The Interactive Association between Sodium Intake, Alcohol Consumption and Hypertension among Elderly in Northern China: A Cross-Sectional Study

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Abstract

**Background:** Hypertension is a worldwide public health problem. We sought to examine the interactive association between sodium intake, alcohol consumption and hypertension among elderly residents of Inner Mongolia in Northern China.

**Methods:** This cross-sectional study used the National Survey Data for Nutrition and Adult Chronic Disease in Inner Mongolia. The prevalence of hypertension was age standardized by direct method. Sodium intake and alcohol consumption were estimated using a weighing method and 24-hour recalls over three consecutive days. Hypertension was either self-reported or eld-measured. Participants were categorized into six subgroups according to the sodium intake status and drinking levels. Logistic regression was used to determine the interactive effects between sodium intake and drinking on hypertension.

**Results:** A total 820 elderly participated in the study, of whom 523 (63.80%, age-standardized rate 62.33%) had been diagnosed with hypertension. The mean sodium intake was 4.88g. Sodium intake and drinking excessively were both independently related to a higher risk of hypertension. Adjusting for confounders, there was interaction between sodium intake and alcohol consumption in the six subgroups, with the risk of hypertension being highest among the group with excessive sodium intake and excessive alcohol consumption, with an odds ratio of 3.639 (95% confidence interval: 1.666–7.947).

**Conclusions:** The study highlights the interactive association between sodium intake and alcohol consumption with hypertension. Primary healthcare providers should take special consideration of those who are older age with hypertension in Inner Mongolia, especially those with an unhealthy diet including both excessive sodium and excessive alcohol intake.

**Background**

The Global Burden of Disease (GBD) Study showed that the burden related to hypertension remains high, with the largest contributors to global disability-adjusted life-years (DALYs) among Level 3 risks being high systolic blood pressure (211.8 million global DALYs) in 2015 [1]. Notably, older adults account for the bulk of hypertension, due largely to dramatically greater prevalence among the elderly [2]. Hypertension is also more prevalent in low- and middle-income countries, where those who are diagnosed hypertension may not have the resources or the access to quality care to successfully control their illness over the long term [3]. Nearly three quarters of people have been diagnosed with hypertension reside in low- and middle-income countries [4]. In China, the overall aging population also represents a significant challenge for hypertensive control.

Hypertension seriously affects the quality of life for the elderly [5]. However, hypertension could be prevented and controlled effectively by modifying lifestyle and dietary factors known to be associated with hypertension [6, 7], especially excessive sodium intake and heavy alcohol consumption. Where other countries have reported a mean sodium intake of 3–5 g/day, the majority of communities in China have reported a mean sodium intake of greater than 5 g/day. The global sodium intake survey found that the average sodium intake of residents was 10.06 g/d [8], and the fifth dietary survey conducted in China reported it to be 14 g/d, which is double the World Health Organization’s recommended intake [9]. Additionally, heavy alcohol consumption has become increasingly recognised as a leading risk factor for the development of hypertension [10]. In 2016, 32.5% of people globally were current drinkers. The burden of disease caused by drinking increases with age, peaking in men aged 55-65 years [11]. A meta-analysis has shown that reducing alcohol consumption, which is known to be an effective intervention, would reduce the burden of disease caused by hypertension [12].

In Inner Mongolia, the prevalence of hypertension is higher than in other parts of China due to its lower rate of awareness, treatment, and control, which lead to a younger median age among patients suffering from hypertension [13]. Because of its less developed economy and medical care system, residents lack awareness of health care issues, leading to poor public health conditions in terms of hypertension [14]. Therefore, hypertension has become a common chronic disease in people over 55 years old in Inner Mongolia, which the hypertension crude prevalence rate was 54.10% [15].

High sodium intake and excessive drinking are prevalent in Inner Mongolia [16]. Both factors play an important role in the development of hypertension; most evidence supports a positive association between sodium intake and blood pressure [17, 18], and the literature on excessive alcohol consumption and it associated harmful effects on blood pressure level is mostly consistent [19, 20]. However, little is known about the interactive association between excessive sodium intake and drinking with hypertension in the elderly. Therefore, with a view to expanding the present evidence base for prevention of hypertension and developing future public
health interventions in Inner Mongolia, we sought to use Chinese adult chronic disease and nutrition monitoring data to explore the association between sodium intake and alcohol consumption in their effects on hypertension in people over 55 years old in Inner Mongolia, particularly whether sodium intake and alcohol consumption impact additively or synergistically on hypertension, and whether a positive or negative interaction is present.

