Improved serum HDL cholesterol profile among Bangladeshi male students during Ramadan fasting

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تحسن مرتسم الكوليسترول للبروتين الشحمي المرتفع الكثافة في المصل لدى الطلاب الذكور في بنغلاديش أثناء صيام رمضان

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الخلاصة: تم تقييم أثر صيام رمضان على شحميات المصل في عشرين من الذكور الأصحاء في بنغلاديش. وتم قياس المتغيرات للقياسات البشرية وشحميات الدم قبل يوم واحد من رمضان وفي اليوم السادس والعشرين منه وبعد شهر من انقضاء رمضان. وقد انخفض وزن الجسم ومنسب كتلة الجسم انخفاضاً ملحوظاً أثناء شهر رمضان بالمقارنة مع قياسات الفترة السابقة له واللاحقة به. وقد كان استهلاك الدهنيات أعلى أثناء شهر رمضان مقارنة بما بعده. وقد ازداد كوليسترول البروتين الشحمي المرتفع الكثافة زيادة ملحوظة أثناء شهر رمضان، في حين لم يكن هناك تغير ملحوظ في الكوليسترول الكلي، وكوليسترول البروتين الشحمي المنخفض الكثافة، في ثلاثي الغليسريدات. وتشير التحليلات المتعددة التحوُّف لمستويات كوليسترول البروتين الشحمي الرفيع الكثافة في رمضان وبوجود علاقة إيجابية مع سرعة النبض واستهلاك الدسم مع علاقة سلبية مع ضغط الدم الانقباضي وخسارة الوزن. وتشير الموجودات إلى تحسن مرتسمات كوليسترول البروتين الشحمي المرتفع الكثافة أثناء صيام رمضان.

ABSTRACT Effects of Ramadan fasting on serum lipids of 20 healthy males in Bangladesh were assessed. Anthropometric parameters and blood lipids were measured 1 day before Ramadan, day 26 of Ramadan and 1 month after Ramadan. Body weight and body mass index decreased significantly during Ramadan compared with before and after Ramadan. Fat intake was significantly higher during Ramadan than after. High-density lipoprotein (HDL) cholesterol increased significantly during Ramadan. Other lipids were not significantly different. Regression analysis of Ramadan HDL cholesterol levels indicated positive association with pulse rate and fat intake and negative association with systolic blood pressure and weight loss. The findings indicate improved HDL cholesterol profiles during Ramadan.

Amélioration du profil du cholestérol HDL sérique chez les étudiants bangladais pendant le jeûne du mois de ramadan

RESUME Les effets du jeûne du mois de ramadan sur les lipides sériques chez 20 sujets de sexe masculin en bonne santé au Bangladesh ont été évalués. Les paramètres anthropométriques et les lipides sanguins ont été mesurés un jour avant le ramadan, au 26e jour du ramadan et un mois après le ramadan. Le poids corporel et l'indice de masse corporelle ont considerablement diminué pendant le ramadan par rapport aux mesures avant et après le ramadan. L'apport lipidique était significativement plus élevé pendant le ramadan qu'après. Le cholestérol des lipoprotéines de haute densité (HDL) augmentait de manière significative pendant le ramadan. Les autres lipides n'étaient pas significativement différents. L'analyse de régression pour les taux de cholestérol HDL pendant le ramadan indiquait une association positive avec la fréquence du pouls et l'apport lipidique et une association négative avec la pression artérielle systolique et la perte de poids. Ces résultats montrent une amélioration des profils du cholestérol HDL durant le ramadan.

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Received: 28/03/02; accepted: 23/12/02

Introduction

Ramadan fasting is one of the 5 pillars of Islam and one of the most significant *ibadat* (worships) of Islam [*1*]. Throughout the world, millions of Muslims fast during Ramadan to fulfil this religious obligation. Because the lunar calendar determines the month of Ramadan and is about 11 days shorter than the solar year, Ramadan is not fixed to any season. The timing of daily fasting varies from country to country and with the season in which the month of Ramadan falls. Thus, depending upon the season and the geographical position of the country, the length of the fast varies from 12 to 19 hours per day [*2*].

