

## Effects of Ramadan fasting and physical activity on glucose levels and serum lipid profile among Type 2 diabetic patients

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### ABSTRACT

**Objectives:** To assess the effect of fasting and physical activity on blood pressure, fasting glucose, cholesterol, triglyceride, high density and low density lipoproteins among diabetic type 2 patients.

**Methodology:** Seventy five patients who had three visits (last ten days of Shabann (visit 1), Ramadan (visit 2) and Shawwal (visit 3)) were included in the study. Physical measurements, clinical measurements and 12 hours fasting blood sample were taken, along with an interview for demographic information and physical activity on each visit. The samples were analyzed for 1) Glucose, 2) Cholesterol, 3) Triglyceride, 4) Uric Acid, 5) HDL-C, and 6) LDL-C.

**Results:** The mean weight of the patients decreased significantly from 71.43 kg to 69.41 kg from visit 1 to visit 2. Mean systolic blood pressure also decreased significantly from 124.25 mm/Hg to 119.86 mm/Hg while. Mean triglyceride level decreased from 239.095mg/L to 207.07 mg/L from visit 1 to visit 2 and it kept decreasing to 159.25 mg/L till third visit. Mean LDL value increased from 104.12 mg/L to 112.64 mg/L from visit one to visit two and then further increased to 119.0 mg/L on the third visit.

**Conclusion:** Ramadan fasting is safe for diabetes type II patients and is associated with weight loss and improvement in the overall diabetic control. Furthermore, the physical activities could reduce the body weight, waist measurement, systolic blood pressure, triglyceride and HDL.

**KEY WORDS:** Ramadan fasting, Diabetic patients, Physical activity, Lipid profile, Glucose levels, Pakistan.

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### INTRODUCTION

Fasting is obligatory for all adult Muslim men and women from dawn to dusk in the month of Ramadan except those who are sick. Some studies have discussed the biochemical changes among fasting patients both in non diabetic subjects<sup>1-6</sup> and diabetic patients.<sup>7-13</sup> An International Consensus Meeting<sup>14</sup> and a study of 13 Muslim countries<sup>7</sup> on diabetic subjects established the guidelines pertaining to definitions of patient groups who should be exempted from fasting, as well as recommendations on medication regimens and monitoring of diabetes before, during, and after Ramadan, and proposed education programs for diabetic patients. A Saudi study showed that only

33% diabetic patients received general advice on fasting during Ramadan.<sup>15</sup>

During the fasting Muslims change their diet and sleep patterns. They consume foods that are richer in carbohydrate and lipids, particularly mono- and polyunsaturated fatty acids.<sup>16</sup> Their night sleep is reduced due to changes in eating timings and prayers, and their physical activities are decreased due to long hours without food. Ziaee et al<sup>1</sup> has explained that the changes in lipid profile during Ramadan might be due to the physical activity. Many studies including those done in Pakistan have reported, changes in the lipid profile and glucose levels among diabetes type 2 patients.<sup>5,7,10,13</sup>

However, none of these studies looked at the effect of physical activities of Ramadan fasting of type 2 diabetic patients on glucose level and lipid profiles. The objective of this study was to assess the effect of fasting and physical activity on blood pressure, fasting glucose, cholesterol, triglyceride, high density and low density lipoproteins among diabetic type 2 patients.

## METHODOLOGY

One hundred seventy nine patients of Type 2 diabetes mellitus (DM) of age group of more than 20 years were invited to participate in this study. They were selected from the National Institute of Diabetic and Endocrinology of Dow University of Health Sciences and private clinics of one of the co-authors (MZS). The study was approved by Ethical Review Board of Dow University of Health Sciences. The excluding criteria were the patients with type 1 DM, pregnant women, seriously sick, renal failure, hepatic impairment, user of weight reducing agents and subjects who fasted for less than 20 days. The

