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Estimation of salt intake assessed by 24-h urinary sodium level among adults speaking different dialects from the Chaoshan region of southern China

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Abstract

Objective: Dietary salt intake may vary depending on different lifestyles. We aimed to estimate the different salt intakes and evaluate the knowledge and self-awareness about salt among people speaking the Teochew, Teochew–Hakka and Hakka dialects in the Chaoshan region of southern China.

Design: The study followed a cluster sampling of residents in Chaoshan region. General characteristics, lifestyles, health status as well as knowledge and self-awareness related to salt intake were investigated using a questionnaire. Anthropometric variables as well as Na and K excretion in a 24-h urine collection were measured.

Setting: Chaoshan region of China.

Participants: Four hundred fifteen adults who spoke only one of these three dialects.

Results: The salt intake of adults who spoke the Teochew, Teochew–Hakka and Hakka dialects was 7·19 (interquartile range (IQR) 5·29–10·17), 9·03 (IQR 6·62–11·54) and 10·12 (IQR 7·61–12·82) g/d, respectively, with significant differences between Teochew and Teochew–Hakka speakers and between Teochew and Hakka speakers (both $P < 0{\cdot}05$). The Na:K ratio for adults who spoke the three dialects was 3·00 (IQR 2·00–4·11), 3·50 (IQR 2·64–4·82) and 4·52 (IQR 3·35–5·97), respectively, and differed significantly among the groups (all $P < 0{\cdot}05$). Multiple linear regression analysis showed increased Na:K ratio associated with hypertension ($\beta = 0{\cdot}71$, $P = 0{\cdot}043$) in Hakka speakers. Knowledge and self-awareness about salt intake were poor in this population.

Conclusions: Salt intake was closely related to lifestyles and was higher than the upper limit (5 g/d) recommended by the WHO in adults of Chaoshan, especially those speaking the Hakka dialect.

Keywords
Salt intake
Urinary Na excretion
24-h urinary collection
Knowledge
Self-awareness

CVD is the first leading cause of death in the world. As a major risk factor for CVD, hypertension contributed to 10·3 million deaths and 208 million disability-adjusted life years in 2013[1]. In 2013, almost 300 million Chinese adults had hypertension, which accounted for 2·5 million deaths and 15 % of total disability-adjusted life years[2,3].

Epidemiological and clinical studies showed that excessive salt consumption is positively associated with the incidence of hypertension[4,5]. Besides, salt consumption increases the relative risk of CHD[6,7], stroke[8] and gastric cancer[9]. In addition, a high dietary Na:K ratio could contribute to an increased risk of cardiovascular events[10]. In contrast, restricting salt intake can lower the blood pressure (BP) of hypertensive patients and also reduce the risk of hypertension and cardiovascular events[11]. Excessive salt

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intake was reported to be a modifiable determinant of hypertension. Reducing salt intake is well known to have many beneficial effects and is the most cost-efficient measure to prevent CVD[12–14]. An amount of 5 g/d is recommended by the WHO as the upper limit for daily salt intake[15]. Data available in China show that the average salt intake of residents ranges from 10 to 20 g/d[16–18], much higher than the WHO recommendation. However, evidence of daily salt intake among inhabitants in Chaoshan region is absent.

The Chaoshan region is located in the east of Guangdong Province in China, bordering the sea, which is one of the famous hometowns of overseas Chinese. Over hundreds of years, people from this area have emigrated and most of them still retain the customs and habits of their ancestors. People living in this region mainly speak the Teochew and Hakka dialects. Besides, they have distinct dietary habits compared with people in other regions of China[19,20]. However, due to cultural differences, the dietary habits and lifestyles of people speaking different dialects in this region differ widely.

It is hard to gather data on salt intake and salt-related knowledge, attitudes as well as behaviours of the population in this region. One reason for this lack of information is the difficulty in assessing salt intake. The gold standard for measuring Na and K excretion is 24-h urine collection[21,22]. However, such a measurement is challenging for researchers and for participants to comply with, often leading to a difficulty in its implementation[22].

