 2 illustrate that the mean physical activity levels of the participants did not change significantly across the four occasions (BR, RW2, RW3, AR). Interestingly, participants in the present study spent less than 6 hr in sedentary behaviors on all four occasions (BR, RW2, RW3, AR), and the mean time spent in sedentary activity remained without significant changes across the four occasions (BR, RW2, RW3, AR). The mean time of sleep duration was lower than the recommended sleep duration time (for adults 7–9 hours; National Sleep Foundation, 2017), and there were no significant differences between the four trials (BR, RW2, RW3, AR) for sleep duration.

Table 2. Physical Activity Levels (Mean + SD) for the Four Occasions (BR, RW2, RW3, AR; $n = 44$).

Physical activity levels and sleeping time	Before Ramadan	Ramadan Week 2	Ramadan Week 3	After Ramadan	*F*	*p*
Moderate activity (min/week)	50.9 ± 121.7	64.4 ± 137.6	50.2 ± 154.51	34.6 ± 89.5	0.40	.75
Vigorous activity (min/week)	48.9 ± 108.4	61.3 ± 143.9	60.8 ± 162.4	22.2 ± 76.0	0.92	.43
Total moderate/vigorous (min/week)	99.8 ± 210.9	125.7 ± 260.4	111.0 ± 275.4	56.7 ± 151.0	0.74	.53
Sedentary behavior (hr/day)	5.8 ± 2.2	5.2 ± 1. 9	5.7 ± 3.0	5.5 ± 2.6	0.56	.64
Sleep duration (hr/day)	6.9 ± 1.0	6.6 ± 1.1	6.7 ± 1.0	6.3 ± 1.1	2.58	.06

Note. Significant differences from BR ($P < 0.05$). AR = 6 weeks later (after Ramadan); BR = 2–3 days before the month of Ramadan; RW2 = end of second week of Ramadan; RW3 = end of third week of Ramadan.
No significant found in any of the measured varaibles between any two occasions.

Table 3. Data Presented as Mean Percentage of Consumed Food per Week Across the four occasions (BR, RW2, RW3, AR; $n = 44$).

	Frequency of consumed food per week				
Food types	<2 times/week	<3–5 times/week	>6 times/week	χ^2	*p* value
Vegetables	27.8%	39.8%	32.4%	3.97	.68
Fruit	20.5%	47.7%	31.8%	9.11	.17
Milk and dairy products	29.5%	40.3%	30.2%	5.62	.47
Soda and soft drinks	43.8%	34.1%	22.2%	11.37	.08
Energy drinks	89.2%	10.23%	0.57%	3.90	.27
Fast food	43.2%	42.6%	14.2%	6.20	.40
Chips and French fries	46.0 %	39.8%	14.2%	3.70	.72
Biscuits and cakes	54.6%	25.5%	19.9%	11.97	.22
Chocolates and sweets	36.3%	30.7%	33.0%	9.30	.16

Note. AR = 6 weeks later (after Ramadan); BR = 2–3 days before the month of Ramadan; RW2 = end of second week of Ramadan; RW3 = end of third week of Ramadan.

Diet Behavior

The present study assessed diet behavior in terms of type and frequency of the consumed food (including the most common healthy and unhealthy foods). The main purpose of assessing diet behavior was to track the change in participants' diet behavior as one of the essential factors that can influence the investigated variables. Participants were asked to fill out the questionnaire including the diet behavior during each visit (BR, RW2, RW3, AR). Table 3 illustrates the mean percentage of the consumed food per week across the four occasions (BR, RW2, RW3, AR). Frequency of the consumed food was classified into three levels, two or less times per week, between three to five times per week, and six or more times per week. The differences between occasions were evaluated statistically using χ^2. The results indicated that there is no significant difference in the frequency of the consumed food per week across all occasions (BR, RW2, RW3, AR).

Physiological and Blood Parameters

Data of the heart rate, blood pressure, and blood parameters were analyzed using one-way repeated measures ANOVA and post hoc comparisons were applied when significant differences were identified between occasions. Figure 1 illustrated that although most of the measured blood parameters reported no significant changes across all four occasions (BR, RW2, RW3, AR), Ramadan fasting significantly influenced FG and LDL cholesterol (LDL-C). FG was elevated slightly in RW3 and AR compared to BR (BR = 74.60 mml/L vs. RW3 = 81.52 mmol/L and AR = 86.51 mmol/L). In contrast, there was a manifest decrease in LDL-C during Ramadan especially in RW3 compared to BR and AR (RW3 = 83.49 mg/dl, vs. BR = 93.11 mg/dl and AR = 101.59 mg/dl).

