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Original Article

Effect of Ramadan on Glucose Levels, Serum Lipid Profile, and Blood Pressure among Fasting and Nonfasting Medical Students in a Public University of Karachi

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Abstract

Objective: The objective of this study was to assess the effect of Ramadan fasting on blood pressure, fasting glucose, lipid profile, and serum proteins between non-Muslim and fasting Muslim students. **Methodology:** The study was conducted on undergraduate medical students of a medical university of Karachi. Participants were invited for data collection: in the last 10 days of Shaban, Ramadan, and Shawwal. Along with blood pressure, height, and weight were measured and a sample of 10 cc blood was also drawn in each visit. Blood samples were analyzed for glucose, lipid profile, and serum protein. Two samples, "*t*"-test and repeated measure design analysis of variance were utilized for statistical analysis. **Results:** Sixty Muslims and 15 non-Muslim students completed all the three visits. Seventy-five percent were females. Mean systolic blood pressure reduced significantly in Ramadan. Mean diastolic blood pressure reduced noticeably in Ramadan and Shawwal for non-Muslim students and minor changes occurred in Muslim students. Even though the fasting blood sugar increased insignificantly from Shaban to Ramadan in the total sample, but the increment among Muslim students showed a significant increase. The mean cholesterol value of Muslim students significantly increased in Ramadan but decreased in Ramadan for non-Muslim students. The mean value of low-density lipoprotein increased significantly in Ramadan for Muslim students but decreased in Ramadan for non-Muslim. The mean values of triglyceride showed a significant reduction from Shaban to Ramadan and then increased in Shawwal. **Conclusion:** The study revealed that the environment of Ramadan was helpful to the non-Muslim students more than the Muslim students, with respect to the biochemical parameters.

Keywords: Medical University, Muslim and non-Muslim students, Ramadan environment, Ramadan fasting

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Introduction

Fasting is a compulsory obligation for each healthy Muslim adult man and woman in Ramadan, except sick, traveling, pregnant, breastfeeding, menstruating, or debilitated individuals. More than a billion Muslims in the world who are 15 years and older practice the fasting during this month. Fasting period in Ramadan during summer ranges from 14 to 15 h in Karachi, Pakistan. For most of the fasting people, the number of meal is reduced to two, once at Sahoor and another at Iftar. The dishes of Iftar are mostly comprised fried items and fruits. It provides about 90% of the daily requirement of calories.[1] Ramadan also affects the sleep pattern due to extra night prayers and early wake-up for eating Sahoor, and consequently shorten the nighttime sleep.[2] Most of those who miss sleeping compensate for it by taking a nap in the afternoons. In addition, the daytime regular exercises are reduced due to fasting and engagements of religious activities at night.[3] Literature indicates that changes in eating habits and timing of meals, sleeping patterns, and physical activities may change the physiological and behavior attitude during the month of Ramadan.[4]

Many studies have been conducted to determine the effect of Ramadan fasting. Most of them were conducted on diabetic patients.[5-8] Some studies were performed on nondiabetics patients[9-12] and some on healthy controls.[13,14] Some studies were conducted on Muslim students.[15-20] However, studies comparing the environmental effects of Ramadan on non-Muslim and fasting Muslim students are scarce. Hence to compare the effect of the month of Ramadan of non-Muslim and fasting Muslim students of a medical school in Karachi, this study was organized. The objective of the study was to assess the effect of Ramadan fasting on blood pressure, fasting glucose, cholesterol, triglyceride, high-density lipid, low-density lipid, serum proteins, weight, and body mass index (BMI) between non-Muslim and fasting Muslim students.

