Original Article

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The Effect of Ramadan Fasting on Biochemical Parameters in Healthy Thai Subjects

Biochemistry Section

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ABSTRACT

Introduction: Although, the effect of Ramadan fasting on the risks for Cardiovascular Disease (CVD) has been reported in several studies, the results were inconsistent. In addition, the effect of Ramadan fasting on biochemical parameters in Thai subjects has not been evaluated.

Aim: The aim of this study was to investigate the effect of Ramadan fasting on anthropometry, blood pressure, Fasting Blood Glucose (FBG), lipid profiles, and body composition in healthy Thai subjects.

Materials and Methods: A total of 65 healthy subjects (21 men and 44 women) aged between 19-24 years were randomly recruited. Anthropometry, blood pressure, FBG, Total Cholesterol (TC), Triglyceride (TG), High Density Lipoprotein-Cholesterol (HDL-C), Low Density Lipoprotein-Cholesterol (LDL-C), and body composition were measured before Ramadan, end of Ramadan and after one month of Ramadan.

Results: There were no changes in anthropometry, blood pressure, lipid profiles and body composition in both genders before Ramadan, end of Ramadan and after one month of Ramadan. Nevertheless, FBG levels were significantly increased after one month of Ramadan compared with baseline (5.09±0.50 versus 4.83±0.38 mmol/L, p=0.016, respectively) in women.

Conclusion: The Ramadan fasting did not affect the lipid, anthropometric and body composition in healthy Thai subjects. However, the increased FBG levels after one month of Ramadan were observed in women. To improve the favourable biochemical parameters after Ramadan fasting, the lifestyle modifications such as, increased intake of healthy diets and increased physical activity should be recommended.

Keywords: Anthropometry, Blood glucose, Body composition, Lipid profiles

INTRODUCTION

Ramadan is the holiest month in the Islamic calendar [1]. Muslims fast during this month. They abstain from all intakes of food, water, beverages and smoking from approximately one hour before sunrise till sunset, from 8 to 18 hours for 29-30 days. The period of fasting may vary depending on the geographical location of the country and the season of the year.

During Ramadan fasting, the consumption of food and liquids are mainly nocturnal and the food frequency, quantity, sleep duration at night, as well as exercise are reduced. Previous studies demonstrated that macronutrient and micronutrient intake during Ramadan are changed but some are not different compared with non-Ramadan period [2-7]. Although, several studies have demonstrated the effects of Ramadan fasting on biochemical markers in healthy subjects [7-16], subjects with obesity [17], Metabolic Syndrome (MetS) [2,4], hypertension [18,19], hypercholesterolaemia [5] and in patients with CVD [3,20], type 2 diabetes mellitus [6,21-24] and Chronic Kidney Disease (CKD) [25], the results were inconsistent. Some studies have reported favourable metabolic changes and could reduce the risk for CVD after Ramadan fasting [2,3,8,10,12-14,15,17]. However, some studies have shown unfavourable effects on metabolic parameters and may increase the risk for CVD [11,15,17]. Because the mechanisms underlying the physiological changes induced by Ramadan fasting are not well understood, such discrepancy in the results could be attributed to several confounding factors. These include age, gender, ethnicity, hours of fasting, number of fasting days, climatic conditions, cultural influences, the sample size, the study subjects, exercise, dietary patterns and genetic background [26-28].

In Thailand, most Muslims live in the Southern region. The effect of Ramadan fasting on biochemical parameters in Thailand has not been evaluated. Therefore, this study was aimed to investigate the effect of Ramadan fasting on anthropometry, blood pressure, FBG, lipid profiles and body composition in healthy Muslims in Southern Thailand.

