

Effects of Ramadan Fasting on Anthropometric Measures, Blood Pressure and Glucose Level among Type 2 Diabetic Patients on Metformin Treatment

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Abstract

Background: Fasting from dawn to dusk during Ramadan is obligatory for all healthy adult Muslims. Our study was conducted to investigate the effects of Ramadan fasting and metformin as monotherapy for long period on waist circumference, body mass index, blood pressure and fasting plasma glucose among type 2 diabetic patients.

Methods: This a prospective observational study was conducted in the year 2018, among a representative sample of type 2 diabetic patients (aged 30 to 50 years), during Ramadan month that was falling in May 16 to June 14. All patients were on antidiabetic metformin 850mg twice daily, during Ramadan (Duration of disease was between 1 to 12 years). Finally, 73 patients successfully finished the study, with an average fast 16 ± 1 hours and maximum temperature was 42-48 °C. Data were analyzed using SPSS version 21.

Results: There were 44 (60.3%) females and 29 (39.7%) males with a mean age of 44.8 ± 7.2 years. The major finding of our study was the significant increase in systolic blood pressure; and the significant decrease in fasting plasma glucose, body mass index, and waist circumference in long-term metformin users after the end of Ramadan (P value < 0.05 for all). No significant association was found in diastolic blood pressure.

Conclusion: Intermittent fasting, healthy lifestyle, and regular drug administration might play an important role in the prevention and management of metabolic disorders in type 2 diabetes. But metformin users need more attention for their blood pressure as our result shows. Further future studies are required to confirm these findings.

Keywords: Blood Glucose; Blood Pressure; Overweight; Ramadan Fasting; Type 2 Diabetes Mellitus

List of abbreviations: BP: Blood Pressure; BMI: Body Mass Index; WC: Waist Circumference; FPG: Fasting Plasma Glucose; IDF: International Diabetes Federation; SPSS: Statistical Package for Social Science

Introduction

One of the pillars of Islam is fasting throughout the holy month of Ramadan (The profit of Islam). It is mandatory for all healthy adults to contribute in a sporadic fast for 29-30 days as established upon Islamic lunar calendar. Because Islamic calendar is shorter than solar calendar by 10-12 days, the time of fasting is not fixed during a given year, i.e., Ramadan fasting may fall within different seasons and rotate throughout the year each few years resulting in variation in time of fasting between countries and provinces [1]. Generally, duration of fasting fluctuates between 8 to 17 hours in winter and summer. During this period from brightening to gloaming all Muslims should not devour and drink (Holy Quran). Change in blood pressure (BP) was reported by many researcher during fasting, this change may result of dehydration then increased blood viscosity [2]. In terms of prevalence, hypertension has risen over last decades and rapidly increasing in developing countries among diabetic patents compare to none diabetic [3]. In view of the fact that knowing the prevalence of BP is important for determining the size of the population that may benefit from strategies that reduce BP and weight while fasting. Based on the Holy Quran, Ramadan fast is not obligatory for all

Muslims. For example, being “sick” is one of the exceptions. It is very important for medical professionals to be aware of potential risks or benefits of fasting, because the number of meals per day generally reduced to two large meals during the Ramadan. Study reported that fasting for a long period was beneficial to hypertensive and is associated with weight loss [4]. However, conflicted result on body mass index (BMI) and BP has been reported [5].

While most of the previous studies have focused on the effect of Ramadan fasting on metabolic changes in different groups of Muslims [6,7]. On the other hand, the efficacy and benefits of metformin treatment in type 2 diabetes have been confirmed by recent large-scale studies [8,9]. In addition, Almalki *et al.* [10] show that, people who take metformin alone should be able to fast safely given that the possibility of hypoglycemia is minimal. To the best of our knowledge, no published reports are available about the effect of Ramadan on the metabolic control in type 2 diabetic patients during different seasons in the Moslems Arab countries. Moreover, there is no study associating the summer fasting to the health outcome in the diabetic patients. In Particular, until now, there are no Kurdish health guidelines or formal trainings for diabetic Muslims in the Kurdistan region of Iraq. Thus, the objective of this study was to determine, the association between Ramadan fasting with waist circumference (WC), BMI, BP and fasting plasma glucose (FPG) in type 2 diabetic Muslim patients on metformin treatment, in Kurdistan region of Iraq.

