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Original/*Obesidad*

Influence of age and religious fasting on the body composition of Muslim women living in a westernized context

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Abstract

Introduction: **Currently there is some controversy to whether Ramadan fasting leads to changes in the nutritional status and body composition of females who observe this practice. Furthermore, recent research suggest that age may be an important factor that affects anthropometric values and body composition just before and at the end of Ramadan. The aim of our study was to analyze the effects of Ramadan fasting, as modulated by age, on the nutritional status and body composition of a group of Muslim female subjects living in a westernized context.**

Material and Methods: **A longitudinal study was carried out of 62 Berber Muslim females of ages ranging from 18 to 61 in the North African city of Melilla (Spain). The nutritional status was evaluated by anthropometry and their body composition studied by means of bioimpedance scales. These evaluations were performed before fasting began and again in the last week of Ramadan.**

Results: **The intermittent fasting produced important changes in the nutritional status and body composition of the female subjects. More specifically, there was a significant reduction (p=0.000) in total body weight values, BMI, body fat percentage measured by bioimpedance, and hip circumference (p=0.008). Significant differences were found (p=0.000) in anthropometric values and body composition before and at the end of Ramadan, depending on age.**

Conclusions: **All the subjects experienced significant changes in nutritional status and body composition at the end of Ramada. These changes were more pronounced in the group of women over thirty years of age. .**

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Key words: *Ramadan. Woman. Anthropometry. Bioelectrical impedance. Body composition.*

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INFLUENCIA DE LA EDAD Y EL AYUNO RELIGIOSO SOBRE LA COMPOSICIÓN CORPORAL, EN MUJERES MUSULMANAS, EN UN CONTEXTO OCCIDENTALIZADO

Resumen

Introducción: **Actualmente existe controversia a cerca de si la práctica del Ramadán implica, o no, cambios en el estado nutricional y composición corporal en las mujeres que lo practican. Asimismo, estudios recientes sugieren que la edad puede constituir un factor influyente en los valores antropométricos y de composición corporal antes y al final del Ramadán. El objetivo de nuestro estudio fue analizar los efectos del ayuno practicado durante el Ramadán sobre el estado nutricional y la composición corporal en un grupo de mujeres que viven en un contexto occidentalizado, así como el efecto de la variable edad.**

Material y Métodos: **Se llevó a cabo un estudio longitudinal con 62 mujeres, bereberes y musulmanas, de edades comprendidas entre los 18 a 61 en la ciudad norteafricana de Melilla (España). El estado nutricional se evaluó mediante antropometría y el estudio de la composición corporal, a través de bioimpedancia. Estas evaluaciones se realizaron antes del inicio del ayuno y la última semana de Ramadán.**

Resultados: **El ayuno intermitente produce cambios importantes en el estado nutricional y en la composición corporal de las mujeres. Observándose una reducción significativa (p=0.000) en los valores del peso corporal total, índice de masa corporal, porcentaje de grasa corporal medida por bioimpedancia, y circunferencia de la cadera (p=0.008). Se encontraron diferencias significativas (p=0.000) en los valores antropométricos y de composición corporal, antes y al final del Ramadán, en función de la edad.**

Conclusiones: **Se observaron cambios significativos en el estado nutricional y en la composición corporal en todas las mujeres al finalizar el Ramadán. Estos cambios fueron más acusados en el grupo de mujeres mayores de treinta años.**

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Palabras clave: *Ramadán. Mujer. Antropometría. Impedancia bioeléctrica. Composición corporal.*

Introduction

The observance of Ramadan is regarded as one of the five pillars of Islam and corresponds to the ninth month of the Islamic calendar. During this sacred month from sunrise until sunset, Muslims are required to abstain from sexual relations, smoking, drinking and eating. On average, it lasts twelve hours each day. In fact, certain authors regard Ramadan as a unique model of intermittent fasting[1].

During Ramadan, eating habits are modified[2] as well as social activity[3] and sleep patterns[4,5]. Given this unique context, it is interesting to study the effects of intermittent fasting on different aspects of human health[6]. Until now, most of the research on this subject has been conducted in countries where the majority of the population is Muslim.

Currently, there are few studies on this subject that have been carried out in Western countries in which city life is not affected by Ramadan. Not surprisingly, this makes it more difficult to reconcile religious obligations with day-to-day responsibilities[7]. In a Muslim society, it is still customary for females to prepare the food served from the time when fasting is broken until when the sun rises. They are also responsible for taking care of family members who are not required to observe Ramadan, such as children, the sick, and the elderly[8]. Evidently, this cumulative work overload may make it even more difficult for women to observe the fasting period. For this reason, it is necessary to ascertain the impact that Ramadan has on the nutritional status of Muslim women who live in westernized contexts, based on anthropometric parameters and body composition.