MATERIALS AND METHODS

Subjects

This was a prospective observational study that was conducted in the month of Ramadan during June 2015 to August 2015. The subjects were students of Walailak University. Of these 69 were enrolled and signed informed consent, but only 65 (21 men and 44 women) aged 19-24 years completed the study. The sample size was calculated according to a power of 80% and a confidence level of 95%. Inclusion criteria included healthy students. The students with chronic diseases e.g., diabetes mellitus, renal, liver or thyroid disease and receiving any medical treatment were excluded. Moreover, the women were not pregnant, lactating or receiving contraceptives. All participants answered a questionnaire which included questions pertaining to: demographic characteristics, smoking status, alcohol intake, exercise, education, family history of medical diseases and drug history during the first day of Ramadan (pre-Ramadan), the last day of Ramadan and one month later (post-Ramadan). This study was approved by the Ethical Committee from Walailak University (protocol No. 15/040) and volunteers gave informed consent for participation in the study.

Anthropometry and Biochemical Measurement

Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) were measured by the Omron T8 with Intellisense (HEM757A4-C1) automatic blood pressure monitor after 20 minutes of rest. Waist Circumference (WC) was measured midway between the lower rib margin and the iliac crest. Body Mass Index (BMI) was calculated

as a ratio of weight in kg and height in metres square (kg/m^2). Body composition including body fat percentage, fat mass, fat free mass, muscle mass and visceral fat rating were measured by a Bioelectric Impedance Analysis (BIA), Tanita SC-330 (Tanita Corp, Japan). Blood samples were collected after fasting 12 hours. FBG, TC, TG and HDL-C were measured by an enzymatic colorimetric method on Konelab analyzer (KONELAB 20, Tokyo, Japan). LDL-C was calculated using the Friedewald equation.

STATISTICAL ANALYSIS

Continuous variables were expressed as the mean±Standard Deviation (SD). Categorical variables were presented as percentages. Data normality was determined by the Kolmogorov–Smirnov test. Mean differences between genders were assessed by independent t-test and Mann-Whitney U test for comparison of normally distributed and non- normally distributed parameters, respectively. For multiple comparisons of means between groups, one-way Analysis of Variance (ANOVA) followed by Tukey's multiple comparison test was performed. Differences in the percentages between groups were compared using the Chi-square (χ^2) test. A p-value ≤0.05 was considered to be statistically significant. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) Version 16.0 (Chicago, IL, USA).

RESULTS

Characteristics of Study Subjects

The demographic and biochemical characteristics of the study subjects are summarized in [Table/Fig-1]. Among the 69 volunteers participated, 65 completed (21 men and 44 women) the study. The mean age of the study subjects was 20.86±1.35 and 20.80±1.05 years in men and women, respectively. Weight, WC, BMI, SBP and FBG were significantly higher in men than in women, whereas, significantly higher levels of HDL-C were observed in women compared with men. There was no significant difference in other parameters.

Effect of Ramadan fasting on anthropometry, biochemical parameters, body composition and exercise: The anthropometry and body composition according to gender and time (pre-Ramadan, Ramadan and post-Ramadan) are shown in [Table/Fig-2]. There were no significant changes in anthropometry and body composition during and after Ramadan in both genders. The biochemical parameters according to gender and time (pre-Ramadan, Ramadan and post-Ramadan) are shown in [Table/Fig-3]. FBG was significantly increased in women but not in men after Ramadan compared with pre-Ramadan, whereas no significant changes in other biochemical parameters were observed in both genders. The frequency of exercise of the study subjects in pre-Ramadan, Ramadan and post-Ramadan is shown in [Table/Fig-4]. The frequency of exercise (≥3 times/week) in women was significantly decreased (but not in men) during and after Ramadan compared with pre-Ramadan.