**Methods**

**Study design and participants**

As part of data collection for the National Survey Data for Nutrition and Adult Chronic Disease in Inner Mongolia, which was conducted across eight monitoring sites in Inner Mongolia, multi-stage stratified cluster sampling was used to ensure a representative cross-section of the participants. The study design has previously been described [21]. The sample size was calculated using 19.15% prevalence of hypertension in the fifth health service in Inner Mongolia, 3% error, a design effect of 3 and a non-response rate of 10%. There were 820 individuals over 55 years old who participated in the study. This survey was approved by the Ethical Committee of the National Institute for Nutrition and Food Safety, of the Chinese Center for Disease Control and Prevention. Participation in this survey entailed no treatments or interventions that could impact the health of participants. All participants provided written informed consent before the start of the investigation.

**Data collection**

*Weighing method and 24-hour recalls*

Weighing methods and a 24h recall survey administered over three consecutive days were used to collect dietary data. Information about consumption of condiments for three consecutive days, such as cooking oil, salt and monosodium glutamate (MSG), was collected using a weighing method that used standardized weighing tools to weigh the amount of food, so as to quantify food consumption. The investigation lasted four days for each subject. On the first day, trained staff members visited the participant's home and used a food scale to weigh and record all condiments, including the type of container used. On the second day, all condiments purchased and discarded were also weighed and recorded, and the investigator repeated the work in each of the remaining days of the investigation. At the end of the survey, the remaining condiments were weighed, and the amount of condiments consumed by participants for three consecutive days was estimated. In the 24-hour recalls, participants recalled and described all food and alcohol consumption for the same three consecutive days (two weekdays and one weekend day), except for condiments.

*Questionnaires*

Trained health facility interviewed each participant face-to-face using uniform questionnaires, after obtaining informed consent in person. These questionnaires which was developed for the National Survey Data for Nutrition and Adult Chronic Disease included demographic characteristics (e.g., gender, age, education level), health status (e.g., hypertension, diabetes), health-related behaviours (e.g., smoking, physical activity). Physical activity was assessed by the questionnaire, which addressed three activity categories with 26 items: 20 items on physical activity state, four items on resting state, and two items on sleeping state. The items asked participants what kind of activities they engaged in, the frequency of activities per week, and the total time spent on these activities per day. Physical activities were scored using the weighting procedure recommended by the International Physical Activity Guidelines for Americans [22], which calculates the total exercise metabolic equivalent (MET) of three activity categories.

Participants' height and weight were directly measured by trained and evaluated workers, and blood and urine samples were also collected. The laboratory director organized the quality control sample assessment at a field laboratory.

**Measures**

*Sodium intake*

The dietary sodium intake measure included all condiments and food collected by a weighing method and 24-hour recall. According to the China Food Ingredients Table (version II) [23], sodium intake in each type of food was calculated. The sodium intake was then
categorized into two levels as defined by the Chinese Nutrition Society: sodium intake \( \leq 2200 \text{ mg} \) was defined as moderate, and sodium intake \( >2200 \text{ mg} \) was defined as excessive [23].

**Alcohol Consumption**

A 24-hour recall survey over three consecutive days was used to estimate each individual's alcohol consumption. Beverage type (liquor with high alcohol content, liquor with low alcohol content, beer, yellow rice wine, rice wine, wine) and drinking amount were measured over three consecutive days. One standard drinking unit is equal to 10g of alcohol. Then, the alcohol consumption was calculated according to the Manual of Chinese Chronic Disease and Nutrition Surveillance Survey [24]. Each participant's average alcohol consumption was divided into three levels according to the Dietary Guidelines for Chinese Residents 2016: never (0 g/d), moderate (male \( \leq 25 \text{ g/d} \), female \( \leq 15 \text{ g/d} \)), and excessive (male \( >25 \text{ g/d} \), female \( >15 \text{ g/d} \)) [24].