Body mass index is the direct measurement most recommended by international health organizations to define overweight and obesity[9] because of its reliability, simplicity, and accurate correlation with body fat mass[10-12]. Another procedure used to determine modifications in body composition after fasting is the study of skinfolds. By evaluating skinfolds with the Siri and Brozeck formulas, it is possible to calculate the body fat percentage[13,14].

Moreover, waist measurement is another extremely useful anthropometric variable since it provides data regarding the body composition of the subject and more specifically, the volume of intra-abdominal fat[15]. In fact, it can offer accurate information regarding any modification of the intra-abdominal fat deposit after the fasting periods[16,17]. Other parameters of interest in anthropometry and body composition are the waist-to-hip ratio (WHR) and the waist-to-height ratio (WHtR). Both are excellent indicators of abdominal adiposity in an individual[18,19].

Based on the previous considerations, the objectives of this study were the following: to determine whether this period of intermittent fasting modified the anthropometric values and body composition of the female subjects; to analyze the impact of age as a modulating factor in anthropometric values and body composition immediately before and at the end of the Ramadan fasting period.

Material and methods

Study design and population

This research involved a longitudinal study of 62 Berber Muslim females of ages ranging from 18 to 61 (33,6 ± 12,7 years) in the North African city of Melilla (Spain) during the months of July and August in 2012 and 2013. For this purpose, the nutritional status of the subjects was evaluated by anthropometry and their body composition studied by means of bioimpedance scales. These evaluations were performed before fasting began and again in the last week of Ramadan. It was decided to divide the subjects into two groups: (i) women under thirty years of age; (ii) women over thirty years of age. The age threshold was based on the mean age at first childbirth in Spain (30.2 years), according to data published by the National Institute of Statistics in Spain in December 2012[20]. The inclusion criteria for the study were that all subjects had to be Muslim females of legal age. They also had to be non-smokers and willing to voluntarily observe the Ramadan religious fasting. Pregnant women were excluded from the study. All of the participants received detailed information regarding the objectives of the study and gave their written informed consent. The study had been previously approved by the Ethics Committee of the University of Granada. This research was performed in strict compliance with the international code of medical ethics established by the World Medical Association and the Declaration of Helsinki.

Anthropometric measurements

The nutritional status of the subjects was assessed by means of anthropometry. The variables used for this evaluation were weight, height, and body mass index (BMI). Also analyzed were the tricipital, bicipital, subscapular, and suprailiac skinfolds, body fat percentage (BF%), waist circumference (WC), waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR). This assessment was performed before the beginning and in the last week of Ramadan. The subjects were asked to come with an empty stomach and empty bladder. They also had to wear comfortable clothes, not have any metallic objects in contact with their skin, and not have practiced any intense physical exercise in 12 hours previous to the measurements.

The calculation of the total body weight and body composition was carried out with a Whole Body Composition Monitor (TANITA SC-330), which is self-calibrating with has an accuracy of 100 grams. Height was measured with a portable stadiometer (TANITA®). The

subjects were asked to stand on the center of the base plate, feet together, and heels against the rod. Facing forward, their head was oriented so that the Frankfort Plane was in a horizontal position. The subjects' back and pelvis were kept as straight as possible in contact with rod. Once in that position, the measuring arm of the stadiometer was applied to the crown of their head. The subjects' height and weight measurements were used to calculate their BMI and thus classify their nutritional status as normal weight, overweight, or obese, according to the references values of the World Health Organization[21].

The evaluation of the skinfolds was performed with a Holtain® skinfold caliper with an accuracy of 0.1-0.2 mm, following the prediction equations of Durnin & Womersley[22]. Each skinfold was measured three times by the same observer and the mean value was calculated. The waist and hip circumferences were measured with a flexible, inextensible metric measuring tape with an accuracy of 1mm. Waist circumference was measured midpoint between the lower margin of the last palpable rib and the top of the iliac crest. Hip circumference was taken around the widest portion of the buttocks. Each circumference was also measured three times by the same observer and the mean value was calculated. The waist-to-hip ratio (WHR) was calculated by dividing the waist circumference measured in centimeters by the hip circumference also measured in centimeters. Values regarded as normal were 0.8 for females and 1 for males. The waist-to-height ratio (WHtR) was calculated by dividing the waist circumference measured in centimeters by the height in centimeters. Values regarded as normal were 0.4-0.5.