The current study aimed to estimate the baseline salt intake and Na:K ratio as well as knowledge, attitudes and behaviours related to salt intake among adults speaking the Teochew and Hakka dialects in the Chaoshan region by 24-h urinary Na and K excretion to provide information for preventing hypertension and CVD.

Methods

Study population and sampling

On the basis of cluster random sampling, we randomly selected one sub-district each from Jinping, Longhu and Chenghai districts of Shantou city, where we could find the most representative and largest number of Teochew speakers. However, most of Teochew–Hakka and Hakka speakers mainly reside in the Jiexi district of Jieyang city, and that is the reason why we randomly selected two sub-districts from Teochew–Hakka speaking sub-districts and one from Hakka speaking sub-districts in the Jiexi district. The sample sizes of these three dialect groups were comparable. Subsequently, we investigated all residents in the selected sub-districts according to inclusion and exclusion criteria, and informed consent was obtained from March 2016 to June 2017. The response rate of these three dialects reached 89, 86 and 88 %, respectively.

All participants should be aged ≥18 years, of Han nationality and not immigrants; all had resided in the region for at least 10 years before this investigation. Whereas pregnant or breastfeeding females, very heavy manual workers, people who worked in high-temperature environments, professional athletes and people who used any diuretic drug for the last 2 weeks or had other severe diseases were excluded. A total of 506 participants aged 18–80 years were recruited in our study. During the collection and determination of 24-h urine samples, ninety-one participants were excluded; among them, fifty-seven had more than one urine sample not collected during the 24 h or the total volume of the 24-h urine sample was <500 ml; thirty-two had a creatinine level <4 mmol (female) or <6 mmol (male); and two had renal impairment. Finally, 415 participants were included in the analysis.

The required sample size was determined by assuming that the difference of mean salt intake between dialect groups was about 3 g/d[23] and their standard deviation of salt intake was equally 5·87 g/d[24]. Then a sample size of eighty-one participants in each group would be needed to detect a significant difference occurring with a two-sided $\alpha = 0{\cdot}05$ and $\beta = 0{\cdot}10$. Making a 20 % allowance of non-participation and incomplete samples, at least ninety-seven of each dialect group was needed.

Data collection and anthropometric measurements

All information was obtained using a questionnaire that included general characteristics (age, education, occupation, smoking, health status, etc.) as well as knowledge, attitudes and behaviours related to salt intake. We focused on the behaviour of salt usage, which included dietary characteristics and habits.

Anthropometric measurements including height, weight, waist and hip measurements and BP were taken following standardised methods. BMI (kg/m^2) was calculated based on height and weight. We measured BP using a mercury sphygmomanometer three times with an interval of at least 2 min in the same arm, and averages were calculated. Participants were defined as hypertensive if the measured systolic BP (SBP) was ≥140 mmHg and/or diastolic BP (DBP) was ≥90 mmHg, or if they self-reported the use of anti-hypertensive medications within 2 weeks[25].

Collection of 24-h urine sample

We collected 24-h urine samples after questionnaire administration and anthropometric measurements. We distributed a container (4 l) to each subject and taught them how to collect 24-h urine samples. In brief, 24-h urine sampling included the first urination in the morning and all other urinations until the first urination the next morning. Participants were asked to record the beginning and end time of urine collection and any missed urine collection during the 24-h period. The participants came to the community centre the next morning with the containers, and we measured and recorded the volumes of 24-h urine. A 3-ml urine sample from each participant was sent to the laboratory of First Affiliated Hospital of Shantou University Medical College for measuring Na, K and creatinine under freezing after homogenisation of the entire 24-h urine sample, and 20 ml urine was stored at −20°C in a refrigerator immediately. Urinary Na and K was determined using ion-selective electrodes, and urinary creatinine was determined by the Jaffe kinetic method; all analyses were performed with the Backman Coulter LX20 automatic analyser. A 1 mol urinary Na was equal to 58·42 g salt intake (salt (g) = mol Na × 23 × 2·54; 1 mol Na = 23 g Na; 1 g Na = 2·54 g NaCl)[21].