**Definition of hypertension**

The main outcome indicator was hypertension, as indicated by meeting one of the following conditions. The first condition was self-reported hypertension; that is, having a diagnosis of hypertension and currently receiving hypertension treatment [14]. The second condition was field-measured hypertension, assessed as the average of three blood pressure measurements carried out by trained investigators using electronic blood pressure monitor (Model HBP1300, Omron, Japan) with a minimum 1mmHg. A standardized protocol for blood pressure measurements was used following the recommendations issued by the Chinese Working Group on Blood Pressure Measurement [25]. Measurements were taken when the participant was seated, and after at least a 5 minute rest period. Blood pressure was measured three times at 1-minute intervals. Hypertension defined as average systolic blood pressure \( \geq 140 \text{ mmHg} \) and/or average diastolic blood pressure \( \geq 90 \text{ mmHg} \).

**Definition of other variables**

Ethnicity was categorized as Han, Mongolian or other minorities. Marital status was categorized as single, married, or other. Education level was categorized as primary school, junior high school, or high school and above. Smoking status was categorized as non-smoking (never having smoked previously), former smoking (previously smoked but has quit) or current smoking (smoking currently). Total exercise metabolic equivalent (total MET) was divided into tertiles, and physical activity was defined as low (total MET \( < 2988 \text{ MET} \) ), medium (2988 \( \leq \text{ total MET} <8400 \text{ MET} \) ) and high (total MET \( \geq 8400\text{ MET} \) ). Cut-offs of body mass index (BMI) were based on Chinese adjustments issued by a working group on obesity in China [26]. BMI was categorized into three groups, BMI \( < 23.9 \text{ kg/m}^2 \), BMI = 24.0 – 27.9 kg/m\(^2\) or BMI \( \geq 28.0 \text{ kg/m}^2 \).

**Statistical analyses**

The prevalence of hypertension was age standardized to the 2010 national demographic criteria in China using the direct method [27]. Participants with hypertension and without hypertension were compared by demographic characteristics, sodium intake and drinking status, using chi-square tests. Furthermore, according to the sodium intake status and drinking levels jointly, the participants were categorized into six subgroups: moderate sodium intake with no drinking, moderate sodium intake with moderate drinking, moderate sodium intake with excessive drinking, excessive sodium intake with no drinking, excessive sodium intake with moderate drinking, and excessive sodium intake with excessive drinking.

Initially, we analysed the independent associations of sodium intake and drinking with hypertension risk factors by estimating odds ratios (OR) and 95% confidence intervals (CI) in the multivariable logistic models. A multiplicative interaction term of sodium intake and drinking was also set in the logistics models to test whether its effect on hypertension was independent of sodium intake, drinking, and other confounding factors. Then, logistics regression model was used to compute OR for hypertension across the six subgroups by adjusting for important confounding factors, in order to explore the main interaction effects between sodium intake and drinking on hypertension. We established 3 multivariate models: Model 1 was an unadjusted model, and Model 2 adjusted for demographic variables including gender, ethnicity, educational level, marital status, BMI, and family history of hypertension. Model 3 further adjusted for smoking, physical activity, diabetes and dyslipidaemia. Finally, the single effect of sodium intake and drinking on hypertension was compared.

The ‘Forward: LR’ method was used to select variables in logistic regression. Statistical significance was determined by \( a < 0.05 \). All statistical analyses were performed with SPSS software version 19.0 (IBM Corp, Armonk, NY, USA).
Results

Characteristics of Inner Mongolia residents with hypertension

Using the 2010 national demographic criteria to standardize, of a total of 820 residents aged 55 years and older, 523 (63.80%, age-standardized rate 62.33%) had been diagnosed with hypertension. Compared with residents without hypertension, participants with hypertension were more likely to be Mongolian, more likely to have high BMI and a family history of hypertension, lower physical activity, diabetes or dyslipidaemia (Table 1). There were no differences in other variables between participants with or without hypertension.

Association between sodium intake, drinking and hypertension

The average salt consumption was 9.78g, and the mean sodium intake was 4.88g among the participants over 55 years old. Participants with excessive sodium intake had the highest rate of hypertension, as did those who consumed excessive amounts of alcohol (Table 2). Table 2 also presents the effects of sodium intake and drinking separately on hypertension risk. After adjustment for confounders, excessive sodium intake was related to risk of hypertension independently, with an OR of 1.866 (95% CI: 1.235–2.819). The odds ratio for hypertension was nearly doubled (OR = 1.961, 95% CI: 1.101–3.492) in participants with excessive drinking. Compared with the non-drinking group, the odds of hypertension were not significantly higher in those who reported moderate drinking. A formal test for multiplicative interaction between sodium intake and drinking revealed a significant interaction (p = 0.042), and the multivariable-adjusted OR [95% CI] for the interaction was 1.136 [1.011-1.277] (Table 2).

