

## The Relationship between the Amount of Saturated Fat Intake and Semen Quality in Men

### Abstract

**Introduction:** Infertility in men is one of the current problems of human society. Some studies suggest that the metabolic status of a man, including cholesterol intake, closely correlates with sperm function. The aim of this study was to evaluate the correlation between saturated fat intake and semen quality among men referring to the Isfahan Fertility and Infertility Center, Iran. **Materials and Methods:** This cross-sectional study was conducted on all men who referred to the Isfahan Fertility and Infertility Center. The study population consisted of 120 men selected through simple random sampling. The data collection tool consisted of a two-part questionnaire including a demographic and anthropometric characteristics form and the Food Frequency Questionnaire (FFQ). The FFQ consists of 168 items that assess food and nutrient intake for 3 months. The reliability and validity of the instruments were confirmed in previous studies. Semen analysis was performed using computer-aided semen analysis (CASA) method. Descriptive statistics and logistic regression test were used to analyze the data. **Results:** Results showed that the chances of having semen volume of higher than 1.5 ml (normal volume) increased by 27.5% for every 1 g increase in total fat (CI: 1.11–1.46) ( $P = 0.001$ ) and reduced 38% for every 1 g increase in saturated fat (CI: 0.42–0.90,  $P = 0.010$ ). No association was found between semen quality and intake of dietary fats. **Conclusions:** Based on the findings of this study and the prevalence of infertility in recent decades, changes in diet and saturated fatty acids intake may improve semen quality.

**Keywords:** Diet, food frequency questionnaire, Iran, semen quality

### Introduction

Infertility is a global problem that has impacted different communities; its social and psychological consequences affect infertile men and women.<sup>[1]</sup> The incidence of infertility in Iran in 2008 was estimated at 21.9–24.9%, approximately one-fourth of Iranian couples.<sup>[2]</sup> Various factors contribute to the development of infertility.<sup>[3–5]</sup> In recent years, some studies have assessed the role of dietary factors on semen quality, including semen volume, sperm concentration, sperm motility, sperm morphology, and the rate of white blood cells in semen.<sup>[6]</sup> However, still little information is available regarding the effects of diet on the infertility of men.<sup>[3,6]</sup> Cholesterol is a steroid fat and an essential component of mammalian plasma membrane, which is needed for suitable permeability and membrane fluidity. Sperm membrane lipids are extremely sensitive to changes in diet. Research has shown that animals fed diets rich in saturated fat

have increased plasma cholesterol levels. This increase in blood cholesterol levels affects the balance between cholesterol and phospholipids in the cell membrane.<sup>[7]</sup> Some of the findings showed that increased cholesterol changes the function of sperm bilayer membrane including osmotic strength, acrosome reaction, capacity of sperm, and sperm count and motility, causing a significant decrease in the semen volume and a significant increase in the number of sperm cells with abnormal morphology.<sup>[8,9]</sup> Mild hyperlipidemia caused by a diet containing cholesterol can significantly reduce sperm motility and its concentration in the epididymis and testis.<sup>[10]</sup>

Obesity doubled in Iran from 1992 to 1995 due to Western lifestyle, especially in eating foods containing meat and sugar, and low fiber foods along with reduced physical activity.<sup>[11]</sup> Dietary intervention can improve sperm function.<sup>[12]</sup> Because of the high incidence of male factor infertility in

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Iran,<sup>[2]</sup> its unfavorable effects on different life aspects of couples, and the possibility of modification of nutrition, unlike some nonmodifiable risk factors, diet modification is an appropriate intervention. Therefore, it should be considered as an important factor when counseling infertile men. A review of literature and databases revealed that no study has been performed in this regard in Iran. The Western dietary pattern differs from the Iranian dietary pattern. Thus, it is essential that the amount of saturated fat affecting the performance of male fertility system in different societies with different cultural contexts, lifestyles, and different food styles be studied. The potential role of fatty acid consumption rate in the diet on semen quality has had less attention. Therefore, this study aimed to investigate the relationship between the amount of saturated fat in the diet on semen quality in men who referred to reproduction and infertility centers in Isfahan Province, Iran.

