Effect of Ramadan fasting on serum heat shock protein 70 and serum lipid profile

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ABSTRACT

Introduction: Ramadan, the holy month for the Islamic world, is a period every year when food and fluid intake is restricted to the pre-sunrise and post-sunset hours. The aim of this study was to evaluate the effect of Ramadan fasting on the serum concentration of heat shock protein 70 (HSP70) and serum lipid profile in healthy men.

Methods: A total of 32 male volunteers with a mean age of 28.5 (range 23–37) years were selected for the study. Blood samples were obtained one day prior to Ramadan and on the 3rd and 25th days of fasting. Serum HSP70, triglyceride (TG), cholesterol (Chol), low-density lipoprotein (LDL) and high-density lipoprotein (HDL), LDL/HDL and Chol/HDL ratios were investigated.

Results: It was observed that the mean concentrations of serum HSP70 and HDL on the 25th day of Ramadan were significantly higher than those recorded one day before Ramadan and on the 3rd day of Ramadan, and the levels on the 3rd day of Ramadan was significantly higher than those recorded one day before Ramadan. Mean concentrations of serum TG, Chol, LDL, and LDL/HDL and Chol/HDL ratios on the 25th day of Ramadan were significantly lower than those recorded one day before Ramadan and on the 3rd day of Ramadan, and the levels found on the 3rd day of Ramadan were also significantly lower than those recorded one day before Ramadan.

Conclusion: Ramadan fasting increases serum HSP70 and improves serum lipid profile.

Keywords: heat shock protein, lipid profile, Ramadan fasting, stress tolerance

Singapore Med J 2011;52(7):491-495

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INTRODUCTION

During Ramadan, which is the holy month for the Islamic world, food and fluid intake is restricted to the pre-sunrise and post-sunset hours. Healthy adult Muslims are required to abstain from eating, drinking and smoking from sunrise to sunset during this month.[1,2] Some studies have shown the beneficial effects of Ramadan fasting and similar religious fastings on lipid profile, atherosclerosis risk factors, insulin resistance and diabetes mellitus.[3-7] Although some mechanisms, such as decreased calorie and fat intake as well as abstinence from smoking, have been proposed for these effects,[6] some findings are not in line with these hypotheses. For example, it has been shown that calorie and fat intake during Ramadan fasting may be significantly increased instead of decreased.[2,7,8] Therefore, there are other mechanisms that may play important roles in the effects of Ramadan fasting on health.

It has long been known that if cells are exposed to a sublethal stress before being exposed to a lethal stress, their resistance against the lethal stress will be increased due to the induction of heat shock proteins (HSPs) by the sublethal stress. This phenomenon is regarded as stress tolerance.[9] In addition to cells, tissues can also develop stress tolerance when exposed to a sublethal stress.[10-12] Due to the long duration of diurnal fasting in Ramadan, hunger and dehydration levels increase beyond those experienced at other times of the year.[7] Food intake is restricted to the night hours within a short span of time, which delays and reduces the duration of sleep.[13] Furthermore, if the period of daytime fasting is fragmented by spells of sleeping, the normal sleep-wake cycle associated with the solar day is disrupted.[7] These effects suggest that Ramadan fasting can be considered as a period when the human body is exposed to different mild stresses, and hence, fasting may induce stress tolerance and HSPs. The aim of this study was to evaluate the effect of Ramadan fasting on the serum concentration of HSP70 in healthy men. Additionally, the effect of Ramadan fasting on serum lipid profile was evaluated.

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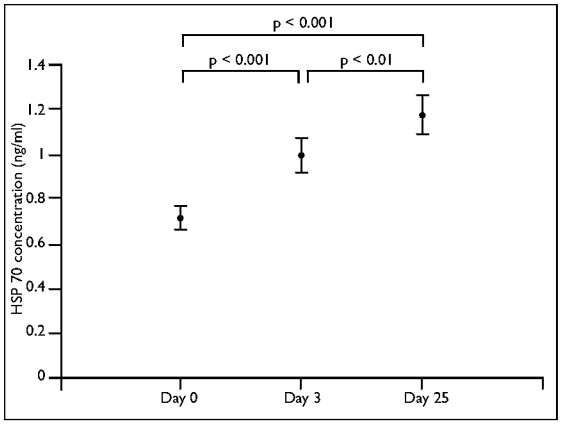
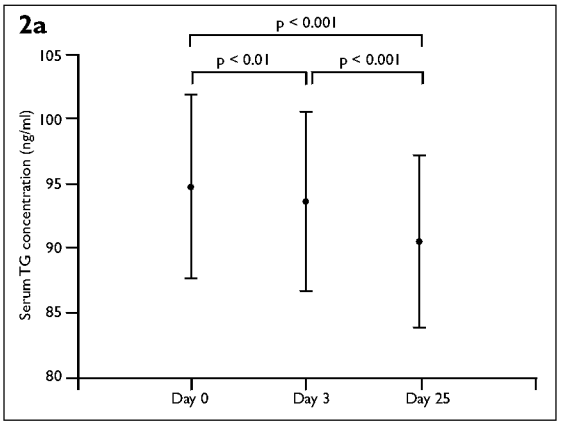