Correlations

Table 4 illustrated the correlation between body composition variables and the investigated blood parameters obtained after 21 days of Ramadan fasting (RW3). Although the observed reductions in most of the body composition variables were not significant, there were significant correlations between some of the body composition variables and blood parameters. In the present study, a significant positive correlation was found between WC and FG, TC (both $p < .05$), and TG

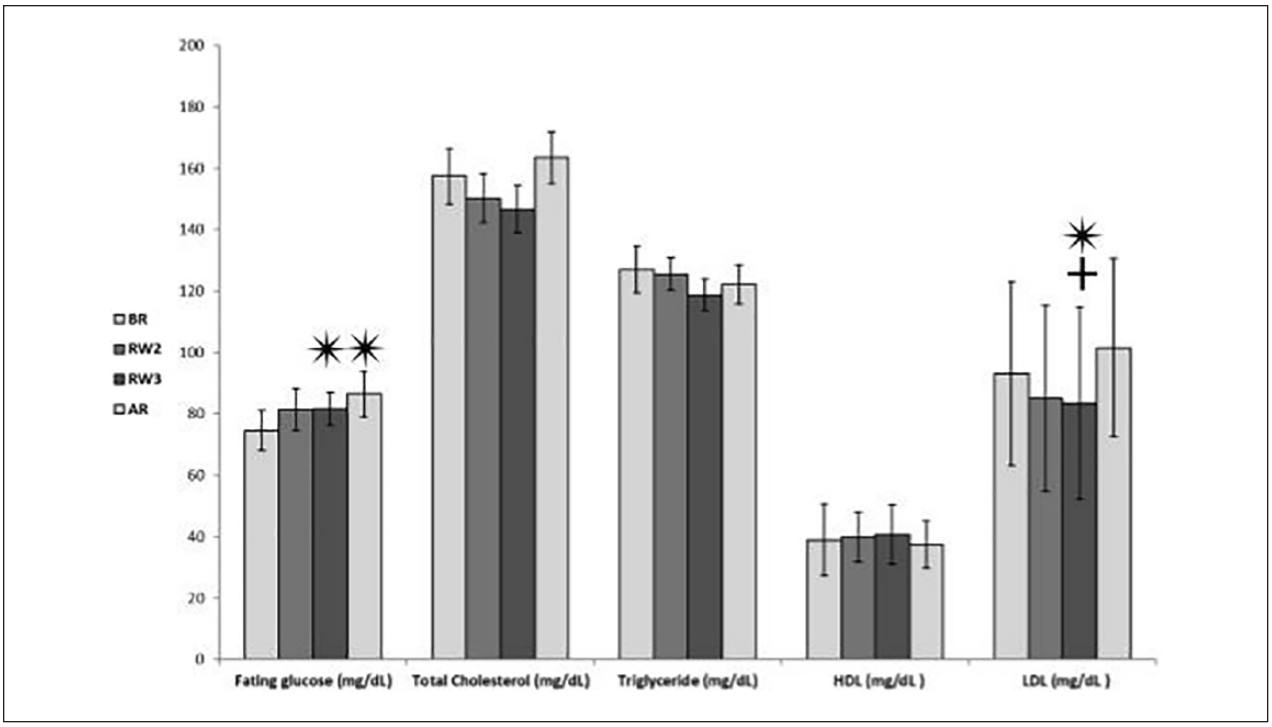

Figure 1. The effect of Ramadan fasting on fasting glucose, total cholesterol, triglyceride, high-density lipoprotein cholesterol, and low-density lipoprotein cholesterol ($n = 44$).
*Significant differences from BR, $p < .05$.
+Significant differences from AR, $p < .05$.

Table 4. Pearson Correlation Coefficient Between Body Composition Variables and Investigated Blood Parameters. All Results Obtained During the Third Week of Ramadan ($n = 44$).