Methodology

The study was approved by the Institutional Review Board of Jinnah Sindh Medical University (JSMU) and was funded by the Research Funding Committee of JSMU. Participants of this study were the students of JSMU, Karachi. The principal investigator has visited all the classes from 1st to 5th year of Bachelor of Medicine and Bachelor of Surgery (MBBS) and briefed about the project through multimedia and invited to register. Willing students were informed that they would visit three times; in the last 10 days of each of 3 months (Shaban, Ramadan, and Shawwal). Sixty Muslims and 15 non-Muslims completed all the three visits. Blood pressure was measured twice from each subject in all the three visits. Height, weight, waist, and hips measurements were also taken. A fasting blood sample (12 h fasting) of 10 cc was collected by trained phlebotomists in the pathology laboratory of Jinnah Postgraduate Medical Center and JSMU Diagnostic Laboratory and Blood Bank. The blood samples were collected in two tubes, one for blood glucose measurement and other for serum separation, with number and participant's name. All the samples were analyzed for (1) glucose, (2) cholesterol, (3) triglyceride, (4) uric acid, (5) high-density lipoprotein (HDL)-C, (6) low-density lipoprotein (LDL)-C, and (7) serum proteins. A questionnaire was also administered to each participant for demographic information, systemic diseases, physical activities, and sleeping habits in each visit. It was announced in the beginning that a Muslim student must intend to fast 20 days to be enrolled as fasting Muslim. The number of days the participants has fasted during the Ramadan period and the number of days of *Taraweeh* prayers were asked in the last visit. All the Non-Muslims were hostel residents. The blood samples in Ramadan were arranged before the Iftar. Statistical Package for Social Sciences (SPSS version 20; SPSS Inc., Chicago, IL, USA) was used to enter and analyzed the data obtained. Two independent samples "*t*"-test was utilized to compare the mean values of height, weight, waist, and hip measurements of Shaban between Muslim and non-Muslim students. Repeated measure design analysis of variance with visits as within-subjects and religion and BMI as co-factors was used to analyze the mean values of systolic and diastolic blood pressures, glucose level, cholesterol, triglyceride, HDL, LDL, very-low-density lipoprotein (VLDL), and serum proteins of the three visits.

Results

Sixty fasting Muslim and 15 non-Muslim students completed all the three visits. Seventy-five percent were females and about 70% of them were aged between 19 and 22 years. Eighty percent of the participants were Muslims [Figure 1].

The mean values of the Muslim and non-Muslim students' height, weight, waist, and hips measurements are shown in Figure 2. The mean value of the heights of non-Muslim students in the month of Shaban was little more than Muslim students (161.37 cm vs. 160.79 cm). The mean values of weight, waist, and hips measurements of Muslim versus non-Muslim students were 57.17 kg versus 54.47, 71.85 cm versus 69.69 cm, and 92.42 versus 87.58, respectively. The mean differences in all the four parameters mentioned above were statistically insignificant ($P > 0.05$).

Table 1 shows the mean ± standard deviation (SD) of systolic blood pressure (SBP), diastolic blood pressure (DBP), fasting blood sugar (FBS), and protein level for Muslim, non-Muslim students and total sample in all the three visits. It also indicates the significant effects of religion (Muslim and non-Muslim) and initial BMI in changing the mean values of the aforementioned parameters. Figure 3 shows the pattern of changes of these parameters for Muslim and non-Muslim students. In Shaban, the mean SBP of both the groups were almost the same (111.0 [M] vs. 111.3 [N]). It reduced noticeably in Ramadan (107,4 [M] vs. 105.0 [N]) and increased slightly in Shaban (108.9 [M] vs. 105.5 [N]). It should be noticed that reduction in SBP was more in Non-Muslim students than Muslim students. This is linked to the BMI measurements in Shaban, which showed a significant effect ($P < 0.0001$) in reducing the SBP.

The mean DBP of Muslim students were almost the same in three visits. However, it reduced noticeably in Ramadan and Shawwal for non-Muslim students (73.4 [Shaban], 71.6 [Ramadan], 70.6 [Shawwal]). Nevertheless, the changes in mean DBP in the total sample were insignificant ($P > 0.05$). However, the initial BMI showed a significant effect in the changes of DBP ($P = 0.001$).

Mean FBS increased for both Muslim and non-Muslim students in the end of Ramadan (Muslim [69.7 (Shaban), 81.8 (Ramadan)], non-Muslim [66.0 (Shaban), 68.1 (Ramadan)]). However, it reduced little bit for Muslim students but kept an upward trend for non-Muslims. But changes in the mean value of Muslim students were more conspicuous than non-Muslim students [Figure 3]. There was no significant difference in all the three mean values of the total sample ($P > 0.05$). The religion factor (Muslim/non-Muslim) showed a significant effect in changing the mean values ($P = 0.035$). Mean protein values decreased in the month of Ramadan and then increased in the month of Shawwal for both Muslim and non-Muslim students. However, these changes were marginal and were statistically insignificant ($P > 0.05$). Religion and BMI also did not show any statistically significant changes.

