Original Research Article

Impact of intermittent fasting on human health

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A B S T R A C T

Background: Throughout the world, millions of Muslims fast daily during the month of Ramadan from sunrise (Sahar) until sunset (Iftar). Considering the impacts of environment on physiological functions, we performed this study in order to examine the effects of Ramadan fasting on some blood parameters of healthy volunteers and hypertensive patients.

Materials and Methods: The study was carried out on 50 healthy, volunteer medical students of different tertiary health centers in the city. Inclusion Criteria: Healthy young, medical students aged between 18 to 28 years, they should be fasting according to the recommendations of Ramadan fasting for the whole month. Exclusion Criteria: Students with any major illness like hypertension, type-2 diabetes mellitus, hyperthyroidism, hypothyroidism, hypercholesterolemia, Cushing's disease or on any medication.

Results: The mean age was 22.5 years with standard deviation of 2.763. This reduction in Body Weight after Ramadan fasting is found to be statistically significant. (P value < 0.05). The difference of these values shows statistically significant reduction in BMI. (P value < 0.05). The reduction in Waist-Circumference is statistically significant. (P value < 0.01). The reduction in Waist to Hip ratio is statistically significant. (P value < 0.05). The Pre-Ramadan Mean Pulse Rate is reduced from 75.31 ± 4.23 beats/min (M±SD) to Post Ramadan Mean Pulse Rate of 75.12 ± 4.03 beats/min (M±SD). Pre-Ramadan Mean Systolic Blood Pressure decreases from 121.23 ± 6.32 mm of Hg (M±SD) to Post Ramadan Mean Systolic Blood Pressure of 119.46 ± 5.01 mm of Hg (M±SD). However, this reduction in Systolic Blood Pressure is statistically not significant. (P value > 0.05). The reduction in Diastolic Blood Pressure is however statistically not significant. (P value > 0.05).

Conclusion: Thus, it is concluded that Ramadan type of intermittent fasting has beneficial effect on the human body in terms of betterment in physiological systems and significant reduction in Body Weight, Body Mass Index, Waist-Circumference, Waist to Hip Ratio, Pulse Rate.

1. Introduction

Fasting is partial or total refrain from all foods or avoiding prohibited foods. Fasting has remained a centre point owing to the potential non-pharmacological strategy to improve health and increasing longevity in various scientific interventions.[1] Generally, there are three most commonly studied fasting strategies; they are a caloric restriction (CR), dietary restriction (DR) and intermittent fasting (IF).[2] The research outcomes of these strategies in different in vivo and vitro studies are given below. In calorie restriction approach reduction in kilocalorie intake to about 20–40% of ad libitum consumption is practised.[3] This approach has been extensively investigated in many experimental models including the dog, fruit fly, rodents and non-human primates. CR has a potential to reduce the initiation of certain disease like atherosclerosis, cardiomyopathies,

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cancer, diabetes, renal diseases, neurodegenerative diseases and respiratory diseases.[4] In case of cardiovascular health, CR is known to reduce resting heart rate (HR) and blood pressure (BP), elevation in heart rate variability, enhancing the left ventricular function and improving flow-mediated vasodilation.[5]

Calorie restricted strategy also reduces the blood glucose level thereby decreasing the plasma insulin level and thus favouring the process of lipolysis.[6] In the calorie-restricted mode, the body uses its stored reserves thereby decreasing the body fat percentage and decreases the incidence of diabetes. However, extreme long-term practising CR regimen for a period of 6 months result in excessive fat and muscle loss that may cause a variety of physiological abnormalities.[7] In dietary restriction approach, one or more food components (macronutrients) are reduced with nominal or no decrease in total caloric intake.[8]

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 hours a day depending on the geographical location and season. The majority of health-specific findings related to Ramadan fasting are mixed.[9] 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.[10] 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.[11]

Many scientific studies were carried out to assess the impact of IF on possible health outcomes and it was found that IF resulted in prolonging lifespan and prevention of an array of discrepancies including CVDs, renal diseases, different forms of cancers and diabetes.[12] IF was observed to provoke the beneficial outcomes in cardiovascular health including lower heart rate and blood pressure, increased post-exercise heart rate variability.[13]

2. Materials and Methods

This is prospective and observational study

3. Methodology

The methods adopted for the present study are described under the following headings:

1. Selection of the subjects
2. General and systemic examination
3. Study procedure

4. Estimation of physiological parameters

3.1. Selection of subjects

The study was carried out on 50 healthy, volunteer medical students of different tertiary health centers in the city. Prior to commencement of study, required pre-test instructions were given and tests were properly explained. 50 male medical students of age group 18–28 years fulfilling the inclusion criteria were included in the study.

