Original Article

Relationships between Dairy Consumption Patterns and Hypertension, Overweight, and Obesity Status

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Abstract

Background: *Obesity is considered a widespread concern internationally. Few studies have investigated the relationships between dairy consumption and hypertension and obesity. Therefore, this study examined the above concern in students.*

Methods: *This cross-sectional study was conducted on 292 male students (18–30 y) living in the dormitories of Tabriz University of Medical Sciences. Students were selected via the multistage stratified random sampling method. Demographic information, anthropometric measurements, blood pressure (BP) readings, and a semi-quantitative validated questionnaire assessing dairy consumption (including a 24-hour dietary record covering 2 typical days and a holiday) were collected. After all the questionnaires were reviewed, they were coded and analyzed with Nutritionist IV software.*

Results: *The average age of the subjects was 22.36 years. The mean±SD values of body mass index (BMI), waist circumference, waist-to-hip ratio, and waist circumference-to-standing height ratio were 22.68±2.58 kg/m², 80.95±7.81 cm, 0.85±0.04, and 0.46±0.04 among the studied population, respectively. The mean±SD values of systolic and diastolic blood pressure were 111.84±10 mm Hg and 70.99±8 mm Hg, respectively. Milk consumption was associated with a low waist circumference (95% credible interval, 1.005 to 4.580; P=0.046). The odds of hypertension (defined as BP>120/90 mm Hg) were 2.686 times higher in the overweight and obese group than in the normal BMI group. The risk of hypertension was 1.045 times higher for individuals with abdominal obesity than for those who did not consume dairy products.*

Conclusion: *Milk consumption was associated with a low waist circumference. The correlations between systolic blood pressure and anthropometric factors were statistically significant. BMI, waist circumference, and waist-to-hip ratio were positively associated with systolic blood pressure.*

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Keywords: *Hypertension; Dairy products; Obesity; Overweight*

Introduction

Obesity and overweight are among the most significant health problems worldwide. Obesity results from an imbalanced amount of energy received through food and energy consumed in physical activity. Obesity is a complex disorder of metabolism and appetite regulation caused by multiple environmental factors and a series of heterogeneous disorders.[1] The prevalence of obesity in the world is increasing in developed and developing countries. Obesity begins in childhood in Western countries.[2] Based on the prevalence of high body mass index (BMI) in the United States, the prevalence of overweight in infants and children aged 0 to 2 years and in children and adolescents aged 2 to 19 years is approximately 5.9% and 9.16%, respectively.[3] Numerous studies have shown that adolescent obesity leads to adult obesity.[4] Indeed, 30% of teenagers have been obese during childhood, too. About 80% of obese teenagers will remain obese when middle-aged, and they are also fatter than those who have turned obese in their middle age.[2] The prevalence of overweight and obesity is significantly higher in American children than in Iranian children.[5] The National Health and Nutritional Examination Survey (NHANES) showed that the prevalence of overweight and obesity was about 68%, and the prevalence of obesity alone was approximately 33.8%.[6] If this trend of weight gain continued until 2030, the prevalence of obesity in American children and adults would double.[7]

The wide-ranging complications of obesity in children and adolescents indicate its great significance. As one of the severe complications of obesity, hypertension is one of the most common diseases in the world.[8] Hypertension can lead to the rupture of arteries, reducing the blood flow to the brain and causing a stroke. Furthermore, hypertension imposes an additional burden on the heart, and in the long run, it will cause heart failure.[9] Other complications, such as type 2 diabetes mellitus, neurological complications, respiratory disorders, cardiovascular disease, and metabolic syndrome and its psychosocial side effects, pose severe risks to the individual's health and affect society.[8]