Body density was calculated by means of the following formula:

$$1{,}1567 - 0{,}0717 \times \mathrm{Lg10}\ \Sigma$$

(Tricipital, Bicipital, Subscapular, and Suprailiac)

The equations used to calculate the body fat percen*tage were those formulated by Siri[13] and Brozeck[14]:*

$$\text{Siri} = [(4{,}95/\text{Density}) - 4{,}50] \times 100$$
$$\text{Brozeck} = [(4{,}57/\text{Density}) - 4{,}142] \times 100$$

This study was carried out in compliance with the ethical guidelines and principles for biomedical research involving human subjects established by the World Medical Assembly (WMA) in the Helsinki Declaration (Finland 1994) and periodically revised in subsequent assemblies (the most recent being the 59th WMA held in Seoul, Korea in October 2008). After being informed about the objectives and details of the study, all subjects gave their informed written consent. Current Spanish legislation that regulates clinical research in humans (Royal Decree 561/1993 on clinical trials) and the Personal Data Protection Act 15/1999 of 13 December guaranteed the total confidentiality of the collected data, which were made anonymous by the use of codes and only used for scientific purposes.

Statistical analysis

The analysis of the data was performed with the SPSS statistical software package, version 20.0 (IBM, Chicago, IL, USA) for Windows. The normality of the data was calculated with the Kolmogorov-Smirnov test, which showed that the variables had a normal distribution. A descriptive analysis of all of the variables was also performed. In relation to the study of anthropometric characteristics and body composition before and at the end of Ramadan, and according to age, a contrast of hypotheses was carried out for each of the variables in order to ascertain whether the mean value of the responses before and after could be regarded as equal. Given the fact that the samples were in pairs, the Student *t*-test was applied. A result was considered to be statistically significant when $p<0{,}05$. Data were expressed as the mean (SD).

Results

Table I shows the percentages of change in the variables in reference to the initial (baseline) values. Something worth highlighting is the change in the BMI, waist and hip circumferences, body fat percentage measured with bioimpedance, and the bicipital skinfold. There was thus a significant reduction (p=0.000) in their total body weight, BMI, body fat percentage measured with bioimpedance, and hip circumference (p=0.008) from the beginning until the end of Ramadan. In contrast, there were no statistically significant differences for this period for the following variables: tricipital skinfold (p=0.613); bicipital skinfold (p=0.069); subscapular skinfold (p=0.787); suprailiac skinfold (p=0.748); waist circumference (p=0.106); and the body fat percentage calculated with the Siri and Brozeck equations, WHR (p=0.633), and WHtR (p=0.104).

In regards to the two groups of ages (table II), the results reflected statistically significant differences (p=0.000) for all anthropometric and body composition parameters, except the waist-to-hip ratio, both before and at the end of Ramadan as well as according to the age of the subjects. In regards to weight, the younger group of women (< 30 years) lost an average of half a kilogram from the beginning to the end of Ramadan. In contrast, the older group (>30 years) experienced a greater weight loss of approximately two kilograms during this same period.

Table I
Anthropometric and body composition characteristics before and at the end of Ramadan.

	Before Ramadan				*After Ramadan*				*% Change for baseline*				
	Mean	*(SE)*	*Minimum*	*Maximum*	*Mean*	*(SD)*	*Minimum*	*Maximum*	*Mean*	*(SD)*	*Minimum*	*Maximum*	p^a
Weight (Kg)	67.2	(14.12)	40.6	106.1	66.1	(14.98)	39.0	104.0	–1.6	(2.8)	–2.1	19.4	0.000
Tricipital skinfold (mm)	22.6	(6.37)	7.3	35.0	22.7	(6.63)	7.7	37.3	0.4	(9.4)	–24.1	18.0	0.613
Bicipital skinfold (mm)	12.9	(4.89)	4.2	24.3	12.3	(5.18)	5.0	27.0	–4.7	(18.2)	–66.6	43.6	0.069
Subscapular skinfold (mm)	20.8	(8.93)	7.1	39.7	20.9	(8.69)	7.0	40.3	0.5	(12.7)	–52.0	29.9	0.787
Suprailiac skinfold (mm)	22.3	(7.92)	6.1	41.3	22.4	(7.58)	6.5	40.2	0.5	(14.4)	–43.9	31.3	0.748
Waist circumference (cm)	90.1	(12.42)	66.3	123.0	89.4	(12.40)	64.2	127.5	–0.8	(3.3)	–8.4	9.8	0.106
Hip circumference (cm)	99.0	(12.72)	76.4	134.8	98.1	(12.69)	74.4	134.8	–0.9	(3.3)	–8.4	9.8	0.008
Fat mass (%)	32.1	(9.39)	4.3	51.5	31.4	(9.50)	3.0	51.2	–2.2	(7.3)	–16.0	33.4	0.000
BMI	26.3	(5.77)	16.5	43.6	25.8	(5.59)	16.4	42.7	–1.9	(1.6)	–1.6	5.2	0.000
Body fat (%) Siri	34.1	(5.18)	18.4	42.54	34.1	(5.03)	19.30	43.38	0.0	(3.1)	–6.8	7.3	0.919
Body fat (%) Brozeck	32.8	(4.78)	18.2	40.53	32.7	(4.64)	19.07	41.30	–0.6	(3.1)	–6.6	7.1	0.919
WHR	0.91	(0.04)	0.81	0.98	0.91	(0.04)	0.80	1.04	0.0	(3.7)	–6.9	13.3	0.633
WHtR	0.56	(0.08)	0.41	0.79	0.56	(0.08)	0.40	0.79	0.0	(3.3)	–8.4	9.8	0.104