Fig. 1 Graph shows the mean concentration of serum HSP70 one day before Ramadan and on the 3rd and 25th days of Ramadan.



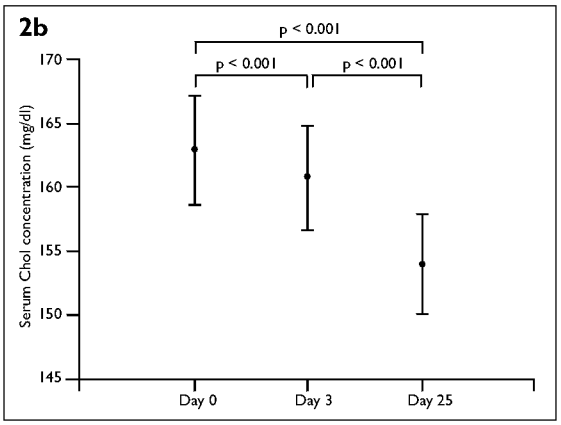


Fig. 2 Graph shows (a) mean serum triglyceride and (b) cholesterol concentrations one day before Ramadan and on the 3rd and 25th days of Ramadan.

METHODS

This work was conducted in accordance with the ethics committee of the Urmia University of Medical Sciences and the ethical standards set out in the Helsinki Declaration of 1975. Healthy male volunteers who fasted during Ramadan and consented to participate in the study were recruited. All participants were in general good health, and none was taking medications for chronic illnesses. In order to confirm this, part of the blood sample taken from the participants before Ramadan was subjected to tests such as blood cell count and differentiation, blood urea nitrogen, serum creatinine, triglyceride (TG), cholesterol (Chol), low-density lipoprotein (LDL), high-density lipoprotein (HDL), uric acid, fasting blood sugar and erythrocyte sedimentation rate. A volunteer was excluded from the study if any of these parameters were found to be abnormal.

A total of 32 volunteers with a mean age of 28.5 (range 23–37) years were included in the study. Blood samples were obtained at 8–9 am one day prior to Ramadan and at 1–2 pm on the 3rd and 25th days of fasting. Serum TG, total Chol, LDL and HDL were quantitatively determined using enzymatic colorimetric kits (Human Gesellschaft für Biochemica und Diagnostica mbH, Wiesbaden, Germany). Serum concentration of HSP70 was determined using an HSP70 high-sensitivity ELISA kit (Assay Designs, Ann Arbor, MI, USA). Data of different days were compared with repeated-measurement ANOVA test. The Statistical Package for the Social Sciences version 16 (SPSS, Chicago, IL, USA) was used for statistical analysis. A p-value < 0.05 was considered statistically significant.

RESULTS

As shown in Fig. 1, the mean concentration of serum HSP70 on the 25th day of Ramadan was significantly higher than that recorded one day before Ramadan and on the 3rd day of Ramadan ($p < 0.001$ and $p < 0.01$, respectively). Also, the mean concentration of serum HSP70 on the 3rd day of Ramadan was significantly higher than that recorded one day before Ramadan ($p < 0.001$). The mean concentrations of serum TG and Chol on the 25th day of Ramadan were significantly lower than those recorded one day before Ramadan ($p < 0.001$ for both) and on the 3rd day of Ramadan ($p < 0.001$ for both) (Fig. 2). The mean concentrations of serum TG and Chol on the 3rd day of Ramadan were significantly lower than those noted one day before Ramadan ($p < 0.01$ and $p < 0.001$, respectively).