Table 2 shows the mean ± SD of total cholesterol, HDL, LDL, VLDL, and triglyceride, along with significant values of the effects of religion and BMI. The changes of these parameters in

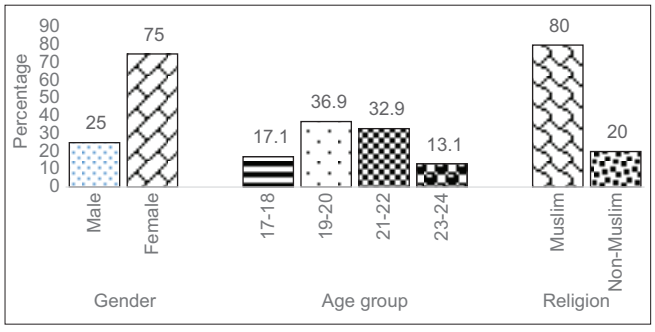

Figure 1: Descriptive statistics of gender, age-group and religion

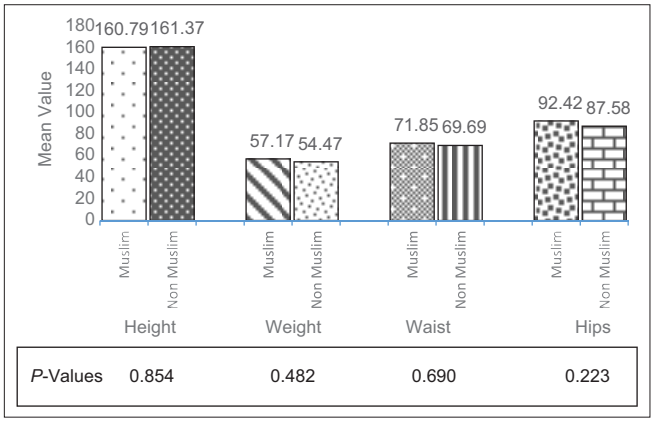

Figure 2: Mean value of height, weight, waist and hips

Table 1: Descriptive statistics with comparisons between Muslim and non-Muslim in three visits of systolic and diastolic blood pressures, fasting blood sugar and protein

Item	Category	Visit 1	Visit 2	Visit 3	*P*
SBP	Muslim	111.0[a]±8.9	107.4[a]±9.3	108.9[a]±9.9	Religion: 0.722
	Non-Muslim	111.3[a]±4.4	105.0[a]±8.1	105.5[a]±5.9	BMI: <0.0001
	Total	111.0[a]±8.5	107.2[a]±9.1	108.5[a]±9.5	
DBP	Muslim	74.0[a]±7.2	74.3[a]±7.6	74.4[a]±7.1	Religion: 0.692
	Non-Muslim	73.4[a]±6.0	71.6[a]±7.8	70.6[a]±9.4	BMI: 0.001
	Total	73.9[a]±7.0	74.0[a]±7.6	73.9[a]±7.5	
FBS	Muslim	69.7[a]±10.7	81.8b±9.9	75.4c±10.5	Religion: 0.035
	Non-Muslim	66.0[a]±10.4	68.1[a]±4.4	74.3[a]±8.6	BMI: 0.336
	Total	69.3[a]±10.7	80.2[a]±10.4	75.3[a]±10.2	
Protein	Muslim	7.7[a]±0.7	7.5[a]±0.5	8.2[a]±0.6	Religion: 0.177
	Non-Muslim	8.0[a]±0.7	7.8[a]±0.3	8.1[a]±0.6	BMI: 0.350
	Total	7.8[a]±0.7	7.5[a]±0.5	8.2[a]±0.6	

Different alphabets denote the statistical significance. BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, FBS: Fasting blood sugar

