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Association between socioeconomic status and hypertension among adults in Fujian province and the mediating effect of BMI and cooking salt intake: a cross-sectional study

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ABSTRACT

Objectives This study aimed to investigate the association between socioeconomic status (SES) and the prevalence of hypertension in Fujian province, China, and to evaluate the mediating effect of body mass index (BMI) and cooking salt intake between SES and hypertension.

Design Community-based cross-sectional survey was conducted between June 2018 and December 2019.

Setting Fujian province, China.

Participants A total of 26 500 participants aged >18 years completed the survey.

Outcome measures The primary outcome was the prevalence of hypertension. Education, income and occupation were used as SES indicators. Meanwhile, certain health behaviours and metabolic risk factors were used as secondary indicators of SES.

Results The prevalence of hypertension was relatively high among participants who finished primary education (34.8%), had the lowest annual income (46.0%), were unemployed or retired (34.7%). Education and income levels were negatively associated with the prevalence of hypertension ($p<0.05$). Regular smoking, alcohol consumption, BMI and high cooking salt intake were also significantly associated with the prevalence of hypertension ($p<0.05$). Cooking salt intake was identified as a partial mediator between income and hypertension, mediating 3.45% of the association. Both BMI and cooking salt intake were partial mediators between education and hypertension, mediating 5.23% and 1.93% of the association, respectively.

Conclusions SES was associated with the prevalence of hypertension among adults in Fujian province, China. BMI and cooking salt intake were partial mediators of the association between SES and hypertension.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The data used in the study were obtained from a large survey conducted in Fujian province.
⇒ Mediation analyses were employed to assess the mediating effect of body mass index and cooking salt intake between socioeconomic status (SES) and hypertension.
⇒ The recall bias of study participants may affect the accuracy of the results.
⇒ We only evaluated the cooking salt intake of the participants. Dietary sodium intake is more accurate to explain the correlation between SES and hypertension.

INTRODUCTION

Hypertension is the most common risk factor for cardiovascular diseases and the leading cause of all-cause mortality and disability worldwide.[1] Elevated blood pressure accounted for 19.2% of all deaths and 9.3% of disability-adjusted life-years.[2] Due to an ageing population and increased exposure to unhealthy lifestyles, the prevalence of hypertension has markedly increased worldwide. Approximately 1.28 billion adults aged 30–79 years worldwide have hypertension, two-thirds of whom live in low-income and middle-income countries.[3] In the past decades, China has experienced a notable increase in the prevalence of hypertension, from 5.1% in 1958–1959 to 38.1% in 2018.[4] This escalation underscores hypertension as a critical public health concern, affecting individual health and imposing substantial societal and economic costs. The clarification of the risk factors for hypertension is deemed crucial, as it may be beneficial for establishing valid preventive measures to curb the development of hypertension and its progressive effects.

Socioeconomic status (SES) is a system of social stratification derived from access to material and social resources. It is indirectly measured by class, prestige, occupation and/or educational level.[5] Existing studies have indicated that demographic factors (eg, age or sex), socioeconomic factors (eg, income, marital status and education) and health behaviours (smoking, drinking, etc) are well-known risk factors for hypertension.[6 7] Although extensive studies have examined the correlation between SES and hypertension, varying outcomes have been documented. Some studies have demonstrated an association between low SES and a high prevalence of hypertension.[8] However, a study conducted in Kenya found a high prevalence of hypertension among the wealthiest urban individuals.[9] China has experienced substantial economic growth and societal development in recent decades. Accordingly, dramatic changes have occurred in the economic and social structures, affecting the lifestyle and health of the population. Fujian province, located in the southeastern coastal area of China, is a developed province with a gross domestic product exceeding 4 trillion. Owing to its coastal location and traditional customs, Fujian residents adopt a distinctive lifestyle and diet, known as the eastern healthy diet pattern in the Dietary Guidelines for Chinese Residents of 2022.[10] Their diet encompasses a variety of vegetables, fruits and seafood, with a preference for a light and low-salt dietary approach. Additionally, foods are cooked by steaming and poaching. All of these factors may affect the prevalence of chronic diseases such as hypertension.