Statistical analysis

A database was established using Epidata 3·0, and data were analysed using SPSS 21·0 (SPSS Inc.). Shapiro–Wilk test was used to test the normality of distribution of continuous variables. Continuous variables were described as mean and SD (normally distributed data), or median and interquartile range (non-normally distributed data). Categorical variables were described with numbers and percentages or ratio. Student's t test and ANOVA (normally distributed data), or Mann–Whitney U test and Kruskal–Wallis H test (non-normally distributed data) were used for comparing 24-h urinary Na level or Na:K ratio in different groups. If ANOVA was statistically significant, the SNK test was used for a comparison between the two groups. χ^2 test was used to compare salt-related knowledge, attitudes and behaviours in different groups, and Spearman correlation was used to analyse the correlation between 24-h urinary Na level and BP. A multiple linear regression analysis was used to identify the risk factors of 24-h urinary Na level and Na:K ratio by dialect groups. Independent variables included in the models were age, sex (male, female), BMI, hypertension, family history of hypertension, education level (illiterate or primary school, middle school, above middle school), marital status (married, unmarried), smoking (non-smoker, former/current smoker), income (≤3000, >3000 Chinese Yuan/month) and waist–hip ratio (WHR). Two-sided tests were performed, and $P < 0·05$ was considered statistically significant.

Results

Basic characteristics

Among the 415 enrolled participants, 171 (41·2 %) spoke the Teochew dialect, 131 (31·6 %) the Teochew–Hakka dialect and 113 (27·2 %) the Hakka dialect. The mean age was 59·70 (SD 14·50) years. The general characteristics of participants are shown in Table 1. Hakka dialect speakers had higher WHR, BP and hypertension prevalence compared with Teochew dialect speakers (all $P < 0·05$).

24-h urinary sodium level and related indexes across participants speaking different dialects

The mean 24-h urinary Na and K and Na:K ratio was 149·88, 40·33 mmol and 3·48, respectively, and the mean daily salt intake was 8·76 g/d. The 24-h urinary Na level was higher for Hakka than Teochew speakers (173·28 *v.* 123·00 mmol; $P < 0·05$). In contrast, the mean 24-h urinary K level was lower for Hakka than Teochew speakers (36·00 *v.* 40·63 mmol; $P < 0·05$). The mean Na:K ratio was higher for Hakka than Teochew–Hakka and Teochew speakers (all $P < 0·001$) and was significantly higher for Teochew–Hakka than Teochew speakers ($P = 0·004$). The salt intake of adults who spoke the Teochew, Teochew–Hakka and Hakka dialects was 7·19 (interquartile range 5·29–10·17), 9·03 (interquartile range 6·62–11·54) and 10·12 (interquartile range 7·61–12·82) g/d, respectively, with significant differences between Teochew and Teochew–Hakka speakers and between Teochew and Hakka speakers (both $P < 0·05$). Besides, the daily salt intake in >85·0 % of participants was >5 g and for 36·4 % was >10 g. Only 14·0 % of

Table 1 General characteristics of participants speaking different dialects

	Total (*n* 415)		Teochew dialect (*n* 171)		Teochew–Hakka dialect (*n* 131)		Hakka dialect (*n* 113)		
Variable	Mean or *n*	SD or %	Mean or *n*	SD or %	Mean or *n*	SD or %	Mean or *n*	SD or %	*P*
Age (years)	59·70	14·50	56·42*	16·55	62·42	12·45	61·50	12·35	0·002
Height (cm)	157·52	7·92	157·71	7·44	157·78	7·99	156·93	8·55	0·714
Weight (kg)	59·47	10·95	58·54	10·25	59·22	9·99	61·15	12·80	0·305
BMI (kg/m^2)	23·99	4·23	23·53	3·76	23·82	3·85	24·89	5·14	0·113
WHR	0·89	0·07	0·88†	0·07	0·90	0·07	0·91	0·07	0·001
Systolic BP (mmHg)	130·39	17·11	125·92*†	17·23	131·63	16·62	135·71	15·82	<0·001
Diastolic BP (mmHg)	82·00	10·97	78·42†	10·34	81·41‡	10·56	88·12	9·78	<0·001
Hypertension	151	36·4	44	25·7	51	38·9	56	49·6	<0·001
Diabetes	42	10·1	15	8·8	15	11·5	12	10·6	0·731
Hyperlipidaemia	21	5·1	7	4·1	9	6·9	5	4·4	0·517
CHD	14	3·4	5	2·9	5	3·8	4	3·5	0·907

WHR, waist–hip ratio, BP, blood pressure.
**P* < 0·05, Teochew *v.* Teochew–Hakka speakers.
†*P* < 0·05, Teochew *v.* Hakka speakers.
‡*P* < 0·05, Teochew–Hakka *v.* Hakka speakers.