During Ramadan, Muslims abstain from food and drink from dawn until sunset. Traditionally the practice is to eat 2 meals, 1 before dawn, *sahri*, and 1 just after sunset, *iftar*. Often Muslims eat a greater variety of foods in their meals during Ramadan than in other months. As a result, the Ramadan fast provides an excellent opportunity to study the effects of various diets on the human body and can serve as an excellent research model for metabolic and behavioural studies [*3*].

Ramadan fasting and starvation are not synonymous. Many physiological and psychological changes take place during Ramadan, most probably due to the changes in eating patterns, eating frequency and sleep patterns [*4*]. Some studies in the eastern Mediterranean area have indicated improved high-density lipoprotein (HDL) cholesterol during Ramadan fasting [*5,6*].

The objective of our study was to investigate the serum lipid profile as influenced by diet patterns and other parameters during Ramadan.

Methods

The study was conducted in Dhaka, Bangladesh, with 20 healthy male volunteers residing in the hostel of the National Institute of Preventive and Social Medicine (NIPSOM). Prior to selection, written consent was obtained from each. Clearance was obtained from the Ethical Committee of NIPSOM. Data were collected at 3 intervals: before Ramadan (1 day before the start of Ramadan), during Ramadan (day 26 of Ramadan) and after Ramadan (1 month after Ramadan). Data collection started in December 1998 and ended in March 1999. During the month of Ramadan the average duration of fasting was approximately 12 hours and the maximum ambient temperature ranged from 11 °C to 29 °C [*7*]. The mean age ± standard deviation of the volunteers was 38.27 ± 4.07 years. All volunteers were in good health and none were using any medication. All were engaged in light physical activities and the nature of their work was more or less similar. Body weight and mid-arm circumference were recorded before, during and after Ramadan.

Diet information was obtained during Ramadan and after Ramadan using 24-hour recall method for 3 consecutive days. No dietary intervention was provided to the volunteers and they were allowed to eat anything they wanted. Food intake was analysed for energy, protein, carbohydrate and fat. Diet composition was calculated with published and unpublished composition tables of the foods of Bangladesh (A. Haque, unpublished data) [*8*].

Blood was tested in the Department of Nutrition and Biochemistry of NIPSOM. Before and after Ramadan, blood was col-

lected in the morning after overnight fasting; during Ramadan it was taken just after breaking the fast with a glass of water. Total cholesterol, HDL cholesterol and triglycerides were determined by enzymatic methods. Low-density lipoprotein (LDL) cholesterol was obtained by the formula:

LDL cholesterol = total cholesterol − HDL cholesterol − triglycerides/5

Determination of all biochemical parameters was done with a photoelectric colorimeter and reagent kits (manufactured by Human Gesellschaft für Biochemica und Diagnostica GmbH, Weisbaden, Germany) [9].

Data were analysed by ANOVA for model-period (fixed effect) and subjects (random effect) using *StatSoft Statistica*, version 5. The mean values of the 3 test periods were compared for significant differences using Duncan's multiple range *t*-test at $P < 0.05$.

Results

Anthropometric measurements

The mean values of anthropometric measurements significantly changed before, during and after Ramadan (Table 1). All parameters at day 26 of Ramadan, i.e. body weight, body mass index (BMI), mid-arm circumference, pulse rate and systolic and diastolic blood pressure, were significantly lower than pre-Ramadan values ($P < 0.05$). One month after Ramadan fasting, body weight and other parameters had a trend to recoup to pre-Ramadan status; however, they were still significantly lower than the pre-Ramadan values ($P < 0.05$). When the post-Ramadan values were compared with the day 26 Ramadan values, body weight, BMI, mid-arm circumference and systolic blood pressure were significantly higher ($P < 0.05$). Pulse rate and diastolic blood pressure were not significantly different. This indicates longer lasting lowering effect of

Table 1 **Anthropometric and other measurements (mean ± standard deviation) of the 20 healthy male volunteers**