Higher body mass index (BMI) emerges as a significant contributor to adverse health outcomes. Epidemiological studies have shown a strong association between obesity and hypertension.[11] Obesity accounts for approximately 75% of the risk associated with hypertension.[12] For every 1 kg/m^2 increase in BMI, the odds of developing hypertension increased by 23% among men and 35% among women.[13] Higher sodium intake is another risk factor for hypertension. Numerous studies have thoroughly documented the positive association between sodium intake and blood pressure.[14 15] Individuals exceeding the recommended daily sodium intake level of 2 g/day may have an increased risk of developing hypertension. Individuals with low SES are prone to adopting an unhealthy diet characterised by the consumption of highly processed foods, typically rich in both energy and sodium content. This dietary pattern contributes to an increased risk of higher BMI and excessive dietary sodium intake.[16 17] In China, the primary source of dietary sodium is the salt added during cooking.[18] To better understand the interplay between SES, BMI, cooking salt intake and hypertension, it is necessary to conduct mediation analyses and clarify their relationship. Knowledge of this topic may help in comprehending the pathways to hypertension and developing prevention and intervention programmes to curb the hypertension epidemic.

In this study, we aimed to investigate the prevalence of hypertension in participants aged >18 years in Fujian province and evaluate its association with SES. Furthermore, mediation analyses were conducted to examine the mediating effects of BMI and cooking salt intake on the association between SES and hypertension.

METHODS

Study population

A community-based cross-sectional survey was conducted in Fujian province between June 2018 and December 2019. The study participants were recruited using a multistage sampling approach. Sixteen districts were randomly selected for this study. From each selected district, six administrative streets were randomly chosen using probability proportional to size. From each selected administrative street, 3 communities with 750–1500 households were randomly selected using the aforementioned sampling method. A total of 100 households were selected from each community. One person was selected from each household using Kish grid sampling. Individuals aged >18 years, residing for more than 6 months in the study setting, were eligible to participate. Pregnant women and those with mental or language disorders were excluded. In total, 28 800 participants were recruited for this study. The sample size was calculated based on the prevalence of hypertension in Fujian province in 2018, which was approximately 20.1%.[19] The calculation aimed to achieve a 90% power and a 5% significance level. The following formula was employed for the sample size calculation: $n = deff\frac{u_\alpha^2 p(1-p)}{\delta^2}$, where p denotes the prevalence of hypertension (20.1%), u_α is set to $u_{0.05}$ (1.96), and *deff* is equal to 3, with a relative error of 10% (δ=0.1×p). Considering the stratified sampling by community and gender and a 15% non-response rate, the sample size was calculated to be 21 558.

Study measurement

The study was conducted based on the WHO STEPwise approach to chronic disease risk factor surveillance with slight modifications and included a questionnaire survey and anthropometric measurements. A standard questionnaire was designed based on the China Adult Chronic Disease and Nutrition Surveillance questionnaire with minor adjustments.[20] This instrument included questions related to the respondent's baseline characteristics (age, sex, marital status, nationality, region and residence), SES (education, occupation and income) and health behaviours (smoking, alcohol consumption and diet). Trained investigators conducted face-to-face household interviews. The investigators provided the participants with a thorough explanation of the study and standardised instructions before questionnaire completion. The questionnaires were assessed regularly. If any missing information was identified, additional information was collected by calling the phone number provided by the participants or by conducting an additional visit to the participant's residence.

Dietary intake was assessed by conducting three consecutive 24 hours dietary recalls in each participant, along with measuring and documenting the amount of salt and oil used in each household. At the commencement and conclusion of the initial 24 hours dietary recall, the quantities of cooking salt, oil and food waste were weighed and recorded, respectively. The intake of cooking salt and oil among individuals of each household was estimated based on their respective share of the total energy consumed.[21 22] In this study, cooking salt was the only salt added during cooking, excluding other condiments such as soy sauce or monosodium glutamate.

The anthropometric parameters included height, weight, waist circumference (WC) and blood pressure. All measurements were conducted by well-trained investigators using standardised instruments and procedures. Height and weight were measured with a standardised scale (RGZ-120, Suhong, China), which was calibrated using a calibration rod and weight, with measurement errors of 0.1 cm and 0.1 kg. The scale was placed on a horizontal, hard floor surface. The participants, wearing light clothing with no shoes, stood in an upright position with their heels together, arms to the side, legs straight, shoulders relaxed and head positioned in the Frankfurt plane. BMI was calculated by dividing body weight in kilograms by height in metres squared. WC was measured to the nearest 0.1 cm at the iliac crest using a constant-tension tape with the participants placed in a standing position. The tape was calibrated using a calibration rod before use.[23 24]