3.2. Inclusion criteria

Healthy young, medical students aged between 18 to 27 years, they should be fasting according to the recommendations of Ramadan fasting for the whole month, Students who have given written informed consent voluntarily.

3.3. Exclusion criteria

Students belonging to age group <18 and >27 years, students with any major illness like hypertension, type-2 diabetes mellitus, hyperthyroidism, hypothyroidism, hypercholesterolemia, Cushing's disease or on any medication.

3.4. Study procedure

The study was carried out in the month of Ramadan, when average duration of fasting was 14 hours a day. Volunteers fast during the daylight hours (dawn to dusk) and were allowed to eat freely from "Iftar" to "Sahar" (dusk to dawn).

1. Prior to test, students were instructed about the pre-test preparations.
2. Students were asked to come after overnight fast (8 to 10 hours), 2 to 3 days before the commencement of the month of Ramadan for assessment of physiological parameters [Body Weight, Body Mass Index, Waist-Circumference, Waist to Hip Ratio, Pulse Rate, Systolic and Diastolic Blood Pressure]. These readings are Pre-Ramadan readings.
3. For the assessment of Post-Ramadan readings of the above-mentioned parameters, students were called on 28th day of fast in the afternoon (8 to 10 hours after the morning meal, "sahar").

3.5. Estimation of physiological parameters

3.5.1. Body weight
Weight in kilograms was measured by weighing machine to the nearest 0.5 kilogram.

3.5.2. Height
Height in centimeters was measured using a stadiometer with subject standing flat feet, eyes looking straight ahead

and back in contact with measuring bar.

3.5.3. Body mass index (BMI)

Body Mass Index was calculated from Body Weight and Height using the Quettet's Index.

$$BMI = \frac{Body\ Weight\ (in\ kg)}{Height\ (in\ meters)^2}$$

3.5.4. Waist circumference (WC)

Waist circumference in centimeters was measured with the help of measuring tape at the navel where the girth is minimum with the person is standing relaxed, and not pulling in his stomach.

$$Waist\ to\ Hip\ Ratio\ (WHR):\ WHR = \frac{Waist\ Girth}{Hip\ Girth}$$

Waist girth is measured at navel where the girth is minimum with the person is standing relaxed with feet together, and not pulling in his stomach. Hip girth is measured over the buttocks where girth is largest while standing with feet together.

3.6. Pulse rate and blood pressure

Volunteers were asked to lie relaxed in supine position on a bed for 15 minutes. Pulse rate was assessed by examining the radial pulse by the palpatory method for one complete minute. Three readings were taken and the average of these readings was noted.

With the help of mercury sphygmomanometer Systolic and Diastolic Blood Pressures were recorded in the same position by palpatory method first and then by auscultatory method. Three readings were taken and the average of these readings was noted.

3.7. Statistical analysis

The data was recorded in MS-EXCEL-2013 format and the statistical analysis was done using SPSS software 25th version. Quantitative data were reported as Mean $\pm$ Standard Deviation (M$\pm$SD) and Pre-and Post-Ramadan fasting values were compared using the paired two-tailed student's "t" test.

4. Results

The study procedure was carried out on 50 healthy, volunteer medical students aged between 18 to 28 years. Assessment of physiological and biochemical parameters were done 2 to 3 days before the commencement of Ramadan fasting (Pre-Ramadan readings) and on 28th day of fasting (Post-Ramadan readings.)

Table 1: Age statistics

Mean (Age in years)	22.5
Std. Deviation	2.763
Minimum	18
Maximum	27

The age group of participants in the study was 18 to 27 years. The mean age was 22.5 years with standard deviation of 2.763.

