

# Association of white and red meat consumption with general and abdominal obesity: a cross-sectional study among a population of Iranian military families in 2016

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## Abstract

**Purpose** To assess the association of red and white meat consumption with general and abdominal obesity among Iranian military families.

**Methods** In this cross-sectional study, 525 subjects with age range of 19–55 years belong to military families of Army of Islamic Republic of Iran were recruited during 2016. Dietary data were collected using semi-quantitative food-frequency questionnaire. A self-reported questionnaire was used to collect data on demographic characteristics and anthropometric measurements. General obesity was defined as body mass index  $\geq 25$  kg/m<sup>2</sup> and abdominal obesity as waist circumference  $\geq 80$  cm for women and  $\geq 94$  cm for men. Finally, we had complete data on 170 subjects for analysis.

**Results** Mean age of subjects was  $33.78 \pm 6.48$ . We found a significant positive association between red meat consumption and abdominal obesity in fully adjusted model, so

that subjects in the fourth quartile had 4.51 more odds to be abdominally obese compared with those in the first quartile of red meat consumption (OR 4.51, 95% CI 1.32–15.40). Such relationship was not seen for general obesity. In addition, white meat consumption was not associated with general and abdominal obesity either before or after adjustment for covariates.

**Conclusions** Red meat consumption was positively associated with abdominal obesity. No significant relationship was found between white meat consumption, and general and abdominal obesity. Therefore, further studies are needed to shed light our findings.

**Keywords** Anthropometry · Obesity · Red meat · Diet · Military family · Iran

## Introduction

Obesity is an epidemic problem in all over the world [1] and is associated with greater risk of death and a number of chronic diseases including diabetes mellitus, cardiovascular diseases, and some types of cancer [2–4]. In US, overall age-adjusted prevalence of obesity was reported 37.7% in adults' population from 2013 to 2014 [5]. Recently, the prevalence of obesity is increasing at an alarming rate, especially in Asian countries [1]. Based on the recent National Survey in Iran, the prevalence rate of obesity among adults increased from 12% in 2000 to 22% in 2011 [6]. It was reported that general and abdominal obesity is prevalent in 9.7 and 27.7% of the Iranian adults, respectively [7].

It has been shown that several factors including genetic and environmental factors are involved in the obesity epidemic [8]. It seems that diet, as an environmental factor,

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has an important role in etiology of obesity [9]. Red meat is one of the important parts of the human diet, which provides high-quality nutrients (zinc, iron, vitamin B<sub>6</sub>, protein, and vitamin B<sub>12</sub>), but that also constitutes a relevant source of cholesterol and saturated fatty acids [10, 11].

Today, several epidemiologic studies have investigated the association of red meat consumption with general and abdominal obesity, but findings in this regard are conflicting [12]. Some studies have indicated a positive association between red meat consumption and obesity [13–17], while others have failed to reach any significant relationships [18, 19]. Most prior studies have mainly focused on red meat, and the association between white meat consumption, and general and abdominal obesity has less been paid attention and results are more controversial in this regard [20, 21]. Furthermore, earlier studies are mostly done on general population, and few data are available on military population [21]. Most military individuals and their families have different dietary patterns compared to general population [22, 23]. Therefore, it is important to assess the association between dietary intakes and obesity in this population independently. Current study aimed to examine the association of white and red meat consumption with general and abdominal obesity among Iranian military families.

## Materials and methods

### Subjects and design

This is a cross-sectional study which was done on a population of military families affiliated to Army of Islamic Republic of Iran during 2016. A self-administered questionnaire containing information on demographic characteristics, anthropometric measurements, and dietary intakes was delivered to 525 individuals, aged 19–55 years. Totally 468 subjects gave back the questionnaires, which among those we excluded individuals with missing data ( $n=53$ ) and those who had over-reporting and under-reporting for dietary intakes on the basis of total calorie intake outside the range of 800–4200 kcal/day ( $n=245$ ). Finally, we had complete data on 170 subjects including 85 men and 85 women for the current analysis.

The Bioethics Committee of AJA University of Medical Sciences, Tehran, Iran, approved the study. A written informed consent form was taken from all subjects prior to study enrolment.