## Materials and Methods

This was a cross-sectional, descriptive correlational study. The study population included all males who referred to the Isfahan Fertility and Infertility Center for sperm motility test. The sample size was determined as 120 subjects based on  $z_1 = 1.96$ ,  $z_2 = 0.84$ , and  $r$  estimated correlation coefficient between saturated fats and factors related to semen (its absolute value was at least 0.25). The participants were selected through simple random sampling. During the study, every other patient referring to the infertility center was selected using admission tickets. The research tool was a questionnaire consisting of two parts; demographic and anthropometric characteristics form and the Food Frequency Questionnaire (FFQ). The FFQ contains 168 questions, and its validity and reliability were confirmed by Hosseini *et al.* in 2010.<sup>[13]</sup> Each question had 4 items of daily, weekly, monthly, and yearly use, and the participants responded to them according to the frequency of usage of each nutrient per day, week, month, or year. Subsequently, the food consumed per unit gram was entered into N4 software and the amount of total fat, saturated fat, and cholesterol were extracted using the software base on gram, gram, and milligram, respectively.

The inclusion criteria included general health (approval of the center's physician), lack of varicocele, surgery of the testicles, congenital anomalies such as unilateral testicular or undescended testicles, any previous injuries to the testicles (according to the patient and medical diagnosis of the center's physician), exposure to a fever of higher than 38 degrees in the past 3 months, and use of any form of tobacco and alcohol in the past 3 months, and willingness to participate in the study, literate, and residing in Isfahan. The exclusion criterion included unwillingness to continue to participate in this study. The researcher referred to the infertility center after obtaining the necessary approvals from the ethics committee of Isfahan University of Medical Sciences, Isfahan. Then, via simple random

sampling method, the participants were selected from among those who referred to the center. After explaining the purpose of the study to the participants and obtaining their consent to participate in the research, the inclusion criteria (health status and education level) were studied. Physical examination and medical history evaluation were performed by the physician of the center. Written informed consent forms were obtained from the participants when their health was approved. Then, the demographic and anthropometric characteristics form (age, occupation, education, height, weight, body mass index, and waist circumference) was completed. Then, the necessary training on completing the FFQ was provided and the participants were asked to complete the questionnaires and return them to the researcher.

Semen samples were collected in a sterile container through masturbation. Each individual was questioned regarding the lack of ejaculation during the past 48 hours. Each sample container was delivered to the laboratory. In order to estimate the volume of semen, each sample was weighed with a digital scale, and then, 10  $\mu$ l of well-mixed semen was placed on a Mac Lor slide. The sperm concentration and the percentage of sperm motility were determined by the researcher using computer-aided semen analysis (CASA). It should be noted that the researcher received the required validity and reliability to perform the research after passing 100 hours of training courses. To determine the percentage of sperm motility, a minimum of 200 sperms were evaluated. Then, 10  $\mu$ l of well-mixed semen were taken for smears. After staining using Diff-Quik method, at least 200 sperms were observed using a microscope with lens of 100 to determine their morphology. The number of white blood cells in semen was calculated using a microscope with lens of 20 and their mean was estimated. Data were analyzed in the Statistical Package for the Social Sciences software (version 18, SPSS Inc., Chicago, IL, USA) using descriptive statistics and logistic regression test.  $P$  values of less than 0.05 were considered significant.

## Ethical considerations

The Ethical Committee of Isfahan University of Medical Sciences approved the study protocol. The researcher explained the study and possible side effects of medications to all the eligible men who were candidates for study. Then, if they agreed to participate, the researcher provided them with consent form and replies to probably questions. Each participant completed the informed consent form before enrolling in the study. Participants could leave the study at any time of the study. They were also not required to pay for additional care.

## Results

Kolmogorov–Smirnov test showed that the variables studied were normal. Results showed that the highest percentage of the participants were self-employed and had

a diploma. The mean age of the participants was 33.98. The mean BMI of the participants was 26.38 and their mean waist circumference was 95.39 [Table 1].

The mean and standard deviation of total fat, saturated fat, and cholesterol intake was calculated using the FFQ and were 18.85 (9.83), 66.3 (37.05), and 6.50 (4.42), respectively [Table 2]. According to quartiles of 25, 50, and 75, total fat, saturated fat, and cholesterol intake were divided into four groups. Their correlation with each of the indicators of semen quality, which was evaluated according to the World Health Organization (WHO) standards in 2010,

**Table 1: The mean and standard deviation of variables such as age, height, weight, body mass index, and waist circumference of the subjects**

Variable	Minimum	Maximum	Mean	SD
Age	23	76	33.98	7.57
Height	160	195	176.43	6.58
Weight	55	130	82.4	16.59
Body mass index	18.83	41.03	26.38	4.62
Waist circumference	68	135	95.39	13.98

**Table 2: Mean and standard deviation of total fat, saturated fat, and cholesterol intake of the subjects based on the Food Frequency Questionnaire**