Blood pressure was measured following a standard protocol.[25] Measurements were taken in the right arm using an appropriately sized cuff while the participant was seated, following a 5 min rest. Three readings were obtained using a mercury sphygmomanometer (Yuwell, China). The average of the second and third measurements was calculated to record systolic and diastolic blood pressures for the analysis. The sphygmomanometer was calibrated by directly comparing it with a newly calibrated and accurate mercury sphygmomanometer, with a measurement error of ≤3 mm Hg.[26]

Outcome: prevalence of hypertension

The primary outcome of this study was the prevalence of hypertension. Hypertension was defined as a systolic blood pressure of ≥140 mm Hg or a diastolic blood pressure of ≥90 mm Hg measured on two separate occasions, or self-reported use of antihypertensive medications, and/or a previous diagnosis of this condition by a healthcare provider.[27]

SES variables

Education, income and occupation were the commonly used indicators of SES. Education level was divided into four categories: primary school, middle school, high school or secondary school and college or higher. Income was stratified into five levels according to the annual income: lowest (<¥10 000), lower (¥10 000–¥30 000), mid-low (¥30 000–¥80 000), mid-high (¥80 000–¥150 000) and high (≥150 000). Occupation was divided into six categories: production personnel, equipment operators, business or service staff, office workers, other workers and unemployed or retired people. Marital status was classified as unmarried, married or living with a partner and divorced or windowed.

Variables related to health behaviours and metabolic risk factors were also collected. Health behaviours included alcohol consumption, smoking, and cooking salt and oil intake. Current alcohol consumption was defined as alcohol intake of more than once per week in the past 2 months. According to smoking status, the participants were classified as former, occasional, regular and never-smokers. Former smokers were defined as individuals who had habitually smoked in the past but had stopped smoking for at least 1 month before the survey. Occasional smokers were defined as individuals who currently smoked, but did not smoke daily or on most days. Regular smokers were defined as individuals who smoked daily or on most days. High cooking salt intake was defined as more than 6 g/day of salt used during cooking. Oil intake was classified as consumption of less than 25 g of oil per day, 25–45 g per day or more than 45 g per day. The metabolic risk factors included BMI and abdominal obesity. Based on BMI, the participants were categorised as underweight (<18.5 kg/m^2), normal weight (18.5–23.9 kg/m^2), overweight (24.0–27.9 kg/m^2) and obese (≥28.0 kg/m^2).[28] Participants were defined as having abdominal obesity if the WC values were ≥90 cm for men and ≥85 cm for women.[29]

Statistical analysis

Continuous variables were expressed as the mean±SD, while categorical variables were expressed as numbers and frequencies. Comparisons across groups were carried out using unpaired Student's t-test for continuous variables and χ^2 test for categorical variables. Multiple logistic regression analysis was used to investigate the association between SES indicators and the prevalence of hypertension.

Mediation analyses were conducted using the PROCESS macro software (V.3.3) for SPSS to investigate the mediating effect of BMI and cooking salt intake between SES and hypertension. Mediation occurs when an independent variable (X) influences a dependent variable (Y) through mediator(s) (M). The effect of X on M is expressed as path a, while the effect of M on Y is expressed as path b after controlling for the effect of X. Path c' represents the direct effect of X on Y. The indirect effect of X on Y through M is the product of a and b (ie, a×b). The total effect of X on Y is the sum of the indirect effect and direct effect (ie, c=a×b+c' for a single mediator model and $c=a_1 \times b_1 + a_2 \times b_2 + c'$ for a two multiple mediator model). The mediated (indirect) effect was analysed using a non-parametric bootstrapping procedure (n=5000 samples), which estimated the sampling distribution of the indirect effect and the corresponding bias-corrected and accelerated 95% CI.[30] Indirect effects were considered significant when the 95% CI did not include zero. All analyses were conducted by using SPSS V.23.0. A p<0.05 was considered significant.

Table 1 Characteristics and prevalence of hypertension of the recruited study participants