Table 2: Pre-ramadan and post ramadan body weight changes

Study Subjects	Weight (kg/m2) Mean ±SD	P Value
Pre-Ramadan	65.84 ± 7.46	<0.05
Post Ramadan	61.31 ± 7.37	

S: Statistically Significant

It is observed from Table 2 that; Mean Body Weight of subjects Pre-Ramadan and Post Ramadan are 65.84 ± 7.46 kg (M±SD) and 61.31 ± 7.37 kg (M±SD) respectively. This reduction in Body Weight after Ramadan fasting is found to be statistically significant. (P Value < 0 05)

Table 3: Pre-ramadan and post ramadan bmi changes

Study Subjects	BMI (kg/m2) Mean ±SD	P Value
Pre-Ramadan	22.83 ± 2.36	<0.05
Post Ramadan	19.17 ± 2.11	

S: Statistically Significant

It is observed from Table 3 that, Pre-Ramadan Mean BMI is 22.83 $\pm$ 2.36 kg/m^2(M$\pm$SD) and Post Ramadan Mean BMI is 19.17 $\pm$ 2.11 kg/m^2 (M$\pm$SD). The difference of these values shows statistically significant reduction in BMI. (P value < 0.05).

Table 4: Pre-ramadan and post ramadan wc changes

Study Subjects	WC (cm) Mean ±SD	P Value
Pre Ramadan	82.58 ± 9.11	<0.05
Post Ramadan	79.99 ± 8.32	

S: Statistically Significant

It is observed from Table 4 that, Mean Waist-Circumference is reduced from Pre-Ramadan reading of 82.58±9.11 cm (M±SD) to Post Ramadan reading of 79.99 ± 8.32 cm (M±SD). This reduction in Waist-Circumference is statistically significant. (P value < 0.01).

Table 5: Pre ramadan and post ramadan whr changes

Study Subjects	WHR Mean ±SD	P Value
Pre-Ramadan	0.86 ± 0.02	<0.05
Post Ramadan	0.82 ± 0.02	

S: Statistically Significant

It is observed from Table 5that, Mean WHR is reduced from Pre-Ramadan reading of 0.86 ± 0.02 (M±SD) to Post Ramadan reading of 0.82 ± 0.02 (M±SD). This reduction

Table 6: Pre-ramadan and post ramadan pulse rate changes

Study Subjects	Pulse Rate (beats/minute) Mean ±SD	P Value
Pre Ramadan	75.31 ± 4.23	0.31
Post Ramadan	75.12 ± 4.03	

NS: Statistically not significant.

in Waist to Hip ratio is statistically significant. (P value < 0.05).

It is observed from Table 6 that, the Pre-Ramadan Mean Pulse Rate is reduced from 75.31 ± 4.23 beats/min (M±SD) to Post Ramadan Mean Pulse Rate of 75.12 ± 4.03 beats/min (M±SD). The reduction in Pulse Rate is statistically not significant. (P value = 0.31).

Table 7: Pre-ramadan and post ramadan sbp changes

Study Subjects	SBP (mm/Hg) Mean ±SD	P Value
Pre Ramadan	121.23 ± 6.32	>0.05
Post Ramadan	119.46 ± 5.01	

NS: Statistically Not Significant

It is observed from Table 7 that; the Pre-Ramadan Mean Systolic Blood Pressure decreases from 121.23 ± 6.32 mm of Hg (M±SD) to Post Ramadan Mean Systolic Blood Pressure of 119.46 ± 5.01mm of Hg (M±SD). However, this reduction in Systolic Blood Pressure is statistically not significant. (P value > 0.05).

Table 8: Pre-ramadan and post ramadan DBP changes

Study Subjects	DBP (mm/Hg) Mean ±SD	P Value
Pre Ramadan	83.03 ± 4.33	>0.05
Post Ramadan	81.93 ± 4.21	

NS: Statistically Not Significant

It is observed from Table 8 that; the Pre-Ramadan Mean Diastolic Blood Pressure decreases from 83.03 ± 4.33 mm of Hg (M±SD) to Post Ramadan Mean Diastolic Blood Pressure of 81.93 ± 4.21 mm of Hg (M±SD). This reduction in Systolic Blood Pressure is however statistically not significant. (P value > 0.05).

5. Discussion

Ramadan is the Islamic lunar calendar of the ninth month. Every year millions of Muslims across the globe, living under various geographical, climatic, social, cultural, and economic conditions, fast during the month of Ramadan to fulfill their religious obligation. Ramadan fast affects the human body in diverse ways and many physiological and psychological changes take place during Ramadan. Most probably these changes occur due to the changes in eating patterns, eating frequency and sleep patterns in this

month.[14] As there is a specific eating pattern, Ramadan fasting is a special model of intermittent fasting.