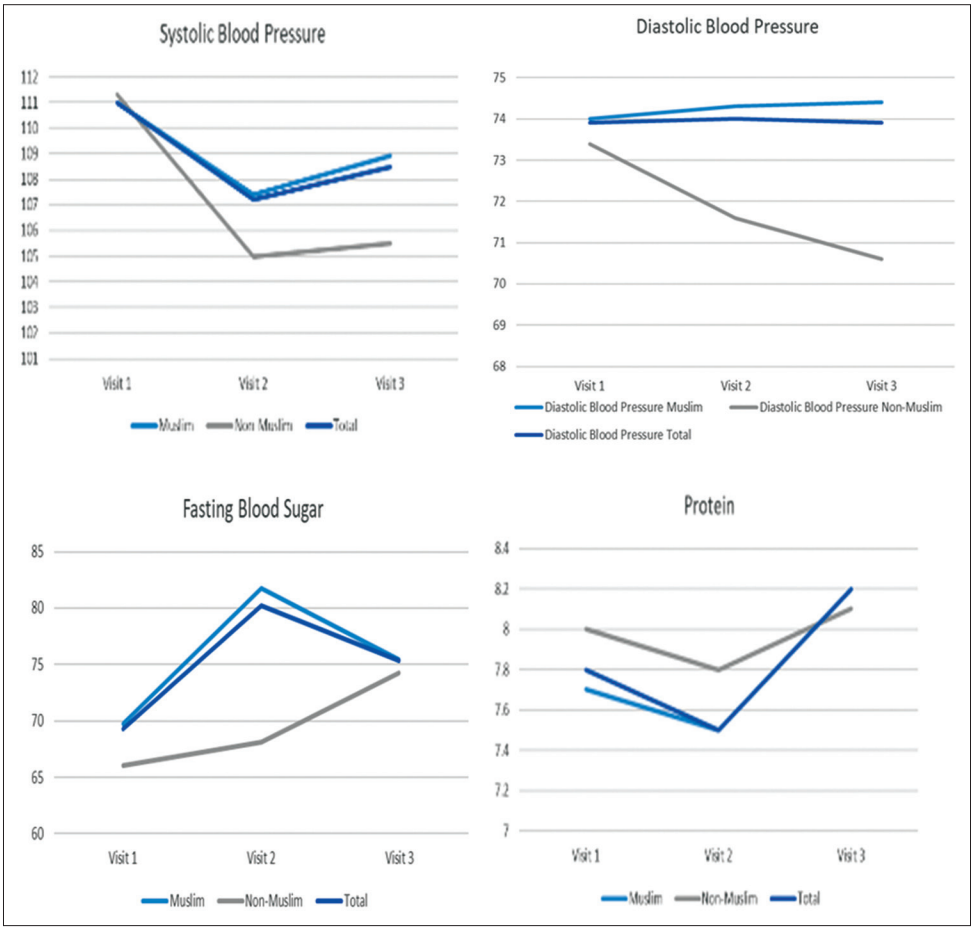

Figure 3: Mean values of systolic blood pressure, diastolic blood pressures, fasting blood sugar and protein of Muslim and non-Muslim students in three visits

the three readings are shown in Figure 4. The mean cholesterol value of Muslim students significantly increased in Ramadan (150.3 [Shaban], 162.7 [Ramadan]), but dropped back significantly in Shawwal (136.9). However, the mean cholesterol value of non-Muslim students decreased in Ramadan (151.1 [Shaban], 132.3 [Ramadan]), but increased in Shawwal (137.9). These changes did not show any statistical significance. For the total sample, only the mean value of Shawwal decreased significantly

Table 2: Descriptive statistics with comparisons between Muslim and Non-Muslim in three visits of cholesterol, high density lipoprotein, low density lipoprotein, very low density lipoprotein and triglyceride level

Item	Category	Visit 1	Visit 2	Visit 3	*P*
Cholesterol	Muslim	150.3^{a}±24.9	162.7^{b}±25.9	136.9c±20.7	Religion: 0.329
	Non-Muslim	151.1^{a}±36.1	132.3^{a}±38.4	137.9^{a}±41.8	BMI: 0.380
	Total	150.4^{ab}±26.1	159.0^{b}±29.1	137.1^{a}±23.7	
HDL	Muslim	43.0^{a}±7.3	44.5^{a}±6.9	45.0^{a}±10.3	Religion: 0.502
	Non-Muslim	41.0^{a}±7.7	42.8^{a}±9.4	44.5^{a}±9.8	BMI: 0.136
	Total	42.8^{a}±7.4	44.3^{ab}±7.2	44.9^{b}±10.1	
LDL	Muslim	93.1^{a}±21.6	100.3^{b}±21.8	76.2c±20.8	Religion: 0.183
	Non-Muslim	87.8^{a}±28.5	71.4^{a}±25.4	76.8^{a}±34.0	BMI: 0.142
	Total	92.4^{a}±22.4	96.7^{a}±24.0	76.3^{a}±22.4	
VLDL	Muslim	24.6^{a}±9.1	15.9^{b}c±6.7	13.1c±4.8	Religion: 0.755
	Non-Muslim	28.4^{a}±10.6	17.2^{a}±4.9	17.0^{a}±4.7	BMI: 0.450
	Total	26.1^{a}±9.4	16.4^{a}±5.8	14.6^{a}±4.9	
Triglyceride	Muslim	85.2^{a}±33.5	82.7^{a}±31.8	78.2^{a}±34.4	Religion: 0.193
	Non-Muslim	110.9^{a}±48.7	88.8^{a}±30.6	84.4^{a}±23.9	BMI: 0.108
	Total	88.3.3^{a}±36.2	83.5^{a}±31.5	79.0^{a}±33.2	