Behavioral and environmental factors play a more important role than genetic changes in increasing the prevalence of obesity. Changes in dietary habits, including high-fat and high-energy diets, increased consumption of animal food products, and reduced consumption of grains and fiber, have been linked to obesity.[10] Therefore, lifestyle changes, including increasing physical activity and a healthy eating diet, could be taken into consideration to reduce obesity.[1] Various compounds in dairy products, like calcium, are crucial to their anti-obesity effects. One of the proposed weight loss mechanisms is calcium binding in the digestive tract to free fatty acids, making them unavailable for the small intestinal wall cells and increasing the excretion of free fatty acids.[11] Increasing calcium intake lowers the level of 1,25 dihydroxyvitamin D, reducing intracellular calcium. This process can stimulate lipolysis and inhibit lipogenesis in fat cells.[12,13] It also augments insulin sensitivity in fat and muscle cells.14 Additionally, decreased intracellular calcium concentrations can lower blood pressure by decreasing intravascular smooth muscle tonicity and reducing peripheral vascular resistance.[15] Other mechanisms include the effects of whey protein on insulin stimulation and the beneficial effects of magnesium on insulin sensitivity.[13]

Despite numerous studies on the link between dairy consumption and hypertension and obesity, scarce research has been done exclusively on the educated population. Therefore, the present study was conducted among the student population because this group of subjects will become a productive force in society in the next few years. On the other hand, obesity and hypertension escalate the incidence of chronic diseases, which will increase absence from work and lessen the total valuable hours of work. In addition, most previous studies have used only BMI to determine overweight and obesity. In contrast, in the present study, other obesity indicators, such as waist circumference (WC), waist-to-hip circumference ratio, and WC-to-standing height ratio, were also calculated. Further, the relationship between dairy consumption and overweight, obesity, and blood pressure will be reported in the case of any relationship so that by providing appropriate recommendations, the prevalence of obesity in this age group decreases.

Methods

This descriptive cross-sectional study was conducted between February 28 and May 3, 2018. The study population consisted of 292 male students (18–30 y)

living in the dormitories of Tabriz University of Medical Sciences. Exclusion criteria were composed of taking blood pressure medications; having diseases such as congestive heart failure, lung disease, type 2 diabetes mellitus, and kidney failure; having specific eating patterns such as vegetarianism and other restricted diets; being over 30 or under 18 years old; having a body mass index (BMI) above 40 kg/m2 or below 18 kg/m2; having spinal deformities; and doing professional sports activities. Individuals filled out a general information questionnaire including age, field of study, level of education, level of education of parents, occupation of parents, and information on anthropometric indices, including weight, height, WC, hip circumference, systolic and diastolic blood pressure (DBP), and pulse rate.

A dish-based 106-item semi-food frequency questionnaire (DS-FFQ), created to assess Iranian dietary intakes, was utilized. The information about the validity and design of this questionnaire has been published previously.[16] Previous studies have included these 106 food items in 5 categories and drawn upon the dairy product category to assess dairy intake.[17] We also used the items in the dairy category to define the amount of calcium intake in the population. This semi-quantitative questionnaire was used to determine the frequency of dairy (milk, yogurt, yogurt drink, curd, cheese, porridge, ice cream, milk powder, and cream and dairy desserts) consumption. The questionnaire also determined the number of times the above items were consumed per day, week, month, and year. Afterward, a 24-hour food registration questionnaire was filled out to collect food information, specifically the amount of received calcium and energy. Data were converted to grams and then coded. The information from the questionnaires was analyzed with Nutritionist IV software.

Each student's height was measured without shoes in a standing and straight position using a wall height gauge with an accuracy of 0.1 cm. Weight was measured with minimal clothing with a hand scale boasting an accuracy of 0.1 kg. BMI was calculated by dividing weight (kg) by height square (m2). The students were classified as thin (BMI<18.5), normal (18.5<BMI<25), overweight (25<BMI<30), and obese (BMI>30). WC was measured by placing an anthropometric meter around the abdomen (without clothing) between the lowest ribs and the iliac crest just above the pelvis and without squeezing the skin. Hip circumference was measured in the widest part of the hip. Percentiles above 75% (the last quarter) were used to determine abdominal obesity in the study population. Before the blood pressure measurement, the subjects were asked about their food, tea, and coffee consumption, as well as their physical activity. They were also asked whether their bladder was full. Subsequently, standardization was done. For the blood pressure measurement, the subjects were asked to rest for 15 minutes, and blood pressure was measured in a seated position from the right arm of the subjects with a standard sphygmomanometer by a trained expert.