Materials and Methods

Study Participants

This a prospective observational study was conducted in the year 2018, among a representative sample of Kurdish type 2 diabetic Muslims patients, selected through cluster random sampling method, during Ramadan month that was falling in May 16 to June 14. Age of the sample population ranged between 30-50 years. All patients were taking antidiabetic (Metformin 850mg twice daily) during Ramadan (Duration of disease was between 1 to 12 years). The present study was conducted in the communicable and non-communicable disease's control centers at Halabja hospital, Kurdistan region of Iraq. Overall, 125 patients were invited to participate, face-to-face interviews was conducted for 30 to 40 Minutes. Patients were excluded from the study if they did not follow the test regularly. Long and short-term insulin intake, type 1 diabetic, BP medicine intake, any interruption of Ramadan fasting more than five days (Subject who fasted less than 21 days), pregnant women, women with menstrual cycle during data collection and smokers were excluded. Finally, 73 patients (29 men and 44 women) with no history of high BP were successfully finished the study. The average fasting time was 16 ± 1 hours per day with a maximum temperature 40-45 °C. All patients continued their treatment with metformin during the course of the study (Metformin 850mg twice daily), once at Eftar time after meal and the other at Shoor time before meal.

Data collection

Data was collected at 4 different time points; One week before Ramadan start, 10th and 20th of Ramadan, and one week after Ramadan. Subjects came to the clinic in the morning for data collection.

Anthropometric Measurements

Detailed history and anthropometric measurement was performed for all the subjects, in four different times. Weight was measured with the use of a Seca scale and recorded to the nearest 0.1 kg. Height was measured with a Seca stadiometer while subjects were standing with their shoulders positioned normally. The BMI was calculated as the weight in kilograms divided by the height in meters square [11]. Furthermore, a stretch-resistant tape was used for measuring WC (cm); WC was measured at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest [12]. Measure of WC was defined according to the International Diabetes Federation definition (IDF) definition, ≥ 80 cm for women and ≥ 94 cm for men [13].

Assessment of Blood Pressure

During each visit, BP was measured from the left arm (mmHg), by mercury sphygmomanometer. While the patient was seated after relaxing for at least 15 minutes in a quiet environment, empty bladder [11]. In addition, hypertension was diagnosed according to IDF definition [13]. Raised BP: Systolic BP ≥ 130 mmHg or diastolic BP ≥ 85 mmHg, higher than 150/100 mmHg was excluded.

Biochemical Analysis

During each visit, after 12 hours fasting, venous blood samples was collected from all patients in the communicable and non-communicable disease's control centers at Halabja hospital, by well- trained and experienced nurses. Venous blood (4.0ml) was drawn into vacutainer tubes and was used for blood chemistry analysis. Serum was separated immediately and the extracted serum was investigated for FPG (mg/dl). Mindray BS 300 chemistry analyzer instrument was used for blood chemistry analysis [14]. The laboratory tests were analyzed in Halabja hospital laboratory.

Data Analysis

All statistical analyses were performed using Statistical Package for Social Science (SPSS) version 21. The descriptive statistics of mean, standard deviation and percentages were calculated for the entire sample. Chi-square test was used to examine differences

in the prevalence of different categorical variables. The differences between means were tested by one way ANOVA. P value less than 0.05 was considered as statistically significant.