Different alphabets denote the statistical significance. HDL: High density lipoprotein, LDL: Low density lipoprotein, VLDL: Very LDL, BMI: Body mass index

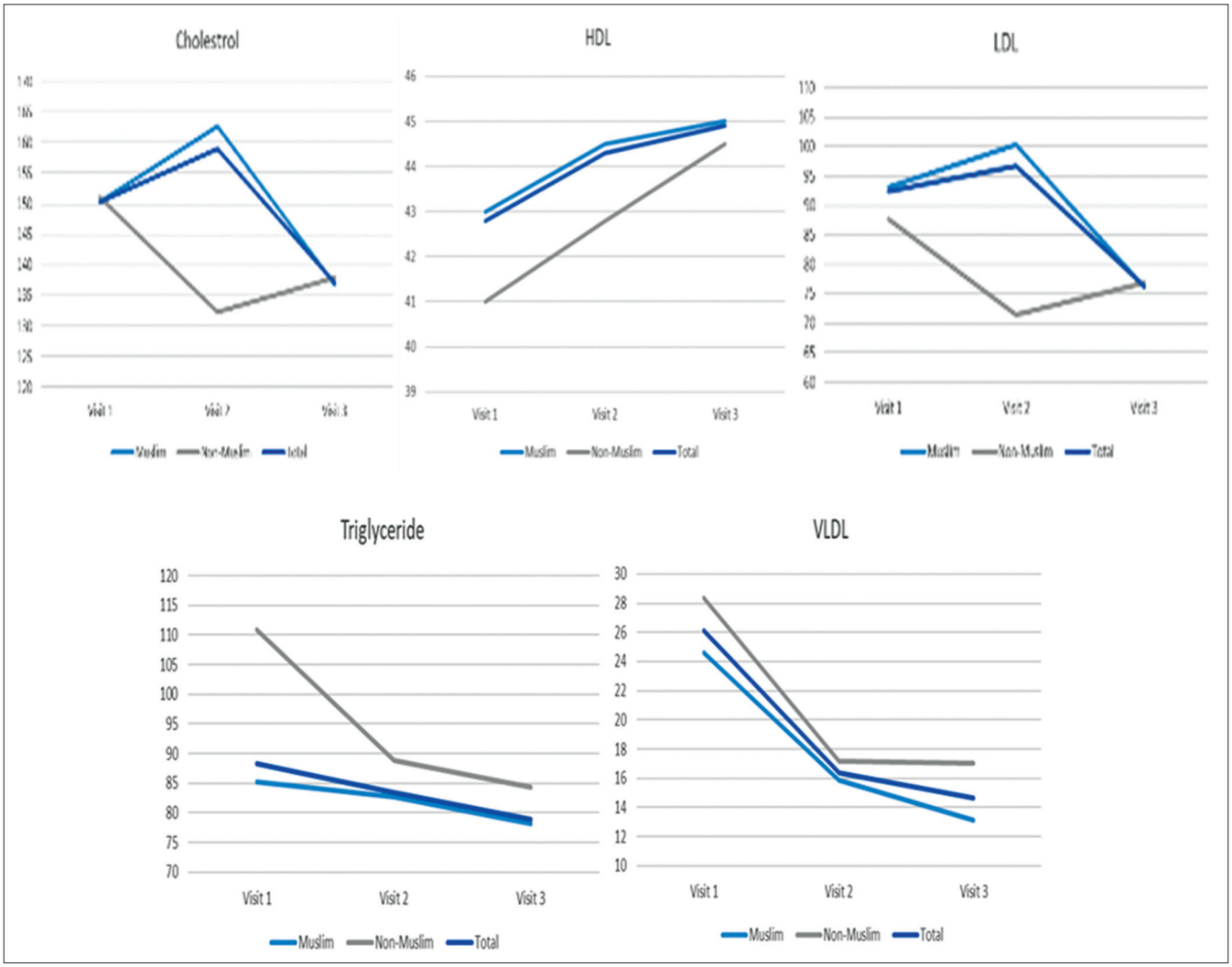

Figure 4: Mean values of cholesterol, high-density lipoprotein, low-density lipoprotein, very-low-density lipoprotein and triglyceride of Muslim and non-Muslim students in three visits