The Bayesian regression model examined the significance of the difference in the mean values of anthropometric factors between the normal and prehypertension groups. A Bernoulli prior distribution was assumed for blood pressure with 4000 iterations and 2000 burnouts. The 95% credible interval (CrI) was estimated based on the Bayesian approach. P values were estimated via frequentist methods and a binary logistic regression model. Quantreg, Ggplot2, and Brms packages were used accordingly. The association between quantitative variables was defined using the Spearman correlation coefficient. All the statistical tests were conducted in the R3.6.3 environment, and the level of significance was set at a $P<0.05$.

Despite the noninvasive nature of the present study, all the stages of the project were explained to the subjects before their participation. The study was performed only after informed consent had been obtained from all the participants.

Results

The distribution of independent variables by the status of milk consumption and blood pressure is shown in the Whisker-Scatter plot (Figure 1).

Figure 2 shows the correlation between systolic blood pressure (SBP) and independent variables. The correlations between SBP and anthropometric factors were statistically significant (range of r: 0.120.21).

The scatter plot of the association between SBP and anthropometric factors by controlling the effect of milk consumption is presented in Figure 3. It seems that milk consumption affected the associations among them, except for waist circumference-to-hip (WC/Hip) ratio.

The associations between SBP and the anthropometric factors are shown in Table 1. BMI, WC, waist-to-hip ratio (WHtR), and the WC-to-height ratio with a power of 0.50 (WHtR0.50) were positively associated with SBP, whereas the odds of hypertension (defined as SBP>120 mm Hg or DBP>90 mm Hg) were 2.686 times higher in the overweight and obese group than in the regular BMI group. The interaction effect between milk and WC was statistically significant; therefore, the association between SBP and WC should be studied among milk consumer and non-consumer categories. The risk of hypertension was 1.045 times higher for abdominally obese individuals than for normal individuals in the non-consumer group. However, there was no significant association between SBP and WC in the milk consumer group.