Characteristics	Sample n	Sample %	Prevalence of hypertension n	Prevalence of hypertension %	P value
Sociodemographic variables					
Sex					
Male	11 865	44.8	3566	30.1	<0.001
Female	14 635	55.2	3966	27.1	
Age (years)					
15–29	1547	5.8	65	4.2	<0.001
30–39	2892	10.9	200	6.9	
40–49	5413	20.4	1001	18.5	
50–59	7032	26.5	2038	29.0	
60–69	5972	22.5	2350	39.4	
≥70	3644	13.8	1878	51.5	
Marital status					
Unmarried	1358	5.1	180	13.3	<0.001
Married or living with a partner	22 809	86.1	6242	27.4	
Divorced or widowed	2333	8.8	1110	47.6	
Socioeconomic variables					
Education					
Primary school or below	15 769	59.5	5482	34.8	<0.001
Middle school	5655	34.3	1277	22.6	
High school or secondary school	2652	10.0	560	21.1	
College or higher	2423	9.1	213	8.8	
Occupation					
Production personnel	8755	33.0	2631	30.1	<0.001
Equipment operator	833	3.1	188	22.6	
Business or service staff	1730	6.5	295	17.1	
Office worker	2636	9.9	373	14.2	
Other workers	2822	10.6	671	23.8	
Unemployed/retired people	9724	36.7	3374	34.7	
Annual income (yuan)					
<¥10 000	1151	8.6	530	46.0	
¥10 000~	3027	22.7	1014	33.5	
¥30 000~	5780	43.3	1573	27.2	
¥80 000~	2423	18.2	547	22.6	
≥¥150 000	953	7.1	224	23.5	
Health insurance					
No insurance	490	1.8	112	22.9	<0.001
Urban Employee Basic Medical Insurance	3243	12.2	657	20.3	
Urban-Rural Resident Basic Medical Insurance	22 349	84.3	6677	29.9	
Others	418	1.6	86	20.6	
Weight status variables					
BMI					
Underweight	1148	4.3	226	19.7	<0.001
Normal	14 183	53.5	3236	22.8	
Overweight	8655	32.7	2972	34.3	

Continued

Table 1 Continued

Characteristics	Sample n	Sample %	Prevalence of hypertension n	Prevalence of hypertension %	P value
Obesity	2514	9.5	1098	43.7	
Abdominal obesity					
Yes	7875	29.7	3261	41.4	<0.001
No	18625	70.3	4271	22.9	
Community variables					
Residence					
Rural	18549	70.0	5469	29.5	<0.001
Urban	7951	30.0	2063	25.9	
Regions					
Siming district	1601	6.0	210	13.1	<0.001
Fuqing city	1596	6.0	551	34.5	
Yongding district	2534	9.6	808	31.9	
Changtai district	1179	4.4	212	18.0	
Xinluo district	1895	7.2	110	5.8	
Wuping country	1618	6.1	741	45.8	
Xiapu country	1614	6.1	508	31.5	
Zherong country	1507	5.7	315	20.9	
Anxi country	1616	6.1	504	31.2	
Datian country	1618	6.1	576	35.6	
Dongshan country	1607	6.1	267	16.6	
Guangze country	1632	6.2	476	29.2	
Jiangle country	1623	6.1	415	25.6	
Minhou country	1619	6.1	602	37.2	
Youxi country	1623	6.1	561	34.6	
Zhangpu country	1618	6.1	413	25.5	

Patient and public involvement

The patients and general public were not involved in the study design. The participants were invited to participate in interviews, where their blood pressure and BMI values were discussed. Additionally, handouts related to the prevention and control of hypertension were provided. The findings of this study will be disseminated through open-access publications. The public and the study participants were not involved in the data analysis or writing of the manuscript.

RESULTS

Characteristics of study participants

Of the 28800 participants, 26500 were included in the analysis after excluding those who did not respond (n=2017) or had missing or incorrect data (n=283). This study obtained a response rate of 92.01%. Most of the study participants were women (55.2%), aged 40–69 years (69.5%), were married or living with a partner (86.1%), finished primary school or below (59.5%) and were living in rural areas (70.0%). Furthermore, 42.7% of the participants were manual labourers, and 84.3% had Urban-Rural Resident Basic Medical Insurance.

Prevalence of hypertension

Table 1 presents the prevalence of hypertension according to the sociodemographic and socioeconomic characteristics. The overall prevalence of hypertension was 28.4%, with a higher rate in men than in women (30.1% vs 27.1%, respectively). Notably, individuals who were divorced or widowed (47.6%), unemployed or retired (34.7%) and living in rural areas (29.5%) exhibited a higher prevalence of hypertension. The prevalence of hypertension demonstrated a linear increase with age, peaking at the age of ≥70 years. Education and income showed a stronger association with the prevalence of hypertension, with the rate decreasing as the levels of these variables increased. Additionally, the prevalence of hypertension significantly increased with increasing BMI. Participants with abdominal obesity had a higher prevalence of hypertension (41.4%). Moreover, the prevalence of hypertension was highest in Wuping country (45.8%) and lowest in Xinluo district (5.8%).