The main aim of this study is to determin the effects of Ramadan fasting on certain physiological and biochemical parameters in healthy medical students aged between 18 to 28 years, and to find out whether or not Ramadan fasting has any beneficial or harmful effects on the human body.

In the current study, we investigated the effect of Ramadan fasting on multiple physiological and biochemical parameters among healthy students. Fasting and dietary lifestyles comprise significant conditions of physiological and biochemical variations. The current findings show critical changes in the weight of the subjects, in spite of the fact that the normal pre-Ramadan estimations of subjects were higher contrasted and the post Ramadan esteems. There are few investigations support with our findings.[15–17]It appears to be that body weight may diminish after Ramadan fasting; nonetheless, Frost and Pirani reaveled that Ramadan fasting caused a huge expansion in the body weight.[18]

The way that Muslims change the quality and example of design of food and drink utilization during Ramadan is very notable.[19] Conventionally, the majority of the Muslims burn-through a more prominent assortment of nourishments in their dinners. Throughout this month, they want to take more sugars and sweet nourishments, and it is realized that the intake of these supplements at an unusual time can change metabolic functions in the body.[20] Some analysts noticed an abatement in the body weight and subcutaneous fat in the two sexes by the decrease of energy intake during fasting. These and different scientists saw that there was a huge expansion in the calorie, fat, starch and protein consumption during Ramadan, in this way causing a huge expansion in weight during Ramadan.[21]

The specialists who noticed a reduction in the body weight recommended that this is most likely because of a diminishing in the size of the fat cells during and after fasting.[22] The current investigation comprised of subjects from college. These subjects commonly managed to eat more carbohydrate rich foods alongside sweet beverages subsequent to breaking their fast. It was unrealistic to normalize the eating routine during this study, since subsequent to fasting, every individual would in general eat as per his/her longing and will.[23] The noticed contrasts in the examinations might be because of the distinction in the financial status and the degree of actual work in various gatherings of different investigations. This may likewise be because of the way that our subjects were not experiencing drawn out starvation, since they were burning-through more food around evening time and were additionally being rehydrated simultaneously.[24]

In the present study, no changes were observed in BMI in subjects. Almost similar findings have been reported in previous studies.[25] Marbut et al. observed

that if caloric intake is reduced during fasting, there is a significant decrease in blood HDL-C (highdensity lipoprotein-cholesterol), though they found changes in total serum cholesterol.[26] Mohsen et al. studies that BMI decreased during the fasting period, although it returned to the normal level as the fasting period ended.[27] However, all of these researchers noted that significant changes were observed in BMI. The reason for the differences in these findings may be the variations in socioeconomic status of the subjects. It also appears that the quality and quantity of fat intake during Ramadan may govern blood cholesterol level.[28] The level of physical activity may also account for these findings. The subjects in these studies were residing in developed countries, whereas the subjects in our study were not only from a developing country, but also from an underdeveloped area of the country; therefore, the variations are justified.

Our study demonstrated no significant changes in the SBP and DBP in the subjects. This again may be due to the fact that the subjects were not suffering from prolonged starvation as they were consuming food at night and were also being rehydrated at the same time. Mohmoud and Mansi have observed a slight decrease in HR, though it was statistically non-significant after Ramadan fasting.[29] Al-Kubati et al. have confirmed that fasting during Ramadan has advantages in lowering BP and HR during the day and disadvantages in the evening and early morning, which could increase the risk for patients with uncontrolled hypertension, unstable angina pectoris, myocardial infarction, or heart failure.[30] Although, we observed insignificant changes in the SBP and DBP of subjects. Trepanowski and Bloomer noticed that resting BP fell simultaneously with weight loss. They found a systematic correlation between weight changes and BP, and predicted a BP fall of 1.5 or 2.5 mmHg/ per kg of weight loss; therefore, our study results are in consistence with these findings. Fasting helps keep BP normal and control body weight, which is of high significance, especially for diabetic patients.[31]

6. Scope of the Study

Ramadan type of intermittent fasting has many health benefits in terms of improvement in Lipid profile and reduction in Body Weight and Body fat. It gives solution to Obesity, which has been recognized as a serious risk factor for mortality and morbidity due to cardiovascular diseases, stroke, diabetes mellitus, in the general population. Thus, it is beneficial, if the diet pattern is framed according to the routine followed in Ramadan on regular intervals.