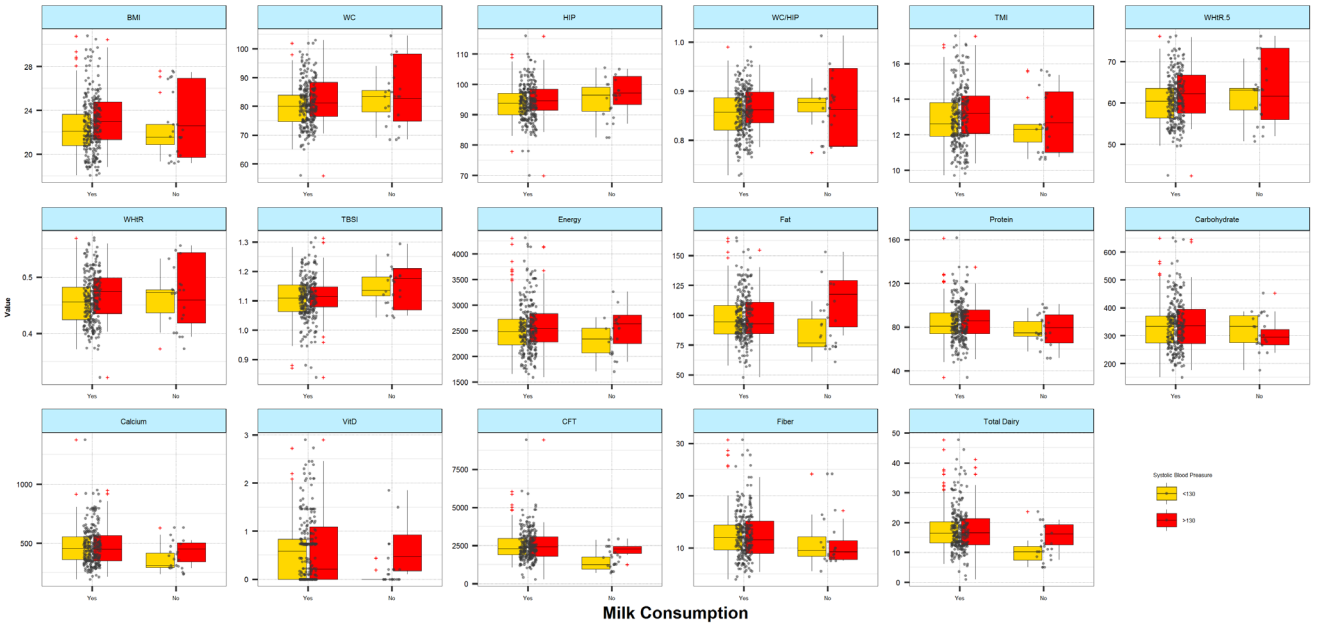

Figure 1. The images depict the distribution of independent variables by the status of milk consumption and blood pressure.
BMI, Body mass index; WC, Waist circumference; Hip, Hip circumference, WC/hip, Waist circumference-to-hip ratio; TMI, Tri-ponderal mass index; WHtR5, WC-to-height ratio with a power of. 5; WHtR, Waist circumference-to-height ratio; TBSI, Tri-ponderal body shape index; VitD, Vitamin; CFT, combined fiber of the total intake

Table 1. Associations between hypertension and anthropometric factors by controlling the effect of milk consumption

Factor	OR	SE	P	95% CrI
BMI (Obese/Normal)	2.282	0.33	0.020	[1.21, 4.36]
Milk consumption (Yes/No)	0.836	0.57	0.836	[0.24, 2.46]
Milk *BMI	1.11	1.09	0.912	[0.14, 9.25]
WHtR (Obese/Normal)	2.282	0.37	0.009	[1.35, 5.57]
Milk consumption (Yes/No)	0.766	0.57	0.728	[0.24, 2.20]
Milk *WHtR	1.57	1.2	0.691	[0.16, 17.13]
HIP	1.037	0.02	0.119	[0.99, 1.09]
Milk consumption (Yes/No)	0.056	7.58	0.770	[0, 80539.26]
Milk *HIP	1.029	0.08	0.775	[0.89, 1.21]
WC (Obese/Normal)	1.85	0.28	0.041	[1.06, 3.29]
Milk consumption (Yes/No)	0.887	0.58	0.982	[0.27, 2.59]
Milk *WC	1.81	0.3	0.046	[1.005, 4.58]
WC/Hip (Obese/Normal)	1.805	0.93	0.441	[0.29, 11.15]
Milk consumption (Yes/No)	0.699	0.49	0.576	[0.25, 1.77]
Milk *Hip	inf	1703.07	-	Inf
WHtR0.50	1.064	0.02	0.011	[1.02, 1.11]
Milk consumption (Yes/No)	2.147	4.55	0.769	[0, 10086.97]
Milk *WHtR0.50	0.986	0.07	0.752	[0.86, 1.14]
TBSI	2.675	1.9	0.615	[0.05, 101.45]
Milk consumption (Yes/No)	0.12	8.72	0.821	[0, 3769300.51]
Milk *TBSI	5.733	7.59	0.825	[0, 16272709.52]

BMI, Body mass index; WHtR, Waist circumference-to-height ratio; HIP, Hip circumference WC, Waist circumference; WHtR0.50, WC-to-height ratio with a power of 0. 50; TBSI, Tri-ponderal body shape index