Variable	Minimum	Maximum	Mean	SD
Total fat	5.10	72.34	18.85	9.83
Saturated fat	1.05	37.83	6.50	4.42
Cholesterol	15.85	116.75	66.3	37.05

is provided in Table 3. Results showed that the chances of having semen volume of more than 1.5 ml (normal volume) increased by 27.5% for every 1 g increase in total fat. This correlation was significant (CI: 1.11–1.46) ( $P = 0.001$ ). For every 1 g increase in saturated fat, the chance of having semen volume of higher than 1.5 reduced 38% and this relationship was also significant ( $P = 0.010$ ). The chance of having sperm concentration of higher than 15 million increased 8.1% and 0.7% per 1 g increase in saturated fat and 1 mg increase in cholesterol, respectively. In addition, it decreased by 21% for every 1 mg increase in saturated fat. The greatest chance of fertility in terms of sperm concentration was related to the lowest percentile of total fat intake compared to the base percentile and its amount was 5.696, although it was not significant ( $P = 0.340$ ).

The relationship of dietary intake of fats with sperm morphology and motility was not significant in any of the cases. However, the results showed that the highest chance of having morphology of higher than 4% and total sperm motility of higher than 40%, according to the WHO manual, were related to the lowest percentile cholesterol intake compared to the base percentile. With every 1 mg increase in cholesterol, the morphology and motility of sperm increased by 0.1% and 1.4%, respectively. The greatest chance of having white blood cells count of less than 1 million in the second percentile of saturated fat was 5.32 compared to the base percentile. Moreover, with every 1 mg increase in saturated fat, the chance of normal white blood cells count increased by 6.7%. However, this amount was not significant.

**Table 3: The relationship between mean total fat, saturated fat, and cholesterol intake and semen characteristics in subjects**

	Volume		Concentration		Motility		Morphology		WBC						
	CI	OR	CI	OR	CI	OR	CI	OR	CI	OR					
Total fat															
<11.850	58.09	0.01	0.77	202.62	0.16	5.69	4.02	0.11	0.67	13.27	0.08	1.04	42.16	0.12	2.27
-11.851-16.310	17.29	0.01	0.33	9.68	0.14	1.16	6.60	0.65	2.08	14.86	0.71	3.25	5.25	0.20	1.03
-16.311-23.810	23.49	0.06	1.24	5.42	0.04	0.46	3.98	0.48	1.39	6.27	0.25	1.26	7.11	0.29	1.44
23.811	Reference		Reference		Reference		Reference		Reference						
Continue	1.46	1.11	1.27	1.25	0.93	1.08	1.13	0.93	1.02	1.13	0.87	0.99	1.12	0.87	0.98
Saturated fat															
<2.442	1.39	3.06	206.56	148.07	0.14	4.57	5.02	0.01	0.29	12.69	0.01	0.38	0.79	0.001	0.02
2.443-3.097	461.81	0.21	9.89		0.00	0.00	4.38	0.07	0.58	12.54	0.03	0.66		0.000	5.32
3.098-3.691	600.20	0.11	8.33	20.65	0.02	0.72	1.93	0.05	0.32		0.00	0.00	1.41	0.01	0.13
>3.692	Reference		Reference		Reference		Reference		Reference						
Continue	0.90	0.42	0.62	1.20	0.51	0.79	1.10	0.55	0.78	1.46	0.68	1.00	1.50	0.75	1.06
Cholesterol															
<26.337	9.97	0.00	0.19		0.00	0.00	163.59	0.33	7.43	200.76	0.11	4.69		0.000	2.34
26.338-32.880	16.12	0.02	0.57	12.92	0.01	0.27	26.57	0.36	3.11	26.96	0.10	1.67	144.87	0.16	4.89
32.881-42.350		0.00	0.00		0.00	0.00	6.41	0.41	1.62	8.90	0.37	1.82	61.55	0.38	4.84
>42.351	Reference		Reference		Reference		Reference		Reference						
Continue	1.02	0.99	1.01	1.03	0.98	1.01	1.03	0.99	1.01	1.02	0.98	1.001	1.01	0.97	0.99