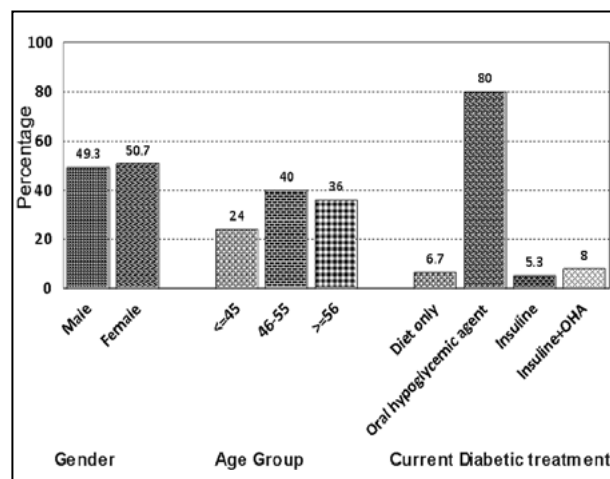


Fig.1: Distribution of patients by gender, age group and current diabetic treatment.

visits were arranged in the last ten days of Shaban (visit 1), Ramadan (visit 2) and Shawwal (visit 3) of 1429 Hijri, corresponding about 24 August to 01 September, 22 to 30 September and 21 to 31 October of 2008, respectively. The fasting duration in Karachi was about 14 hours in 2008. The objective was explained to the study patients on first visit with the benefits of free testing and treatments during the study period and informed consent was taken from each participant. The patients who showed up in all the three visits were only 75.

On all three visits, physical measurements (height, weight, waist and hips measurements), clinical measurements (systolic and diastolic blood pressures) and blood sample were taken, along with an interview on a pre-designed Performa from each patient. Blood sample was collected after 12 hours fasting in two tubes and sent to the Diagnostic Research and Reference Laboratory of Dow University of Health Sciences for blood analysis within two hours. All samples were analyzed for 1) Glucose, 2) Cholesterol, 3) Triglyceride, 4) Uric Acid, 5) HDL-C, and 6) LDL-C on Hitachi 902 auto analyzer using Diasorin kits. The questionnaire contained the demographic data, systemic disease, physical activity (frequency, intensity and type of exercise), smoking, eating and sleeping habits. The number of days fasted during the Ramadan period was asked on the last visit.

Type of physical activities was divided into high, medium and low intensity. High intensity activity, such as running, swimming and fast cycling were given Metabolic Energy Turnover (MET) value of 7.5, moderate intensity activity, such as cycling, light jogging and brisk walking were given MET value of 6 and low intensity activity such as golfing

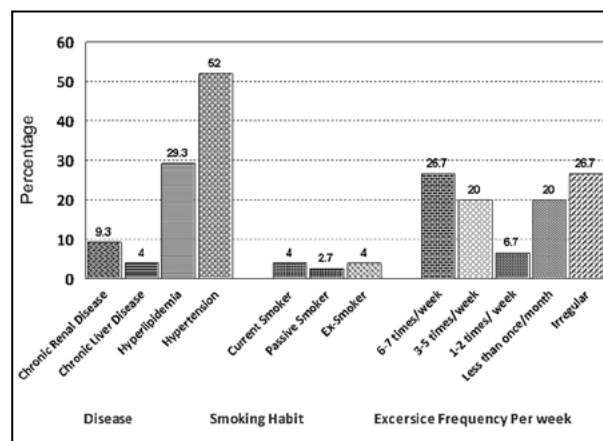


Fig.2: Percentage of diabetic patients with other chronic disease, smoking habits and frequency of exercise.

and normal walking were given MET value of 2.5. One MET value is equal to the energy expenditure at rest, or roughly 3.5ml of oxygen consumed per kilogram of the body weight per minute. Physical activity is defined as:

Physical Activity = MET value x (duration of activity in minutes/session) x frequency of the activity/week. A person was defined as 'active, if the physical activity value was more than 600 MET-minutes per week, otherwise he/she was categorized as 'inactive'.<sup>17</sup>

Analysis of Variance (ANOVA) with repeated measure design was employed with number of fasting days and physical activity (active/inactive) as co-factors. Least square difference (LSD) was used as post Hoc test for differences between the visits. The p-value less than 5% were considered as significant difference.