### Dietary assessment

We assessed the usual dietary intakes of subjects using a 168-item semi-quantitative food-frequency questionnaire (FFQ). This questionnaire contains a list of food

items and a standard serving size for each item. At first, subjects were instructed how to fulfil the questionnaire by two trained dietitians, who had more than 5 years' experience for administration of this questionnaire. Then, subjects were asked to report their consumption frequency of each item during the previous year on a daily (e.g., bread), weekly (e.g., rice or meat), monthly (e.g., fish), or yearly basis, and then report the amount of consumption for each time based on serving size. We converted the portion size of consumed foods to grams using household measures. Daily intakes of nutrients for each subjects were calculated using the US Department of Agriculture's (USDA) national nutrient databank [24]. The previous studies have shown that the FFQ provided valid and reliable data on long-term intake of food groups and nutrients [25]. In the current study, we obtained the total red meat consumption by summing up the consumption of all kind of red meat (beef, veal, mutton, and lamb) and visceral meats (lamb's liver, kidney, and heart). Processed meat (sausages, hamburgers, hot dogs) was not considered as red or white meat, because in food industries of Iran, different kinds of meat including red and white meats are used to produce processed meat. To calculate the total white meat consumption, we summed up the consumption of chicken, poultry and fish.

### Demographic and anthropometric measurements

Data on age (year), education (high school diploma, below/above high school diploma), smoking status (non-smoker, former smoker, current smoker), and economic status (based on monthly salary of the head of family: 1 million toman or below/above 1 million toman) were collected using a self-reported questionnaire. Subjects with the monthly salary of 1 million toman or below were considered as poor economic status and those with above 1 million toman monthly salary were considered as well-economic status. In addition, a self-reported questionnaire was applied to collect data on weight, height, and waist circumference. Body mass index (BMI) was calculated as weight in kilograms divided by the height in meters squared. We classified subjects into two categories based on their BMI: normal weight ( $\leq 24.9$  kg/m<sup>2</sup>) and overweight or obese ( $\geq 25$  kg/m<sup>2</sup>). Based on waist circumference, abdominal obesity was defined. We considered abdominal overweight and obesity based on criteria reported by Lean et al., and the National Cholesterol Education Program (NCEP), respectively [25, 26]. Subjects were categorized into two groups according to Lean et al., criteria: normal ( $< 80$  cm for women,  $< 94$  cm for men) and with abdominal obesity ( $\geq 80$  cm for women and  $\geq 94$  cm for men).

**Statistical analyses**

In this study, we first obtained energy-adjusted intakes of red and white meat using the residual method [27]. Then, subjects were categorized by quartiles of energy-adjusted red and white meat consumption. We used one-way analysis of variance (ANOVA) to assess the differences in continuous variable including age and intakes of food groups and nutrients across quartiles of red and white meat consumption. To assess the distribution of subjects in terms of categorical variables across quartiles of red and white meat consumption, we applied the Chi-square test. Binary logistic regression in different models was used to examine the association of red and white meat consumption with general and abdominal obesity. In the first model, age (continuous), gender and energy intake (continuous) were adjusted. In the second or final model, further adjustments were done for education (high school diploma or below/above high school diploma), smoking status (non-smoker, former smoker, and current smoker), and economic status (poor and well). In all analyses, the first quartile of red and white meat consumption was considered as the reference category. To determine the overall trend of odds ratios across increasing quartiles of red and white meat consumption, we considered these quartiles as an ordinal variable in the logistic regression models. All statistical analyses were done with SPSS software (version 19.0; SPSS Inc, Chicago, IL, USA). Significant level was considered as *P* values <0.05.

**Results**

Mean age of subjects was  $33.78 \pm 6.48$ , and 50% were female. Totally, general and abdominal overweight/obesity were prevalent in 50.6 and 53.8% of subjects, respectively. General characteristics of subjects across quartiles of red and white meat consumption are presented in Table 1. Compared with the first quartile, subjects in the fourth quartile of white meat consumption were more likely to be current smoker. No significant differences were observed in age, gender, education, and economic status across quartiles of red and white meat consumption.