from Ramadan's mean value (159.0 vs. 137.1). The religion and BMI did not show any significant effect (P = 0.329 and P = 0.380, respectively). Minor and insignificant changes have appeared in the mean values of HDL in all three readings. Mean value of LDL increased significantly in Ramadan for Muslim students and reversed back significantly in Shawwal (93.1 [Shaban], 100.3 [Ramadan], 76.2 [Shawwal]). However, the changes for non-Muslim were in the opposite direction, decreased in Ramadan, and increased in Shawwal. However, there was an increase in mean LDL value in Ramadan and then decreased in mean LDL value in Shawwal for the total sample. These changes were statistically insignificant for non-Muslim and total samples. The mean value of VLDL showed continuous reduction in Ramadan and Sahwwal from Shaban. However, only the mean value of Shawwal showed a significant reduction from Shaban (24.6 [Shaban], 15.9 [Ramadan], 13.1 [Shawwal]). The same trend was seen for non-Muslim students. Even though the reduction from Shaban to Ramadan was quite noticeable, but it was not statistically significant due to the low number of readings for this parameter. The total sample showed the same trends of continuous reduction, but none of them were statistically significant. Religious and BMI factors also did not show any effect in the change of VLDL values. The mean values of triglyceride showed a significant reduction from Shaban to Ramadan and then increased in Shawwal among Muslim, non-Muslim students, and total sample. None of the changes showed statistical significance. Religion and BMI also did not show any effect in the changes of mean values. The mean values of triglyceride of non-Muslim students were noticeably higher than Muslim students.

Discussion

As far as the studies are concerned, this is the first study to discuss the effect of the month of Ramadan between fasting Muslim and non-Muslim students of a medical university. Non-Muslim students are fewer than Muslim students in the sample. It is because: (1) non-Muslim students are fewer in number in the university as compared to Muslim students and most of them are transferred students from interior Sindh, (the province of Pakistan in which Karachi is the capital), live in students' hostels; (2) non-Muslim students did not take that much interest due to religious inclination of the study. However, the percentage of non-Muslim in the sample was well-above of the percentage of non-Muslim in the university and in the Pakistani population.[20]

No significant difference was observed in the height, weight, waist, and hips measurements between fasting and nonfasting students in the first visit. Therefore, those two groups were comparatively equivalent and did not need any initial adjustments. However, mean values of weight, waist, and hips measurements of non-Muslim were a little bit shorter than Muslim students, even though the former students were a little bit taller than later students. It is because almost all the non-Muslim students belonged to the Hindu religion and expected to be vegetarians. A meta-analysis showed that vegetarians showed lesser weight than nonvegetarians.[21]

This study showed that the systolic and DBPs reduce insignificantly from Shaban to Ramadan. However, the reductions were faster among non-Muslim than Muslim students. Literature shows that there is a positive correlation of blood pressures with BMI.[22] Since the mean weight of non-Muslim students was lower than Muslim students with higher mean height. Therefore, BMI of non-Muslim students was lower than Muslim students, and hence faster reduction of blood pressures of non-Muslim could also be due to lower BMI along with the lesser frequency of food intake. Even though the FBS increased insignificantly from Shaban to Ramadan in the total sample, but the increment among Muslim students was significant. Furthermore, it should also be noted that increment in FBS among non-Muslim students in Ramadan was comparatively quit lower than Muslim students. Consequently, P value related to religion showed a significant difference. It is usual practice that sugar consumption increases in Ramadan, especially during Iftar dinner.[23] Therefore, there is a high probability that the blood sugar level will increase more among Muslim students by the end of Ramadan than non-Muslim students.

Cholesterol level increased significantly from Shaban to Ramadan among Muslim students but decreased insignificantly among non-Muslim students. Even though the consumption of fat increases during Ramadan,[23,24] other studies have showed that there is no significant change in the blood cholesterol level from Shaban to Ramadan[17,18] or sometimes it decreased.[19] Nevertheless, if only female students are considered, then there is a significant increase in the cholesterol level[23] which agrees with this study. Since 75% of our participants were females, therefore it follows Lamri-Senhadji *et al*.[24] studies. There is no significant change in HDL values for both Muslim and non-Muslim students. However, there is a significant increase in the total sample in Shawwal. Khan *et al*.[17] also showed that there was a significant increase in HDL value in Shawwal. Muslim students showed a significant increase in mean LDL, which agrees with Khan *et al*.,[17] but other studies[18,23] showed that there is no change in LDL values during and after Ramadan among young university students. However, there was a reduction in the mean LDL value of non-Muslim students. The mean triglyceride level reduced from Shaban to Ramadan. Even though the differences were not statistically significant for Muslim or non-Muslim students, but the difference of mean values of among non-Muslim students was noticeable. This downward trend of mean triglyceride from Shaban to Ramadan is agreed by Khan *et al*.,[17] Mansoor[19] and female data of Ongsara *et al*.[18]