Results

A total of 73 patients with type 2 diabetes mellitus, 44 (60.3%) females and 29 (39.7%) males with a mean age of 44.8 ± 7.2 years, with long-term metformin use were included in this study. The total number of days of fasting was 28 ± 2 days, and daily fasting duration was 16 ± 1 hours. The study subjects were taking normal diet before and after Ramadan. Table 1 shows the distribution of the study population by gender, age and duration of disease. Our findings revealed that no significant association was found between the study participants in term of gender, age and duration of disease (p value > 0.05). On the other hand, Table 2, show the change of anthropometric and other measurements of the study population before, during, and after Ramadan. The result of the present study demonstrate that the mean BMI (kg/m^2) was significantly decreased over time, 31.20 ± 4.36 one week before Ramadan vs. 30.34 ± 4.33 one week after of Ramadan (P value = 0.031). Furthermore, the mean BMI (kg/m^2) in 10th of Ramadan, 20th of Ramadan, and in one week after of Ramadan is lower than one week before of Ramadan. Furthermore, the mean FPG level (mg/dl) was significantly decreased over time, 269.24 ± 83.27 one week before Ramadan vs. 218.90 ± 74.55 one week after Ramadan (P value < 0.001). Moreover, the mean FPG level (mg/dl) in 10th of Ramadan, 20th of Ramadan, and in one week after of Ramadan is lower than one week before of Ramadan.

Variables	Frequency (n=73)	Percentage (100%)	P Value
Gender			
Male	29	39.7	0.073
Female	44	60.3	
Age (years), Mean: 44.8 ± 7.2			
30- 35 years	9	12.3	0.221
36-40 years	22	30.1	
41-45 years	20	27.4	
46-50 years	22	30.2	
Duration of diabetes mellitus (years), Mean: 8.45 ± 3.2			
4-6 years	27	37.0	0.354
7-9 years	36	49.3	
10-12 years	10	13.7	

Chi-square test was used to examine differences in the prevalence of different categorical variables. P value less than 0.05 was considered as statistically significant.

Table 1: Distribution of the study population by gender, age and duration of disease

Measurements	One week pre Ramadan (mean \pm SD)	10 th of Ramadan (mean \pm SD)	20 th of Ramadan (mean \pm SD)	Week after Ramadan (mean \pm SD)	P Value
Body mass index (kg/m^2)	31.20 ± 4.36	30.52 ± 4.34	30.52 ± 4.43	30.34 ± 4.33	0.031
Fasting plasma glucose (mg/dl)	269.24 ± 83.27	247 ± 77.78	242.42 ± 86.32	218.90 ± 74.55	0.001
Systolic blood pressure (mmHg)	122.6 ± 1.29	124.8 ± 1.31	129.2 ± 1.39	129.9 ± 1.13	0.027
Diastolic blood pressure (mmHg)	82.22 ± 1.00	81.41 ± 1.09	80.35 ± 1.09	82.58 ± 0.98	0.624
Waist circumference (cm)	105.8 ± 12.7	103.5 ± 15.9	103.0 ± 13.4	101.2 ± 16.0	0.047

The descriptive statistics of mean, and standard deviation were calculated for the entire sample. The differences between means were tested by one way ANOVA. P value less than 0.05 was considered as statistically significant.

Table 2: Anthropometric and other measurements of the study population before, during, and after Ramadan

With respect to BP, our findings revealed that, the mean systolic BP (mmHg) was significantly increased over time, 122.6 ± 1.29 one week before Ramadan vs. 129.9 ± 1.13 one week after Ramadan (P value = 0.027). Additionally, the mean systolic BP (mmHg) in 10th of Ramadan, 20th of Ramadan, and in one week after of Ramadan is higher than one week before of Ramadan. No significant association was found in diastolic BP over time (P value = 0.624). Finally, the results of the present study revealed that, the mean WC (cm) was significantly decreased over time, 105.8 ± 12.7 one week before Ramadan vs. 101.2 ± 16.0 one week after Ramadan (P value = 0.047). Moreover, the mean WC (cm) in 10th of Ramadan, 20th of Ramadan, and in one week after of Ramadan is lower than one week before of Ramadan.