Dietary and nutrient intakes of subjects across quartiles of red and white meat consumption are shown in Table 2. Subjects in the top quartile of red meat consumption had higher intakes of fruits, legumes and protein and lower intakes of vegetables, dairy, whole grains, energy, carbohydrate, and dietary fiber compared with those in the bottom quartile. In addition, subjects had significantly different intakes of refined grains, fat, fructose, and folate across categories of red meat consumption. In terms of white meat consumption, compared with the lowest quartile, subjects

**Table 1** General characteristics of subjects across quartiles of red and white meat consumption

	Quartiles of red meat consumption				Quartiles of white meat consumption				<i>P</i> <sup>a</sup>
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Age	32.7 ± 5.9	33.7 ± 6.4	34.6 ± 6	33.1 ± 6.4	33.7 ± 0.9	34 ± 0.8	32.5 ± 0.8	33.9 ± 1.1	0.7
Gender (female) (%)	54.8	47.6	47.6	52.4	50	45.2	59.5	47.6	0.57
Education (higher than high school diploma) (%)	35.7	28.6	26.2	28.6	33.3	21.4	33.3	31	0.58
Economic status (well) (%)	42.9	51.2	50	60	51.2	56.1	48.8	47.6	0.87
Smoking status (current smoker) (%)	7.1	9.5	7.1	0	14.3	4.8	0	4.8	0.04

Data are presented as mean ± standard deviation (SD) or percent

<sup>a</sup>Obtained from ANOVA or Chi-square test, where appropriate

**Table 2** Dietary and nutrient intakes of subjects across quartiles of red and white meat consumption

	Quartiles of red meat consumption				Quartiles of white meat consumption				<i>P</i> <sup>b</sup>
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
<b>Food groups (g/day)</b>									
Fruits	341.5±41.5	168.8±23.8	294.6±41.8	293.5±36.1	277.7±37.4	241±38.5	257.6±37.2	322±37.3	0.46
Vegetables	401.6±52.8	219.8±21.5	286.7±27.6	292±29.3	305.2±32.9	272.1±29.3	318.6±46.1	304.3±34.4	0.82
Dairy	562.7±74.6	304.5±32.1	546.2±52.5	418.8±32.6	483.9±61.4	328.9±33.3	438.3±43	581±63	0.008
Red meat					50.2±8.5	27±4.2	49.1±6.4	56.6±8.9	0.02
Processed meat	5.1±0.9	4.6±0.7	6.6±3.1	3.8±0.6	3±0.5	2.4±0.3	5.9±0.8	8.9±3.1	0.02
White meat	22.5±2.6	17.9±2.4	31.8±3.8	33.7±4.7					
Legumes	42.3±7	28.9±3.5	37.7±5.9	67.3±7.7	40.2±6.2	38.2±5.2	43.7±5.6	54±8.6	0.33
Nuts	13.3±3.4	7.1±1.6	6.9±0.9	7.7±0.9	12.5±3.4	7.1±1.6	7.7±1	7.7±1.1	0.22
Whole grains	114.3±23.1	48±5	56.5±6.8	76.8±12.8	96.9±17.2	76.1±18.7	70.5±10	52.1±7.8	0.17
Refined grains	345.2±30.4	428.5±43.4	299.9±16.9	337.1±26.7	440.2±48	312.2±22.8	339.2±19.3	319.1±23.9	0.01
<b>Nutrients</b>									
Energy (Kcal/day) <sup>a</sup>	2617.8±88	1973.3±93	2256.5±117	2374.8±99	2497.5±96	2039.3±102	2295.6±113	2390.1±100	0.01
Protein (g/day)	85.6±4.6	67.6±6.2	83.5±4.6	94.4±4.5	87.5±6.3	65±4.2	80.3±4.4	98.2±4.4	<0.001
Fat (g/day)	81.5±3.5	63.9±4.7	79.1±4.7	84.6±4.3	83.5±5.2	67.5±3.6	80.2±4.8	77.9±3.7	0.06
Carbohydrate (g/day)	403±17	298.1±15.6	317.5±18.8	320.2±16.4	370±19	305±17.6	325.6±18.3	338.1±16	0.07
Dietary fiber (g/day)	22.8±1.5	14.8±0.8	18.1±1.3	19.8±1.2	19.9±1.3	16.5±1.2	18.8±1.4	20.3±1.2	0.18
Fructose (g/day)	13.1±1	7.6±0.7	10.9±1.1	11.1±0.8	10.5±0.9	9±0.9	10.5±0.9	12.8±1	0.05
Folate (µg/day)	357.3±25	242.3±15.1	320.1±27.3	328.4±17.7	328.1±26.5	265.3±17.7	302.6±20.1	352.1±23.9	0.04
Caffeine (mg/day)	157.6±19.7	131.6±19	219±80.8	160.5±20.1	229.2±80.5	136.6±16.5	145.9±17.1	156.9±24.6	0.42

Data are presented as mean ± standard error (SE)

<sup>a</sup>Energy was not adjusted<sup>b</sup>Obtained from ANOVA

in the highest quartile had higher intakes of dairy, processed meat, and protein and lower intakes of refined grains and energy. Furthermore, subjects across quartiles of white meat consumption had different intakes of folate.