## RESULTS

Seventy five patients completed all the three visits. The gender distribution was almost the same (Male = 38; Female 37). The mean age of the participants was  $52.8 \pm 8.5$  years (R: 36 – 71 years). Eighty percent of the patients were taking only 'oral hypoglycemic agent' as the diabetic treatment (Fig.1). The mean duration of diabetes was  $5.6 \pm 5.3$  years (R: 9 months – 18 years). The patients with history of chronic liver diseases, hyperlipidemia and hypertension were

4.0%, 29.3% ad 52.0%, respectively (Fig.2). Seventy eight percent of the patients were involved in some physical exercises. The frequency of the exercises of 6-7 times/week, 3-5 times/week, 1-2 times/week, less than once a month and irregular was 26.7%, 20.0%, 6.7%, 20.0% and 26.7%, respectively. Eighty percent of the patients were doing normal walking as the exercise.

Mean weight was decreased significantly ( $p < 0.0001$ ) from 71.43 kg to 69.41 kg from first visit to second visit and then increased to 70.16 kg on third visit. The changes in mean waist and hip values, and waist/hip ratio during study period were very modest and insignificant.

Mean systolic blood pressure decreased significantly ( $p = 0.011$ ) from 124.25 mmHg to 119.86 mmHg from 1<sup>st</sup> visit to 2<sup>nd</sup> visit and then increased on 3<sup>rd</sup> visit to 124.17 mmHg. The mean diastolic blood pressure also decreased insignificantly from visit 1 to visit 2 and then insignificantly to visit 3. Mean fasting blood sugar decreased from 158.09 mg/L to 148.96 mg/L from first visit to second visit and then increased to 153.68 mg/L on third visit. The changes were statistically insignificant.

Mean cholesterol level increased significantly on third visit from first visit. Mean triglyceride level also decreased insignificantly ( $p=0.125$ ) from 239.95 mg/L to 207.07 mg/L from first visit to second visit and further reduced significantly ( $p < 0.0001$ )

Table-I: Mean  $\pm$  SD of physical measurements and blood pressure in the 3 visits.

	Visit 1	Visit 2	Visit 3	Effect of Covariate p-value		
	Mean $\pm$ SD (95% CI)	Mean $\pm$ SD (95% CI)	Mean $\pm$ SD (95% CI)	Fasting days	Activity	Fasting days *Activity
Weight (kg)	71.43 $\pm$ 15.45 <sup>a</sup> (69.1 – 74.5)	69.41 $\pm$ 11.55 <sup>b</sup> (66.3 – 71.8)	70.16 $\pm$ 11.37 <sup>b</sup> (67.1 – 72.6)	0.311	0.375	0.163
Waist (cm)	98.16 $\pm$ 10.13 <sup>a</sup> (95.9 – 100.4)	97.84 $\pm$ 9.24 <sup>a</sup> (96.0 – 99.7)	98.80 $\pm$ 8.82 <sup>a</sup> (97.0 – 100.7)	0.155	0.184	0.109
Hips (cm)	102.26 $\pm$ 10.42 <sup>a</sup> (98.8 – 105.7)	103.79 $\pm$ 10.65 <sup>a</sup> (100.3 – 105.9)	103.69 $\pm$ 10.08 <sup>a</sup> (100.5 – 105.5)	0.736	0.522	0.741
Waist-hip ratio	0.96 $\pm$ 0.074 <sup>a</sup> (0.94 – 0.98)	0.95 $\pm$ 0.072 <sup>a</sup> (0.93 – 0.97)	0.96 $\pm$ 0.079 <sup>a</sup> (0.94 – 0.98)	0.581	0.418	0.203
Systolic Blood Pressure (mmHg)	124.25 $\pm$ 17.39 <sup>a</sup> (121.7 – 128.7)	119.86 $\pm$ 12.50 <sup>b</sup> (115.9 – 123.4)	124.17 $\pm$ 15.72 <sup>ab</sup> (119.35 – 128.2)	0.510	0.271	0.714
Diastolic Blood Pressure (mmHg)	82.19 $\pm$ 8.81 <sup>a</sup> (80.5 – 84.8)	79.31 $\pm$ 9.24 <sup>a</sup> (79.2 – 83.7)	81.11 $\pm$ 7.56 <sup>a</sup> (75.9 – 82.6)	0.798	0.741	0.969
Physical Activity	248.9 $\pm$ 413.4 <sup>a</sup> (153.8 – 344.0)	196.4 $\pm$ 287.4 <sup>a</sup> (130.4 – 262.6)	224.1 $\pm$ 355.1 <sup>a</sup> (142.4 – 305.8)			

The superscripts show the pair-wise significance. The different alphabets show statistical significance.