Discussion

To the best of our knowledge, this is the first study which describes the association between Ramadan fasting with WC, BMI, BP and FPG in type 2 diabetic Muslim patients on metformin treatment, in Kurdistan region of Iraq. The main findings of this

study indicate that, BMI and WC was significantly decreased after Ramadan, this was in accordance with similar studies [15-17]. Decrease in body weight and BMI [18], improve in glycemic control has also been reported in type 2 diabetics [19], and healthy adults [20]. In addition, different periods of fasting in different seasons (16 to 17 hours) is another important factors, which can affect the obtained findings [21]. Overweight and obesity is a heterogeneous disease associated with the risk factor for development of type 2 diabetes [22,23]. The qualifications of eating configuration, low calorie intake, loss of midday meals when the body is metabolically active, exercise religious activity (prayer), behavioral changes, and improvement of psycho-physiological during Ramadan fast status [24], might helpful in improving and arrangement of life style related disorder like metabolic syndrome, overweight and obesity [25]. Beside, meta-analysis study shows that, being overweight associated with increased risk of diabetic retinopathy [26]. The greatest parts of researchers and physicians are find an intermittent fasting is satisfactory for patients with well-controlled diabetes. BMI and WC are significantly changes, not just result of decrease in food intake (less energy intake and more energy expenditure) but also the result may strongly have related to dehydration produced by exhaustion of body fluids and loss of water and fluid intake, not related to decrease in body fat [27].

In term of FPG conflicting result leading to differences especially in the management of type 2 diabetics. "Expert Muslim medical practitioner" believe that fasting during Ramadan may make disease harmful, but, it is different in patients with type 2 diabetes if fitting direction about meal and hypoglycemic medication is designated [28,29]. In the result of our study we found that, range of FPG are significantly changes during and after Ramadan fasting. It is acceptable that living with type 2 diabetics did not inhabit patients from fasting with regular metformin medication and it can improve insulin sensitivity due to long duration of fasting [30]. Studies have been reported noticeable decline in glucose level during Ramadan fast [31,32]. However, many factors such as environmental factors, regular drug intake, different in dietary habits, seasons, prolonged hunger, sleep disorder, physical activity and sugar intakes, make our result to agreement with some of the previous studies [3-35]. Conflict report study shows a significant increase in blood glucose level towards the end of Ramadan in adult, it may be related to increased gluconeogenesis [36].

Mixed change in BP among diabetic patients was reported by many researchers during Ramadan fasting [37-39]. This change may result of different reasons; people are allowed to eat and drink after dusk and before dawn, traditional high sugar intake and consuming of high fat foods [36], longer fasting hours associated with dehydration then increased blood viscosity [2], changing in dietary pattern and behaviors-weak up for meal at night and return to sleep-some afternoon nap and less physical activity [37], sleep imbalance, energy restriction, physiological effects and decrease number of meals [5]. All reasons may be able to have posed on additional risk for BP control. Analysis of our data indicated significant increase in systolic BP during Ramadan fast compared to before and after. But this change did not required treatment. Our finding is in contrast with other studies in diabetic patients [38-40], no significant changes [8,37], no change in BP may due to fact that people are on balanced diet and exercise doing, this retained homeostasis and BP did not change. This discrepancy may be due to long hunger period in which glucose storage exhausted and fat become as a source of energy, thus, help in weight loss, better glycemic control, help in decrease BP and other lifestyle related disease [41]. Beside, mixed result for change in BP among diabetic patients that use metformin during Ramadan has been reported [42]. The beneficial effect of metformin has been appraised it is anti-hyperglycemic efficacy and it can effect on body weight and BP [41]. Study shows that metformin significantly decreases BP in non-diabetic hypertensive obese [42]. Improving insulin sensitivity by metformin during Ramadan fast decrease BP in untreated hypertensive non-obese [43]. Concluded result shows use of metformin for diabetic control had no effect on BP [44,45]. Interestingly, all finding are in contrast with our finding [46]. Further future studies with long period are required to confirm these findings.

The strength of the present study is that this is the first study, which investigated the association between Ramadan fasting with WC, BMI, BP and FPG among type 2 diabetic patients on metformin treatment. However, this study has some limitations that must be considered. There was no control group in this study, as it was not attainable to find eligible Muslims who did not fast during the month of Ramadan. Likewise, it was impossible to monitor food record and food intake due to eating of too much sugar-rich food during non-fasting hours. Unfortunately, we do not have measure of glycated hemoglobin as a marker of diabetes control. Moreover, decreased physical activity was another concern during the data collection in Ramadan. Usually, people who fast do not perform their normal physical activities during the month of Ramadan. However, it was known that all participants had Taraweh prayer at night after Eisha. Further future studies are required to confirm these findings.