Measurements	Pre-Ramadan[a]	Day 26 of Ramadan	Post-Ramadan[b]	*F*	*P*-value
Weight (kg)	64.05 ± 7.78[c]	62.07 ± 8.08[e]	63.05 ± 7.75[d]	14.1	< 0.001
Body mass index (kg/m²)	24.20 ± 2.48[c]	23.44 ± 2.52[e]	23.81 ± 2.37[d]	13.4	< 0.001
Mid-arm circumference (cm)	27.75 ± 1.88[c]	27.20 ± 1.88[e]	27.42 ± 1.91[d]	13.1	< 0.001
Pulse rate (per minute)	82.5 ± 8.9[c]	75.2 ± 7.8[d]	77.0 ± 8.0[d]	21.0	< 0.001
Systolic blood pressure (mmHg)	124.3 ± 13.9[c]	111.8 ± 10.8[e]	116.0 ± 9.9[d]	26.3	< 0.001
Diastolic blood pressure (mmHg)	82.3 ± 11.4[c]	77.3 ± 10.6[d]	78.8 ± 10.6[d]	9.04	< 0.001

[a] *One day before Ramadan.*
[b] *One month after Ramadan.*
Dissimilar superscripts indicate significant difference between 2 means; Duncan's multiple range t-test, $P < 0.05$.

Ramadan fasting on pulse rate and diastolic blood pressure.

Energy intake

Total daily energy, carbohydrate and protein intake were not significantly different between during and post-Ramadan periods (Table 2). However, there was a significant increase in fat intake ($P < 0.01$). Energy from fat as a percent of the total energy intake was 10.6% during Ramadan versus 7.6% after Ramadan. Significant decreases in blood glucose levels during Ramadan suggest energy intake as the limiting factor in our study (Table 3).

Table 2 **Mean energy intake (± standard deviation) of the 20 male volunteers during and after Ramadan**

Energy intake	During Ramadan	Percent of total energy intake	Post-Ramadan	Percent of total energy intake
Energy (kcal/day)	2113.8 ± 168.5	–	2134.1 ± 132.6	–
Carbohydrate (g/day)	406.3 ± 49.9	77.1 ± 5.2	456.3 ± 42.6	81.1 ± 5.0
Protein (g/day)	64.6 ± 20.5	12.3 ± 4.1	60.1 ± 21.5	11.3 ± 4.1
Fat (g/day)	24.7 ± 3**	10.6 ± 1.4	17.9 ± 3.61	7.6 ± 1.5

***Significant difference between 2 means at P < 0.01.*

Table 3 **Serum lipids and glucose measurements (mean ± standard deviation) of the 20 healthy male volunteers**

Measurement	Pre-Ramadan	Day 26 of Ramadan	Post-Ramadan	*F*	*P*-value
Total cholesterol (mg/dL)	166.4 ± 30.32	165.15 ± 24.24	174 ± 29.66	1.1	NS
HDL cholesterol (mg/dL)	38.14 ± 7.40	46.71 ± 14.33[a]	41.72 ± 7.70	4.1	< 0.05
LDL cholesterol (mg/dL)	103.92 ± 34.57	92.33 ± 23.40	99.68 ± 27.54	1.2	NS
Triglycerides (mg/dL)	146.66 ± 72.78	131.04 ± 41.47	152.71 ± 57.59	1.7	NS
Total cholesterol/LDL cholesterol	4.6 ± 1.3	3.7 ± 0.9[b]	4.3 ± 1.1	5.2	< 0.01
LDL/HDL cholesterol	2.9 ± 1.2	2.1 ± 0.8[a]	2.5 ± 0.8	4.3	< 0.05
Glucose (mg/dL)	95.9 ± 14.1[c]	85.6 ± 12.4	91.0 ± 11.6	4.6	< 0.05

Dissimilar superscripts indicate significant difference between 2 means; Duncan's multiple range t-test at P < 0.05.
LDL = low-density lipoprotein.
HDL = high-density lipoprotein.
NS = not significant at P < 0.05.

