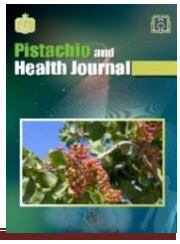

Association between Nut Consumption and Hypertension: A Cross-Sectional study using the Results of the Rafsanjan Cohort Study (2020)

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Abstract

Introduction: Hypertension, as a risk factor for cardiovascular diseases, is highly influenced by dietary parameters. This study aims to investigate the possible association of hypertension prevalence and nut consumption.

Materials and Methods: In this cross-sectional study, 9990 participants from the Rafsanjan cohort study, as a part of the prospective epidemiological research studies in IrAN (PERSIAN), aged 35-70 years were included. Nut consumption was assessed using an abbreviated food questionnaire. Further, demography, personal habit, physical activity, medical history, blood pressure, and body mass index (BMI) questionnaires were used. Logistic regression models were applied to examine the possible relationship between hypertension risk and nut consumption. Statistical analyses were performed using STATA statistical software.

Results: The results showed that the average consumption of all nuts except walnuts was significantly higher in non-hypertensive individuals (P<0.001). In the crude regression model, the odds of hypertension were significantly lower among pistachio, walnuts, seeds, and total nuts consumers. However, a protective association was observed between the prevalence of hypertension and the consumption of all nuts together and seeds, after adjusting for sex, age, and other confounders.

Conclusion: The data show that the intake of all nuts and seeds is inversely associated with hypertension risk.

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1. Introduction

Unfortunately, the prevalence of hypertension, as one of the leading causes of mortality [1], is increasing drastically. In 2019, 1.5 billion hypertensive people were diagnosed worldwide. As the World Health Organization (WHO) reported, stroke and ischemic heart disease, the main complication of hypertension, were the most important cause of death in 2020 [2, 3]. Hypertension has been demonstrated to increase the risk of heart, kidney, brain, and other diseases [3].

In a meta-analysis in 2008, Haghdoust *et al.* estimated the total prevalence of hypertension to be 23% and 50% in the Iranian population aged 30 – 55 years and >55 years, respectively. Also, they found a remarkable increase in hypertension with increasing age and a higher risk of hypertension among women [4]. They used the word «considerable» for the overall hypertension prevalence in Iran. This may be an important reason for the considerable rates of cardiovascular diseases (CVDs) in the country [5].

Mohsenzadeh *et al.* analyzed 22 articles that investigated hypertension in the Iranian population from 1999 to 2012. The mean prevalence of hypertension was found to be 17%. As regards age, the values were 24% and 5% for the population aged >20 years and <20 years, respectively [6].

Nutrition, in parallel with pharmacotherapy, has a great impact on managing or even decreasing high blood pressure. For example, a high intake of sodium chloride increases blood pressure. Moreover, alcohol consumption may result in an acute increase in blood pressure. Contrastingly, the consumption of poly-unsaturated fatty acids, potassium, and proteins may decrease blood pressure [7]. In this regard, dietary approaches emphasize the higher intake of fruits, vegetables, low-fat dairy, and all grains, as well as the lower uptake of sodium, red meats, fats, and added sugars [8]. Mediterranean Dietary Pattern (MDP) that contains nuts as its integral part [9] has been found to be a beneficial dietary for age-related alerts in blood pressure [10]. Additionally, the Physicians Health Study (PHS) has reported that the subjects consuming nuts daily have a lower risk of hypertension [11].

Nuts (especially pistachios, almonds, and walnuts) have been demonstrated to have useful impacts on lipid and glycemic parameters [12-14]. Among them, pistachios have a higher content of monounsaturated fatty acids (67%) and a lower ratio of poly-unsaturated to saturated fats (1:21). Thus, this edible nut has favorable effects on lipid profile [15-17]. Furthermore, pistachios are naturally cholesterol-free nutrients with a low glycemic index, a rich source of

phytosterols, protein, fiber, and antioxidants [17].

Given that no similar study has been found in this regard, the present study aims to evaluate the possible association between nut consumption and hypertension prevalence using the results of the Rafsanjan Cohort Study (RCS).