Risk of hypertension by sodium intake interaction with drinking

Participants were categorized into 6 subgroups according to sodium intake and drinking jointly, and the excessive sodium intake with excessive drinking group had the highest prevalence of hypertension, while non-drinkers with moderate sodium intake had the lowest prevalence of hypertension (p =0.013) (Table 3). Table 3 also presents the interactive association between sodium intake and drinking on hypertension for the six subgroups. After adjustment for demographic variables, compared with the moderate sodium intake and the non-drinking group, those non-drinkers with excessive sodium intake and excessive drinkers with excessive sodium intake displayed higher risk of suffering from hypertension, with ORs of 1.861 (95% CI: 1.182–2.930) and 3.422 (95% CI: 1.658–7.065) respectively. After further adjustment for smoking, physical activity and variables related to disease, compared with non-drinkers with moderate sodium intake, those with excessive sodium intake and excessive drinking had the highest risk of suffering from hypertension, with an OR of 3.639 (95% CI: 1.666–7.947). The odds ratio for hypertension was 26.39% higher in participants with excessive sodium intake and excessive drinking than in those with moderate sodium intake and no drinking. Compared with moderate sodium intake participants, excessive sodium intake participants had increased odds of hypertension, but this was restricted to the group with no drinking and with excessive drinking (Figure 1). The odds of hypertension were 1.8 times higher in participants with excessive sodium intake and no drinking (adjusted OR 1.844, 95% CI: 1.134–2.998), and 3.6 times higher in participants with excessive sodium intake and excessive drinking (adjusted OR = 3.639, 95% CI: 1.666-7.947) than in participants with moderate sodium intake (Figure 1).

Simple Effect of Hypertension at Different Sodium Intake or Drinking Status.

Figure 2 shows the simple effect of drinking and sodium intake on hypertension. At the same level of sodium intake, compared with no drinking, the risk of suffering from hypertension was higher with excessive drinking (Figure 2a). Likewise, at the same level of drinking, compared with moderate sodium intake, the group with excessive sodium intake had a significantly higher risk of suffering from hypertension (p < 0.05) (Figure 2b). However, no significant association between moderate drinking and hypertension was detected, irrespective of the level of sodium intake.

Discussion

In this cross-sectional study, the standardized prevalence rate of hypertension was 62.33% among participants with age ≥ 55 years in Inner Mongolia, significantly higher than the 54.6% previously reported in 31 other provinces [28]. Excessive sodium intake and excessive drinking were each independently associated with hypertension. Moreover, the combined effect of sodium intake excessively and drinking excessively was associated with the highest risk of hypertension, which suggests that preventive interventions including sodium reduction and alcohol consumption control are both very important.
The prevalence of hypertension was higher among participants with age ≥ 55 years in this study. The risk of hypertension rose with age, and those in the age group from 55 to 60 years were the most likely to be hypertensive [29]. Moreover, with increasing age, people are more susceptible to chronic depression or declines in body function due to changes in metabolic status, which may influence the intensity of physical activity after age 55 [30]. Because of the characteristics of residents who are aged 55 years and above in Inner Mongolia, interventions for the prevention of hypertension should be paid significantly more emphasis in this population.

The present study showed that sodium intake and drinking were both independently related to the risk of hypertension among a representative sample of residents of Inner Mongolia. Increased sodium intake was more closely related to hypertension (OR = 1.708, 95% CI: 1.235–2.819), which was in accordance with other studies [31]. And it confirmed that excessive sodium intake is independently associated with risk of hypertension. Other studies in adults reported that a reduction in sodium intake significantly reduced systolic blood pressure by 3.39 mmHg [32]. The effect of lowering blood pressure by reducing sodium intake was more pronounced in the elderly, compared with younger subjects. Interestingly, participants above 55 years old who used a salt substitute (containing 65% sodium chloride) had lower blood pressure than did those consuming the normal salt intake (100% sodium chloride) after a 12-month follow-up visit [33].