Blood parameters / Body composition	SBP (mmHg)	Diastolic blood pressure (mmHg)	Fasting blood glucose (mmol/L)	Total cholesterol (mg/dl)	High-density lipoprotein cholesterol (mg/dl)	Low-density lipoprotein cholesterol (mg/dl)	Triglyceride (mg/dl)
Body mass (kg)	.20	.22	.25	.32*	−.41*	.23	.44**
Body mass index (kg/m^2)	.13	.16	.27	.39*	−.39*	.32*	.43**
Waist circumference (cm)	.14	.21	.35*	.38*	−.53**	.28	.54**
Body fat (%)	.06	.01	.28	.45**	−.29	.39*	.36*
Fat-free mass (%)	−.05	−.04	−.28	−.45**	.29	−.38*	−.36*
Total Body water (%)	−.07	−.01	−.27	−.45**	.28	−.40*	−.35*

Note. *$p < .05$. **$p < .01$. SBP = systolic blood pressure.

($p < .05$), but this was inversely associated with HDL ($p < .01$). Similarly, the association between BF percentage (BF%) and TC ($p < .01$), LDL, and TG (both $p < .05$) was positive and significant. Interestingly, a significant negative correlation was reported between TBW and TC ($p < .01$), LDL, and TG (both $p < .05$). A similar association was observed between FFM and TC ($p < .01$), LDL, and TG (both $p < .05$).

Discussion

The main aim of the present study was to investigate the effect of Ramadan fasting and lifestyle during the month of Ramadan on body composition and the characteristics of metabolic syndrome in a hot and dry environment. Forty-four apparently healthy college students participated in this study. The results indicated no significant changes in any of the body composition parameters. Moreover, no significant changes were reported in any of the metabolic syndrome markers.

Physical Activity Status and Diet Behavior

Data of the present study reported that physical activity levels, sedentary behavior, and sleep duration did not change significantly across all four occasions (BR, RW2,

RW3, and AR; ($p = .53$ for moderate–vigorous activity [min/week], $p = .64$ for sedentary behavior [hr/day], $p = .06$ for sleep duration [hr/day]). On the other hand, Table 3 indicates that diet behavior did not change significantly across the four occasions (BR, RW2, RW3, and AR; all $p > .05$). These results may help to understand the influence of Ramadan fasting on body composition and the characteristics of metabolic syndrome.

Body Composition

All measured body composition parameters did not change significantly across all four occasions of BR, RW2, RW3, and AR. To the best of our knowledge, no study has examined the effect of Ramadan fasting in a hot and dry environment situation where temperature rises above 45°C. Although BM, BMI, and WC decreased gradually, especially in RW3 compared to BR, the slight decrease was not significant ($p = .99$ for both BM and BMI and $p = .96$ for WC). These findings agreed with a number of previous studies (Al-Hourani & Atoum, 2007; Asl, 2011; Leiper & Molla, 2003; Ongsara et al., 2017; Ramadan, 2002; Sadeghirad, Motaghipisheh, Kolahdooz, Zahedi, & Haghdoost, 2012; Sadiya, Ahmed, Siddieg, Babas, & Carlsson, 2011). The slight decrease in BF%, FFM%, and TBW% were not significant across the four assessment occasions (BR, RW2, RW3, and AR; $p = .88$ for BF%, $p = .94$ for FFM%, $p = .20$ for TBW%). This result seems to be acceptable as the body composition parameters of most participants were within the average (lean individuals). On the other hand, recent research reported different results. Nachvak and colleagues concluded that body weight, BMI, and BF% were decreased significantly at the end of Ramadan compared with the same indices measured prior to Ramadan (all $p < .001$; Nachvak et al., 2018). However, the reduction in body weight in some studies comes from skeletal muscle mass and FFM. A recent study demonstrated that Ramadan fasting (at the end of Ramadan month) led to significant reduction in body weight, BMI, skeletal muscle mass, and FFM (Nugraha, Ghashang, Hamdan, & Gutenbrunner, 2017). Moreover, the reduction in some body composition parameters recorded in some studies can refer to the obesity level of the participants. Sezen and colleagues investigated the effects of Ramadan fasting on body composition and arterial stiffness in obese and overweight adults (mean age 37 ± 7 years). They concluded that Ramadan fasting could decrease body composition parameters including BF% and TBW rate (Sezen et al., 2016). Thus, Ramadan fasting may influence body composition in obese individuals more than in lean individuals (Harder-Lauridsen et al., 2017). Further studies may investigate the effect of Ramadan fasting in different populations such as obese participants or professional players because they may be influenced more by hot and dry environments.