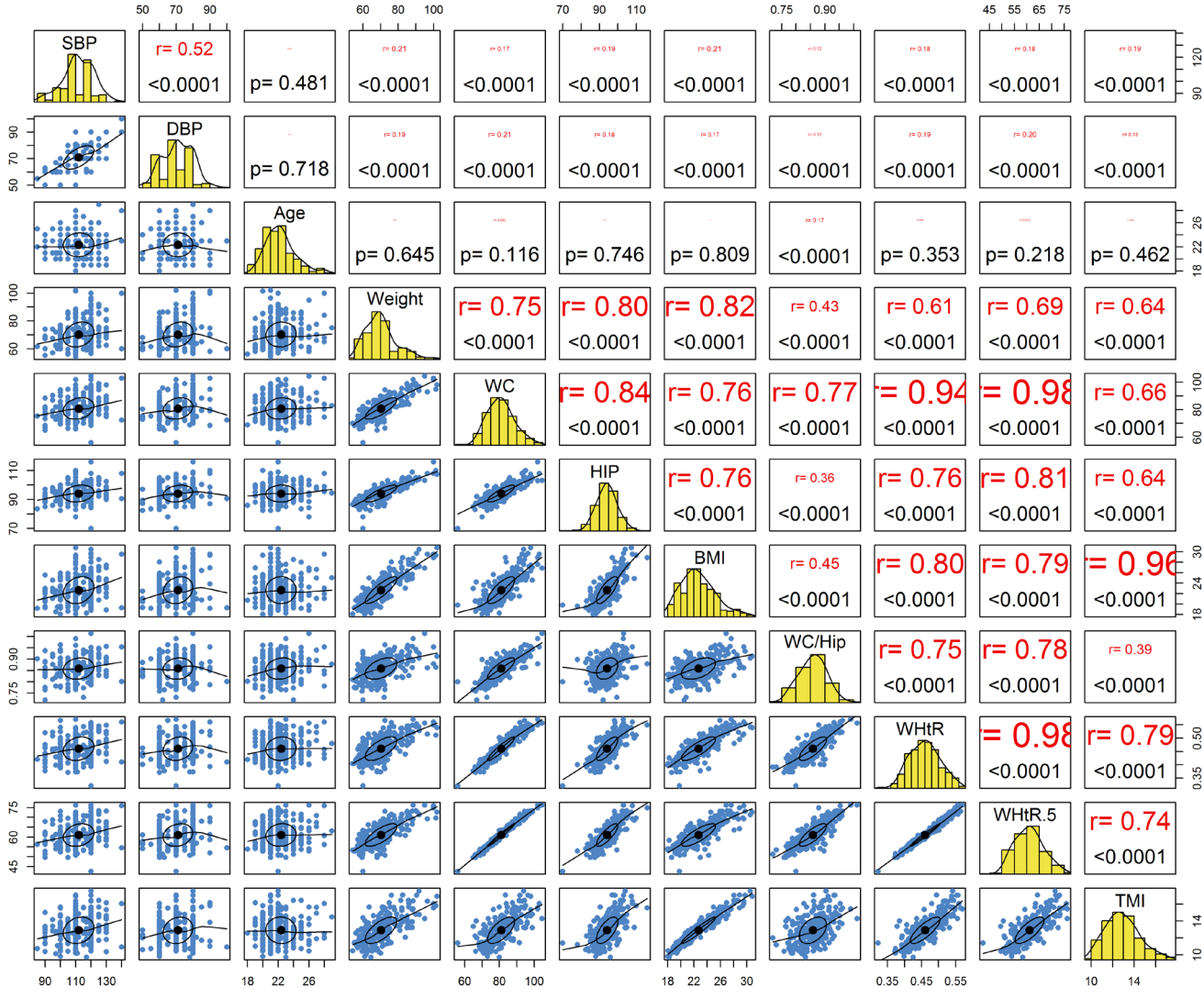

Figure 2. The image illustrates the correlation matrix between systolic blood pressure and independent variables.
SBP, Systolic blood pressure; DBP, Diastolic blood pressure; BMI, Body mass index; WC, Waist circumference; Hip, Hip circumference; WC/Hip, Waist circumference-to-hip ratio; TMI, Tri-ponderal mass index; WHtR5, WC-to-height ratio with a power of. 5; WHtR, Waist circumference-to-height ratio