Table 2 Multiple logistic regression analysis of factors affecting the prevalence of hypertension of residents in Fujian province

Parameters	OR	95% CI	P value	Adjusted OR	95% CI	P value
Sociodemographic variables						
Female (Ref: male)	0.82	0.76 to 0.88	p<0.01	0.73	0.65 to 0.82	<0.01
Age (Ref: 15–29)						
30–39	1.54	1.01 to 2.35	p<0.05	1.58	1.02 to 2.47	<0.05
40–49	4.71	3.21 to 6.92	p<0.01	4.18	2.76 to 6.32	<0.01
50–59	8.29	5.67 to 12.12	p<0.01	6.82	4.51 to 10.31	<0.01
60–69	13.08	8.93 to 19.14	p<0.01	10.38	6.82 to 15.81	<0.01
≥70	21.57	14.64 to 31.78	p<0.01	15.90	10.34 to 24.46	<0.01
Marital status (Ref: unmarried)						
Married or living with partner	1.79	1.41 to 2.26	p<0.01	0.75	0.56 to 0.99	<0.05
Divorced or widowed	4.01	3.08 to 5.22	p<0.01	0.96	0.70 to 1.32	
Community variables						
Residence (Ref: urban)						
Rural	1.10	1.01 to 1.20	p<0.05	1.24	1.13 to 1.37	<0.01
Socioeconomic variables						
Education (Ref: primary school or below)						
Middle school	0.61	0.55 to 0.66	p<0.01	0.89	0.80 to 0.98	<0.05
High school or secondary school	0.63	0.56 to 0.71	p<0.01	0.87	0.76 to 1.00	<0.05
College or higher	0.28	0.23 to 0.33	p<0.01	0.74	0.60 to 0.90	<0.01
Occupation (Ref: production personnel)						
Equipment operator	0.76	0.62 to 0.93	p<0.01	1.10	0.88 to 1.36	
Business or service staff	0.60	0.51 to 0.72	p<0.01	1.03	0.85 to 1.24	
Office worker	0.49	0.43 to 0.57	p<0.01	0.97	0.80 to 1.17	
Other workers	0.82	0.72 to 0.94	p<0.01	1.08	0.93 to 1.24	
Unemployed/retired people	1.39	1.27 to 1.51	p<0.01	1.30	1.18 to 1.44	<0.01
Annual income (yuan) (Ref: <¥10 000)						
¥10 000~	0.59	0.51 to 0.68	p<0.01	0.83	0.72 to 0.97	<0.05
¥30 000~	0.44	0.39 to 0.50	p<0.01	0.78	0.67 to 0.90	<0.05
¥80 000~	0.34	0.30 to 0.40	p<0.01	0.72	0.61 to 0.86	<0.01
>¥150 000	0.36	0.30 to 0.44	p<0.01	0.80	0.64 to 0.99	<0.05
Health behaviours						
Smoke (Ref: < never)						
Former	1.56	1.36 to 1.79	p<0.01	1.00	0.85 to 1.18	
Occasional	0.98	0.77 to 1.25		0.94	0.72 to 1.23	
Regular	1.01	0.92 to 1.10		0.85	0.75 to 0.96	<0.05
Alcohol (Ref: < no)						
Yes	1.06	0.98 to 1.14		1.31	1.19 to 1.43	<0.01
Oil intake per day (g) (Ref: < 25)						
25–45	1.19	1.09 to 1.30	p<0.01	1.10	0.99 to 1.21	
>45	1.26	1.14 to 1.40	p<0.01	1.11	0.99 to 1.24	
Cooking salt intake per day (Ref: ≤ 6)						
>6	1.34	1.24 to 1.44	p<0.01	1.10	1.02 to 1.19	<0.05
Metabolic risk factor						
Body mass index (Ref: normal)						
Underweight	0.76	0.60 to 0.96	p<0.05	0.75	0.59 to 0.97	<0.05

Continued

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Table 2 Continued

Parameters	OR	95% CI	P value	Adjusted OR	95% CI	P value
Overweight	1.78	1.64 to 1.94	p<0.01	1.41	1.28 to 1.56	<0.01
Obesity	2.75	2.44 to 3.11	p<0.01	1.91	1.63 to 2.23	<0.01
Abdominal obesity (Ref: < no)						
Yes	2.45	2.26 to 2.65	p<0.05	1.65	1.49 to 1.84	<0.01