As shown in Fig. 3a, the mean concentration of serum LDL on the 25th day of Ramadan was significantly lower than that recorded one day before Ramadan and on the 3rd day of Ramadan ($p < 0.001$ for both). The level on the 3rd day of Ramadan was significantly lower than that recorded one day before Ramadan ($p < 0.01$). The mean concentration of serum HDL on the 25th day of Ramadan was significantly greater than that observed one day before Ramadan and on the 3rd day of Ramadan ($p < 0.001$ for both) (Fig. 3b). The mean concentration of serum HDL on the 3rd day of Ramadan was significantly greater than that

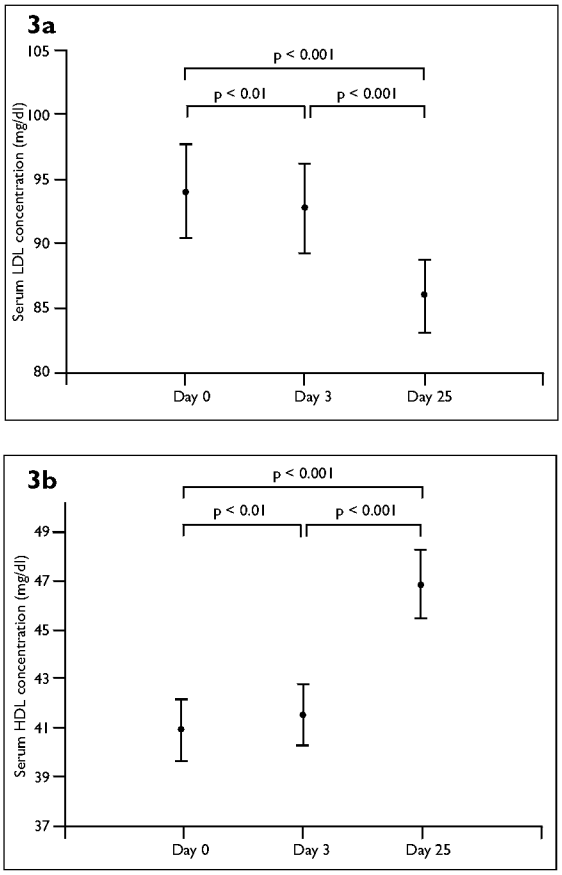


Fig. 3 Graph shows (a) mean serum low-density and (b) high-density lipoprotein concentrations one day before Ramadan and on the 3rd and 25th days of Ramadan.

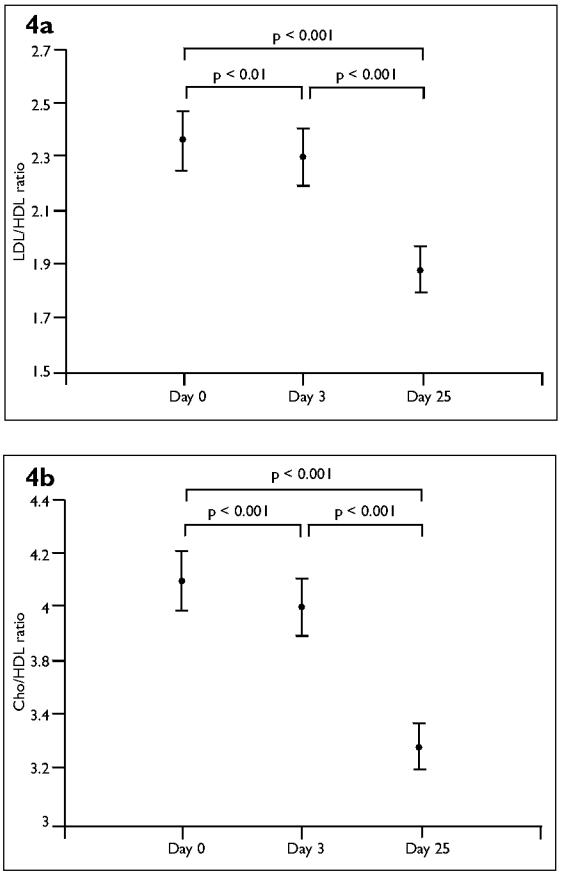


Fig. 4 Graph shows (a) low-density/high-density lipoprotein and (b) cholesterol/high-density lipoprotein ratios one day before Ramadan and on the 3rd and 25th days of Ramadan.

observed one day before Ramadan ($p < 0.01$). As shown in Fig. 4, the mean LDL/HDL and Chol/HDL ratios on the 25th day of Ramadan were significantly lower than those recorded a day before Ramadan ($p < 0.001$ for both) and on the 3rd day of Ramadan ($p < 0.001$ for both). The above ratios on the 3rd day of Ramadan were significantly lower than those recorded a day before Ramadan ($p < 0.01$ and $p < 0.001$, respectively).

