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Effects of Ramadan Fasting on Micronutrients and Their Correlations with the Ocular Axial Length and Anterior Chamber Depth

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ABSTRACT

Introduction: The present study aimed to assess the effects of Ramadan fasting on micronutrients and their correlations with ocular biometry.

Methods: This prospective study was conducted on 89 healthy volunteers (51 males and 38 females) with the mean of 34.98±9.10 years in Mashhad, Iran. Participants received complete ophthalmic and systemic examinations one week before and one week after the holy month of Ramadan in 2015. Subjects with no history of systemic and ophthalmic diseases were enrolled in the study. Blood samples were obtained from all the participants in the morning in both phases of the study. Levels of micronutrients were measured in the blood samples using the Hitachi 717 analyzer (Hitachi, Japan). In addition, IOLMaster (Carl Zeiss Meditec AG, Germany) was applied to determine the ocular axial length (AL) and anterior chamber depth (ACD).

Results: No significant differences were observed in the AL and ACD of the subjects before and after Ramadan fasting (P>0.05). Fasting was found to decrease the levels of uric acid, selenium, sodium, and potassium (P<0.05). However, serum phosphor was observed to increase after the fasting period (P=0.032). No changes were reported in the concentrations of the other micronutrients, including urea, calcium, iron, zinc, creatinine, and albumin (P>0.05). Moreover, no significant association was observed between the AL and ACD with the concentrations of the micronutrients during Ramadan (P>0.05).

Conclusion: According to the results, fasting had no significant effects on the overall health and ocular biometry of the fasting individuals during Ramadan. Therefore, it seems that Ramadan fasting is a safe for healthy adults.

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Introduction

The Islamic world consists of 57 countries with the population of 2.02 billion Muslims. More than one billion Muslims fast in the holy month of Ramadan in different regions of the world (1). Since the Islamic lunar calendar is shorter than the solar calendar by 10-11 days, Ramadan may coincide with a different season each year, altering the length of fasting depending on the season and region (2). In Ramadan, eating patterns are different compared to the other times of year, so that fasting individuals have only two major meals, including Sahur and Iftar (3, 4).

Some researchers believe that prolonged

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fasting may be a risk factor for several eye conditions (5). According to the literature, fasting could alter various physiological and ocular parameters in the individuals (6-11). In a study in this regard, Nowrooz Zadeh et al. investigated the effects of Ramadan fasting on the ocular refractive and biometric characteristics of fasting individuals during summer. According to the findings, the eye axial length diminished significantly during Ramadan, which could be due to the prolonged dehydration in the fasting individuals (4). Similarly, the axial length of the eye was reported to decrease slightly in the study by Baser et al. (9).

The present study aimed to evaluate the changes in the micronutrients and ocular biometry of fasting individuals, as well as their correlations during the holy month of Ramadan. To the best of our knowledge, no previous studies have investigated the effects of Ramadan fasting on micronutrients and their associations with the axial ocular length and anterior chamber depth.

Material and methods

This prospective, cross-sectional study was conducted on 100 healthy male and female volunteers (age range: 20-50 years) in Mashhad, Iran, who decided to fast for a minimum of 20 days during Ramadan. Measurements were performed one week before and one week after Ramadan during June-July 2015.

The present study was performed in accordance with the tenets of the Declaration of Helsinki, and the study protocol was approved by the Research Ethics Committee of Mashhad University of Medical Sciences (code: 940149). Informed consent was obtained from all the participants prior to the examinations.

Participants with systemic diseases, such as diabetes, hypertension, eye disorders, history of ocular surgery, those using special medications, and the individuals who were unwilling to participate in the second phase of the research were excluded from further evaluation. Final sample size was determined at 89 subjects, the biometric characteristics and micronutrient levels of whom were investigated.

Ocular axial length (AL) and anterior chamber depth (ACD) were measured using the IOLMaster (Carl Zeiss Meditec, Jena, Germany), which is a non-contact optical biometer. To measure the ACD, the IOLMaster directs a 0.7-mm wide slit light beam through the anterior segment of the eye at a 38-degree angle to the visual axis. The instrument's camera is aligned, so that the light beam would form an optical section and the internal software would measure the distance between the corneal epithelium and anterior crystalline lens surface in order to calculate the ACD (12).