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Table 2 Comparison of 24-h urinary sodium and relative indexes for participants speaking different dialects

	Total (n 415)		Teochew dialect (n 171)		Teochew–Hakka dialect (n 131)		Hakka dialect (n 113)		
Variable	Mean or median or n	SD or IQR or %	Mean or median or n	SD or IQR or %	Mean or median or n	SD or IQR or %	Mean or median or n	SD or IQR or %	P
24-h urinary Na (mmol)	149·88	103·40–193·60	123·00*†	90·55–174·15	154·56	113·40–197·54	173·28	130·30–219·50	<0·001
24-h urinary K (mmol)	40·33	30·48–55·30	40·63†	30·60–59·80	43·12	33·80–54·90	36	27·25–51·25	0·035
24-h urinary creatinine (mmol)	7·78	6·37–9·82	7·24†	5·92–9·05	7·98‡	6·47–9·79	8·96	7·28–11·30	<0·001
Urinary volume (ml)	1949·91	696·6	1694·97	610·17	2251·49	702·42	1986·11	670·05	–
Salt intake (g/d)	8·76	6·04–11·31	7·19*†	5·29–10·17	9·03	6·62–11·54	10·12	7·61–12·82	<0·001
WHO maximum target (≤5 g/d)	54	13	33	19·3	10	7·6	11	9·7	
World's average intake (>10 g/d)	151	36·4	43	25·1	51	38·9	57	50·4	
Na:K ratio	3·48	2·50–4·88	3·00*†	2·00–4·11	3·50‡	2·64–4·82	4·52	3·35–5·97	<0·001
≤2	58	14	44	25·7	8	6·1	6	5·3	
2–3	92	22·2	44	25·7	39	29·8	9	8	
3–4	111	26·7	37	21·6	41	31·3	33	29·2	
4–5	59	14·2	21	12·3	14	10·7	24	21·2	
>5	95	22·9	25	14·6	29	22·1	41	36·3	
Na:creatinine ratio	18·93	13·90–23·68	17·08†	12·78–23·06	19·99	14·58–24·87	19·57	14·52–23·32	0·032
K:creatinine ratio	5·27	3·82–6·77	5·73*†	4·15–7·67	5·49	4·37–6·83	3·93	3·17–5·65	<0·001

IQR, interquartile range. *P < 0·05, Teochew *v.* Teochew–Hakka speakers.
†P < 0·05, Teochew compared with Hakka dialect adults.
‡P < 0·05, Teochew–Hakka compared with Hakka dialect adults.

the population had a Na:K ratio ≤2, and for 22·9 %, the ratio was >5 (Table 2).

Factors associated with 24-h urinary sodium level and sodium:potassium ratio

After adjusting for age, sex, BMI, education and income, 24-h urinary Na level was associated with SBP ($\beta = 1·01$, 95 % CI 0·30, 1·72, $P = 0·006$) and DBP ($\beta = 1·52$, 95 % CI 0·42, 2·61, $P = 0·007$) in Teochew, and SBP ($\beta = 0·96$, 95 % CI 0·07, 1·86, $P = 0·035$) in Teochew–Hakka. The Na:K ratio was associated with SBP ($\beta = 0·03$, 95 % CI 0·01, 0·06, $P = 0·002$) and DBP ($\beta = 0·04$, 95 % CI 0·01, 0·07, $P = 0·036$) in Teochew, and SBP ($\beta = 0·02$, 95 % CI 0·01, 0·04, $P = 0·036$) in Teochew–Hakka. However, hypertension was associated with the Na:K ratio ($\beta = 0·86$, 95 % CI 0·10, 1·61, $P = 0·026$) only in Hakka (Table 3).