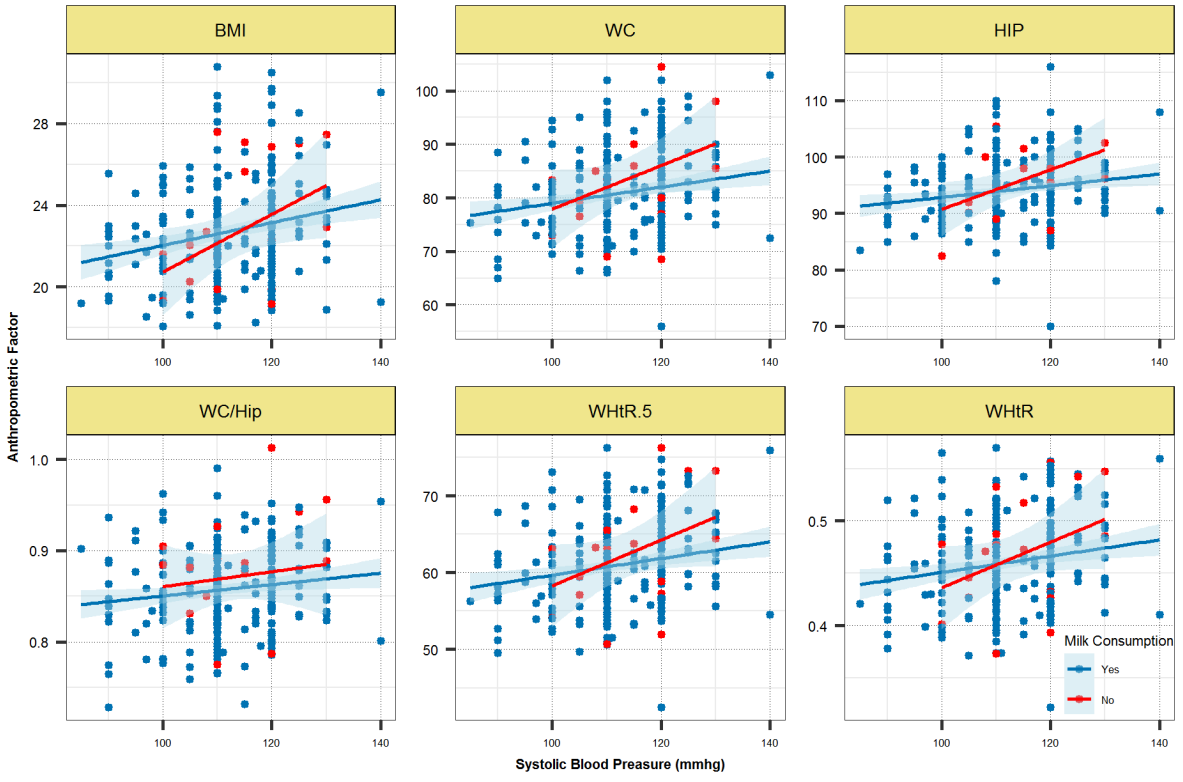

Figure 3. The image presents the scatter plot of the correlations between systolic blood pressure and anthropometric factors by milk consumption. BMI, Body mass index; WC, Waist circumference; Hip, Hip circumference; WC/hip, Waist circumference-to-hip ratio; WHtR0.50, WC-to-height ratio with a power of 0. 50; WHtR, Waist circumference-to-height ratio

Discussion

There are only a few studies aimed at finding the link between food habits and non-contagious diseases, especially among youth. Therefore, this study was conducted on male university students because preventing these diseases, such as obesity, could play a significant role in evading further related complications. Epidemiologists' latest theory indicates that it is more desirable to concentrate on different food groups and the proper food patterns rather than on micronutrients in people's diets. One of these food groups is, of course, dairies. In Iran, the average dairy intake is 1.1 servings per day, lower than the recommended amount.[18] Azad Pokht et al[19] found an inverse link between dairy consumption and metabolic syndrome and showed that the average intake of milk, yogurt, and cheese was 0.7, 1.06, and 0.9 units per day, respectively. Individuals with the most consumption were at a lower risk of high WC, hypertension, and metabolic syndrome. A cross-sectional study of 926 women between 40 and 60 years old demonstrated that abdominal obesity was related to low calcium and dairy intake.[19] Beydoun et al[20] reported similar results. In a clinical trial study performed on 61 individuals aged between 18 and 35 with a BMI range of 25.9 to 34 kg/m2, the participants were divided into 3 groups: dairy, calcium supplements, and placebo recipients. An inverse relationship was observed between the dairy intake and anthropometric indicators, while this association was not observed in calcium and placebo recipients.[21] Moreover, Brooks et al[22] showed a significant inverse relationship between low-fat dairy and calcium intake and waist-to-hip circumference ratio. Rosell et al[23] conducted a prospective study on 19,352 middle-aged women and divided them into 4 groups based on dairy intake. They concluded that there was an inverse link between consuming milk and cheese more than 1 unit per day and gaining weight.