Multivariable-adjusted odds ratios for general and abdominal obesity across quartiles of red and white meat consumption are indicated in Table 3. No significant association was observed between red meat consumption and general obesity. This relationship was non-significant even after adjustment of potential confounders. Moreover, there was no significant relationship between red meat consumption and abdominal obesity. When potential confounders were taken into account, a significant positive association was found between red meat consumption and abdominal obesity, so that subjects in the fourth quartile had 4.51 more odds to be abdominally obese compared with those in the first quartile of red meat consumption (OR 4.51, 95% CI 1.32–15.40). No overall significant association was observed between white meat consumption, general, and abdominal obesity either in crude or adjusted models.

### Discussion

To the best of our knowledge, this study is the first to examine the association of red and white meat consumption with general and abdominal obesity among Iranian military families. In this cross-sectional study, we found a significant positive association between red meat consumption and abdominal obesity in fully adjusted model. Such relationship was not seen for general obesity. In addition, white meat consumption was not associated with general and abdominal obesity either before or after adjustment for covariates.

Most previous studies have mainly done on general population and assessed the association of red meat consumption with general and abdominal obesity, and few evidences are available on white meat consumption [12, 28]. In line with our findings, Wang et al. reported in a US national cross-sectional study that red meat consumption is positively associated with central adiposity [15]. Another study conducted by Wang et al. in a Chinese population, indicated that greater intake of red meat consumption was significantly associated with higher abdominal obesity risk [16]. In addition, Montonen et al. reported that subjects in the top quartile of red meat consumption have greater WC and BMI compared with those in the bottom quartile [13]. In another study in Japanese-Brazilians population, Cristofolletti et al. reported that the red meat consumption was associated with abdominal obesity only in women after adjustment of covariates [17]. In another study by Babio et al., results showed that individuals in the fourth quartile of red meat consumption had an increased risk of central

**Table 3** Odds ratio (95% CI) for general and abdominal obesity according quartiles of red and white meat consumption

	Quartiles of red meat consumption				Quartiles of white meat consumption				p-trend
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
<b>General obesity</b>									
Crude	1	0.95 (0.40–2.25)	0.90 (0.37–2.18)	0.58 (0.33–1.86)	1	1.10 (0.46–2.58)	0.72 (0.30–1.76)	1.47 (0.62–3.48)	0.57
Model 1 <sup>a</sup>	1	1.06 (0.41–2.74)	0.91 (0.36–2.32)	0.81 (0.33–1.97)	1	1.23 (0.50–3.03)	0.80 (0.32–2.00)	1.53 (0.63–3.73)	0.53
Model 2 <sup>b</sup>	1	1.12 (0.42–2.94)	0.88 (0.34–2.26)	0.85 (0.34–2.12)	1	1.20 (0.47–3.09)	0.79 (0.30–2.04)	1.45 (0.58–3.62)	0.6
Model 3 <sup>c</sup>	1	1.04 (0.38–2.83)	0.85 (0.32–2.26)	0.82 (0.32–2.10)	1	1.28 (0.49–3.33)	0.78 (0.30–2.05)	1.51 (0.59–3.86)	0.58
<b>Abdominal obesity</b>									
Crude	1	0.70 (0.27–1.83)	0.94 (0.36–2.42)	2.54 (0.93–6.88)	1	1.15 (0.44–3.00)	0.50 (0.19–1.29)	0.93 (0.37–2.37)	0.52
Model 1	1	0.67 (0.22–1.96)	0.99 (0.35–2.79)	2.83 (0.97–8.22)	1	1.39 (0.47–4.08)	0.38 (0.13–1.10)	1.00 (0.37–2.73)	0.48
Model 2	1	0.57 (0.18–1.79)	0.84 (0.28–2.49)	3.68 (1.14–11.88)	1	1.63 (0.51–5.25)	0.43 (0.14–1.33)	1.06 (0.37–3.07)	0.57
Model 3	1	0.64 (0.19–2.15)	0.98 (0.31–3.05)	4.51 (1.32–15.40)	1	1.67 (0.50–5.56)	0.43 (0.14–1.37)	1.33 (0.43–4.04)	0.87