Association between SES and the prevalence of hypertension

Table 2 shows the relationship between SES and hypertension. After adjusting for potential confounding factors, the OR for developing hypertension significantly increased with age. People living in rural areas were more likely to develop hypertension (OR 1.24, 95% CI 1.13 to 1.37) compared with those living in urban areas. The ORs for developing hypertension among individuals who completed middle school, high school or secondary school and college or higher were 0.89 (95% CI 0.80 to 0.98), 0.87 (95% CI 0.76 to 1.00) and 0.74 (95% CI 0.60 to 0.90), respectively. Individuals who were unemployed or retired had a higher risk of developing hypertension (OR 1.30, 95% CI 1.18 to 1.44). The ORs for developing hypertension among individuals with low, mid-low, mid-high and high-income levels were 0.83 (95% CI 0.72 to 0.97), 0.78 (95% CI 0.67 to 0.90), 0.72 (95% CI 0.61 to 0.86) and 0.80 (95% CI 0.64 to 0.99), respectively. Individuals with alcohol consumption and high cooking salt intake (>6 g) were more likely to develop hypertension. The metabolic risk factors for overweight, obesity and abdominal obesity were positively associated with hypertension. However, the ORs for undernutrition and smoking were 0.75 (95% CI 0.59 to 0.97) and 0.85 (95% CI 0.75 to 0.96), respectively, indicating a negative association with the prevalence of hypertension. No association was found between the intake of cooking oil and the prevalence of hypertension. No association was also observed between the intake of saturated fatty acids, monounsaturated acids and polyunsaturated fatty acids from cooking oil and the prevalence of hypertension (online supplemental appendix table 1).

Mediation analyses

Tables 3 and 4 present the results of the single-mediator analyses examining the influence of BMI and cooking salt intake on the association between income/education and hypertension. Income had a significant total effect (path c) on hypertension (table 3). Individuals with less income were more likely to develop hypertension (β: −0.058, 95% CI −0.089 to −0.026). Income had a significant effect on cooking salt intake but not on BMI (path a). Income was negatively associated with cooking salt intake (β: −0.092, 95% CI −0.133 to −0.051). BMI (β: 0.113, 95% CI 0.100 to 0.126) and cooking salt intake (β: 0.020, 95% CI 0.010 to 0.031) were positively associated with hypertension (path b). However, only cooking salt intake showed a significant indirect effect (β: −0.002, 95% CI −0.003 to −0.001). As the direct effect of cooking salt intake was also significant (β: −0.054, 95% CI −0.104 to −0.003), cooking salt intake was recognised as a partial mediator between income and hypertension, accounting for 3.45% of the association (figure 1A).

Education had a significant total effect (path c) on hypertension (table 4), indicating that individuals with lower education levels were more likely to develop hypertension (β: −0.363, 95% CI −0.407 to −0.320). Education had a significant effect on BMI and cooking salt intake (path a). Education was negatively associated with BMI (β: −0.169, 95% CI −0.229 to −0.108) and cooking salt intake (β: −0.053, 95% CI −0.615 to −0.447). BMI (β: 0.111, 95% CI 0.098 to 0.124) and cooking salt intake (β: 0.014, 95% CI 0.004 to 0.023) were positively associated with hypertension (path b). Both BMI (β: −0.019, 95% CI −0.025 to −0.012) and cooking salt intake (β: −0.008,

Table 3 The single mediator model of BMI and cooking salt intake between income and hypertension

	Income effect on mediator (path a，X M)			Mediator effect on hypertension (path b, M Y)			Direct effect (path c'-X Y_{adjM})			Indirect effect (a×b XMY)		
Total effect (path c) (95% CI) −0.058 (−0.089 to −0.026); p<0.01												
Mediators	β	95% CI	P value	β	95% CI	P value	β	95% CI	P value	β	95% CI	P value
BMI	0.019	(−0.008 to 0.046)	0.164	0.113	(0.100 to 0.126)	<0.01	−0.060	(−0.091 to −0.028)	<0.01	0.002	(−0.001 to 0.005)	0.196
Cooking salt intake	−0.092	(−0.133 to −0.051)	<0.01	0.020	(0.010 to 0.031)	<0.01	−0.054	(−0.104 to −0.003)	<0.05	−0.002	(−0.003 to −0.001)	<0.05

Path a, association between income and the mediator; path b, association between mediator and hypertension adjusted for income; total effect, unadjusted association between income and hypertension; direct effect, association between income and hypertension adjusted for the mediator; indirect effect, product of path a and path b (bootstrapping, 5000 samples). X, predictor (income); Y, outcome (hypertension); M, potential mediator, β, unstandardised regression coefficient.