Table-II: Mean  $\pm$  SD of lipid profile and uric acid in the 3 visits.

Lipids	Visit 1 Mean $\pm$ SD (95% CI)	Visit 2 Mean $\pm$ SD (95% CI)	Visit 3 Mean $\pm$ SD (95% CI)	Effect of Covariate p-value		
				Fasting days	Activity	Fasting days *Activity
Fasting blood sugar (mg/dl)	158.09 $\pm$ 47.52 <sup>a</sup> (144.6 – 166.1)	148.96 $\pm$ 52.64 <sup>a</sup> (137.51 – 160.8)	153.68 $\pm$ 50.94 <sup>a</sup> (131.5 – 164.4)	0.277	0.381	0.565
Total Cholesterol (mg/dl)	173.08 $\pm$ 36.20 <sup>a</sup> (164.1 – 181.5)	172.27 $\pm$ 38.82 <sup>ab</sup> (163.7 – 180.8)	177.83 $\pm$ 37.58 <sup>b</sup> (169.2 – 188.9)	0.293	0.390	0.436
Triglyceride (mg/dl)	239.95 $\pm$ 113.85 <sup>a</sup> (213.7 – 262.1)	207.07 $\pm$ 96.44 <sup>a</sup> (178.4 – 229.5)	159.25 $\pm$ 72.75 <sup>b</sup> (140.7 – 176.1)	0.110	0.226	0.335
HDL (mg/dl)	40.88 $\pm$ 9.35 <sup>a</sup> (38.9 – 43.1)	40.34 $\pm$ 9.62 <sup>a</sup> (38.5 – 43.4)	43.28 $\pm$ 10.15 <sup>b</sup> (41.8 – 45.9)	0.424	0.239	0.420
LDL (mg/dl)	104.12 $\pm$ 35.51 <sup>a</sup> (97.9 – 111.8)	112.64 $\pm$ 34.19 <sup>b</sup> (104.0 – 119.3)	119.0 $\pm$ 35.1 <sup>c</sup> (108.4 – 130.1)	0.472	0.465	0.493
HDL/LDL Ratio	4.392 $\pm$ 1.144 <sup>a</sup> (4.1 – 4.6)	4.25 $\pm$ 1.02 <sup>a</sup> (4.0 – 4.5)	4.16 $\pm$ 1.15 <sup>a</sup> (3.8 – 4.5)	0.276	0.838	0.558
Uric acid	5.83 $\pm$ 1.64 <sup>a</sup> (5.4 – 6.2)	5.48 $\pm$ 1.61 <sup>b</sup> (4.9 – 5.9)	5.59 $\pm$ 1.60 <sup>ab</sup> (5.2 – 6.1)	0.897	0.558	0.908

The superscripts show the pair-wise significance. The different alphabets show statistical significance.

to 159.25 mg/L on third visit. Mean HDL values increased significantly ( $p < 0.001$ ) on visit 3 from visit 2. Mean LDL value increased significantly ( $p = 0.007$ ) from 104.12 mg/L to 112.64 mg/L from visit 1 to visit 2 and then further increased significantly ( $p = 0.036$ ) to 119.0 mg/L on third visit. Mean Uric acid value decreased significantly ( $p = 0.046$ ) from 5.83 mg/L to 5.48 mg/L from first visit to second visit and then increased to 5.59 mg/L on third visit.

Neither the number of fasting days, nor the physical activities nor its interaction showed any significant effect on any physical and biochemical outcomes. However, marked changes were observed in waist measurement, systolic blood pressure, triglyceride and HDL values among active patients.