Data are OR (95% CI)

<sup>a</sup>Model 1: adjusted for gender, age, and energy intake

<sup>b</sup>Model 2: additionally adjusted for economic status, education, and smoking status

<sup>c</sup>Model 3: further adjustment for dietary intakes of fruits, vegetables, whole grain, and dietary fiber

obesity at the end of the follow-up compared to the lowest quartile [19]. In Spanish Mediterranean population, it was reported by Sotos Prieto et al. that red meat consumption was associated with greater weight and prevalence of obesity [29]. In contrast with our findings, Wagemakers et al. in a prospective cohort study in British adults revealed no significant association between red meat consumption and abdominal obesity [18]. In addition, in a study on Belgian military population, Mullie et al. reported that 5 year adherence to meat dietary pattern increased the risk of general obesity [30]. However, abdominal obesity was not assessed in this study; its findings on general obesity are inconsistent compared with our findings which may be due to differences in subjects' culture, health status, and genetic and psychological factors. Furthermore, different cooking and process of red meat in various cultures might be another reason for different findings in this regard.

The association between red meat consumption and abdominal obesity is complex. In our study, individuals in the fourth quartile of red meat consumption had lower intake of fruits, vegetables, whole grain, and dietary fiber compared to those in the first quartile. It has been shown that lower intake of fruits, vegetables, whole grain, and dietary fiber is associated with greater odds of abdominal obesity. Although we adjusted these potential confounders for obtaining an independent association between red meat consumption and abdominal obesity, assessing whole dietary intakes or dietary patterns in relation to abdominal obesity is better than focusing on single food or nutrient intake due to decreasing the co-linearity problem which might occur when assessing single food and nutrient intakes. This subject should be considered in future studies in this regard.

Some hypothesis can be mentioned on the positive association between red meat consumption and abdominal obesity. Red meat and its products are one of the high-energy density foods, because it is rich source of protein, cholesterol, and saturated fatty acids [31]. A significant positive association between energy density and obesity has been established previously [32]. Although we did not assess the kinds of red meat (lean, low fat, and full fat) in this study, but Iranian people often consume full-fat red meats. Therefore, we can consider red meats as high-energy density foods in Iran. In addition, consumption of red meat increases the count of some gut microbiota such as *Bacteroides enterotype* [33]. Some studies have shown a significant positive association between presence of these gut microbiota and obesity [33, 34]. However, this relationship is controversial and further studies are required to confirm this relationship.

In the current study, we found no significant association between white meat consumption and both kinds of obesity. In line with our findings, Winkvist et al. reported in

a cross-sectional study that white meat consumption was not associated with obesity among adolescents in Western Sweden [35]. In contrast, other studies showed significant association between white meat consumption and obesity. Vergnaud et al. reported that higher poultry consumption is related to lower odds for having general obesity [21]. In addition, findings from Maskarinec et al. showed a significant positive association between white meat consumption and obesity [36]. Such findings were also seen in the Oxford Vegetarian Study [37]. Differences in the previous findings might be explained by different processing and cooking of white meat or consumption of various kinds of white meats including poultry and fish in different cultures.

Some limitations should be considered for interpreting our findings. Due to cross-sectional design of current study, we cannot infer a causal link between meat consumption, and general and abdominal obesity. Therefore, findings of current study need to be confirmed in prospective studies. In addition, obese subjects may have low dietary intake to lose weight. Therefore, these residual confounding effects may attenuate the risk estimates and actual results may be even stronger than those obtained. Although some confounders were adjusted in current study to reach an independent association between meat consumption and obesity; some other confounders such as menopausal status, hormone therapy, and psychological factors should be controlled in mentioned relationship in future studies.

## Conclusion

Red meat consumption was positively associated with abdominal obesity, but such a significant relationship was not seen for general obesity. In addition, no significant relationship was found between white meat consumption, and general and abdominal obesity. Further studies are needed to shed light our findings.

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## Compliance with ethical standards

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**Conflict of interest** Authors declared no personal or financial conflicts of interest.

**Ethical approval** All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed consent** Informed consent was obtained from all subjects included in the study.

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