Serum lipids

Significant improvement in the HDL cholesterol profile (HDL cholesterol, total cholesterol/HDL cholesterol, LDL cholesterol/HDL cholesterol) was observed during the Ramadan fasting period compared with the pre-Ramadan period ($P < 0.05$) (Table 3). There were no significant differences in total cholesterol, LDL cholesterol and triglycerides between the 3 periods.

Discussion

Anthropometric and other measurements

The mean difference between pre-Ramadan and during Ramadan body weights was 1.97 kg. Significant reductions in body weight, BMI and mid-arm circumference during Ramadan suggest that the subjects in our study had a negative energy balance ($P < 0.05$). Similarly, many studies have reported weight loss during the month of Ramadan fasting [*3,10–16*]. In contrast to this, one Saudi Arabian study reported weight gain during Ramadan [*17*] and still others did not find any significant change in body weight [*2,18*]. In one study among healthy males, a significant reduction in skin fold thickness was reported during Ramadan fasting [*3*]. A study of Tunisian women suggested that increased fat oxidation during Ramadan fasting results in an adaptive mechanism for body weight maintenance [*18*]. Our observation of decreases in systolic and diastolic blood pressure is supported by the findings of Athar and Habib [*16*].

Energy intake

The mean energy intake during Ramadan (2113.8 ± 168.5 kcal/day) was somewhat below the average energy consumption of Bangladeshi people, which has been estimated at 2244 kcal/day [7]. Among tropical Asiatic males energy intake has been reported to be 2557 kcal/day on normal days with a reduction of 20%–25% during Ramadan fasting [*10*]. In contrast, Frost et al. reported increased energy intake during Ramadan (3680 kcal/day) compared with energy intake after Ramadan (2425 kcal/day) [*17*].

There were no significant differences in carbohydrate and protein intake during and after Ramadan in our study. The Bureau of Statistics of Bangladesh reports average protein consumption to be 65 g/day [7]. This is approximately in agreement with the reported protein intake of our subjects. Protein intake has been reported to increase during the month of Ramadan fasting among both Tunisian women and Moroccans [*4,18*].

Fat intake was significantly higher among our subjects during Ramadan ($P < 0.001$). This was similar to increases in fat intake during Ramadan among Tunisian women and among Moroccans [*4,18*]. Bangladeshi people prefer fried food items during *iftar*. This habit increases the intake of unsaturated fat (mainly soybean oil) that ultimately results in an increase in fat consumption during Ramadan. It may be noted that fat intake calories as a percentage of total energy intake during and after Ramadan in our study were far lower than is consumed in the affluent societies of some industrialized nations. Because low intake of fat rather than excess fat is a concern in the general population in developing countries like Bangladesh, it seems that during Ramadan fat intake slightly improved.

Serum lipids

It is well established that a high level of HDL cholesterol has an inverse relation with coronary heart disease [*19*]. The improved HDL cholesterol profile in our study is supported by many studies [*4–6,20,21*].

Streja et al. and Murphy et al. noted similar increases in HDL cholesterol profiles in 2 non-Ramadan studies [*22,23*]. Nonetheless, some studies have reported decreases [*3,24*]. In multiple regression analysis (r^2 = 0.74, $P < 0.001$, $n = 20$), HDL cholesterol was positively associated with pulse rate and fat intake and negatively with weight loss and higher systolic blood pressure. The prediction equation is:

HDL cholesterol = 1.4024 + 1.4032 pulse rate + 1.5642 fat intake – 0.9608 systolic blood pressure – 4.3295 weight change

where HDL cholesterol was measured in mg/dL, fat intake was measured in g/day and weight change was calculated as weight on Ramadan day 26 – weight before Ramadan measured in kg.

Improvement in HDL cholesterol profile with higher fat intake agrees with the findings of Nomani et al. [*1*].

In conclusion, Ramadan fasting contributed to better blood lipid profiles under the prevailing limited energy intake conditions of the study. One of the contributing factors may be higher fat intake. The findings may have an application in improving HDL cholesterol levels among subjects irrespective of religion under restricted energy intake conditions.

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