Parameters	Total (n= 65)	Men (n=21)	Women (n=44)	p-value*
Age (years)	20.82±1.14	20.86±1.35	20.80±1.05	1.000
Weight (kg)	55.73±12.99	64.56±15.33	51.41±9.12	<0.001
Waist circumference (cm)	72.31±10.44	79.83±12.40	68.45±6.66	<0.001
Body Mass Index (BMI) (kg/m^2)	21.49±3.55	22.94±4.12	20.79±3.05	0.022
Systolic Blood Pressure (SBP) (mmHg)	113.48±13.89	126.76±15.38	107.14±7.05	<0.001
Diastolic Blood Pressure (DBP) (mmHg)	73.00±8.75	75.10±11.66	72.00±6.90	0.270
Fasting Blood Glucose (FBG) (mmol/L)	4.99±0.49	5.34±0.51	4.83±0.38	<0.001
Total Cholesterol (mmol/L)	4.62.48±0.85	4.58±0.70	4.63±0.92	0.841
Triglyceride (mmol/L)	0.86±0.31	0.92±0.36	0.83±0.28	0.340
HDL-cholesterol (mmol/L)	1.40±0.32	1.26±0.24	1.47±0.33	0.014
LDL-cholesterol (mmol/L)	2.82±0.72	2.90±0.61	2.78±0.77	0.549

[Table/Fig-1]: Basic characteristics of the study subjects.
Data are expressed as means ± SD.
*p-value obtained in the Student's t test and Mann–Whitney U test for the comparison between genders. A p-value<0.05 was considered significant.

DISCUSSION

To the best of our knowledge, this is the first study to investigate the effect of Ramadan fasting on biochemical parameters in healthy Thai subjects. We found that there were no changes in SBP and DBP at the end and after Ramadan compared with baseline in both genders [Table/Fig-2]. Our results were consistent with some reports in healthy subjects in UAE [10] and Netherlands [17] in which there were no significant changes in SBP and/or DBP after Ramadan fasting. In contrast, the reduction in SBP and DBP after Ramadan

Parameters	Men (n=21)				Women (n=44)			
	Pre-Ramadan	Ramadan	Post-Ramadan	p-value*	Pre-Ramadan	Ramadan	Post-Ramadan	p-value*
Weight (kg)	64.56±15.33	63.66±15.39	64.71±15.96	0.936	51.41±9.12	50.95±9.92	51.33±9.05	0.922
Waist circumference (cm)	79.83±12.40	76.26±10.84	76.50±12.21	0.514	63.45±6.66	65.44±7.00	66.66±7.10	0.172
Body mass index (BMI) (kg/m^2)	22.94±4.12	22.58±4.10	22.95±4.35	0.880	20.79±3.05	20.56±2.98	20.73±2.99	0.990
Systolic blood pressure (SBP) (mmHg)	126.76±15.38	126.95±14.54	126.76±15.38	0.999	107.14±7.05	107.36±9.86	107.14±7.13	0.989
Diastolic blood pressure (DBP) (mmHg)	75.10±11.66	79.05±9.65	75.10±11.66	0.412	72.00±6.90	69.02±7.79	72.14±6.92	0.078
Body fat percentage	18.17±7.35	17.61±6.49	21.06±8.90	0.317	26.58±5.79	25.15±6.51	26.37±5.82	0.514
Fat mass (kg)	12.68±7.89	12.15±7.54	14.86±10.40	0.606	14.10±5.60	13.13±5.58	13.90±5.55	0.576
Fat free mass (kg)	52.47±8.44	52.16±8.45	50.48±7.88	0.673	37.32±4.05	37.36±4.06	37.22±4.05	0.964
Muscle mass (kg)	49.74±8.01	49.44±8.03	47.75±7.48	0.655	34.97±4.01	35.25±3.72	35.12±3.70	0.966
Visceral fat rating	5.50±4.27	5.05±4.27	5.45±3.78	0.887	2.68±1.82	2.41±1.70	2.71±1.75	0.595

[Table/Fig-2]: Anthropometry and body composition before Ramadan (pre-Ramadan), Ramadan, and one month after Ramadan (post-Ramadan) in men and women.
Data are expressed as means ± SD.
*p-value obtained in the ANOVA for the comparison between groups.
**p-value obtained in the Tukey post-hoc test, Post-Ramadan vs. Pre-Ramadan, p value <0.05 was considered significant.