2. Materials and Methods

2.1. Study population

This cross-sectional study population was the same as that of RCS, consisted of 9990 people aged between 35 to 70 years from both urban and suburban areas of Rafsanjan city, located in the Southeast of Iran. The RCS is one of the Prospective Epidemiological Research Studies in IrAN (PERSIAN) [18]. The subjects were selected based on two criteria: first, the inclusion of areas with minimum migration rates to limit loss in the follow-up phase; second, the inclusion of population with different environmental and occupational exposures and different socio-economic levels [18]. People with incomplete dietary information were excluded.

2.2. Outcome assessment

Expert interviewers interviewed all participants to carefully complete related questionnaires containing questions about demography, personal habit, physical activity, body mass index (BMI), medical history, blood pressure, and food frequency. All questionnaires were previously validated in the PERSIAN cohort study [19].

Education level was reported as the mean of years of education± standard deviation (SD) [18]. Daily physical activity of the subjects in both occupational and leisure status was assessed using a standardized physical activity questionnaire. Also, each activity was weighted by its relative metabolic cost, referred to as a metabolic equivalent (MET). Then, MET-hours/day was derived and calculated for 24 hours [19, 20]. Cigarette smoking and alcohol drinking were expressed as yes (formerly or currently) or no (never) [18].

Diabetes mellitus and hypertension prevalence were assessed using self-reported information obtained from the medical history questionnaire or used drugs. BMI was also expressed as average± SD [18].

A food frequency questionnaire (FFQ) was applied to measure the consumption of pistachios, walnuts, peanuts, other nuts (cashews, almonds, hazelnuts), and seeds (watermelon, pumpkin, sunflower) in g/day. The consumption of salt (mg/day), fruits/vegetables, dairy, egg, fish, red meat, and breakfast cereal (g/day) were also measured using the FFQ.

In this study, «total nuts» is used for all nuts and seeds, and "all nuts together" is used for pistachio, walnuts, peanuts, cashews, almonds, and hazelnuts together.

2.3. Statistical analyses

To compare the continuous variables of the groups, a t-test was used. Logistic regression models were applied to evaluate the possible association between nuts' consumption and hypertension prevalence. In the adjusted model, socio-demographic characteristics (age, gender, and education years), cigarette smoking, alcohol drinking, physical activity level, BMI, diabetes mellitus, and salt, as confounders were considered. Statistical analyses were conducted with STATA statistical software, version 12 (STATA Corp, College Station, TX). All the p-values were two-sided and P< 0.05 and 95% confidence intervals, were considered statistically significant.

3. Results

The number of the participants was 9990 according to the baseline phase of the Rafsanjan adult cohort study, including 4655 (46.60%) males and 5335 (53.40%) females. Table 1 presents the data obtained from both hypertensive and non-hypertensive participants about different aspects of socio-demographic characteristics, anthropometric measures, clinical risk factors, personal habits, and nuts intake. The rate of hypertension was comparatively high in the RCS participants, especially in women (35.8% of men and 64.2% of women). The obtained results also showed educational attainment to be lower in the hypertensive participants (P<0.001). BMI of these participants was significantly higher than non-hypertensive subjects (P<0.001). Physical activity, alcohol consumption, cigarette smoking, and diabetes mellitus were less common among the participants with hypertension (P<0.001). The results showed that the average consumption of all nuts except walnuts was significantly higher in non-hypertensive individuals (P<0.001). Also, the consumption of eggs, fish, red meat, and breakfast cereal were significantly higher in these participants.

Table 2 shows the association of hypertension with nut consumption, obtained using the adjusted and crude regression models. In the crude model, the hypertension odds (odds ratio (OR): 0.96, 95%CI 0.94 to 0.98), 1.020 (95% CI 1.006 to 1.034), 0.93 (95% CI 0.92 to 0.95) and 0.98 (95% CI 0.97 to 0.99) were significant among pistachio, walnuts, seeds, and total nuts consumers, respectively. In seeds and total nuts consumers, this association was persistent after adjusting for the confounders (adjusted model). The adjusted model included all variables, including age, gender, education, cigarette smoking, alcohol drinking, physical activity level, BMI, diabetes mellitus, as well as intake of salt, fruits/vegetables, dairy, egg, fish, red meat, and breakfast cereal. The corresponding adjusted ORs calculated for seeds and total nuts were 0.97 (95% CI 0.96 to 0.99) and 0.99 (95% CI 0.98 to 0.99), respectively.