A multiple linear regression analysis showed 24-h urinary Na level to be associated with age ($\beta = -1·00$, 95 % CI −1·77, −0·22, $P = 0·012$), BMI ($\beta = 4·60$, 95 % CI 1·40, 7·80, $P = 0·005$) and WHR ($\beta = 185·48$, 95 % CI 15·42, 355·54, $P = 0·033$) in Teochew, with income ($\beta = 34·18$, 95 % CI 1·85, 66·51, $P = 0·038$) in Teochew–Hakka and education ($\beta = -25·10$, 95 % CI −46·67, −3·54, $P = 0·023$) in Hakka. On the other hand, a higher Na:K ratio was associated with both hypertension ($\beta = 0·71$, 95 % CI 0·02, 1·40, $P = 0·043$) and smoking ($\beta = 0·90$, 95 % CI 0·07, 1·73, $P = 0·033$) in Hakka while with lower education ($\beta = -0·48$, 95 % CI −0·91, −0·05, $P = 0·028$) in Teochew (Table 4). BMI was weakly but positively correlated with both 24-h urinary Na level ($r_s = 0·244$, $P < 0·001$) and Na:K ratio ($r_s = 0·124$, $P = 0·011$). The 24-h urinary Na level was weakly but positively correlated with both SBP and DBP ($r_s = 0·215$, 0·258) as was Na:K ratio ($r_s = 0·238$, 0·276) (all $P < 0·001$) (see online supplementary material, Supplemental Fig. S1).

Knowledge, attitudes and behaviours related to salt intake

Only 16·6 % of the participants believed they consumed too much salt (data not shown). Among all participants, more than a half could not identify the relation between hypertension and high salt intake. Also, <13 % of participants paid attention to Na label on food packages, and nearly 21 % residents used a spoon to add salt when cooking. Approximately 50 % of participants aimed to reduce their salt intake. Significant differences were found in knowledge, attitudes and behaviours related to salt intake among different dialect speakers (all $P < 0·001$). Moreover, the consumption of fruits, pickled food, deli meat and seafood differed (all $P < 0·001$) (Table 5).

Discussion

We estimated salt intake and evaluated the knowledge and self-awareness about salt intake among people speaking

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Table 3 Associations of 24-h urinary sodium and sodium:potassium ratio with BP and prevalence of hypertension by multiple linear regressions

	24-h urinary Na						Na:K ratio					
	Teochew dialect		Teochew–Hakka		Hakka dialect		Teochew dialect		Teochew–Hakka		Hakka dialect	
Variable	β	95 % CI	β	95 % CI	β	95 % CI	β	95 % CI	β	95 % CI	β	95 % CI
SBP†	1·01*	0·30, 1·72	0·96*	0·07, 1·86	−0·21	−1·10, 0·67	0·03*	0·01, 0·06	0·02*	0·01, 0·04	0·02	−0·01, 0·04
DBP†	1·52*	0·42, 2·61	0·94	−0·41, 2·30	0·36	−1·03, 1·76	0·04*	0·01, 0·07	0·02	−0·01, 0·05	0·04	−0·01, 0·08
Hypertension†	11·37	−14·39, 37·13	23·91	−6·13, 53·95	−4·50	−31·69, 22·70	0·69	−0·10, 1·47	0·48	−0·12, 1·07	0·86*	0·10, 1·61

SBP, systolic blood pressure; DBP, diastolic blood pressure.
*$P < 0·05$.
†Adjusted for age, sex, BMI, education, income.