The IOLMaster measures the AL by partial coherence interferometry. In this process, the laser diode generates infrared light (λ=780 μm) of short coherence length (C_L=160 μm), which is reflected into the eye by mirrors after splitting into two equal coaxial beams by the beam splitter. Both the coaxial beams enter the eye, where reflections occur at the corneal epithelium and retinal interfaces. On leaving the eye, the difference in the frequency between the coaxial beams is detected by a photo detector after passing through a second beam splitter (13).

In order to determine the levels of micronutrients, blood samples were obtained from the brachial vein after a minimum of 15 minutes rest and centrifuged immediately (14). Following that, concentrations of the micronutrients, including calcium, phosphorus, sodium, potassium, iron, albumin, zink, selenium, creatinine, uric acid, and urea, were measured using the Hitachi 717 analyzer (Hitachi, Tokyo, Japan).

In the present study, the blood samples were collected by a single experienced physician in the morning (8:00-10:00 AM). Furthermore, the biometric measurements were performed at 04:00-06:00 PM by a single skilled optometrist. It is notable that all the instruments used in the study were calibrated by the manufacturer's representative prior to performing the procedures.

Data analysis was performed in SPSS version 16 (IBM company, Chicago, USA). Normality of the data was assessed using the Kolmogorov-Smirnov test, and paired samples t-test was used to compare the mean values. In addition, Pearson's correlation-coefficient was employed to evaluate the correlations between the changes in the AL and ACD and levels of the micronutrients in the fasting individuals during Ramadan. In all statistical analyses, the

significance level was considered to be 0.05.

Results

In total, 89 healthy Muslims, including 51 men (57.3%) (aged: 35.51±8.94 years) and 38 women (42.7%) (aged: 34.26±9.41 years) were enrolled in the study. Mean age in total study population was 34.98±9.10 years. Our findings showed no significant differences in the AL and ACD of the subjects before and after Ramadan (P>0.05) (Table 1).

Changes in the levels of micronutrients in the fasting participants during Ramadan are presented in Table 2. Fasting was found to decrease the levels of uric acid, selenium, sodium, and potassium (P<0.05). However, serum phosphor was observed to increase after the fasting period (P=0.032). No changes were

Table 1. Changes of ocular biometric parameters during Ramadan fasting

Variables	Gender	Before Ramadan	After Ramadan	P-value
Right eye AL (mm)	Total	23.65±1.09	23.67±1.07	0.459
	Male	24.00±1.15	24.04±1.13	0.519
	Female	23.14±0.75	23.15±0.73	0.719
Left eye AL (mm)	Total	23.61±1.07	23.62±1.06	0.446
	Male	23.95±1.13	23.98±1.12	0.671
	Female	23.11±0.74	23.10±0.73	0.462
Right eye ACD (mm)	Total	3.45±0.33	3.44±0.35	0.453
	Male	3.47±0.35	3.48±0.35	0.616
	Female	3.40±0.30	3.38±0.34	0.545
Left eye ACD (mm)	Total	3.44±0.33	3.44±0.33	0.449
	Male	3.46±0.35	3.45±0.36	0.085
	Female	3.40±0.29	3.43±0.28	0.083

AL: Axial Length, ACD: Anterior Chamber Depth. All data are presented as mean± SD.* p <0.05

Table 2. Changes of micronutrients during Ramadan fasting

Micronutrients	Gender	Before Ramadan	After Ramadan	P-value
Calcium	Total	9.75±0.43	9.63±0.47	0.054
	Males	9.87±0.43	9.75±0.46	0.158
	Females	9.59±0.38	9.48±0.43	0.190
Phosphorus	Total	4.55±0.69	4.77±0.74	0.032*
	Males	4.48±0.71	4.76±0.79	0.041*
	Females	4.66±0.67	4.80±0.66	0.369
Sodium	Total	139.61±2.74	138.46±2.21	0.007*
	Males	140.00±2.40	138.41±2.27	0.003*
	Females	139.12±3.10	138.54±2.16	0.364
Potassium	Total	4.19±0.24	4.12±0.24	0.028*
	Males	4.17±0.25	4.11±0.25	0.238
	Females	4.22±0.23	4.12±0.24	0.043*
Iron	Total	78.35±29.17	80.81±32.40	0.519
	Males	84.90±25.46	85.45±29.74	0.911
	Females	69.55±31.77	74.58±35.10	0.412
Albumin	Total	4.83±0.27	4.85±0.26	0.400
	Males	4.92±0.28	4.97±0.22	0.175
	Females	4.71±0.21	4.69±0.23	0.644
Zinc	Total	76.29±8.37	74.61±7.21	0.170
	Males	77.62±8.79	76.60±6.64	0.548
	Females	74.52±7.52	71.94±7.17	0.151
Selenium	Total	87.18±13.71	82.79±13.30	0.016*
	Males	85.54±13.62	80.42±11.64	0.020*
	Females	89.38±13.70	85.96±14.82	0.271
Creatinine	Total	0.96±0.18	0.93±0.18	0.056
	Males	1.05±0.16	1.03±0.16	0.177
	Females	0.83±0.12	0.80±0.09	0.182
Uric Acid	Total	4.74±1.30	4.34±1.47	<0.001*
	Males	5.48±1.08	5.15±1.19	<0.001*
	Females	3.74±0.82	3.26±1.05	<0.001*
Urea	Total	32.54±9.83	31.60±6.85	0.300
	Males	36.02±9.39	33.75±6.84	0.085
	Females	27.87±8.45	28.71±5.77	0.480