fasting has been reported in a study in Iran [2]. While a decrease in SBP and an increase in SBP after Ramadan fasting has been reported in the studies in UAE [10] and Kuwait [12], respectively. There were no significant changes in WC, BMI and body weight at the end and after Ramadan in this study. Our results were similar to the studies in Turkey [13] and Netherlands [17] in which body weight and/or BMI did not change after Ramadan fasting. However, the decrease in anthropometric parameters after Ramadan fasting has been observed in several studies in Iran [2,15], Jordan [7], Pakistan [8], UAE [10] and Malaysia [29]. Moreover, we did not observe any significant changes in body composition parameters at the end and after Ramadan in the present study. These findings were consistent with the studies in Jordan [7], Kuwait [12] and Malaysia [29] in which there were no significant changes in body fat percentage after Ramadan fasting. Nevertheless, a decrease in body fat percentage and an increase in fat free mass after Ramadan fasting have been demonstrated in a study in Netherlands [Table/Fig-5] [17].

In addition, there were no significant changes in TC, TG, LDL-C and HDL-C levels at the end and after Ramadan in the present study [Table/Fig-3]. Our results were consistent with a study in Iran [14]. Whereas, the reduction in TC, TG, LDL-C and HDL-C levels after Ramadan fasting has been reported in a study in Pakistan [8]. Moreover, the reduction in TG [10], LDL-C [10,11], HDL-C [15], an increase in TC [17], LDL-C [15,17], HDL-C [2,10,11,13,17] and unchanged in TC [10-15] and TG [11,17,12-15] levels after Ramadan fasting have been demonstrated in Iran [2, 15], UAE [10], Algeria

Parameters	Men (n=21)				Women (n=44)			
	Pre-Ramadan	Ramadan	Post–Ramadan	p-value*	Pre-Ramadan	Ramadan	Post–Ramadan	p-value*
Fasting blood glucose (FBG) (mmol/L)	5.34±0.51	5.27±0.41	5.26±0.56	0.844	4.83±0.38	4.90±0.41	5.09±0.50**	0.016
Total cholesterol (mmol/L)	4.58±0.70	5.05±0.76	4.87±0.78	0.140	4.63±0.92	4.71±0.92	4.60±1.01	0.871
Triglyceride (mmol/L)	0.92±0.36	1.02±0.30	1.01±0.57	0.513	0.83±0.28	0.79±0.28	0.83±0.29	0.835
HDL-cholesterol (mmol/L)	1.26±0.24	1.42±0.30	1.37±0.28	0.184	1.47±0.33	1.51±0.35	1.53±0.34	0.428
LDL-cholesterol (mmol/L)	2.90±0.61	3.16±0.69	3.03±0.76	0.472	2.78±0.77	2.84±0.76	2.70±0.79	0.692

[Table/Fig-3]: Biochemical parameters before Ramadan (pre-Ramadan), Ramadan, and one month after Ramadan (post-Ramadan) in men and women.
Data are expressed as means ± SD.
*p-value obtained in the ANOVA for the comparison between groups.
**p-value obtained in the Tukey post hoc test, Post-Ramadan vs. Pre-Ramadan, p value <0.05

Exercise	Frequency	Men (n=21)			p-value*	Women (n=44)			p-value*
		Pre-Ramadan	Ramadan	Post-Ramadan		Pre-Ramadan	Ramadan	Post-Ramadan	
Exercise more than 30 minutes/day	≥ 3 times/ week	12 (47.62%)	8 (38.10%)	10 (42.86%)	0.670	35 (70.45%)	4 (9.09%)	6 (13.64%)	<0.001
	0-2 times/ week	9 (42.86%)	13 (52.38%)	11 (47.62%)	0.695	9 (18.18%)	40 (61.36%)	38 (72.73%)	<0.001

[Table/Fig-4]: Frequency of exercise before Ramadan (pre-Ramadan), Ramadan, and one month after Ramadan (post-Ramadan) in men and women.
*p-value obtained in the Chi-Square test for the comparison between groups.