Table 4 Factors associated with 24-h urinary sodium and sodium:potassium ratio by multiple linear regressions

	24-h urinary Na						Na:K ratio					
	Teochew dialect		Teochew–Hakka		Hakka dialect		Teochew dialect		Teochew–Hakka		Hakka dialect	
Variable	β	95 % CI	β	95 % CI	β	95 % CI	β	95 % CI	β	95 % CI	β	95 % CI
Age	−1·00*	−1·77, −0·22	−0·81	−2·17, 0·56	−0·76	−2·06, 0·55	−0·02	−0·04, 0·01	−0·01	−0·04, 0·01	−0·03	−0·06, 0·01
Sex	−5·21	−35·96, 25·55	0·16	−45·70, 45·74	12·49	−25·20, 50·18	−0·36	−1·32, 0·59	0·19	−0·72, 1·10	0·05	−1·00, 1·09
BMI	4·60*	1·40, 7·80	1·42	−2·66, 5·50	−0·72	−3·44, 2·00	0·03	−0·07, 0·13	−0·03	−0·11, 0·06	−0·03	−0·11, 0·05
Hypertension	11·13	−14·51, 36·76	21·39	−9·22, 52·00	−6·54	−33·84, 20·76	0·69	−0·10, 1·49	0·45	−0·16, 1·05	0·71*	0·02, 1·40
Family history of hypertension	16·45	−10·34, 43·23	−26·28	−87·92, 35·36	−16·21	−59·07, 26·64	−0·48	−1·31, 0·35	−0·44	−1·66, 0·79	−0·91	−2·10, 0·27
Education	3·13	−10·76, 17·02)	−13·00	−36·09, 10·09	−25·10*	−46·67, −3·54	−0·48*	−0·91, −0·05	−0·31	−0·77, 0·15	−0·47	−1·07, 0·13
Marital status	−16·54	−43·36, 10·29	6·33	−47·34, 60·00	−8·59	−63·05, 45·88	0·22	−0·60, 1·06	−0·33	−1·40, 0·74	−0·16	−1·67, 1·34
Smoking	−13·23	−52·17, 25·71	−4·56	−49·81, 40·69	−0·62	−40·19, 38·95	0·26	−0·95, 1·46	0·25	−0·65, 1·15	0·90*	0·07, 1·73
Income	−9·29	−29·03, 10·46	34·18*	1·85, 66·51	−15·79	−66·05, 34·46	−0·17	−0·78, 0·44	0·42	−0·22, 1·07	−0·26	−1·65, 1·13
WHR	185·48*	15·42, 355·54	172·58	−60·39, 405·54	289·03	64·57, 513·50	−1·20	−6·46, 4·08	3·11	−1·52, 7·75	5·41	−0·80, 11·63

WHR, waist–hip ratio.
*$P < 0·05$.

Table 5 Knowledge, attitudes and behaviours related to salt intake in participants speaking different dialects

	Total		Teochew dialect		Teochew–Hakka		Hakka dialect		
Variable	*n*	%	*n*	%	*n*	%	*n*	%	*P*
Hypertension associated with high salt intake									<0·001
Yes	136	32·8	106	62·0	19	14·5	11	9·7	
No	279	67·2	65	38·0	112	85·5	102	90·3	
Distinguish high-salt foods									<0·001
More than two foods	120	28·8	81	47·4	15	11·4	14	12·4	
One or two foods	108	26·1	58	33·9	22	16·8	38	33·6	
Don't know	187	45·1	32	18·7	94	71·8	61	54·0	
Na label on food is beneficial									<0·001
Yes	69	16·6	53	31·0	6	4·6	10	8·8	
No	53	12·8	35	20·5	6	4·6	12	10·6	
Don't know	193	70·6	83	48·5	119	90·8	91	80·5	
Plan to reduce salt intake									<0·001
Yes	207	49·9	112	65·5	73	55·7	22	19·5	
No	208	50·1	59	34·5	58	44·3	91	80·5	
Buy low-Na salt									<0·001
Yes	167	40·2	98	57·3	33	25·2	36	31·9	
No	248	59·8	73	42·7	98	74·8	77	68·1	
Pay attention to Na label on food									<0·001
Yes	53	12·8	37	21·6	8	6·1	8	7·1	
No	362	87·2	134	78·4	123	93·9	105	92·9	
Use spoon to add salt when cooking									<0·001
Yes	87	21·0	58	33·9	9	6·9	20	17·7	
No	328	79·0	113	66·1	122	93·1	93	82·3	
Vegetables (times/week)									0·141
1–6	23	5·5	11	6·4	10	7·6	2	1·8	
≥7	392	94·5	160	93·6	121	92·4	111	98·2	
Fruits (times/week)									<0·001
≤1	117	28·2	13	7·6	46	35·1	58	51·3	
2–4	140	33·7	60	35·1	39	29·8	41	36·3	
≥5	158	38·1	98	57·3	46	35·1	14	12·4	
Pickled food (times/week)									<0·001
≤1	193	53·4	103	60·2	66	50·4	24	21·2	
2–4	116	34·2	56	32·7	34	26·0	26	23·0	
≥5	106	12·4	12	7·0	31	23·7	63	55·8	
Deli meat (times/week)									<0·001
≤1	250	60·2	76	44·4	69	52·7	105	92·5	
2–4	107	25·8	62	36·3	39	29·8	6	5·3	
≥5	58	14·0	33	19·3	23	17·5	2	1·8	
Seafood (times per week)									<0·001
≤1	227	54·7	42	24·6	74	56·5	111	98·2	
2–4	90	21·7	43	25·1	45	34·3	1	0·9	
≥5	98	23·6	86	50·3	12	9·2	1	0·9	

