

Association between dairy and calcium intake and general and central obesity among female students

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ABSTRACT

Background: Nowadays, obesity is considered a worldwide problem. Although genetics is one of the factors associated with obesity, its predisposing factors include nutritional and environmental factors. Several studies have addressed the relationship between nutritional factors and general and central adiposity. Therefore, the purpose of this study was to determine the relationship between the consumption of dairy products and prevalence of obesity and central obesity in young female university students at the Isfahan University of Medical Sciences. **Materials and Methods:** This cross-sectional study was conducted on 236 healthy female university students in the age range of 18 and 30 years who were selected randomly from among the students at the Isfahan University of Medical Sciences, Iran. A previously validated semiquantitative food questionnaire was used to assess their entire dietary component intake. Physical activity was evaluated by recording daily physical activities. **Findings:** The prevalence of obesity, central adiposity, and excess weight was 1.7, 0.9, and 8.1%, respectively. The mean values of body mass index (BMI) and waist circumference were 21.54 kg/m² and 70.37 cm, respectively. Moreover, the mean value of dairy product consumption was 444.24 g/day. The results showed no significant relationship between dairy or calcium intake and weight and waist circumference as well as prevalence of obesity, central adiposity, and excess weight ($P > 0.05$). **Conclusion:** There was no significant relationship between the consumption of dairy products and calcium intake and excess weight, obesity, and central adiposity among female university students. However, this study is important in that the prevalence of obesity, central adiposity, and excess weight along with the mean values of BMI and waist circumference are reported.

Key words: BMI, calcium, central obesity, dairy products, obesity

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INTRODUCTION

Nowadays, the increase in energy intake and inactive life has turned obesity into a global problem.^[1] Obesity has incurred heavy expenses on American society.^[2] Although genetics is strongly associated with obesity, the global prevalence of obesity suggests the severe impact of environmental factors. Socioeconomic status, sex, marital status, education, and physical activity, change in nutritional pattern, smoking, and replacing a healthy diet with high-fat and low-fiber diets which are rich in refined carbohydrates are among these factors.^[1,3] Currently, 55% of the American adults are either overweight or fat; this percentage almost equals to 97 million

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Americans aged 20 years or more, 22% of whom are obese.^[4] Many studies have reported that the pattern of fat distribution in the body is considered a riskier factor than general obesity. Central obesity increases mortality risk in all societies. In most studies, prevalence of central obesity has been reported in women more than in men. In Iran, 67% of the women and 33% of the men over 20 years have central obesity.^[3]

Different factors, including environmental and dietary factors, are associated with central obesity. Among the components of diet, dairy products which are a rich source of calcium are associated with obesity. Moreover, dairy products and calcium may reduce the risk of coronary artery diseases and strokes.^[5] High calcium intake is inversely related to the obesity caused by metabolic disorders like hypertension, diabetes, and insulin resistance.^[4] A point to be noted is that the calcium intake from dairy products is far more influential in reducing fat accumulation compared with calcium supplements (if both are equal in terms of quantity).^[6] Another study revealed that high calcium intake from dairy products after lunch or dinner reduces blood lipids, which is probably due to decreased fat absorption; however, calcium supplements do not show such effects.^[7] Dicker *et al.* stated that although dietary calcium has an important role in obesity control, other components of milk accelerate fat oxidation. Milk proteins may be mentioned in this regard which have an effect like that of angiotensin-converting-enzyme (ACE) inhibitors.^[6] Inhibition of rennin-angiotensin system in fat cells reduces high blood pressure and obesity.^[5] In another study, it was stated that the obtained inverse relationship between intake of dairy products and changes in anthropometric indices in overweight men cannot be explained by calcium intake from dairy products; probably, other dairy components or dietary patterns can explicate this relationship.^[8] The fat available in milk is a major source of conjugated linoleic acids (CLA) which has attracted much attention due to its role in fat accumulation in fatty cells.^[5,9] Many probable mechanisms have been postulated for the beneficial role of dairy products in body weight.^[9] The simplest effect of calcium in prohibiting obesity is through preventing the absorption of fat and fatty acids and, thereby, increasing the percentage of excreted fatty acids in feces.^[5] Increase in calcium intake raises fat oxidation and reduces RQ (respiratory quotient).^[10] Dietary calcium plays a key role in regulating energy metabolism due to negative self-regulation of the parathyroid and calcitriol hormone concentrations.^[9] Many studies have explored the relationship between intake of dairy products and obesity; however, these studies have rarely focused on central obesity and fat distribution in the body. In a cross-sectional study on 40-to 60-year-old women in Tehran, it was observed that central obesity was associated with lifestyle factors like low physical activity, depression, smoking, low intake of vitamin C, calcium, and dairy products, and a high consumption of fat.^[3] Another cross-sectional study revealed an inversely significant relationship between calcium intake and body mass index (BMI) in men and women, but an inversely significant relationship between calcium and waist circumference was found only in women.^[6] Another cross-sectional study also