Study subjects	n	Age (years) Mean ± SD	SBP	DBP	WC	BMI	Body weight	Body fat percentage	FFM
Thailand (Present study)	65 students (21 males, 44 females)	19-24 years Mean age: 20.82 ± 1.14	No change	No change	No change	No change	No change	No change	No change
Iran [2]	55 male adults	34-61 years Mean age: 34.1 ± 8.9	Decreased	Decreased	Decreased	Decreased	Decreased	N/A	N/A
Jordan [7]	57 female students	18-29 years Mean age: 21.6 ± 4.14	N/A	N/A	N/A	Decreased	Decreased	No change	N/A
Pakistan [8]	80 students (50 males, 30 females)	18-24 years	N/A	N/A	N/A	N/A	Decreased	N/A	N/A
UAE [10]	42 males, 18 females	Mean age: Male: 43.2 ± 9.4 Female: 35.3 ± 9.1	Decreased	No change	Decreased	N/A	Decreased	N/A	N/A
Algeria [11]	46 young adults (22 males, 24 females)	Mean age: 24 ± 3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kuwait [12]	16 male adults	Mean age: 35 ± 1.9	Increased	N/A	N/A	N/A	N/A	No change	N/A
Turkey [13]	24 young adults (12 males, 12 females)	21-35 years Male: 31 ± 2.7 Female: 29 ± 3.2	N/A	N/A	N/A	N/A	No change	N/A	N/A
Iran [14]	50 adults	30-45 years	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iran [15]	81 students (41 males, 40 females)	18-29 years Mean age: 22.7 ± 2.3	N/A	N/A	N/A	Decreased	Decreased	N/A	N/A
Netherlands [17]	25 adolescents	12-18 years	No change	No change	N/A	No change	No change	Decreased	Increased
Malaysia [29]	46 adults (14 males, 32 females)	25-40 years Mean age: 33.04 ± 4.57	N/A	N/A	Decreased	N/A	Decreased	No change	N/A

[Table/Fig-5]: Comparison the effects of Ramadan on anthropometric and body composition of our findings with other studies at the end of Ramadan.
SBP-Systolic blood pressure; DBP-Diastolic blood pressure; WC-Waist Circumference; BMI-Body mass index; FFM-Fat free mass;
N/A-Not applicable

Study subjects	n	Age (years) Mean ± SD	TC	TG	HDL-C	LDL-C	FBG
Thailand (Present study)	65 students (21 males, 44 females)	19-24 years Mean age: 20.82 ± 1.14	No change	No change	No change	No change	No change (Increased after 1 month of Ramadan in women only)
Iran [2]	55 male adults	34-61 years Mean age: 34.1 ± 8.9	N/A	N/A	Increased	N/A	Decreased
Jordan [7]	57 female students	18-29 years Mean age: 21.6 ± 4.14	N/A	N/A	N/A	N/A	N/A
Pakistan [8]	80 students (50 males, 30 females)	18-24 years	Decreased	Decreased	Decreased	Decreased	Decreased
UAE [10]	42 males, 18 females	Mean age: Male: 43.2 ± 9.4 Female: 35.3 ± 9.1	No change	Decreased	Increased	Decreased	N/A
Algeria [11]	46 young adults (22 males, 24 females)	Mean age: 24 ± 3	No change	No change	Increased	Decreased	N/A
Kuwait [12]	16 male adults	Mean age: 35 ± 1.9	No change	No change	N/A	N/A	No change
Turkey [13]	24 young adults (12 males, 12 females)	21-35 years Male: 31 ± 2.7 Female: 29 ± 3.2	No change	No change	Increased	No change	N/A
Iran [14]	50 adults	30-45 years	No change	No change	No change	No change	No change
Iran [15]	81 students (41 males, 40 females)	18-29 years Mean age: 22.7 ± 2.3	No change	No change	Decreased	Increased	Decreased
Netherlands [17]	25 adolescents	12-18 years	Increased	No change	Increased	Increased	No change
Malaysia [29]	46 adults (14 males, 32 females)	25-40 years Mean age: 33.04 ± 4.57	N/A	N/A	N/A	N/A	N/A

[Table /Fig-6]: Comparison the effects of Ramadan on lipid profiles of our findings with other studies at the end of Ramadan. TC-Total Cholesterol; TG-Triglyceride; HDL-C-High density lipoprotein-cholesterol; LDL-C-Low density lipoprotein-cholesterol; FBG-Fasting blood glucose, N/A-Not applicable.