It should be noted that all the non-Muslim students were hostel residents. During the Ramadan period, the kitchens of the hostel do not serve food during daytime; they only serve Iftars, dinners and Sahures. Nonfasting students have to arrange their lunches by themselves. Due to this Ramadan environmental effect, non-Muslim students only eat dinner, because they usually do not wake up early in the morning to eat Sahur meal. Therefore, non-Muslim students spend more time without food as compared to Muslim students, and hence, they affected more during this month. Furthermore, as it is discussed earlier that the amount of protein, fat, and sugar increased during Iftar and dinner as compared to meals of other days. These two factors affected the non-Muslim students more during Ramadan period than Muslim students, and indicators such as blood pressures, cholesterol, LDL, and triglyceride decreased more among non-Muslim students than Muslim students. Furthermore, other indicators were also comparable in both groups. We were not expecting these results, when we hypothesized this study. This factor of not receiving food during the daytime and hostel as the residence of non-Muslim students may be playing a major role for these un-expected results. Therefore, these results should be read with caution. Furthermore, studies should be conducted without these limitations to verify the outcomes.

Conclusion

The study revealed that the environment of Ramadan was helpful to the non-Muslim students more than the Muslim students, with respect to the biochemical parameters.

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Authors' contributions

Prof. Nazeer Khan developed the idea, prepared the tools and concept form, supervised the project, analyzed the data, and prepared the manuscript.

Prof. Syed Muhammad Tariq Rafi facilitated to make contact to the Pathology laboratory and arrange the research funding and support in manuscript writing.

Prof. Shameem Siddiqui registered the students and facilitated for blood sample collections. She also read and edited the manuscript.

Dr. Saba Shakeel, Dr. Haseeb-ur-Rahman, and Ms. Wajiha Hasan collected the data, including the filling of questionnaires, physical and blood pressure measurements, and blood sample collections.

Financial support and sponsorship

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Conflicts of interest

There are no conflicts of interest.

Compliance with ethical principles

The study followed the Nuremberg Codes and Declaration of Helsinki for participants' voluntary consent without any constraint and compulsion. The study was approved by the Institutional Review Board of JSMU.