BMI: body mass index; WHR: waist-to-hip ratio; WHtR: waist-to-height ratio.

[a]Statistical significance at <0.05.

Table II
Anthropometric characteristics and body composition before and after Ramadan.

		Before Ramadan					*After Ramadan*				
	Age (y)	*n*	*Mean*	*(SD)*	*Minimum*	*Maximum*	*Mean*	*(SD)*	*Minimum*	*Maximum*	*p*[a]
Weight (Kg)	≤30	29	59.9	(11.00)	40.6	84.6	59.4	(10.88)	39.0	85.2	0.000
	>30	33	73.7	(13.49)	50.8	106.1	71.9	(13.90)	47.7	104.0	
Tricipital skinfold (mm)	≤30	29	19.3	(5.37)	7.3	32.0	19.2	(5.13)	7.7	28.7	0.000
	>30	33	25.4	(5.87)	16.0	35.0	25.8	(6.32)	15.7	37.3	
Subscapular skinfold (mm)	≤30	29	13.8	(5.74)	7.1	30.3	14.2	(5.56)	7.0	31.3	0.000
	>30	33	27.0	(6.31)	11.8	39.7	26.8	(6.35)	12.7	40.3	
Bicipital skinfold (mm)	≤30	29	9.9	(3.50)	4.2	19.3	10.0	(4.01)	5.0	19.3	0.000
	>30	33	15.5	(4.48)	8.0	24.3	14.3	(5.30)	6.5	27.0	
Suprailiac skinfold (mm)	≤30	29	17.9	(6.77)	6.1	32.0	18.6	(6.06)	6.5	30.0	0.000
	>30	33	26.1	(6.85)	11.8	41.3	25.7	(7.26)	13.3	40.2	
Waist circumference (cm)	≤30	29	82.6	(9.43)	66.3	102.7	81.7	(9.00)	64.2	102.8	0.000
	>30	33	96.7	(10.94)	76.8	123.0	96.2	(10.96)	77.2	127.5	
Hip circumference (cm)	≤30	29	91.6	(8.77)	76.4	110.0	90.9	(8.37)	74.4	108.3	0.000
	>30	33	105.5	(12.11)	84.8	134.8	104.4	(12.54)	84.3	134.8	
Fat mass (%)	≤30	29	25.7	(8.31)	4.3	41.5	25.0	(8.44)	3.0	41.1	*0.000*
	>30	33	37.7	(6.11)	27.0	51.5	37.0	(6.37)	24.4	51.2	
BMI	≤30	29	22.8	(3.92)	16.5	33.9	22.6	(3.88)	16.4	34.1	*0.000*
	>30	33	29.3	(5.43)	20.9	43.6	28.7	(5.30)	20.3	42.7	
Body fat (%) (Siri)	≤30	29	30.53	-4.609	18.38	39.61	30.83	–4.395	19.30	38.47	*0.000*
	>30	33	37.25	-3.269	29.58	42.54	36.97	–3.619	29.05	43.38	
Body fat (%) Broceck	≤30	29	29.44	-4.255	18.22	37.82	29.72	–4.058	19.07	36.77	*0.000*
	>30	33	35.65	-3.018	28.57	40.53	35.38	–3.341	28.07	41.30	
WHR	≤30	29	0.90	(0.038)	0.81	0.96	0.90	(0.039)	0.80	0.96	*0.085*
	>30	33	0.92	(0.035)	0.85	0.98	0.92	(0.043)	0.80	1.04	
WHtR	≤30	29	0.51	(0.057)	0.41	0.65	0.50	(0.055)	0.40	0.65	*0.000*
	>30	33	0.61	(0.073)	0.49	0.79	0.61	(0.072)	0.49	0.79	

BMI: body mass index; WHR: waist-to-hip ratio; WHtR: waist-to-height ratio. [a]Statistical significance at <0.05.