DISCUSSION

We found that Ramadan fasting significantly increased serum HSP70 concentration and serum HDL, whereas it significantly decreased serum TG, Chol, LDL and the LDL/HDL and Chol/HDL ratios. Our findings on the lipid profile are congruent with previous findings in the literature.[3,4,14-18] To our knowledge, this is the first time that the effect of Ramadan fasting on the induction of HSPs has been studied. It has been suggested that circulating HSP70 has multiple roles in the maintenance of physiological homeostasis and can be considered an exogenous cytoprotector.[19] Therefore, our finding that Ramadan fasting increased serum HSP70 may suggest a new mechanism for some of the beneficial effects of Ramadan fasting on homeostasis. The following findings on the effects of HSPs are similar to the physiological effects of Ramadan fasting, and may support our hypothesis that some effects of Ramadan fasting are attributable to the induction of HSPs.

HSP70 can lower LDL and very low-density lipoprotein (VLDL) formation by enhancing apolipoprotein B degradation.[20-23] Additionally, several studies have shown that Ramadan fasting decreases LDL and VLDL,[3,15,17,18] and some have even suggested that this effect is not due to decreased calorie and lipid intake.[4] Reduction of insulin resistance by HSP70[24-27] may be another mechanism by which HSP70 can improve dyslipidaemia.[28-30] Therefore, it is possible that decreased LDL and VLDL levels during Ramadan fasting are due to the induction of HSP70. Furthermore, it has been suggested that Ramadan fasting and other kinds of religious fasting may decrease the risk of atherosclerosis.[6] The mechanism proposed for such an effect is a decrease in various atherosclerosis risk factors, including beneficial changes to the lipid profile.[6,17] The results of the current study suggest that the induction of HSPs, among other mechanisms, plays important direct

and/or indirect roles in the possible protective effects of Ramadan fasting against atherosclerosis. This is in line with findings that reported the protective effects of circulating HSP70 against atherosclerosis.[31] Moreover, some other reported effects of Ramadan fasting, such as reduced insulin resistance[32] and decreased low-grade inflammation,[33] may be due to the induction of HSP70.[24-27,34] In addition, the finding that Ramadan fasting reduces low-grade inflammation in Type 2 diabetes mellitus patients[33] may be explained by the fasting-induced anti-inflammatory effects of HSP70.[34]

As physical activity considerably decreases during Ramadan,[35] this could have deleterious effects on the lipid profile and could be a risk factor for coronary atherosclerosis, insulin resistance and inflammation.[36-39] Therefore, the finding of the current study that Ramadan fasting increases serum HSP70 concentration attributes the beneficial effects of Ramadan fasting on lipid profile, atherosclerosis risk factors, insulin resistance and inflammation to the induction of HSP70. Our findings also suggest that Ramadan fasting may be considered as a kind of stress tolerance builder. People who fast during Ramadan undergo some low-grade stresses, such as abstinence from eating and drinking, decreased sleep duration and disruption of the normal sleep-wake cycle. These sublethal stresses may induce HSP70 and produce stress tolerance. The finding that Ramadan fasting elevates serum cortisol, a known stress hormone, is in line with this suggestion.[1] Furthermore, it has been shown that glucocorticoids can induce HSP70.[40,41]

In conclusion, our results show that Ramadan fasting significantly increases serum HSP70 concentration and serum HDL, and significantly decreases serum TG, Chol, LDL as well as the LDL/HDL and Chol/HDL ratios. To our knowledge, this is the first time that the effect of Ramadan fasting on the induction of HSPs has been studied. Therefore, follow-up studies are needed to confirm these results.

ACKNOWLEDGEMENTS

This work was supported by research grants from the Urmia University of Medical Sciences, Urmia, Iran and the Immunology, Asthma and Allergy Research Institute affiliated with the Tehran University of Medical Sciences, Tehran, Iran.

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