References

1. Farooq A, Herrera CP, Almudahka F, Mansour R. A prospective study of the physiological and neurobehavioral effects of Ramadan fasting in preteen and teenage boys. J Acad Nutr Diet 2015;115:889-97.
2. Roky R, Chapotot F, Hakkou F, Benchekroun MT, Buguet A. Sleep during Ramadan intermittent fasting. J Sleep Res 2001;10:319-27.
3. BaHammam A, Alrajeh M, Albabtain M, Bahammam S, Sharif M. Circadian pattern of sleep, energy expenditure, and body temperature of young healthy men during the intermittent fasting of Ramadan. Appetite 2010;54:426-9.
4. Bahammam AS, Alaseem AM, Alzakri AA, Sharif MM. The effects of Ramadan fasting on sleep patterns and daytime sleepiness: An objective assessment. J Res Med Sci 2013;18:127-31.
5. Khan NB, Khan MH, Shaikh MZ, Khanani MR. Effects of Ramadan fasting on glucose levels and serum lipid profile among Type 2 diabetic patients. Saudi Med J 2010;31:1269-70.
6. Khan N, Khan MH, Shaikh MZ, Khanani MR, Rasheed A. Effects of Ramadan fasting and physical activity on glucose levels and serum lipid profile among Type 2 diabetic patients. Pak J Med Sci 2012;28:91-6. Available from: http://pjms.com.pk/index.php/pjms/article/view/1712. [Last accessed on 2017 Feb 08].
7. Jabbar A, Wan Mohamed WM, Spaepen E, Reed V, Tayeb K, Assaad Khalil SH, *et al*. Fasting experience of patients with Type 2 diabetes mellitus on insulin therapy during Ramadan: VISION Ramadan substudy. Diabetes Res Clin Pract 2019;151:285-9.
8. Khafaji HA, Bener A, Osman M, Al Merri A, Al Suwaidi J. The impact of diurnal fasting during Ramadan on the lipid profile, hs-CRP, and serum leptin in stable cardiac patients. Vasc Health Risk Manag 2012;8:7-14.
9. Khan N, Siddiqui S, Ali S, Qamar SM. Effect of physical activities and obesity on Ramadan fasting among hypertensive patients. J Fasting Health 2016;4:156-62.
10. Mbarki H, Tazi N, Najdi A, Tachfouti N, Arrayhani M, Sqalli T. Effects of fasting during Ramadan on renal function of patients with chronic kidney disease. Saudi J Kidney Dis Transpl 2015;26:320-4.
11. Rasheed AA, Rashid YA, Pirzada FT, Haroon F, Jabbar AA, Rahim A. Knowledge, attitude and perceptions of Muslim cancer patients regarding cancer treatment during Ramadan: Results from a tertiary care hospital Karachi. J Pak Med Assoc 2017;67:1144-50.
12. BaHammam AS, Pandi-Perumal SR, Alzoghaibi MA. The effect of Ramadan intermittent fasting on lipid peroxidation in healthy young men while controlling for diet and sleep: A pilot study. Ann Thorac Med 2016;11:43-8.
13. Nugraha B, Ghashang SK, Hamdan I, Gutenbrunner C. Effect of Ramadan fasting on fatigue, mood, sleepiness, and health-related quality of life of healthy young men in summer time in Germany: A prospective controlled study. Appetite 2017;111:38-45.
14. Shruthi B, Hassan A, Reddy BV. The effect of Ramadan fasting on the body composition, blood pressure, heart rate of healthy young adults. Inter J Recent Trends Sc Tech 2013;8:31-5.
15. Sayedda K, Kamal S, Ahmed Q. Effect of Ramadan fasting on anthropometric parameters, blood pressure, creatinine phosphokinase activity, serum calcium and phosphorus in healthy students of Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly-UP. Natl J Physiol Pharm Pharmacol 2013;3:48-52.
16. Gnanou JV, Caszo BA, Khalil KM, Abdullah SL, Knight VF, Bidin MZ. Effects of Ramadan fasting on glucose homeostasis and adiponectin levels in healthy adult males. J Diabetes Metab Disord 2015;14:55.
17. Khan N, Rasheed A, Ahmed H, Aslam F, Kanwal F. Effect of Ramadan fasting on glucose level, lipid profile, HbA1c and uric acid among medical students in Karachi, Pakistan. East Mediterr Health J 2017;23:274-9.
18. Ongsara S, Boonpol S, Prompalad N, Jeenduang N. The effect of Ramadan fasting on biochemical parameters in healthy Thai subjects. J Clin Diagn Res 2017;11:BC14-8.
19. Mansoor AJ. The effect of Ramadan fasting on body weight, fasting blood sugar and lipid profile of normal healthy and non-obese male medical college students in Tikrit city. Ann Tropical Med Health 2019;22:161-8.
20. Pakistan Bureau of Statistics: Available from: http://www.pbs.gov.pk/sites/default/files//tables/POPULATION%20BY%20RELIGION.pdf. [Last accessed on 2020 Feb 29].Huang RY, Huang CC, Hu FB, Chavarro JE. Vegetarian diets and weight reduction: A meta-analysis of randomized controlled trials. J Gen Intern Med 2016;31:109-16.
21. Goel M, Pal P, Agrawal A, Ashok C. Relationship of body mass index and other life style factors with hypertension in adolescents. Ann Pediatr Cardiol 2016;9:29-34.
22. Al Hourani HM, Atoum MF, Akel S, Hijjawi N, Awawdeh S. Effects of Ramadan fasting on some haematological and biochemical parameters. Jordan J Biological Sci 2009;2:103-8.
23. Lamri-Senhadji MY, El Kebir B, Belleville J, Bouchenak M. Assessment of dietary consumption and time-course of changes in serum lipids and lipoproteins before, during and after Ramadan in young Algerian adults. Singapore Med J 2009;50:288-94.
24. Al Hourani HM, Atoum MF, Akel S, Hijjawi N, Awawdeh S. Effects of Ramadan fasting on some haematological and biochemical parameters. Jordan J Biological Sci 2009;2:103-8.