showed the strongest inverse relationship between calcium intake, body composition, and central obesity in black men and white women.^[10] A prospective study demonstrated that the relationship between dairy product intake and weight changes varies according to the kind of dairy product and body mass status.^[9] Yet another cross-sectional study revealed that BMI and excess weight have an inverse relationship with the intake of dairy products.^[11] In addition, no studies have been done on the age group of 18–30 years and obesity, especially central obesity, is increasing in this age group, specifically in girls. Moreover, obesity and central obesity are among the major risk factors for cardiovascular diseases. Therefore, this study aimed to determine the relationship between the consumption of dairy products and anthropometric indices among young female university students at the Isfahan University of Medical Sciences.

MATERIALS AND METHODS

The study subjects were 236 female university students of the Isfahan University of Medical Sciences in the age group of 18–30 years, who were selected through systematic random cluster sampling. First, five disciplines were randomly selected and then, on an average, two to four groups were randomly selected from among junior students in each discipline. Then, depending on the number in each group, a certain number of students was selected from these groups. At the outset, an informed written testimonial was taken from all the subjects and a general information form including age, sex, height, weight, BMI, waist circumference, hip circumference, systolic and diastolic blood pressure, history of medicine intake, and medical history was filled out along with the physical activity form. Then, the participants were guided on filling the validated food frequency questionnaire (FFQ) and their understanding was ensured.^[5,12] The FFQ included 168 items, with proven validity in previous studies about information on fruits, vegetables, grains, and dairy products. The above-mentioned questionnaire included a comprehensive list of different kinds of bread and grain, legumes, white and red meat, dairy products, fruits and vegetables, nuts, fats, and other potential food options. Moreover, this questionnaire determined the consumption of the foods per day, week, month, and year. The proposed project of this study was approved by the Research Council of Faculty of Health, Isfahan University of Medical Sciences. This cross-sectional study had the sample size calculated using the $N = \left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta} \right) S^2 / d^2$ formula. Based on previous studies, the standard deviation of BMI, *d*, and test power were considered 4.6, 0.68, and 80%, respectively.

Measurements: Weight was measured by a standard scale with the accuracy of 0.1 kg, without wearing shoes and with the least possible clothing. Height was measured by a tape measure while standing without shoes beside the wall. The measurement of waist circumference was done at the body's thinnest part while the person was at the end of normal exhalation. Hip circumference was measured at the biggest

part using a nonelastic tape measure with 0.1 cm accuracy; the tape measure did not press against the body during measurement. These measurements were conducted while the participants had light clothes on. BMI was calculated by dividing weight in kg by square of height in square meter. To measure blood pressure, the study subjects were asked to rest for 15 minutes; then, a trained expert measured their blood pressure from their right arm using a standard analog sphygmomanometer while they were seated; the size of its cuff fitted each one's arm circumference. Systolic and diastolic pressure were recorded after hearing the first korotkoff sound and after the sound stopped (the 5th phase of korotkoff), respectively. The subjects were asked about the consumption of coffee and tea, physical activities, and fullness of bladder before blood pressure measurement.

Statistical methods: Nutrition 4 program and SPSS_{11/5} were used to analyze the food survey data and the research data. Normality distribution of variables was first checked using the Kolmogorov-Smirnov test, histogram plot, and p-p plot. The relationship between dairy products and anthropometric indices (weight, waist circumference, and so on) was evaluated through the multiple linear regression by Enter method while adjusting for confounding factors. To investigate the relationship between dairy products and central obesity, logistic regression was used and the effect of confounding factors was adjusted. Also, correlation test was used to observe the relationship between consuming dairy products and calcium on the one hand and BMI and waist circumference on the other. Obesity, central obesity, and excess weight were separately studied; then, excess weight and obesity were considered as a group together with people with BMI above 25 to expand the analyses, while $P < 0.05$ was assumed as the level of significance. All the data were collected after taking the informed written consent form and ensuring the participants about the confidentiality of information. One of the administrative problems of the study was the way the FFQ forms had to be filled by the people; to solve this problem, the participants were trained in filling them and their understanding was ensured. Even after filling the FFQs, in case of mistakes, the questionnaire was returned to the individual to be corrected.