7. Conclusion

Thus, it is concluded that Ramadan type of intermittent fasting has beneficial effect on the human body in terms of betterment in physiological systems and significant reduction in Body Weight, Body Mass Index, Waist-Circumference, Waist to Hip Ratio, Pulse Rate.

8. Source of Funding

9. Conflict of Interest

The authors declare no conflict of interest.

References

1. Johnstone A. Fasting for weight loss: an effective strategy or latest dieting trend? *Int J Obes*. 2015;39(5):727–33. doi:10.1038/ijo.2014.214.
2. Patterson RE, Laughlin GA, LaCroix AZ, Hartman SJ, Natarajan L, Senger CM, et al. Intermittent Fasting and Human Metabolic Health. *J Acad Nutr Dietetics*. 2015;115(8):1203–12. doi:10.1016/j.jand.2015.02.018.
3. Anastasiou CA, Karfopoulou E, Yannakoulia M. Weight regaining: From statistics and behaviors to physiology and metabolism. *Metab*. 2015;64:1395–1407. doi:10.1016/j.metabol.2015.08.006.
4. Gao Q, Jia Y, Yang G, Zhang X, Boddu PC, Petersen B, et al. PPARalpha-deficient Ob/Ob Obese Mice Become More Obese and Manifest Severe Hepatic Steatosis Due to Decreased Fatty Acid Oxidation. *Am J Pathol*. 2015;185:1396–1408.
5. Kim SH, Chun HJ, Choi HS, Kim ES, Keum B, Jeen YT. Current Status of Intragastric Balloon for Obesity Treatment. *World J Gastroenterol*. 2016;22:5495–5504.
6. Habermann N, Makar KW, Abbenhardt C, Xiao L, Wang CY, Utsugi HK, et al. No Effect of Caloric Restriction or Exercise on Radiation Repair Capacity. *Med Sci Sports Exerc*. 2015;47:896–904.
7. Das JK, Lassi ZS, Hoodbhoy Z, Salam RA. Nutrition for the Next Generation: Older Children and Adolescents. *Ann Nutr Metab*. 2018;72(Suppl. 3):56–64. doi:10.1159/000487385.
8. Barnosky AR, Hoddy KK, Unterman TG, Varady KA. Intermittent fasting vs daily calorie restriction for type 2 diabetes prevention: a review of human findings. *Transl Res*. 2014;164(4):302–11. doi:10.1016/j.trsl.2014.05.013.
9. Trepanowski JF, Bloomer RJ. Review: The impact of religious fasting on human health. *Nutr J*. 2010;9:1–57.
10. van Ewijk R, Painter RC, Roseboom TJ. Associations of Prenatal Exposure to Ramadan with Small Stature and Thinness in Adulthood: Results From a Large Indonesian Population-Based Study. *Am J Epidemiol*. 2013;177(8):729–36. doi:10.1093/aje/kwt023.
11. Rashed AH. The fast of Ramadan. *BMJ*. 1992;304(6826):521–2. doi:10.1136/bmj.304.6826.521.
12. Lauby-Secretan B, Scoccianti C, Loomis D, Grosse Y, Bianchini F, Straif K. International Agency for Research on Cancer Handbook Working G: Body Fatness and Cancer - Viewpoint of the IARC Working Group. *New Engl J Med*. 2016;375:794–798.
13. Altman BJ, Stine ZE, Dang CV. From Krebs to clinic: glutamine metabolism to cancer therapy. *Nat Rev Cancer*. 2016;16(10):619–34. doi:10.1038/nrc.2016.71.
14. Cifarelli V, Lashinger LM, Devlin KL, Dunlap S, Huang J, Kaaks R. Metformin and Rapamycin Reduce Pancreatic Cancer Growth in Obese Prediabetic Mice by Distinct MicroRNA-Regulated Mechanisms. *Diabetes*. 2015;64(5):1632–42. doi:10.2337/db14-1132.
15. Farazi M, Nguyen J, Goldufsky J, Linnane S, Lukaesko L, Weinberg AD, et al. Caloric restriction maintains OX40 agonist-mediated tumor immunity and CD4 T cell priming during aging. *Cancer Immunol, Immunother*. 2014;63(6):615–26. doi:10.1007/s00262-014-1542-y.
16. Marosi K, Kim SW, Moehl K, Scheibye-Knudsen M, Cheng A, Cutler R. 3-Hydroxybutyrate regulates energy metabolism and induces BDNF expression in cerebral cortical neurons. *J Neurochem*. 2016;139(5):769–81. doi:10.1111/jnc.13868.