Compared with non-drinkers, the excessive drinking group was significantly independently associated with increased prevalence of hypertension in this study (OR = 1.961, 95% CI: 1.101–3.492). Regular alcohol consumption was related to a doubled risk of hypertension [34]. The ARIC (Atherosclerosis Risk in Communities) cohort study revealed that the risk of hypertension increased in people who drank more than 210 g per week compared to non-drinkers [35]. However, our study did not detect a relationship between moderate drinking and hypertension. Even in the multivariate interactive analysis, the effect of drinking moderately on hypertension risk was less marked. Currently, the impact of lighter alcohol consumption on blood pressure is a controversial question. Accordingly, Jaubert and colleagues evaluated the relationship between alcohol consumption and 24-hour ambulatory blood pressure in a community-based elderly cohort. After adjustment for relevant covariables, the blood pressure was significantly higher in moderate-to-heavy drinkers than in the reference group [36]. However, the GBD 2016 Alcohol Collaborators found that consuming zero standard drinks daily was associated with the minimized risk in all health areas [11]. That is to say, not drinking is the healthiest lifestyle. This suggests that further study is required to explore the effect of moderate alcohol consumption on hypertension.

In addition, there was a significant multiplicative interaction between sodium intake and drinking on the risk of hypertension. Individuals who consumed both sodium and alcohol excessively had the highest risk of hypertension compared with those with moderate sodium intake and no drinking (OR = 3.639, 95% CI: 1.666–7.947). Similar to our findings, consuming excessive alcohol and high levels of salted fermented seafood has been found to be associated with a significantly higher rate of pre-hypertension and hypertension in Korean adults [37]. However, this was a study of dietary patterns which were generated using a factor analysis, and the drinking dietary pattern featuring alcohol and salted fermented seafood intake. Participants consuming high alcohol were 3.05 times more likely to be hypertensive than those with low consumption patterns [37]. Similar studies have been reported in China; drinking and dietary patterns characterized by the amount of alcohol and the condiments including salt and oil consumed were associated with an increased risk of suffering from hypertension [38]. Intake of alcohol also frequently caused significant increases in blood pressure and sodium balance in Japanese males with hypertension in a study by Yuhei and colleagues, suggesting that the sodium intake and alcohol may interact with each other. However, that study did not clarify a specific mechanism for the interaction [39]. Salt-sensitive hypertension is common in the elderly; in addition, long-term drinking can accelerate the development of hypertension through damaging the activity of the renin-angiotensin system, while impairing endothelial function resulting in decreased salt sensitivity. Gennaro and colleagues studied how blood pressure responded to dietary sodium disposal among alcoholics; interestingly, they found that the sodium sensitivity index (SSI), which measures the degree of salt sensitivity, was significantly higher in those of alcoholics, and blood pressure was significantly elevated [40]. Meanwhile, study showed that drinking excessively led to chronic sodium retention and increased intracellular sodium ion concentration, resulting in hypertension [41].

Just as in our findings, there were significant differences in blood pressure level associated with excessive drinking at the same level of sodium intake. At the same level of drinking, excessive sodium intake was associated with a risk of hypertension, irrespective of alcohol consumption group. This suggests that drinking is an influential factor that increases the association of sodium intake with a risk of hypertension. However, no relationship between drinking moderately and hypertension was detected in this study, whether in the univariate analysis or the multivariable analysis.
Inner Mongolia is a multi-ethnic region in the most northern part of China, with large variations in geography and climate. Because the annual cold season is longer in this region than in other areas of China, the diet in Inner Mongolia residents is characterized by less intake of fresh fruits and vegetables, and greater intake of food containing oil and salt, with prevalent habits of excessive drinking [21]. Wine is an essential beverage for social gatherings in Inner Mongolia, and large amounts of alcohol consumption will increase energy intake, as residents are accustomed to eating pickled food with high salt content when they drink. When behaviours of excessive sodium intake and drinking are both consistently present, it will greatly increase the risk of hypertension.

Limitations

There were also some limitations in this study. As in all cross-sectional studies, the difficulty of accurate evaluation of alcohol consumption and the possibility underreporting or over-reporting should be considered. It is likely that any classification or measurement will have occurred at random, which may attenuate the observed findings, leading to an underestimate of effect estimates. Misclassification, particularly reporting of the alcohol consumption, can lead to an underestimation of the effects of drinking on hypertension risk. Additionally, this is a cross-sectional study, and thus the causal association of sodium intake and drinking and risk of hypertension should be further examined in large cohort studies.