On the other hand, a 1-year interventional study conducted on women aged between 18 and 35 with normal weight, calcium intake of lower than 800 mg per day, and calorie intake of less than 2200 Cal per day detected no significant relationship between increasing dairy intake and changes in body weight.[24]

Several studies have found different results. On the one hand, high calcium intake is inversely related to body weight and fat.[25,13] On the other hand, an inverse relationship exists between the frequency of dairy product consumption and the progression of obesity, abnormal glucose homeostasis, and hypertension.[26] Furthermore, there is an inverse relationship between low-fat dairy consumption and high blood pressure.[27-29] There is also an inverse relationship between

milk, yogurt, calcium, and magnesium consumption and obesity, abdominal obesity, and metabolic syndrome. Nonetheless, the relationship is reversed when receiving cheese and phosphorus.[20]

Several studies on the relationship between dairy consumption and high blood pressure have found no inverse relationship at all.[30,31] Moreover, a prior investigation found no association between calcium intake and weight loss, BMI, fat mass, and muscle mass.[10] Furthermore, no relationship was found between dairy consumption and obesity in another study.[32]

One of the strengths of the present study, unlike other studies, is the use of a large number of anthropometric indicators such as BMI, WC, WHtR, and WC/Hip, which has increased our accuracy in determining overweight and obese people. Additionally, a 24-hour food recording for 3 days (2 regular days and 1 day off) is another strength of this study used to modify distortion variables, such as energy, carbohydrates, protein, and fat intake. More to the point, the information obtained from food registration was analyzed using Nutritionist IV software, which is based on Iranian food.

In the Iranian city of Zabol, Goodarzi et al[33] evaluated subjects over the age of 18 and reported a prevalence rate for hypertension of 12.24%. According to the findings of an investigation by the Canadian Heart Association, the prevalence of hypertension was 20%, regardless of gender.[34] However, in the present study, the prevalence of hypertension was 2.1%, lower than the mentioned studies. Perhaps the difference is due to the different ranges of age. Moreover, this study was performed only on males, and the number of samples was lower than that in the studies mentioned above.

The National Heart, Lung, and Blood Institute studied the link between blood pressure and dairy intake in 4797 normal and high-risk individuals with cardiovascular disease. The results showed that from the lowest consumption of dairy products (0.4 servings) to the highest consumption rate (3.1 servings), on the day after the adjustment of the disruptive factors, there was an inverse relationship between dairy consumption and hypertension.[35] In addition, the NHANES study, which examined and compared the food patterns of more than 10,000 American adults, found a significant inverse relationship between calcium intake from food and blood pressure. Calcium intake above 1000 mg was associated with a 40%–50% reduction in blood pressure.[36] In a prospective study by Engbering et al[37] in the Netherlands on 2245 adults, an inverse relationship was found between total dairy consumption and low-fat dairy intake and the development of high blood pressure. Particularly, a strong association was observed during the first 2 years of a 6-year follow-up in overweight individuals. There was also no association between high-fat cheese and high-fat dairy products and the risk of hypertension.

Another prospective study by Steffen et al,[38] which was continued for 15 years, showed no significant relationship between total dairy consumption and blood pressure (P=0.061). Nevertheless, a significant relationship was observed between low-fat milk intake and blood pressure (P=0.031). Likewise, in another prospective study to determine the link between dairy, calcium, and vitamin D intake, a significant inverse relationship was observed between low-fat milk consumption and hypertension. There was also a significant association between the dietary intake of calcium and vitamin D rather than supplemental supplementation.[39] Thus, since high blood pressure is rare in our study's age group, in order to prove the effect of dairy products on obesity, we need studies on a larger sample with a broader age range.

Our study showed a statistically significant difference in anthropometric indicators of individuals with normal blood pressure and persons with hypertension. Similarly, Schmieder et al[40] found a direct link between blood pressure and BMI, meaning that a higher BMI is linked to a higher likelihood of hypertension. Another study by Bray et al[41] on 2432 subjects in the United States found a direct link between BMI and high blood pressure. Likewise, in Canada, Nyamdorj et al[42] assessed 970 subjects aged between 26 and 68 and reported that the prevalence of hypertension was 17.3%. In this study, a significant relationship between hypertension and obesity was observed according to all anthropometric indicators related to obesity, including BMI, WC, and WC/Hip.

Conclusion

Milk consumption was associated with a low WC. The correlations between SBP and anthropometric factors were statistically significant. BMI, WC, and WHtR were positively associated with SBP, whereas the odds of hypertension were 2.686 times higher in the overweight and obese group than in the normal BMI group.

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