[11], Turkey [13] and Netherlands [17] [Table/Fig-6]. It seems that the effect of Ramadan fasting on serum lipid levels may be explained by the dietary habits and other lifestyle changes [5,15]. It has been shown that the increased TC, LDL-C and TG and decreased HDL-C levels were associated with increased consumption of saturated fatty acids, trans fatty acids and cholesterol in the diet [30-32]. A previous study has also shown that Monounsaturated Fatty Acids (MUFA) lower the concentrations of TC and LDL-C and increases the levels of HDL-C [33]. In addition, n-3 Polyunsaturated Fatty Acids (PUFAs) have an efficacy in lowering TG levels [34].

Nevertheless, we found that FBG levels in women were significantly increased after one month of Ramadan fasting compared with baseline. Our results were inconsistent with a previous study in UAE in which FBG levels were significantly increased at the end of Ramadan compared with baseline [4].

Moreover, the contradictory results have also been reported in several studies from Iran [2,14,15], Pakistan [8], Kuwait [12] and Netherlands [17] in which FBG levels were significantly decreased [2,8,15] or remained unchanged during Ramadan [12,14,17] [Table/Fig-6]. These inconsistencies may be attributed to the lifestyle factors such as dietary intake and physical activity.

Our findings suggested that the increased FBG levels after Ramadan in women may be partly due to the decreased frequency of exercise during and after Ramadan compared with before Ramadan. It has been reported that exercise increases insulin sensitivity and glucose uptake into peripheral tissues [35]. Although, we did not collect the information on actual food items consumed during Ramadan in this study, we suggest that women may have increased intake of simple sugars during Ramadan, which may have result in increased FBG levels. This is supported by a previous study, which reported that a shift in the intake of carbohydrates from complex carbohydrates (cereal, legume, fruit and vegetable) to more of simple sugars (sweets and sweetened drinks) during Ramadan could have increased the levels of FBG [4]. In contrast, there were no changes on FBG levels in men during the Ramadan period. This phenomenon could possibly be explained by the unchanged frequency of exercise in men during the Ramadan.

Altogether, we suggested that the discrepant results from the effect of Ramadan on anthropometric and biochemical parameters among various studies may result from several factors e.g. age, gender, ethnicity, physical activity, smoking, dietary intake, cortisol secretion, geographical variation, underlying diseases, effect of seasonal changes on fasting individuals, hours of fasting, number of fasting days and genetic background [26-28].

LIMITATION

Our study had some limitations, including a small sample size especially in men and we did not perform the dietary assessment by Food Frequency Questionnaire (FFQ) or 24-hour dietary recall. Thus, the total energy and macronutrients could not be analysed and compared among pre-Ramadan, Ramadan and post-Ramadan timepoints. Moreover, type of food consumed during Ramadan was not assessed in the present study. We recommend that the study in a larger sample size, in the elderly or in patients with chronic diseases, as well as the nutritional assessment in the study subjects should be performed in further investigations.

CONCLUSION

In conclusion, our study has demonstrated that the Ramadan fasting did not affect the lipid, anthropometric and body composition in healthy Thai subjects. The change in FBG levels may be due to changes in behavioral lifestyle in women post-Ramadan. To improve the favourable biochemical parameters after Ramadan fasting, the lifestyle modifications by increased intake of vegetables, fruit consumption, restricted intake of simple sugars, as well as

promoting physical activity should be recommended.

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