Conclusions

This study indicates that excessive sodium intake and excessive drinking are highly prevalent dietary habits among the elderly in Inner Mongolia. The age-standardized rate of hypertension was 62.33% among those aged 55 years and above. Both sodium intake and alcohol consumption are independently associated with hypertension. However, the relationship between drinking moderately and hypertension was not detected. More importantly, sodium intake interacts with drinking, which is synergistically related to the risk of hypertension among those aged 55 years and above. Primary healthcare should be more inclined to providing interventions to reduce the risk of hypertension in those who are of older age with unhealthy eating habits, and who consume both sodium and alcohol excessively.

Abbreviations

GBD: Global burden disease; DALYs: Disability adjusted life years; MSG: monosodium glutamate; BMI: Body mass index; OR: Odds ratio; 95% CI: 95% Confidence interval; MET: metabolic equivalent; SSI: Sodium sensitivity index; ARIC: Atherosclerosis Risk in Communities

Declarations

Ethics approval and consent to participate

This survey was approved by the Ethical Committee of the National Institute for Nutrition and Food Safety of the Chinese Center for Disease Control and Prevention. In this survey, there were no treatments or interventions that could impact the health of participators. All participants provided written informed consent before the start of the investigation.

Consent for publication

Not applicable.

Availability of data and materials

The questionnaire was printed in paper. The data are available from the corresponding author upon reasonable request, but are not available online.
Competing interests

None declare.

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Authors' contributions

XM-W and XN conceived the idea for this article. XN and HW-L made the calculations and drafted the first version of the manuscript. JW and MM-X participated in analysing the data. YG-Q and WR-W helped to clarify the study data. XM-W identified the final statistical analysis and revised manuscript. All authors approved the final version to be submitted for consideration for publication.

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Tables
Table 1 Characteristics among Inner Mongolia Residents over 55-year-old with Hypertension.

| Variables                | Total, n | Hypertension, % | \(\chi^2\) | \(p\)-value |
|--------------------------|----------|-----------------|-------------|-------------|
| **Gender**               |          |                 |             |             |
| Male                     | 411      | 63.26           | 0.097       | 0.756       |
| Female                   | 409      | 64.30           |             |             |
| **Ethnicity**            |          |                 |             |             |
| Han                      | 728      | 62.91           | 4.772       | 0.092       |
| Mongolian                | 63       | 76.19           |             |             |
| Others                   | 29       | 58.62           |             |             |
| **Education level**      |          |                 |             |             |
| Primary school           | 514      | 64.40           | 3.106       | 0.212       |
| Junior high school       | 172      | 66.86           |             |             |
| High school and above    | 134      | 57.46           |             |             |
| **Marital Status**       |          |                 |             |             |
| Single                   | 6        | 33.33           | 3.128       | 0.209       |
| Married                  | 743      | 63.39           |             |             |
| Others                   | 67       | 68.66           |             |             |
| **BMI**                  |          |                 | 23.368      | <0.001<sup>*</sup> |
| 23.9                     | 309      | 55.34           |             |             |
| 24~27.9                  | 344      | 67.15           |             |             |
| \(\geq 28.0\)            | 154      | 77.27           |             |             |
| **Family History of Hypertension** |    |                 | 22.673      | <0.001<sup>^</sup> |
| No                       | 556      | 58.27           |             |             |
| Yes                      | 264      | 75.38           |             |             |
| **Smoking Status**       |          |                 | 4.182       | 0.124       |
| None-Smoking             | 466      | 65.24           |             |             |
| Former Smoking           | 75       | 70.67           |             |             |
| Current Smoking          | 279      | 57.74           |             |             |
| **Physical Activity**    |          |                 | 12.112      | 0.002<sup>^</sup> |
| Low                      | 326      | 70.86           |             |             |
| Medium                   | 255      | 60.39           |             |             |
| High                     | 239      | 57.74           |             |             |
| **Diabetes**             |          |                 | 7.133       | 0.008<sup>^</sup> |
| No                       | 711      | 62.03           |             |             |
| Yes                      | 109      | 75.23           |             |             |
| **Dyslipidemia**         |          |                 | 6.224       | 0.013<sup>^</sup> |
Table 2 Prevalence and Odds Ratio of Hypertension by Sodium Intake and Drinking.