FINDINGS

The mean, standard deviation, and maximum and minimum variables of the study subjects are given in Table 1. In this study, the prevalence percentage of excess weight, obesity, central obesity, and waist-to-hip ratio (WHR) were obtained as 8.1, 1.7, 0.9, 9.8, and 6.8, respectively. Table 2 shows the mean and standard deviation of consumption of micro and macronutrients and also dairy product and calcium intake. According to the results obtained from the correlation test, there was no relationship between intake of dairy products and obesity and central obesity, after adjusting the effect of total energy intake. The results of this study are given in Table 3. The intake quartile of calcium and tertile of dairy intake was used while adjusting the effect of factors like fruit,

vegetable, whole grains, calcium, and kilocalorie intake to examine the relationship between dairy intake and obesity and central obesity. According to the results of this test [Table 4], there was no relationship between dairy intake, obesity, and central obesity.

DISCUSSION

This study conducted on female students showed no relationship between calcium and dairy intake and obesity and central obesity. Due to inadequate nutritional information about this group of people in Iran, they were selected as the group of study for evaluating nutritional intake and its relationship with obesity. In a published paper by Azizi *et al.*^[1] the process of weight gain, obesity, central obesity, and BMI

Table 1: Variables of study subjects

	Minimum	Maximum	Mean	Standard deviation
Age	18	29	20.76	1.57
BMI(kg/m ²)	14.51	32.03	21.54	2.87
Waist circumference (cm)	52	89	70.37	5.83
Blood pressure (systole)	80	130	104.06	9.84
Blood pressure (diastole)	42	100	72.96	9.75
Height (m)	1.48	1.84	1.61	5.96
Weight (kg)	40	83	55.66	7.94
Hip circumference (cm)	67	117.5	94.92	6.25

Table 2: Mean intake of macro and micro nutrients, calcium, and dairy products

	Minimum	Maximum	Mean	Standard deviation
Protein	21.52	223.1	90.74	31.84
Fat	15.39	262.7	73.93	39.69
Carbohydrate	111.6	904.7	327.25	104.05
Kilocalorie	723.8	5861	2267.16	758.78
Folate	108.2	1553	310.25	147.45
Dietary fiber	5.34	147.4	17.84	11.51
Dairy intake	55	1798.5	444.24	254.5
Calcium intake	202.2	3969	1132.21	503.84

Table 3: Relationship between dairy and calcium intake and central obesity

	Excess weight	Obesity	Excess weight and obesity	Central obesity	BMI	WHR
Dairy intake	-0.02 ^{1,2} $P=0.69$	-0.05 $P=0.39$	-0.04 ^{1,2} $P=0.64$	-0.02 $P=0.65$	-0.05 $P=0.41$	-0.04 $P=0.47$
Calcium intake	-0.04 $P=0.52$	-0.008 $P=0.89$	0.04 $P=0.52$	0.02 $P=0.69$	0.07 $P=0.23$	-0.01 $P=0.81$

BMI: Body mass index, WHR: Waist-to-hip ratio¹; the reported numbers are correlation coefficients²; all correlation coefficients are reported by controlling the effect of received energy.

Table 4: Relationship between calcium and dairy intake and obesity and central obesity

Three parts ³ of dairy intake			P	Quartiles of calcium intake				P	
First three parts	Second three parts	Third three parts		First quartile	Second quartile	Third quartile	Fourth quartile		
Excess weight	1 ¹	1.32	1.07	0.92 ²	1 ¹	3.02	2.63	0.93	0.94 ²
Obesity	1	12.17	11.18	0.78	1	0.014	7.3	8.01	0.87
Excess weight and obesity	1	2.24	1.70	0.46	1	1.95	2.54	1.29	0.74
Central obesity	1	2.8	5.5	0.73	1	0.04	1.1	8.32	0.91
WHR	1	2.09	1.28	0.76	1	0.57	0.46	0.94	0.94

WHR: Waist-to-hip ratio¹; the reported numbers show the odds ratio, which is adjusted for fruit, vegetable, whole grain, calcium, and kilocalorie intakes²; P: The amount of process³.