## DISCUSSION

To the best of our knowledge it was first study conducted in Pakistan to study the effect of fasting and physical activities on lipid profile, glucose level and uric acid of type 2 diabetic patients. In this study, the mean weight and BMI of the patients reduced significantly during the month of Ramadan. Other studies<sup>2,12,15,18</sup> also showed a decrease in weight and BMI among this population. However, few studies<sup>19</sup> did not show any change in the weight of fasting Muslims during Ramadan.

It is generally observed that Muslims stop doing physical activities, especially exercises during the month of Ramadan.<sup>1</sup> It is especially directed toward the diabetic patients who ceased exercises during the day time to avoid hypoglycemia.

Furthermore, dishes that are mostly cooked in oil and ghee are prepared for the iftar time (the time to break the fast). These factors do not help in weight reduction among the fasting people and sometimes, even, increase their body weight. This study did not show any significant change in waist, hips measurements or waist-hips ratio. However, Yarahmadi et al<sup>12</sup> have reported a significant decrease in waist-hips ratio of Iranian men due to Ramadan fasting. There was significant fall of systolic blood pressures (SBP) during the month of Ramadan. The diastolic blood pressure also decreased during Ramadan, but it was not statistically significant. However, these downward changes were reversed in the month of Shawwal. Other studies<sup>13,15,19</sup> did not show any significant change in the blood pressure in diabetic patients.

Mean fasting glucose level in this study decreased during Ramadan and then it increased in month of Shawwal. The differences were not statistically significant. Many other studies<sup>4,10-12,20</sup> also did not show any significant change among fasting diabetic patients in Ramadan. It was suggested

that if there were changes in glucose level, it was due to variation in the amount of food, physical activity, or irregular medication.<sup>21</sup> Surprisingly, the triglyceride level decreased significantly in Ramadan and further reduced significantly in the month of Shawwal. The reduction in triglyceride level is also demonstrated by Sari et al.<sup>20</sup> The decline in triglyceride after Ramadan may be due to the subjects sensitization about healthy eating habits which they continued after Ramadan or/and the metabolic acclimatization of Ramadan continued in post Ramadan period. The changes in HDL in this study were in agreement with the studies of Dowood<sup>4</sup> and Elnasri & Ahmed.<sup>11</sup> About the significant fall in LDL level in this study, Dawood<sup>4</sup> agreed with this finding. However, Yarahmadi et al<sup>12</sup> showed significant increase in LDL level.

Even tough, there was no significant difference due to activity, but low p-values showed that there were some changes in weight, waist measurement, systolic blood pressure, triglyceride and HDL. It could be due to increased fat utilization among active patients, which consequently reduces body mass and body fat content and hence reduces above mentioned physical and clinical parameters, as reported by other studies.<sup>22,23</sup>

Literature indicates that there are many factors which contribute to the changes in body metabolism; especially; changes in diet patterns, sleeping hours and physical activity.<sup>24</sup> Therefore, only physical activity did not show any statistical significance in this study. Al-Hourani and Atoum<sup>25</sup> also did not find any change in physical activity among young healthy females during Ramadan. This study was not designed to measure a comprehensive and deep analysis for altered sleeping and diet patterns along with physical activity and fasting effects. Nevertheless, the sample size was large enough to detect the effects of physical activity and fasting on lipid profiles and glucose level on this population. Furthermore, all the conflicting reports discussed earlier clearly indicate that there is a need for population based study for the three essential elements for DM patients; drug regimens, diet control and daily activity, along with sleeping patterns and dietary habits to come up with some concrete results in change of glucose level, lipid profile, uric acid and other parameters.

## CONCLUSION

Ramadan fasting is safe for diabetes Type-2 patients and is associated with weight loss and improvement in the overall diabetic control.

Furthermore, the physical activities could reduce the body weight, waist measurement, systolic blood pressure, triglyceride and HDL.

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#### **Authors Contributions:**

NK:Suggested and supervised the whole project, and prepared the manuscript.

MHK: Facilitated in funding, helped in writing of discussion and reviewed the manuscript.

MZS:Provided the patients, made arrangement for clinical and physical observations, reviewed the manuscript.

MRK: Arranged clinical testing of blood samples. Critically reviewed the manuscript.

AR:Did all the statistical computations and wrote the results section.