| Variables                  | Total, n | Hypertension, % | c²  | p-value | Unadjusted OR | p-value | 95%CI       | Unadjusted OR | p-value | 95%CI       | Adjusted* OR | p-value | 95%CI       |
|----------------------------|----------|-----------------|-----|---------|---------------|---------|-------------|---------------|---------|-------------|---------------|---------|-------------|
| Sodium intake              |          |                 |     |         |               |         |             |               |         |             |               |         |             |
| Moderately                 | 112      | 52.68           |     |         | 1.000(Ref)    |         |             | 1.000(Ref)    |         |             | 1.000(Ref)    |         |             |
| Excessively                | 708      | 65.54           | 1.744 | 0.007⁴ | (1.163, 2.616) | 1.866 | (1.235, 2.819) | 0.003⁴ |
| Drinking                   |          |                 |     |         |               |         |             |               |         |             |               |         |             |
| No drinking                | 600      | 63.33           |     |         | 1.000(Ref)    |         |             | 1.000(Ref)    |         |             | 1.000(Ref)    |         |             |
| Moderately                 | 147      | 59.18           | 0.81 | 0.265   | (0.559, 1.173) | 0.877 | (0.601, 1.279) | 0.495 |
| Excessively                | 73       | 76.71           | 1.905 | 0.027⁴ | (1.078, 3.369) | 1.961 | (1.101, 3.492) | 0.022⁴ |
| Sodium Intake × Drinking   | -        | -               | -   | -       | -             | -       |             | -             | -       |             | -             | -       |             |
| *Adjusted for age, gender, marital status, educational level, smoking, physical activity, BMI, diabetes, dyslipidemia; ⁴p<0.05; OR: Odds Ratio; 95%CI: 95% confidence interval.
### Table 3 Logistic Regression Analysis of Sodium Intake Interaction with Drinking on Hypertension.

| Variables | Total, n | Hypertension, % | P-value | Model 1@  | Model 2#  | Model 3 &  |
|-----------|----------|-----------------|---------|-----------|-----------|-----------|
| Subgroups |          |                 |         | OR(95%CI) | OR(95%CI) | OR(95%CI) |
| Sodium moderately (No drinking) | 89 | 50.56 | 0.013 | 1.000(Ref.) | 1.000(Ref.) | 1.000(Ref.) |
| Sodium moderately (Moderate drinking) | 13 | 53.85 | | 1.141(0.355, 3.664) | 0.792(0.225, 2.792) | 0.925(0.258, 3.320) |
| Sodium moderately (Excessive drinking) | 10 | 70 | | 2.281(0.554, 9391) | 2.900(0.557, 15.088) | 3.350(0.636, 17.650) |
| Sodium excessively (No drinking) | 511 | 65.56 | | 1.861(1.182, 2.930) | 1.693(1.050, 2.731) | 1.844(1.134, 2.998) |
| Sodium excessively (Moderate drinking) | 134 | 59.7 | | 1.449(0.844, 2.486) | 1.196(0.678, 2.110) | 1.449(0.808, 2.600) |
| Sodium excessively (Excessive drinking) | 63 | 77.78 | | 3.422(1.658, 7.065) | 3.257(1.519, 6.985) | 3.639(1.666, 7.947) |

@Unadjusted model; #Adjusted for gender, ethnicity, educational level, marital status, BMI, family history of hypertension; &Further Adjusted for smoking, physical activity, diabetes, dyslipidemia; &p<0.05; OR: Odds Ratio; 95%CI: 95% confidence interval

### Figures

![Figure 1](image-url)
Interactive Association of Sodium Intake and Drinking with Hypertension.

Figure 1

Interactive Association of Sodium Intake and Drinking with Hypertension.

Figure 2

The Simple Effect of Drinking or Sodium Intake with Hypertension. A. Association of Drinking with Hypertension per Status of Sodium Intake. B. Association of Sodium Intake with Hypertension per Status of Drinking.
Figure 2

The Simple Effect of Drinking or Sodium Intake with Hypertension. A. Association of Drinking with Hypertension per Status of Sodium Intake. B. Association of Sodium Intake with Hypertension per Status of Drinking.

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