Table 1- Selected characteristics in relation to hypertension among the participants of the Rafsanjan Cohort Study

Characteristics	Total	Hypertension		
		Yes	No	P-Value
Age - yr. Mean± SD	49.91±9.56	56.12±8.00	47.94±9.17	<0.001
Gender - no. (%)				
Female	5335(53.4)	1555(64.2)	3755(50.5)	<0.001
Male	4655(46.6)	867(35.8)	3756(50.0)	
Education. yr. Mean± SD	8.53±5.05	6.76±5.15	9.08±4.89	<0.001
Physical activity. Mean± SD	38.77±6.36	37.91±5.42	39.08±6.56	<0.001
Alcohol consumption- no. (%)				
Yes	1350(13.5)	178(7.4)	1172(15.6)	<0.001
No	8561(85.7)	2240(92.6)	6321(84.4)	
Diabetes mellitus- no. (%)				
Yes	1933(19.3)	930(41.6)	1003(13.0)	<0.001
No	8000(80.1)	1305(58.4)	6695(87.0)	
BMI. Mean± SD	27.83±4.89	29.87±4.95	27.16±4.69	<0.001
Cigarette smoking- no. (%)				

Yes	2542(25.4)	462(19.1)	2080(27.7)	<0.001
No	7448(74.6)	1960(80.9)	5431(72.3)	
Intake of nuts. g/day				
Pistachio	2.18±2.94	1.96±2.62	2.24±2.97	<0.001
Walnuts	2.46±3.24	2.61±3.32	2.40±3.20	0.006
Peanuts	0.15±0.95	0.12±0.57	0.16±1.05	0.019
Other nuts (cashews, almonds, hazelnuts)	0.46±1.36	0.43±1.19	0.46±1.41	0.379
Seeds (watermelon, pumpkin, sunflower)	2.13±5.11	1.37±3.42	2.36±5.45	<0.001
Total nuts	7.38±8.16	6.50±6.76	7.62±8.41	<0.001
Intake of fruit and vegetables. g/day	711.24±7993.5	654.019±376.53	729.81±9210.76	0.686
Intake of dairy. g/day	272.76±258.49	268.69±389.027	273.70±198.59	0.544
Intake of eggs. g/day	23.50±19.52	19.31±15.89	24.80±20.33	<0.001
Intake of fish. g/day	6.39±8.011	5.59±7.02	6.34±8.26	<0.001
Intake of red meat. g/day	26.31±27.22	23.24±24.31	27.20±27.46	<0.001
Breakfast cereal intake. g/day	519.08	493.35±801.633	526.61±323.48	0.003
Intake of salt. mg/day	1069.29±712.26	674.59±13.73	720.13±8.33	<0.001

BMI: Body Mass Index

Table 2- Associations between hypertension and consumption of nuts

	Crude model OR (95%Ci)[a]	P-Value	Adjusted model OR (95%Ci)[b]	P-Value
Hypertension				
Pistachio	0.96 (0.94-0.98)	<0.001	0.99 (0.97-1.01)	0.363
Walnuts	1.020 (1.006-1.034)	0.005	0.99 (0.98-1.012)	0.571
Peanuts	0.92 (0.84-1.004)	0.062	0.98 (0.90-1.063)	0.642
Other nuts (cashews, almonds, hazelnuts)	0.98 (0.95-1.020)	0.38	0.99 (0.95-1.032)	0.705
Seeds (watermelon, pumpkin, sunflower)	0.93 (0.92-0.95)	<0.001	0.97 (0.96-0.99)	0.005
Total nuts	0.98 (0.97-0.99)	<0.001	0.99 (0.98-0.99)	0.018

[a]The baseline model is stratified on hypertension.