All data are presented as mean± SD.* p <0.05

Table 3. The result of Pearson correlations test (r values) between axial length and anterior chamber depth with micronutrients changes during Ramadan fasting

	Right eye AL changes	Left eye AL changes	Right ACD changes	Left ACD changes
Calcium changes	0.181	0.198	-0.047	0.175
Phosphorus changes	-0.019	0.053	-0.050	-0.146
Sodium changes	0.115	0.079	-0.136	0.125
Potassium changes	0.129	0.012	-0.193	-0.066
Iron changes	-0.018	0.181	0.006	0.106
Albumin changes	0.120	0.118	-0.010	0.098
Zink changes	-0.039	0.000	-0.006	-0.141
Selenium changes	-0.030	-0.031	-0.207	-0.038

AL: Axial Length, ACD: Anterior Chamber Depth. * p <0.05

reported in the concentrations of the other micronutrients, including urea, calcium, iron, zinc, creatinine, and albumin (P>0.05).

The results of Pearson's correlation-coefficient indicated no significant associations between the AL and ACD with the levels of the micronutrients in the fasting individuals during Ramadan (P>0.05) (Table 3).

Discussion

In the holy month of Ramadan, Muslims abstain from eating and drinking during daytime until after sunset. Modifications in the daily distribution of nutrients are associated with several changes in the metabolism of fasting individuals, which has given rise to concerns regarding the potentially harmful effects of fasting. The current research aimed to investigate the effects of Ramadan fasting on the levels of micronutrients and their correlations with the ocular biometry.

Findings of the present study indicated no significant differences in the mean AL and ACD of both eyes in the fasting individuals during Ramadan. Moreover, no significant changes were observed in the concentration of calcium, iron, albumin, zinc, and creatinine in fasting men and women before and after Ramadan. However, the levels of sodium and selenium significantly reduced in the male participants, while no changes were observed in the fasting women in this regard. On the other hand, concentration of uric acid decreased in the male and female participants. In addition, the level of potassium reduced in women, while no changes were observed in men in this regard. Data analysis also revealed that the level of phosphorus increased in the fasting male subjects. Meanwhile, no significant association was observed between the AL and ACD with the levels of micronutrients during Ramadan.

Some studies have focused on the effects of fasting on micronutrient levels and ocular biometry. For instance, Baser et al. investigated the effect of dehydration due to fasting on the diurnal changes of the AL, reporting that the AL was slightly shorter in the fasting individuals (9). Additionally, Nowrooz Zadeh et al. evaluated the effects of Ramadan fasting on the ocular biometric characteristics and claimed that the AL significantly decreased in fasting individuals although the size returned to normal after one month (4). However, the results of the present study showed no significant difference in the AL before and after Ramadan. Sedagat et al. assessed ocular parameters during Ramadan and showed that AL and ACD, measured by IOL master, remained unchanged during Ramadan. However, ACD parameter, using the Pentacam, decreased during Ramadan. They explained this difference by the different reference points (internal or external) between two instruments for measuring the ACD (15)

Alameen et al. also assessed the effect of fasting on the intraocular parameters and observed shorter AL and ACD in the fasting state. (16)

Consistent with the study by Ramadan et al., our findings indicated that Ramadan fasting had no significant effect on the calcium level (10). On the other hand, a significant reduction in the sodium level was reported in the male subjects, while no changes were observed in the female participants in this regard. In another study, Baccouche et al. assessed the effects of fasting Ramadan on the metabolic parameters of elderly individuals. According to the results, serum sodium increased significantly in the fasting subjects. Baccouche et al. attributed this finding to the reduced water intake and high temperature in the summer in Tunisia (17).