Conclusion

We conclude that, the largest change observed during Ramadan was increased systolic and diastolic BP whereas the other metabolic parameters significantly decreased after Ramadan fasting. We reals that fasting appears to be safe in diabetic patients, but metformin users need more attention for their BP.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the local Ethics Committee of Halabja hospital, centers for control of communicable and non-communicable disease to conduct this study. Furthermore, written informed consent was obtained from the study participants and concerned bodies.

Authors' Contributions

AA, HF, KW, MS, KD and AHB participated in the design of the study, data collection, performed the statistical analysis and drafted the manuscript. KD and AHB supervising the study and participated in draft review. All authors have read and approved the final version of the manuscript and agree with the order of presentation of the authors.

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References

1. Shariatpanahi ZV, Shariatpanahi MV, Shahbazi S, Hossaini A, Abadi A (2008) Effect of Ramadan fasting on some indices of insulin resistance and components of the metabolic syndrome in healthy male adults. *Br J Nutr* 100: 147-51.
2. Akhan G, Kutluhan S, Koyuncuoglu HR (2000) Is there any change of stroke incidence during Ramadan? *Acta Neurol Scand* 10: 259-61.
3. Zargar AH, Wani AA, Laway BA, Masoodi SR, Wani AI, et al. (2008) Prevalence of diabetes mellitus and other abnormalities of glucose tolerance in young adults aged 20-40 years in North India (Kashmir Valley). *Diabetes Res Clin Pract* 82: 276-81.
4. Harvie M, Howell A (2017) Potential benefits and harms of intermittent energy restriction and intermittent fasting amongst obese, overweight and normal weight subjects a narrative review of human and animal evidence. *Behav Sci (Basel)* 7: E4.
5. Stote KS, Baer DJ, Spears K, Paul DR, Harris GK, et al. (2007) A controlled trial of reduced meal frequency without caloric restriction in healthy, normal-weight, middle-aged adults. *Am J Clin Nutr* 85: 981-8.
6. Sadiya A, Ahmed S, Siddiq HH, Babas IJ, Carlsson M (2011) Effect of Ramadan fasting on metabolic markers, body composition, and dietary intake in Emiratis of Ajman (UAE) with metabolic syndrome. *Diabetes Metab Syndr* 4: 409-16.
7. Gur EB, Turan GA, Ince O, Karadeniz M, Tatar S, et al. (2015) Effect of Ramadan fasting on metabolic markers, dietary intake and abdominal fat distribution in pregnancy. *Hippokratia* 19: 298-303.
8. UK Prospective Diabetes Study Group (1998) UKPDS 28: a randomized trial of efficacy of early addition of metformin in sulfonylurea-treated type 2 diabetes. *Diabetes Care* 21: 87-92.
9. Howlett HC, Bailey CJ (1999) A risk-benefit assessment of metformin in type 2 diabetes mellitus. *Drug Saf* 20: 489-503.
10. Almalki MH, Alshahrani F (2016) Options for controlling type 2 diabetes during Ramadan. *Fron Endocrinol* 7: 32.
11. Farag HAM, Hosseinzadeh-Attar MJ, Muhammad BA, Esmailzadeh A, El Bilbeisi AH (2019) Effects of vitamin C supplementation with and without endurance physical activity on components of metabolic syndrome: A randomized, double-blind, placebo-controlled clinical trial. *Clinical Nutrition Experimental* 26: 23-33.