was investigated among 2,102 adults from Tehran in 1998 and 2002. The results obtained from this study showed that mean BMI in men and women was 26.1 ± 4.1 and 27.8 ± 4.9 in 1998, and 26.7 ± 4.1 and 28.7 ± 5.9 in 2002, respectively ($P < 0.001$). Furthermore, frequency of excess weight in women was 40 in 1998 and 39.5% in 2002. The prevalence of obesity in women was 16.5 and 20.8% in 1998 and 2002, respectively ($P < 0.001$). Studies have demonstrated that the prevalence of obesity is 14.4 and 29.5% in men and women in Tehran, respectively. Also, the prevalence of central obesity was reported as 33% in men and 62.7% in women from Tehran.^[11] According to the information obtained, there are few studies about the relationship between nutritional intake and prevalence of noncontagious diseases in the young age group in Iran. Considering the importance of prevention of noncontagious diseases, especially obesity and central obesity at a young age which can help to prevent the development of these diseases in later years, the selection of the target group (university students) was significant. The recent theory of nutrition epidemiologists is based on the principle that different nutritional groups and patterns of food consumption should be considered rather than mere consideration of micronutrients in the diet of people and social groups. One of the nutritional groups which can have an influential role in the health of the youth is dairy products. According to the reported national statistics, the average daily intake of dairy products is 1.1% in the country, which is less than the average recommended amount.^[5] Previous nation-wide studies have demonstrated an inverse relationship between dairy intake and metabolic syndrome in adults from Tehran. In a cross-sectional study by Azadbakht *et al.*^[5] on 827 men and women from Tehran, the relationship between dairy intake and metabolic syndrome was investigated and an inverse relationship was found between them. Also, the mean intake of milk, yoghurt, and cheese was 0.7 ± 0.2 , 1.06 ± 0.6 , and 0.9 ± 0.3 units per day, respectively. Those who were on the topmost quartile of dairy intake were at a lower risk of having higher waist circumference (process: $P < 0.001$), higher blood pressure (process: $P < 0.02$) and metabolic syndrome (process: $P < 0.02$).^[5] Other investigations in Iranian society have revealed that consumption of dairy products is related to inflammatory factors in middle-aged women.^[13]

Although many studies have been done on the relationship between dairy products and risk factors of diseases in middle-aged people in Iran, few studies have focused on the young

age group. Nevertheless, the results of this study revealed no relationship between the consumption of dairy products and excess weight, obesity, and central obesity. A study on the relationship between the intake of calcium supplements and fat oxidation revealed that intake of calcium supplements had no effect on the oxidation of lipids or lipolysis in overweight postmenopausal women.^[14] A cross-sectional study on 926 women of 40–60 years demonstrated a relationship between low calcium intake and dairy products. In that study, mean weight, BMI, and waist circumference were reported as 75 ± 39 kg, 29.4 ± 4.6 , and 85.1 ± 9.9 cm, whereas these variables were 70.37 ± 5.38 kg, 21.54 ± 2.87 , and 55.66 ± 7.94 cm in the present study, respectively. In the earlier study, the prevalence of unemployed, employed, and retired group were 10, 26, and 64 percent, respectively, whereas the present studied group included young university students between 18 and 30 years who had more physical activity. This factor also influenced the emergence of central obesity. The composition of that cross-sectional study was women of menopausal age with the mean age of 49 years, but the group of the present study was young females of 18–30 years.^[3] Another study showed an inversely significant relationship between the intake of whole milk, yoghurt, calcium, and magnesium and metabolic disorders like obesity and central obesity. Due to ethnic and racial differences among the studied population in America and differences in dairy intake, this relationship can be justified according to the ethnic differences, whereas in the present study, all the people were selected from the same race and ethnicity.^[15] In another cross-sectional study, 3,246 men and women between 25 and 64 years were randomly studied after being divided into three groups of A (BMI ≤ 24.9), B (BMI = 25–39.9), and C (BMI ≥ 30). The results of the study showed that the people in group A had the highest calcium intake ($P < 0.002$) and milk consumption ($P < 0.01$); in fact, an inverse relationship was observed between calcium and milk consumption and BMI. It should be noticed that the number of subjects in the study was much more than that of the present study, which can remarkably reduce the error of the study. Furthermore, both sexes with a wide age range participated in that study, and these differences between that study and the present one may lead to the differences in the results.^[6] In a one-year interventional study on 155 girls between 18 and 30 years with normal weight, calcium intake of less than 800 mg, and energy intake of less than 2,200 kilocalories per day, no changes were observed in the body weight or fat mass with the increase in the consumption