BMI, body mass index.

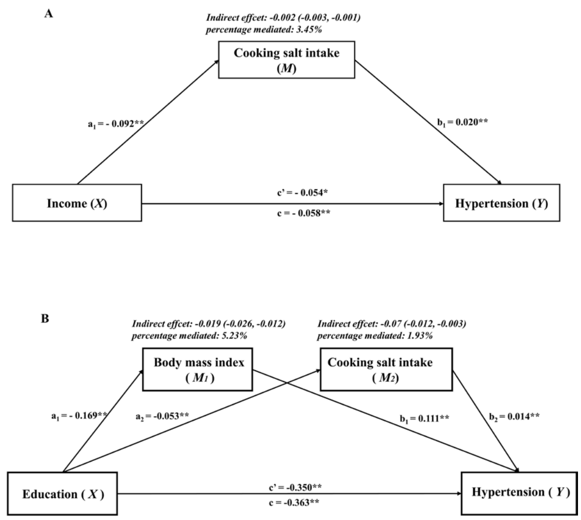

Figure 1 The mediating effect of body mass index (BMI) and cooking salt intake on the association between income/education and hypertension. (A) The mediating effect of cooking salt intake on the association between income and hypertension. (B) The mediating effect of BMI and cooking salt intake on the association between education and hypertension (multiple mediator model). a, effect of X on M; b, effect of M on Y controlling for the effect of X; c', direct effect of X on Y; c, total effect of X on Y (sum of the indirect effect and direct effect; c=a×b+c'). *p<0.05, **p<0.01.

95% CI −0.012 to −0.003) showed an indirect effect. A significant direct effect was also detected (BMI=β: −0.358, 95% CI −0.402 to −0.313; cooking salt intake=β: −0.356, 95% CI −0.400 to −0.312). Therefore, BMI and cooking salt intake were recognised as partial mediators between education and hypertension. BMI mediated 5.23% and cooking salt intake mediated 1.93% of the association between education level and hypertension (figure 1B).

DISCUSSION

This study investigated the association between SES and the prevalence of hypertension among people in Fujian province. Education, annual income, unemployment status, health behaviours and metabolic risk factors were significantly associated with the prevalence of hypertension.

Several studies have identified a positive correlation between SES and health status.[8 31 32] Individuals with low SES are more likely to adopt unhealthy lifestyle behaviours, such as cigarette use, excessive alcohol consumption, poor dietary habits and inadequate physical activity. They experience greater socioeconomic pressure and limited access to healthcare. All of these factors may contribute to a high risk of developing diseases, especially chronic conditions, including hypertension. Education serves as a widely recognised indicator of SES. The level of education is a determinant of an individual's social status and influences the likelihood of securing a particular occupation and attaining a certain level of income. Our results indicated that education was strongly associated with the prevalence of hypertension. Individuals with higher educational levels were less likely to develop hypertension. Numerous studies have consistently affirmed the link between education and hypertension.[33–35] In a study conducted in Thailand, Vathesatogkit *et al* demonstrated a significant risk reduction in hypertension incidence with higher education levels.[33] Liu *et al* reported that people who completed middle school education had a 53.5% higher risk of developing hypertension than those who completed college education.[34] Individuals with higher educational levels tend to be more knowledgeable about hypertension and have a better understanding of blood pressure health, leading to the adoption of a healthier lifestyle. Similarly, our study revealed a negative association between income and the prevalence of hypertension. Individuals with mid-high income levels had the lowest prevalence of hypertension, while those with the lowest income levels had the highest prevalence. Improved economic conditions are generally believed to be beneficial to health. O' Donnell *et al* found that the prevalence of hypertension increased with a decrease in individual patient wealth.[36] Globally, the prevalence of

Table 4 The single mediator model of BMI and cooking salt intake between education and hypertension

	Education effect on mediator (path a，X M)			Mediator effect on hypertension (path b, M Y)			Direct effect (path c'-X Y_{adjM})			Indirect effect (a×b XMY)		
Total effect (path c) (95% CI) −0.363 (−0.407 to −0.320); p<0.01												
Mediators	β	95%CI	P value	β	95%CI	P value	β	95%CI	P value	β	95%CI	P value
BMI	−0.169	(−0.229 to −0.108)	<0.01	0.111	(0.098 to 0.124)	<0.01	−0.358	(−0.402 to −0.313)	<0.01	−0.019	(−0.025 to −0.012)	<0.01
Cooking salt intake	−0.053	(−0.615 to −0.447)	<0.01	0.014	(0.004 to 0.023)	<0.01	−0.356	(−0.400 to −0.312)	<0.01	−0.008	(−0.012 to −0.003)	<0.01