In reference to changes in skinfold values, the younger group of women experienced a slight reduction in the tricipital and bicipital skinfold values and a slight increase in the subscapular and suprailiac skinfolds during the period of intermittent fasting. The older group of women experienced a slight increase in the tricipital skinfold value and a reduction in the other skinfold values. The value that decreased the most was that of the bicipital skinfold.

Both groups also experienced a slight reduction in their waist and hip circumferences. However, the older group of women showed a somewhat greater decrease in hip circumference when the measurement was taken at the end of the religious fasting period. The waist circumference measurements before and at the end of Ramadan were greater than 80 cm in both groups of subjects. In relation to the ratios derived from both circumferences, the values for the waist-to-hip ratio (WHR) were higher than 0.8 before and after the fasting period. As for the waist-to-height ratio (WHtR), only the younger group of women (< 30 years) had higher values both before and after Ramadan.

Both the WHR and the WHtR remained stable in both groups of subjects before and at the end of Ramadan. The body fat percentage of the subjects, as calculated with bioimpedance and the Siri and Brozeck equations, decreased slightly during the fasting period. Nevertheless, the bioimpedance data reflected a marginally greater fat loss than the values calculated by the equations. The subjects' BMI was also somewhat lower at the end of Ramadan although this decrease was slightly more accentuated in the older group of women.

Discussion

The results obtained in this study showed at the end of Ramadan, all of the female subjects had experienced significant changes in their anthropometric values and body composition. This result coincides with Norouzy et al.[23] who concluded that Ramadan fasting led to a reduction of fat-free mass and thus to changes in body composition. In this same line, our results showed important variations in anthropometric values and confirmed body composition changes in both groups of subjects. Moreover, significant modifications were observed in the tricipital, bicipital, subscapular, and suprailiac skinfold values as well as in the body fat percentage determined with the Siri[13] and Brozeck[14] equations, which were not calculated in Norouzy et al.[23].

In the total sample, no statistically significant differences were found in skinfold values before and after Ramadan. In fact, the only change observed was a reduction in the bicipital skinfold and a slight increase in all of the others.

Furthermore, contradictory results were obtained for the body fat percentage at the end of Ramadan, depending on the technique used. In this sense, our results coincide with those of Norouzy et al.[23], who also observed a significant reduction in the percentage of body fat when measured with bioimpedance. However, when body fat was calculated with the Siri[13] and Brozeck[14] equations, the results did not reflect significant differences in the values before and at the end of Ramadan. These results are in consonance with those of Rohin et al. [24] According to Marrodán et al.[25], this divergence in results for body fat percentage, depending on the technique used, could be due to the tendency of bioimpedance measuring devices to overestimate fat mass. This signifies that it is necessary to use both techniques in order to compare the data.

Regarding weight loss, the results of our study reflect statistically significant differences in the subjects' weight as well as BMI. Nevertheless, it is not clear whether this loss was caused by a reduction in the body fat percentage or was due to other circumstances. Rohin et al.[24] concluded that this weight loss could have been produced by the depletion of body fluids because of fasting and not to a reduction in body fat. According to other authors, the reduction of visceral (intra-abdominal) fat in both younger and older women (as compared to men) is a consequence of their higher level of physical activity during Ramadan[26].

When the two age groups were compared, the most significant changes in anthropometric values and body composition occurred in the older group of women (>30 years). This indicates that age had an impact on the other variables studied. Furthermore, given the fact that in this group of women, there was a greater prevalence of overweight and obesity at the beginning of the religious fasting period, it is necessary to consider the potential effect of nutritional status on the changes observed at the end of the fasting period.

One of the limitations of this study was the size of the sample. Another limitation could have been the effect of cigarette consumption as a confusing factor. Nevertheless, since this study was composed only of female non-smokers, we were able to avoid this pitfall that had been a problem in previous studies.[27]

In summary, all the subjects experienced significant changes in nutritional status and body composition at the end of Ramadan. These changes were greater in the group of older women (> 30 years). In future research, we will explore which of the following variables most influenced the changes observed: the age of the subjects, their nutritional status, or a possible association between the two variables.

Conflict of interests

The authors declare that there are no conflicts of interest.

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