

# Study on the relationship between fruit consumption and hypertension in adults of Qingdao

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**Abstract:** To understand the morbidity of fruit intake in Licang District of Qingdao and analyze the relationship between the frequency of fruit intake and the incidence of hypertension in the baseline population. The baseline survey data of the China Kadoorie Biobank (CKB) Qingdao project site from 2004 to 2008 were collected and analyzed. A total of 35509 subjects were enrolled, the ratio of male to female was 1:1.27. The morbidity of hypertension in the study population was 36.11% for men and 30.90% for women ( $\chi^2=113.38$ ,  $P<0.05$ ). Compared with those who rarely eat fruit, the subjects with higher frequency of fruit intake are younger, mostly female, with higher education level and higher family income. With the increase of age, the proportion of people who eat fruit every day is becoming smaller and smaller. In the total population, compared with first group, the other four groups were all protective factors of hypertension ( $P<0.05$ ), and the risk of hypertension was lower in fifth group (OR=0.49, 95% CI:0.42-0.55). In male samples, except the second group, the other groups could reduce the risk of hypertension ( $P<0.05$ ); in female samples, only five groups could reduce the risk of hypertension (OR=0.61, 95% CI:0.46-0.80). Increasing the frequency of fruit intake is beneficial to reduce the incidence of hypertension in adults in Qingdao, and increasing the level of fruit intake has a more important protective effect on male samples.

**Keywords:** Fruit; Hypertension; Morbidity

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## 1. Introduction

Hypertension is the main risk factor of death caused by cardiovascular and cerebrovascular disease, which has become a major public health problem in the world. Prevention and control of hypertension can reduce the morbidity and mortality of cardiovascular and cerebrovascular disease[1]. According to the statistics of the World Health Organization, as of 2014, the morbidity of hypertension among adults in the world is 22%. There are 270 million hypertensive patients in China, which will keep growing without any intervention[2]. The fruit which is an important part of diet is rich in vitamins, dietary fiber, phytochemicals and other components. A large number of epidemiological studies have shown that increasing fruit intake can reduce the risk of morbidity and mortality of chronic noninfectious diseases such as cardiovascular and cerebrovascular diseases[3-5]. However, the relationship between fruit intake and the morbidity of hypertension is not consistent with many experts and scholars from home and abroad. In view of the differences in diet structure, lifestyle and physical fitness among Chinese residents and European and American residents, this paper explores the relationship between the frequency of fruit intake and the incidence of hypertension among residents in

Licang District of Qingdao.

## 2. Methods

### 2.1. Study population

The subjects of this survey come from the baseline survey sample of CKB Qingdao project site in 2004-2008. For the sampling method, inclusion criteria, exclusion criteria and project related information of the respondents, please refer to the literature published before CKB project[6-8], and a total of 35509 subjects were included in the study.

### 2.2. Questionnaire survey

The questionnaire includes general demographic information (age, gender, education level, family income), fruit intake frequency, personal and family health status, BMI, etc. Hypertension is actually measured in the baseline survey. If the respondents take antihypertensive drugs, they are also considered as hypertensive patients. Hypertension is defined as systolic blood pressure of 140 mmHg or above, or diastolic blood pressure of 90 mmHg or above. The height and weight of the respondents were measured with light clothes and without shoes. The Body Mass Index (BMI) was the weight (Kg) divided by the square of height (m<sup>2</sup>).

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**Table 1. Baseline Characteristics of Different Fruit Intake Frequency Groups**

Baseline characteristics	First group (n=930)	Second group (n=3690)	Third group (n=8534)	Fourth group (n=3115)	Fifth group (n=19240)	$\chi^2$ or F	P
Age	52.79±10.03	51.15±10.06	51.06±10.28	49.76±10.17	49.77±10.10	47.86	<0.05
Gender (%)							
Male	681(4.36)	2634(16.86)	4745(30.37)	1340(8.58)	6226(39.84)	2970.52	<0.05
Female	249(1.59)	1056(6.76)	3789(24.25)	1775(11.36)	13014(83.28)		
Degree of Education (%)							
Below primary school	73 (3.53)	278 (13.43)	592 (28.00)	182 (8.79)	945 (45.65)	413.03	<0.05
Primary school	192 (3.11)	733 (11.86)	1653 (26.75)	510 (8.25)	3091 (50.02)		
Junior middle school	432 (2.95)	1736 (11.87)	3478 (23.78)	1208 (8.26)	7769 (53.13)		
High school	180 (1.93)	744 (7.95)	2099 (22.45)	838 (8.95)	5488 (58.70)		
Junior college or above	53 (1.61)	199 (6.05)	712 (21.65)	377 (11.47)	1947 (59.22)		
Family income (%)							
<5000	18 (4.63)	54 (13.88)	101 (25.96)	45 (11.57)	171 (43.96)	250.22	<0.05
5000-19999	442 (3.20)	1670 (12.10)	3483 (25.25)	1109 (8.04)	7092 (51.41)		
20000-34999	339 (2.20)	1529 (9.94)	3638 (23.65)	1476 (9.60)	8401 (54.61)		
>35000	131 (2.21)	437 (7.36)	1312 (22.08)	485 (8.16)	3576 (60.19)		
Family history of related chronic diseases							
Yes	503 (2.98)	1936 (11.48)	3896 (23.11)	1281 (7.60)	9242 (54.82)	117.34	<0.05
No	427 (2.29)	1754 (9.40)	4638 (24.87)	1834 (9.83)	9998 (53.61)		
BMI							
Thin	14 (5.98)	33 (14.10)	65 (27.78)	22 (9.40)	100 (42.74)	68.34	<0.05
Normal	269 (2.47)	1226 (11.26)	2497 (22.94)	967 (8.88)	5926 (54.44)		
Overweight	444 (2.86)	1589 (10.24)	3844 (24.77)	1403 (9.04)	8238 (53.09)		
Obesity	193 (2.29)	801 (9.49)	2024 (23.99)	679 (8.05)	4741 (56.19)		