17. Houten SM, Violante S, Ventura FV, Wanders RJA. The Biochemistry and Physiology of Mitochondrial Fatty Acid β-Oxidation and Its Genetic Disorders. *Ann Rev Physiol*. 2016;78(1):23–44. doi:10.1146/annurev-physiol-021115-105045.

18. Cheng CW, Adams GB, Perin L, Wei M, Zhou X, Lam BS, et al. Prolonged Fasting Reduces IGF-1/PKA to Promote Hematopoietic-Stem-Cell-Based Regeneration and Reverse Immunosuppression. *Cell Stem Cell*. 2014;14(6):810–23. doi:10.1016/j.stem.2014.04.014.

19. Newman JC, Covarrubias AJ, Zhao M, Yu X, Gut P, Ng CP. Ketogenic Diet Reduces Midlife Mortality and Improves Memory in Aging Mice. *Cell Metab*. 2017;26(3):547–57. doi:10.1016/j.cmet.2017.08.004.

20. Lu Y, Hajifathalian K, Ezzati M, Woodward M, Rimm EB, Danaei G. Metabolic Mediators of the Effects of Body-Mass Index, Overweight, and Obesity on Coronary Heart Disease and Stroke: A Pooled Analysis of 97 Prospective Cohorts with 1·8 Million Participants. *Lancet*. 2014;383:970–83.

21. Bailey H, Secor DH. Coastal evacuations by fish during extreme weather events. *Sci Rep*. 2016;6(1):773–825. doi:10.1038/srep30280.

22. Trepanowski JF, Kroeger CM, Barnosky A, Klempel MC, Bhutani S, Hoddy KK, et al. Effect of Alternate-Day Fasting on Weight Loss, Weight Maintenance, and Cardioprotection Among Metabolically Healthy Obese Adults. *JAMA Intern Med*. 2017;177(7):930. doi:10.1001/jamainternmed.2017.0936.

23. Fann DYW, Ng GYQ, Poh L, Arumugam TV. Positive effects of intermittent fasting in ischemic stroke. *Exp Gerontol*. 2017;89:93–102. doi:10.1016/j.exger.2017.01.014.

24. Trabelsi K, Stannard SR, Maughan RJ, Jammoussi K, Zeghal K, Hakim A. Effect of Resistance Training During Ramadan on Body Composition and Markers of Renal Function, Metabolism, Inflammation, and Immunity in Recreational Bodybuilders. *Int J Sport Nutr Exerc Metab*. 2012;22(4):267–75. doi:10.1123/ijsnem.22.4.267.

25. Trabelsi K, Ahmed C, Zohra G, Choumous K, Zouheir S, Mounir ZK, et al. Physical activity during Ramadan fasting: Effects on body composition, hematological and biochemical parameters. *IOSR J Pharm*. 2012;2(5):33–41.

26. Marbut MM, Al-Najjar H, Abdulrahman MA. Effect of Ramadan fasting on some physiological parameters. *Tikrit Med J*. 2005;11(2):6–8.

27. Mohsen AF, Hazmi EL, Faleh Z, Faleh AL, Mofleh IA. Effect of Ramadan fasting on the values of hematological and biochemical parameters. *Saudi Med J*. 1987;8(2):171–6.

28. Hosseini SRA, Sardar MA, Hejazi K, Farahati S. The Effect of Ramadan Fasting and Physical Activity on Body Composition, Serum Osmolarity Levels and Some Parameters of Electrolytes in Females. *Int J Endocrinol Metab*. 2013;11(2):10–20. doi:10.5812/ijem.9602.

29. Mohmoud K, Mansi S. Study the Effects of Ramadan Fasting on the Serum Glucose and Lipid Profile among Healthy Jordanian Students. *Am J Appl Sci*. 2007;4(8):565–9. doi:10.3844/ajassp.2007.565.569.

30. Al-Kubati M, Fišer B, Homolka P, Siegelová J. Ramadan fasting and the circadian rhythm of blood pressure, heart rate and robinson index. *Physiol Res*. 2007;56:3.

31. Nagra SA, Shaista N, Nomani MZA, Ali A. Effect of Ramadan fasting on serum protein concentrations in male and female university students. *Can J App Sci*. 2011;1(2):29–42.

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