The Characteristics of Metabolic Syndrome

Most of the measured blood variables including metabolic syndrome markers did not show significant changes across the four occasions (BR, RW2, RW3, and AR). These results are parallel to those of some of the previous studies (Al-Numair, 2006; Ongsara et al., 2017). However, the present study indicated that SBP and FG were elevated significantly during the month of Ramadan ($p = .023$ and $p = .011$, respectively), especially during the end of Ramadan (RW3) compared to levels before Ramadan (BR). Nevertheless, the elevated values were within the normal levels in both (SBP: BR and RW2 = 109 mmHg vs. AR = 114 mmHg, and FG: BR = 74.60 mml/L vs. RW3 = 81.52 mmol/L and AR = 86.51 mmol/L). Interestingly, Ramadan fasting could be one of the factors that may influence LDL-C. Similar results reported in previous studies examined the effect of Ramadan fasting on college students (Harder-Lauridsen et al., 2017; Mansi, 2007; Qujeq, Bijani, Kalavi, Mohiti, & Aliakbarpour, 2002). Similar to a previous study, the positive significant changes in LDL-C during Ramadan were temporary (Leiper & Molla, 2003; Qujeq et al., 2002). The unique finding of the present study was investigating the effect of Ramadan fasting on apparently healthy adults under stable habitual lifestyle including physical activity status, sleep status, and diet behavior. In general, body composition and metabolic syndrome variables may be influenced by fasting during the month of Ramadan. However, the results of the present study revealed that these changes were limited in apparently healthy individuals. Some of the previous studies that investigated the effect of Ramadan fasting on some of the physiological parameters including blood profile reported positive significant changes in some of the measured variables. These results were attributed to the unstable habitual lifestyle of the participants before, during, and after the month of Ramadan (Norouzy et al., 2013; Waterhouse, Alabed, Edwards, & Reilly, 2009). More studies are needed to investigate different population levels and cases such as obesity and diabetes.

Correlations

Although the observed reductions in most of the body composition variables were not significant, a significant correlation between most of the body composition

variables and blood parameters was reported in the present study at the end of Ramadan fasting (RW3). This result was expected as numerous studies reported similar results (Hamdan, Nassar, Dowli, Al Zaghal, & Sabri, 2012; Hejazi, 2016; Ziaee et al., 2006). The present study supports the positive impact of Ramadan fasting on the human body especially for blood parameters. More research is encouraged to explore the association between Ramadan fasting and other health-related factors. For instance, a significant positive association between BF% and TC ($p < .01$), LDL, and TG (both $p < .05$) were reported. Interestingly, a significant negative correlation was reported between TBW and TC ($p < .01$), LDL, and TG (both $p < .05$). A similar association was observed between FFM and TC ($p < .01$), LDL, and TG (both $p < .05$).

Conclusion

The present study concluded that Ramadan fasting may not affect body composition and characteristics of metabolic syndrome markers in healthy adult men. However, Ramadan fasting could be one of the factors that could reduce LDL-C significantly in apparently healthy adults. Stability of the habitual lifestyle may limit the effect of fasting during Ramadan. The effect of Ramadan fasting seems to be temporary. More investigations are needed to explore the effect of Ramadan fasting on different population especially people with special conditions, such as obese or diabetic patients.

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Authors' Contributions

The principal author (Al-barha) carried out the study design, data collection, as well as data entry. The coauthor (Aljaloud) finalized the data analysis and translated some articles to English. Both authors (Al-barha and Aljaloud) participated in drafting the manuscript and both read and approved the final manuscript.

Ethical Approval and Consent to Participate

The present study was approved by the research center at the College of Sport Sciences and Physical Activity, King Saud University.

Ethics, Consent, and Permission

A consent form was signed by each participant after reading and understanding all parts of the study including the right to withdraw from the study at any time without giving a reason.

Consent to Publish

The signed consent form includes a section indicating that the results of this study will be published in a scientific research journal and/or presented in national or international scientific conferences.

Consent for Publication (for Individual Data)

Not applicable, as the manuscript of the present study does not contain any individual's data.

Availability of Data and Material

All data supporting the results of the preset study are saved in our research lab's computer confidentially. Because we do not inform participants about this section, please contact author for data requests.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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