Another research in this regard was

conducted by Attarzadeh Hosseini et al. on 26 healthy, overweight women aged 20-45 years, and the researchers reported no significant changes in the sodium level (18). This is in line with the results of the present study. Reduction of the sodium concentration during Ramadan could be due to dehydration and the subsequent excretion of this micronutrient.

In the present study, the level of phosphorus remained unchanged in women, while it significantly increased in men. Similarly, Attarzadeh Hosseini et al. reported no significant changes in the phosphorus concentration of fasting women during Ramadan (18). Increased phosphorus in fasting men could be due to the compensatory response to the reduction of serum phosphate.

According to the findings of the current research, the level of potassium decreased in the fasting women, while it showed no changes in men. This is in congruence with the study by Trabelsi et al. (19), in which the researchers assessed the effects of Ramadan fasting on biochemical parameters of physically active men, stating that fasting had no impact on the serum potassium concentration. On the other hand, Farooq et al. investigated the effects of Ramadan fasting on the iron indices of preteen and teenage boys (2). According to the findings, iron indices reduced in preteens, which is inconsistent with our findings. In addition, the results of the present study indicated no significant changes in iron levels, which could be due to the differences in the age range of the participants between the two studies.

In this regard, Ramadan et al. investigated the effects of Ramadan fasting on the iron levels in sedentary and physically active males (10), noting a reduction in the serum iron of the sedentary subjects and no changes in that of the active males. According to the authors, the reduction could be due to the dietary deficiency or changes in the iron distribution associated with the altered synthesis of iron-binding proteins.

In another study, Maughan et al. assessed the dietary intake of soccer players during Ramadan (20) and reported the reduction of dietary iron in the fasting group compared to the non-fasting group, which reflected the difference in energy intake of both study groups during Ramadan. Diversity of the results in the aforementioned studies could be attributed to the variations in the investigated samples.

Findings of the current research indicated no significant differences in levels of zinc and creatinine in the fasting individuals during Ramadan, which is consistent with the results of the previous studies in this regard (10, 21). In contrast, Trabelsi et al. reported the increased concentration of serum creatinine in the physically active men who fasted in Ramadan (19). Accordingly, the increased serum creatinine levels during Ramadan could be due to the increased protein consumption and dehydration, which led to the elevation of this parameter. It should be noted that our study was performed on healthy volunteers with no excessive physical activity.

According to the results of the current research, there were no significant changes in the levels of albumin and urea, which is in line with the previous studies in this regard (10, 21-23). On the other hand, Imtiaz et al. evaluated the clinical and biochemical parameters of hemodialysis patients and reported a significant increase in the serum albumin during Ramadan (24). This discrepancy could be due to the different criteria for selecting the participants between the two studies. It is also noteworthy that the subjects in the mentioned study had metabolic disease, while we evaluated healthy individuals.

According to the results of the present study, uric acid level decreased in both men and women during Ramadan, which could be attributed to the reduced protein intake due to of the fewer number of the meals in this month. This finding is inconsistent with the results of the studies that showed no significant difference in the level of uric acid in fasting individuals during Ramadan (10, 21). On the other hand, some other studies have denoted the increased level of serum uric acid during Ramadan (19, 25), which could be attributed to the increased protein breakdown and dehydration during this month.

The diverse findings of the studies evaluating the metabolic consequences of Ramadan fasting could be due to several factors, such as different protocols, variable nutritional habits, variable climates depending on the location of the study, and differences in the seasonal occurrence of Ramadan.

One of the limitations of the current research was that we did not record the composition of the meals and daily calorie intake of the participants. Therefore, acquisition of these data is recommended for the further investigations regarding Ramadan fasting. Furthermore, it is suggested that standard methods be applied to consider the effects of gender, season, nutritional habits, and ethnic background of the subjects in order to perform comprehensive evaluations.

Conclusion

According to the results of the present study, Ramadan fasting had no significant effects on the overall health and ocular biometry of the subjects during Ramadan. Moreover, our findings showed no significant correlations between the AL and ACD with the levels of micronutrients in the fasting individuals during the holy month of Ramadan. Therefore, it seems that Ramadan fasting is a safe option for all healthy adults.

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Conflict of interest

None declared.

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