of dairy products. This study had a consistent relationship with the present study. Considering the mean calcium intake of 1132 mg per day in the present study, it seems that dairy calcium has no effect upon obesity and central obesity in this age group.^[16] A cross-sectional study by Brooks *et al.* on the relationship between calcium intake, dairy consumption, and excess weight in young adults in a Bogalusa heart study, which was done on 1,306 white and black men and women between 20 and 38 years, showed an inversely significant relationship between calcium and low-fat dairy intake and WHR in white men; it was also proved that white men with normal weight consume more calcium ($P < 0.05$) and low-fat dairy products compared with other groups. Although the age range of the subjects in this study and the present research were similar, both sexes and both races were present in this study, which can be the reason for the differences in the results.^[4]

In another prospective study done by Rosell *et al.*, 19,352 Swedish women between 40 and 55 years were evaluated in 1987–90 and 1997. They were divided into four groups in terms of calcium intake. In the group which consumed more than one unit of whole milk and cheese per day, an inverse relationship was observed with weight gain, and the odds ratio (OR) was 0.85 (95% CI: 0.73–0.99) and 0.70 (95% CI: 0.59–0.84), respectively. According to the above-mentioned results, the studied sample size was larger than that of this study and middle-aged women between 40 and 55 years participated in the study; probably, their different metabolism compared with that of the present young population caused the above-mentioned results. Moreover, the prospective design of the study can also influence the results.^[9]

A study called the HERITAGE Family Study investigated the relationship between calcium intake and obesity in white and black men and women in men and women between 17 and 65 years who were healthy and inactive and had a BMI of less than 40. The mean waist circumference was 92.6 ± 1.6 and 94.5 ± 0.9 cm in black and white men and 86.2 ± 0.9 and 90.2 ± 1.1 cm in white and black women, respectively. The mean total calcium intake in black and white women was 825 ± 42 and 1089 ± 34 , respectively. The results of the studies showed that there was the strongest inverse relationship between calcium intake, body composition, and central obesity among black men and white women. In this regard, the age range of the population of that study was high while the present study only considered people between 18 and 30 years. Furthermore, the people in the HERITAGE study were both white and black and these racial differences can be the reason for the inverse relationship between calcium and obesity. Besides, all the participants of the present study had sufficient physical activity, which can be the reason for obtaining no correlation between calcium, obesity, and central obesity whereas in the HERITAGE study, the studied people were all sedentary.^[10] Another study on young people from Isfahan showed that it is important to consider dietary diversity score apart from the dietary intake of young adults. That study determined that the dietary diversity score of dairy products had an inverse relationship with obesity,

central obesity, body weight, and waist circumference in this group. Furthermore, dietary diversity score had a totally inverse relationship with the status of obesity and central obesity.^[17] Calcium intake is not only related to obesity and central obesity, but is also associated with inflammatory factors; it affects metabolism status with the reduction in inflammatory factors.^[13] Additionally, it has been observed that dairy products naturally consist of trans fatty acids; since these fatty acids are natural, they might not have the harmful effects of hydrogenated trans fatty acids. As a result, it appears that trans fatty acids of dairy products may not have any harmful effects on obesity, central obesity, and waist circumference.^[18] It was observed in another study,^[19] that adolescents from Tehran consume less milk and dairy products while consuming more carbonated drinks and non-nutritious foods. Girls and boys drink 0.5 and 1 glass of cola per day, respectively, but the rate of their dairy intake is low. As a result, it is required to do more studies on adolescents.

One of the strengths of this study was its consideration of potential confounding factors which have been reported in logistic regression models and were adjusted in this paper. The potential effects of foods like whole grains, kilocalories, fruits and vegetables, physical activity, marital status, age, caffeine, dietary fiber, and BMI were adjusted in the present analyses. Also, a semiquantitative FFQ was used to indicate the exact amount of foods. Nutritionist 4 software, based on Iranian food, was also applied.

One of the limitations of this study was its cross-sectional design. Thus, it is essential to do some prospective studies for confirming these relationships. Error in the population classification caused by the FFQ questionnaire was one of the concerns of the present study. As a result, the FFQ application, the report of the participants about their food intake and concerns with regard to the filling of the questionnaires by them were also noticeable. However, it was attempted to control known confounding factors in this study. Probably, the FFQ used in this study may not be the best method for evaluating calcium and dairy intake. Therefore, the results of this study should be evaluated more accurately and more prospective studies should be done to confirm the relationship between calcium intake, regulation of body weight, and obesity.

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