[b]The adjusted model is adjusted for confounding variables age (continuous variable), gender (male/ female), cigarette smoking, alcohol drinking, physical activity level, body mass index (BMI), diabetes mellitus, education, and intake of salt, fruit and vegetables, dairy, eggs, fish, red meat and breakfast cereal.

4. Discussion

In this cross-sectional study based on a cohort, lower hypertension prevalence was observed in the RCS participants consuming nuts. According to the findings, 22.4% of the adult population (35.8% of men and 64.2% of women) was involved in hypertension. Further, no association was found between the consumption of pistachio, walnut, and peanut alone with a lower risk of high blood pressure. The main outcome of the study was that the hypertension prevalence was less among the consumers of all of the nuts together and the seeds (even after adjustment for some confounders). These findings are well consistent with those previously reported in the Physicians' Health Study in the US, which indicated that hypertension was less common among the US male physicians consuming nuts [11].

In addition to the influences of nut intake on blood pressure, different studies have also shown the advantageous effects of nuts on other hypertension risk factors. The results obtained from the Bes-Rastrollo indicated that the risk of weight gain (defined as a 5-kg increase in body weight during the follow-up phase) of the participants consuming nuts 2 times/week was 31% (OR: 0.69; 95% CI: 0.53–0.90) lower compared with those never consumed nuts [21]. The subjects who never consumed nuts were found to gain an average of 424 g (95% CI: 102–746) more than those who frequently consumed, after a median 28-month follow-up [21]. Another study on female nurses indicated a protective relationship between the consumption of nuts and the risk of Type-2 diabetes in a dose-response mode [22].

Due to the low content of sodium in nuts, on the one hand, and the presence of different mono- and poly-unsaturated fatty acids, potassium, magnesium, antioxidants, fiber, and vitamins, on the other hand, their consumption has beneficial effects on blood pressure [23, 24]. A decrease in sodium intake has been demonstrated to lower blood pressure [25]. Dietary fiber can lower blood pressure via inducing satiety and reducing energy intake, in turn, reducing weight. 25 meta-analyses confirmed the beneficial effects of dietary fiber on lowering blood pressure, especially amongst hypertensive people [26]. Magnesium intake has also been shown to reduce blood pressure [27] since it acts as a blocker of calcium channels, resulting in vasodilation [28]. In addition, magnesium induces the production of prostacyclin and synthesis of nitric oxide, regulating both endothelium-dependent and -independent vasodilation [29]. However, findings reported in clinical trials are inconsistent and heterogeneous [30]. Other minerals of nuts have shown favorable effects on blood pressure [24]. Jiang R indicates that the

consumption of nuts and seeds is associated with the lower concentrations of fibrinogen, interleukin-6, and C-reactive protein [31]. This proposes that nut consumption may inhibit inflammation and atherosclerosis progression, the main parameter in hypertension development [31].

The present study has some limitations. The first that limits the generalizability of the data is the age range of the participants (35-70 years old) and their different lifestyle habits compared with the general population. Moreover, the consumption of nuts is evaluated only once (12 months); thus, the possible changes made in their dietary habits are not considered in the analyses. There is also the possibility of incorrectly classifying the subjects due to the recall bias about the consumption of nuts. Further, another possibility is an inverse causal relationship, meaning that people may have started consumption of nuts after the beginning of their hypertension. Accordingly, the reconsideration of this relationship in the follow-up phase is suggested. Nevertheless, the study benefits from some strengths, including the large size of the sample and the complete ascertainment of the obtained results due to the standardized questionnaires used.

5. Conclusion

According to the results, it can be concluded that repeated uptake of nuts is inversely related to the prevalence of hypertension in the participants aged 35-70 years. However, no significant relationship is observed between the consumption of each nut alone and hypertension prevalence in the general population.

Conflicts of interest

Authors declare that they have no competing interests.

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The study protocol was designed according to the Persian cohort study, and it was approved by the Ethics Committee of Rafsanjan University of Medical Sciences (Ethical codes: IR.RUMS.REC.1399.193).

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