If BMI < 18.5, it was lean, if 18.5 ≤ BMI ≤ 23.9, it was normal, if 24 ≤ BMI ≤ 27.9, it was overweight, if BMI ≥ 28, it was obese. The frequency of fruit intake was divided into five groups, first group (< 1 time / month), second group (1-3 times / month), third group (1-3 times / week), fourth group (4-6 times / week), fifth group (every day).

### 2.3. Statistical treatment

The measurement data were  $\bar{X} \pm s$ , the difference

between groups was  $\chi^2$  test, the single factor and multi factor logistic regression analysis were used to analyze the relationship between the frequency of fruit intake and the incidence of hypertension. In this study, covariance analysis was used, and the model adjusted age, gender, BMI, smoking, drinking, education, family income and other factors. Spss24.0 was used for data analysis, and the test level was  $\alpha = 0.05$

**Table 2. Single and multiple factor analysis between total fruit intake frequency and prevalence of hypertension**

Fruit intake frequency	Single factor analysis		Multifactor analysis	
	OR (95% CI)	P	OR (95% CI)	P-value
First group (Reference)				
Second group	0.80 (0.69-0.93)	<0.05	0.88 (0.76-1.03)	<0.05
Third group	0.66 (0.58-0.76)	<0.05	0.75 (0.65-0.87)	<0.05
Fourth group	0.57 (0.49-0.66)	<0.05	0.74 (0.63-0.87)	<0.05
Fifth group	0.49 (0.42-0.55)	<0.05	0.63 (0.54-0.73)	<0.05

**Table 3. Logistic regression single factor analysis between the frequency of fruit intake and the prevalence of hypertension in different genders**

Fruit intake frequency	Male		Female	
	OR (95% CI)	P	OR (95% CI)	P
First group (Reference)		<0.05		<0.05
Second group	0.82 (0.69-0.97)	<0.05	0.75 (0.57-0.99)	<0.05
Third group	0.71 (0.60-0.83)	<0.05	0.52 (0.40-0.68)	<0.05
Fourth group	0.64 (0.53-0.77)	<0.05	0.42 (0.32-0.55)	<0.05
Fifth group	0.70 (0.59-0.82)	<0.05	0.32 (0.25-0.41)	<0.05

**Table 4. multivariate analysis of the relationship between the frequency of fruit intake and the prevalence of hypertension in different genders**

Fruit intake frequency	Male		Female	
	OR (95% CI)	P	OR (95% CI)	P
First group (Reference)				
Second group	0.86 (0.72-1.03)	0.11	0.94 (0.70-1.28)	0.70
Third group	0.72 (0.61-0.86)	<0.05	0.78 (0.59-1.04)	0.09
Fourth group	0.69 (0.56-0.84)	<0.05	0.79 (0.59-1.07)	0.12
Fifth group	0.69 (0.58-0.82)	<0.05	0.61 (0.46-0.80)	<0.05

## 3. Results

### 3.1. General demographic characteristics

The 35509 subjects were included in this study, including 15626 males (44%), 19883 females (56%), and the ratio of males to females is 1:1.27; the average age is 50.30 ± 10.17, the average age of

males is 49.42 ± 9.95, and the average age of females is 50.99 ± 10.29; the morbidity of hypertension in this study population is 33.19%, the morbidity of males is 36.11%, and the prevalence of females is 30.90% ( $\chi^2=113.38$ ,  $P<0.05$ ); 930 people (2.62%) in the first group, 3690 people (10.39%) in the second group, 8534 people (24.03%) in the third group, 3115

people (8.77%) in the fourth group and 19240 people (54.18%) in the fifth group. See table 1 for details of baseline characteristics of different fruit intake frequency groups.