12. Farag HAM, Hosseinzadeh-Attar MJ, Muhammad BA, Esmailzadeh A, El Bilbeisi AH (2019) Effects of vitamin D supplementation along with endurance physical activity on lipid profile in metabolic syndrome patients: A randomized controlled trial. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews* 13: 1093-8.
13. Farag HAM, Hosseinzadeh-Attar MJ, Muhammad BA, Esmailzadeh A, El Bilbeisi AH (2018) Comparative effects of vitamin D and vitamin C supplementations with and without endurance physical activity on metabolic syndrome patients: a randomized controlled trial. *Diabetol metab syndr* 10: 80.
14. El Bilbeisi AH, Hosseini S, Djafarian K (2017) Association of dietary patterns with diabetes complications among type 2 diabetes patients in Gaza Strip, Palestine: a cross sectional study. *J Health Popul Nutr* 36: 37.
15. Saleh SA, Elsharouni SA, Cherian B, Mourou M (2005) Effects of Ramadan fasting on waist circumference, blood pressure, lipid profile, and blood sugar on a sample of healthy Kuwaiti men and women. *Mal J Nutr* 11: 143-50.
16. Saiya S, Saiyad M, Patel U, Verma A (2014) Effect of Ramadan fasting on anthropological and physiological parameters. *NHL Journal of Medical Sciences* 3.
17. Ziaee V, Razaee M, Ahmadinejad Z, Shaikh H, Yousefi R, et al. (2006) The changes of metabolic profile and weight during Ramadan fasting. *Singapore med J* 47: 409-14.
18. Memari AH, Kordi R, Panahi N, Nikookar LR, Abdollahi M, et al. (2011) Effect of Ramadan fasting on body composition and physical performance in female athletes. *Asian J sports med* 2: 161-6.
19. Rahman O, Islam MR (2011) Association between fasting of Ramadan and risk factors of diabetes: A study from Rajshahi city in Bangladesh. *Adv J Food Sci Technology* 3: 360-5.
20. Siaw MYL, Chew DEK, Dalan R, Shakoora A, Kamaldeen SAK, et al. (2014) Evaluating the effect of Ramadan fasting on muslim patients with diabetes in relation to use of medication and lifestyle patterns: a prospective study. *Int J Endocrinol* 2014: Article ID 308546.
21. Çomoğlu S, Temizhan A, Peşinci E, Tandoğan İ, Özbakir Ş (2003) Effects of Ramadan fasting on stroke. *Turk J Med Sci* 33: 237-41.
22. Saada DA, Selselet G, Belkacemi L, Chabane OA, Italhi M, et al. (2010) Effect of Ramadan fasting on glucose, glycosylated haemoglobin, insulin, lipids and protein concentrations in women with non-insulin dependent diabetes mellitus. *African J Biotechnology* 9: 87-94.
23. Karalliedde J, Gnudi L (2014) Diabetes mellitus, a complex and heterogeneous disease, and the role of insulin resistance as a determinant of diabetic kidney disease. *Nephrol Dial Transplant* 31: 206-13.
24. McLaughlin T, Abbasi F, Lamendola C, Reaven G (2007) Heterogeneity in the prevalence of risk factors for cardiovascular disease and type 2 diabetes mellitus in obese individuals: effect of differences in insulin sensitivity. *Arch Intern Med* 167: 642-8.
25. Jaleel MA, Fathima FN, Jaleel BN (2013) Nutrition, energy intake-output, exercise, and fluid homeostasis during fasting in Ramadan. *Journal of Medical Nutrition and Nutraceuticals* 2: 63-8.
26. Ünalacak M, Kara IH, Baltacı D, Erdem Ö, Bucaktepe PGE (2011) Effects of Ramadan fasting on biochemical and hematological parameters and cytokines in healthy and obese individuals. *Metab syndr relat disord* 9: 157-61.
27. Renehan AG, Tyson M, Egger M, Heller RF, Zwahlen M (2008) Body-mass index and incidence of cancer: a systematic review and meta-analysis of prospective observational studies. *Lancet* 371(9612): 569-78.