Path a, association between education and the mediator; path b, association between mediator and hypertension adjusted for education; total effect, unadjusted association between education and hypertension; direct effect, association between education and hypertension adjusted for the mediator; indirect effect, product of path a and path b (bootstrapping, 5000 samples). X, predictor (education); Y, outcome (hypertension); M, potential mediator, β, unstandardised regression coefficient.
BMI, body mass index.

hypertension is highest in low-income countries and declines in high-income countries.[37] In addition to improved living and working conditions, individuals with higher income levels are more likely to have greater access to advanced healthcare and hypertension management and increased affordability of medications.

In terms of occupational status, individuals employed as office workers, business workers or service staff had a lower prevalence of hypertension compared with manual labourers. Retired and unemployed individuals were at higher risk of hypertension. Similar results were reported in Qin *et al*'s study.[38] Considering that the average retirement age in China is approximately 55 years, individuals aged 55–60 years are particularly susceptible to developing hypertension due to ageing and structural and functional changes in blood vessels. Unemployed individuals are more susceptible to depression and anxiety, and usually experience disrupted circadian rhythms, contributing to a higher risk of hypertension.

Our study showed that individuals who consumed alcohol and maintained a high-salt diet had a higher prevalence of hypertension. These findings aligned with those of previous studies, highlighting that the risk of developing hypertension doubled among individuals consuming three or more alcoholic drinks per day.[39] Alcohol and high-salt diet have been identified as risk factors for hypertension.[40 41] We also found that high BMI and abdominal obesity were positively associated with hypertension. The overactivation of the sympathetic nervous system during obesity is considered a significant contributor to the development of hypertension.[42] The risk of developing hypertension increased by 3.47-fold and 2.12-fold in obese and overweight individuals, respectively.[34]

Our mediation analysis indicated that BMI partially mediated the association between education and hypertension, which aligned with the findings of previous epidemiological and Mendelian randomisation studies.[43 44] Individuals with low SES are more prone to having a high BMI due to increased access to energy-dense diets, less leisure time and decreased physical activity. High BMI may increase blood cholesterol levels, leading to hypertension.[45] This mediation role of BMI between education and hypertension was also identified in Wang *et al*'s study.[44] Our results indicated that cooking salt intake played a mediating role in the association between income, education and hypertension. Salt added during cooking is a major contributor to dietary salt in Chinese families, accounting for 63.6% of the dietary sodium intake.[18] The China Nutritional Transition Cohort Study indicated that people with low SES tended to consume higher amounts of cooking salt.[46] Excessive salt intake is associated with an increased risk of hypertension. Therefore, it is not difficult to understand cooking salt intake worked as the mediator between SES and hypertension. As this study is the first to examine the mediating effect of cooking salt intake on the relationship between SES and hypertension, further studies are required to validate and compare the results.

Strengths and limitations

A notable strength of the study was the large sample of participants from Fujian province. Various SES indicators were considered in the regression analysis. Mediation analyses were conducted to investigate the direct and indirect effects of SES on hypertension through BMI and cooking salt intake. Single-mediation analyses were performed to assess the effects of SES on hypertension via BMI and cooking salt intake, while multiple mediation analyses were conducted to compare the importance of these mediators. To the best of our knowledge, this study is the first to examine the mediating effects of BMI and cooking salt intake on the relationship between SES and hypertension.

Our study has several limitations. First, owing to the observational cross-sectional nature of this study, our results cannot infer a causal relationship between SES and hypertension. Second, the potential for recall bias among the study participants may have affected the accuracy of the results. Third, our evaluation focused solely on cooking salt intake. Dietary sodium intake is more accurate to explain the correlation between SES and hypertension. The preferred method for determining the dietary sodium intake in humans is through the measurement of 24 hours urinary sodium excretion. Unfortunately, measuring the 24 hours urinary sodium excretion in a large number of participants is not feasible. Additional studies are required at a later stage to verify this correlation. Furthermore, we only included BMI and cooking salt intake as mediators. More factors should be included in the mediation analyses.

CONCLUSION

Our study supported the hypothesis that SES was significantly associated with the prevalence of hypertension. BMI and cooking salt intake mediated the association between SES and hypertension.

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