### **3.2. The relationship between total fruit intake and prevalence of hypertension**

In this study, single factor and multi factor Logistic regression were used to study the relationship between total fruit intake frequency and hypertension. The results showed that: with the increase of fruit intake frequency, the risk of hypertension decreased, and the risk of hypertension in fifth group was the lowest (OR=0.49, 95% CI:0.42-0.55,  $P<0.05$ ). After adjusting related confounding variables, there was no significant correlation between the second group and hypertension. The risk of hypertension in the other groups was reduced. The risk of hypertension in the fifth group was the lowest. See Table 2 for details.

### **3.3. The relationship between the intake of fruits and the prevalence of hypertension in different genders**

This study studies the relationship between the total intake frequency of fruits and the prevalence of hypertension through the logistic regression of gender stratification. The results show that the risk of hypertension decreases with the increase of the intake frequency of fruits, see Table 3 for details. After adjusting the age, gender, BMI, smoking, drinking, education level, family income and other confounding factors, there was no significant correlation between the second group of men and the prevalence of hypertension, and the risk of hypertension in the other groups was reduced. In women, only fifth group could reduce the risk of hypertension (OR=0.61, 95%CI: 0.46-0.80), see Table 4 for details.

## **4. Discussion**

In addition to the influence of genetic factors on the prevalence of hypertension, the influence of dietary factors on the occurrence and development of hypertension should not be ignored. Therefore, the relationship between dietary structure and hypertension has been paid more and more attention by researchers. The conclusions on the relationship between the frequency of fruit intake and the incidence of high blood pressure are inconsistent. Some studies have pointed out that, the fruit intake has a negative correlation with the morbidity of hypertension[9], but it has not been fully verified in China. The purpose of this study is to explore the relationship between the frequency of fruit intake

and hypertension in adults in Qingdao.

In this study, we analyzed the relationship between the frequency of fruit intake and hypertension in adults in Qingdao through survey. The results showed that there was a negative correlation between the frequency of fruit intake and the risk of hypertension.

The results of two studies conducted by Victor Mundan[10] and Hongji Song[11] respectively showed that there was a statistically significant negative correlation between fruit intake and the risk of hypertension. Alvaro Alonso[12] et al, made a cross-sectional investigation and analysis in the Mediterranean diet (rich in fruits and vegetables and high-fat food at the same time), and found that high fruit intake can reduce the risk of hypertension by 32%; Chen Jia[13] et al, showed that: increasing fruit intake can reduce the incidence of hypertension. Chen Yong[14] et al, pointed out that: increasing fruit intake can reduce the incidence of hypertension systolic blood pressure. This suggests that increasing fruit intake is a protective factor against hypertension, which is basically consistent with the results of this study, while the results of Nunez Cordoba, J.M[15] show that there is no significant correlation between fruit intake and hypertension.

The mechanism of the effect of fruit intake on blood pressure level is not completely clear. According to previous reports, it may be speculated that: first, fruit contains a large number of vitamin C, potassium ion, magnesium ion, phytochemicals, etc., which can reduce blood pressure by relaxing blood vessels, increasing antioxidant activity, improving endothelial function[16]. Second, fruit contains rich dietary fiber which can increase intestinal peristalsis, facilitate defecation, change intestinal flora, and thus play a role in lowering blood pressure. Some studies have shown that intestinal flora is significantly related to the degree of obesity [17], which may reduce blood pressure by changing body weight. Finally, the energy contained in fruits is low, increasing the intake of fruits may reduce the intake of other high-energy foods, thus reducing the intake of total energy of the body, reduce blood pressure by losing weight.

This study has the following advantages: first, the sample size is large, the accuracy of the results is higher; second, the mixed factors such as age, gender, BMI, smoking, drinking, family income, culture are included, the results are more reliable. This study also has the following shortcomings: first, this study adopts questionnaire survey to collect relevant information, and there is recall bias; second, this study only collects the intake frequency of fruit, does not obtain the information of intake and fruit intake types, and cannot further explore the relationship between fruit intake and high blood pressure, nor further study the impact of different fruit types on

hypertension.

## 5. Conclusion

In summary, the cross-sectional study, which included a total of 35509 people, showed that there was a negative correlation between the frequency of fruit intake and the risk of hypertension. According to the gender stratification, this study states that: in male samples, fruit intake frequency  $\geq$  1 time/week is the protective factor of hypertension, while in female samples, only eating fruit every day is the protective factor of hypertension, which suggests that increasing fruit intake has more important protective significance for male residents in Qingdao.

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