28. Rohin MAK, Rozano N, Abd Hadi N, Nor M, Nasir M, et al. (2013) Anthropometry and body composition status during Ramadan among higher institution learning centre staffs with different body weight status. *Scientific World J* 2013: 308041.
29. Sulimani RA, Famuyiwa FO, Laajam MA (1988) Diabetes mellitus and Ramadan fasting: the need for a critical appraisal. *Diabet med* 5: 589-91.
30. Ahmad J, Pathan MF, Jaleel MA, Fathima FN, Raza SA, et al. (2012) Diabetic emergencies including hypoglycemia during Ramadan. *Indian J Endocrinol Metab* 16: 512-5.
31. Landin K, Tengborn L, Smith U (1991) Treating insulin resistance in hypertension with metformin reduces both blood pressure and metabolic risk factors. *J Intern Med* 229: 181-7.
32. Azizi F, Rasouli HA (1987) Serum glucose, bilirubin, calcium, phosphorus, protein and albumin concentrations during Ramadan. *Medical Journal of The Islamic Republic of Iran* 1: 38-41.
33. Hosseini SRA, Hejazi K (2013) The effects of Ramadan fasting and physical activity on blood hematological-biochemical parameters. *Iran J Basic Med Sci* 16: 845-9.
34. Gnanou JV, Caszo BA, Khalil KM, Abdullah SL, Knight VF, et al. (2015) Effects of Ramadan fasting on glucose homeostasis and adiponectin levels in healthy adult males. *J Diabetes Metab Disord* 14: 55.
35. Momen HK, Elzouki ANY, Gatie J, El-Mansoury AM, Tashani A (2007) Effect of Ramadan fasting on blood glucose and serum lipid profiles in Libyan diabetic patients. *J Sci Applications* 1: 14-7.
36. Robertson MD, Henderson RA, Vist GE, Rumsey RDE (2002) Extended effects of evening meal carbohydrate-to-fat ratio on fasting and postprandial substrate metabolism. *Am J Clin Nutr* 75: 505-10.
37. BaHammam A (2003) Sleep pattern, daytime sleepiness, and eating habits during the month of Ramadan. *Sleep and Hypnosis* 5: 165-74.
38. Khalili RMA, Shafekh SE, Norhayati AH, Munira MIS, Nasir MM, et al. (2014) Cardiovascular and Blood Glucose Adaptation during Ramadan Fasting among Different Weight Status Subjects. *Annual Research & Review in Biology*: 3771-9.
39. Shehab A, Abdulle A, El Issa A, Al Suwaidi J, Nagelkerke N (2012) Favorable changes in lipid profile: the effects of fasting after Ramadan. *PloS one* 7: e47615.
40. Salahuddin M, Sayed Ashfak AH, Syed SR, Badaam KM (2014) Effect of Ramadan fasting on body weight, (BP) and biochemical parameters in middle aged hypertensive subjects: an observational trial. *J Clin Diagn Res* 8: 16-8.
41. Perk G, Ghanem J, Aamar S, Ben-Ishay D, Bursztyn M (2001) The effect of the fast of Ramadan on ambulatory blood pressure in treated hypertensives. *J Hum Hypertens* 15: 723-5.
42. Chen Y, Copeland WK, Vedanthan R, Grant E, Lee JE, et al (2013) Association between body mass index and cardiovascular disease mortality in east Asians and south Asians: pooled analysis of prospective data from the Asia Cohort Consortium. *BMJ* 347: f5446.
43. Giugliano D, De Rosa N, Di Maro G, Marfella R, Acampora R, et al. (1993) Metformin improves glucose, lipid metabolism, and reduces blood pressure in hypertensive, obese women. *Diabetes care* 16: 1387-90.
44. Abbink EJ, Pickkers P, Van Rosendaal AJ, Lutterman JA, Tack CJ, et al. (2002) Vascular effects of glibenclamide vs. glimepiride and metformin in Type 2 diabetic patients. *Diabet Med* 19: 136-43.
45. Wulfele MG, Kooy A, Lehert P, Bets D, Donker AJM, et al. (2005) Does metformin decrease blood pressure in patients with Type 2 diabetes intensively treated with insulin? *Diabet Med* 22: 907-13.
46. Chu NV, Kong AP, Kim DD, Armstrong D, Baxi S, et al. (2002) Differential effects of metformin and troglitazone on cardiovascular risk factors in patients with type 2 diabetes. *Diabetes Care* 25: 542-9.

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