WBC: White blood cell

## Discussion

The results of this study showed that the mean total fat, saturated fat, and cholesterol were  $66.3 \pm 37.05$ ,  $6.50 \pm 4.421$ , and  $18.85 \pm 9.83$ , respectively. According to the semen parameters in each percentile of received fat, the chance of having semen volume of higher than 1.5 ml (normal volume) increased by 27.5% with every 1 g increase in total fat. This relationship was significant. With every 1 mg increase in cholesterol, semen volume increased by 0.01, however, this relationship was not significant. Chavarro *et al.* showed that, with increase in cholesterol intake, semen volume decreased.<sup>[14]</sup> Nevertheless, in the study by Jensen *et al.* as well as other studies, no significant relationship was found between cholesterol intake and semen volume. The difference in the results of the two studies were due to use of the 101-item FFQ and sample size of 209 individuals in the study by Chavarro *et al.*, and 136-item questionnaire, sampling among young people in the general population, and the 1999 WHO guideline in the study by Jensen *et al.*<sup>[6,14]</sup>

The study by Attaman *et al.* in America on 99 male Americans showed that sperm concentration reduced by 38% in the highest percentile of total fat and saturated fat intake compared to the lowest percentile.<sup>[3]</sup> The findings of Jensen *et al.* in America were similar to the present study and showed that men in the highest percentile of saturated fat intake had 38% less sperm concentration than men in the lowest percentile.<sup>[6]</sup> The study by Chavarro *et al.* showed that, in the highest percentile of saturated fat intake, sperm concentration was 21% lower than the lowest percentile, although it was not significant. The study by Vujkovic *et al.* showed that the traditional Dutch food pattern increased sperm concentration. This increase was due to the higher consumption of potatoes and lower consumption of nonalcoholic beverages in this diet, but there were no explanations regarding saturated fats in this study.<sup>[15]</sup>

In the present study, however, the correlation between dietary fats and sperm morphology and motility was not significant in any of the cases. Nevertheless, the results showed that the highest chances of having morphology of higher than 4% and total sperm motility of higher than 40%, according to the WHO manual, was related to the lowest percentile of cholesterol intake compared to the baseline percentile. This relationship was not statistically significant. Furthermore, with every 1 mg increase in cholesterol, sperm morphology and motility increased by 0.1% and 1.4%. The study by Audrey *et al.* with two groups of conservative diet and traditional Dutch diet showed that conservative diet was positively associated with progressive sperm motility and no significant correlation was found between traditional diet and semen quality.<sup>[16]</sup> In addition, no significant association was observed between saturated

fat and sperm motility in the present study. However, the study by Chavarro *et al.* showed that the consumption of total fat and saturated fat had a direct relationship with sperm motility. Nevertheless, in the study by Jensen *et al.*, an inverse relationship was found between the percentage of saturated fat and normal morphology.

The results of this study showed that the highest chance of having less than 1 million white blood cells was in the second percentile of saturated fat and was 5.32 compared to the baseline percentile. Moreover, with every 1 mg increase in saturated fat, the chance of normal white blood cells count increased to 6.7%, although this was not statistically significant ( $P = 0.990$ ). White blood cells were not studied in any of the reviewed studies. Therefore, no data was available in this regard for comparison with the present findings.

The results of these studies suggested that further research is essential to examine the relationship between dietary fat and semen quality.<sup>[3]</sup> According to the results of this study as well as other studies, it is essential to use the latest and most accurate methods available for evaluating semen. Furthermore, in accordance with the 2010 standards of the WHO, more studies should be conducted. Overall, the findings of this study showed that mean total fat and cholesterol intake were inversely associated with semen volume. Therefore, recommendations of lower intake of total fat and cholesterol in the diet can be effective in improving semen volume. However, the mean of none of the dietary fats had a significant relationship with semen concentration, percentage of sperm motility, and the percentage of normal sperm morphology. As a result, in order to recommend a specific diet to improve the quality of semen concentration and total sperm motility and morphology, further investigation is required. The findings showed that mean total fat and saturated fat intake had an inverse relationship with the concentration of white blood cells; thus, for men with abnormal levels of white blood cells in semen, a lower total fat and saturated fat diet is recommended.

## Conclusion

The results of this study showed that the significant relationship between total fat and volume semen and the average of these two types of fat was lower in normal volume group, thus, less total fat and cholesterol dietary recommendations can be effective in improving semen volume. But the correlation between dietary fats and sperm concentration and sperm morphology and motility was not significant in any of the cases, thus, need to be investigated further. The results of this study showed that the highest chance of having normal white blood cells was in the second percentile of saturated fat, thus, a diet containing lower amounts of total fat and saturated fats is recommended. Based on the findings of this study and the prevalence of infertility in recent decades, changes in diet and saturated fatty acids intake may improve semen quality.

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## Conflicts of interest

There are no conflicts of interest.

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