the Teochew, Teochew–Hakka and Hakka dialects in the Chaoshan region of southern China. Salt intake differed between Teochew and Teochew–Hakka speakers and between Teochew and Hakka speakers. The Na:K ratio differed significantly among the dialects. Knowledge and self-awareness about salt intake were poor in this population.

Studies of salt intake are limited in southern China. Moreover, most previous studies might have underestimated salt intake in this population because some sources of Na intake were not included, such as snacks and deli meats. Some studies showed that >75 % of participants reported low Na intake, and the consistency was low between self-reported Na intake and actual Na intake[26–28], which suggests that individuals' self-reported outcomes might not reflect their actual daily salt intake. Our study evaluated daily salt intake of the population in the Chaoshan region of southern China using the method of 24-h urine collection[29].

Our study found that the mean salt intake of the Chaoshan population is much higher than 5 g/d, the upper limit recommended by the WHO[15]. The proportion of no more than 5 g/d was only 13 %. The average salt intake was higher than that of residents 18–75 years old in northern Greece (4·4 g/d)[30] but lower than that of residents in Korea[31] (13·2 g/d), Japan[32] (11·0 g/d), Chinese people in the INTERMAP study[18] (13·3 g/d) and other studies. For example, in the Yantai city of China, the average intake was 12·8 g/d in ninety-eight males and 10·8 g/d in ninety-three females 18–69 years of age[33]. Peng *et al.*[17] reported a salt intake of 16·0 g/d in 120 people 35–70 years of age in the Shanxi province of China. Climate and diet habits might influence salt intake in southern and northern China.

Our results showed that BMI is positively correlated with 24-h Na intake, which is consistent with the results of Yan *et al.* in Chinese adults[34]. Furthermore, Chakma *et al.*[35] reported excessive salt intake and high BMI to be associated with an increased risk of hypertension, which indicates that limiting both Na intake and weight gain may be effective ways to prevent high BP. We observed significant, although weak, positive correlations between 24-h urinary Na and BP as well as Na:K ratio and BP, which agrees with other research[36,37].

We found dialect to be associated with the level of salt intake, much higher in Hakka and Teochew–Hakka than Teochew speakers. People speaking the Teochew dialect, the predominant inhabitants of the Chaoshan area, are mainly the descendants of northcentral Chinese Han people. Their ancestors migrated to the Chaoshan area from Fujian, because of wars and famine during the Qin Dynasty (216–207 BC) and Han Dynasty (206 BC–220 AD)[38,39], and ultimately settled in the cultivated coastal plains, which provided plenty of food such as cereals, vegetables and seafood. People speaking the Hakka dialect originated in the Yellow River basin of the Central Plain. From the Jin Dynasty (266–316 AD) to the Tong Dynasty (960–1297 AD), they moved to southern areas also because of wars. When they arrived in the Chaoshan area, people speaking the Teochew dialect had already settled in the rich plain area, so Hakka speakers had to settle in the mountain area where food was scarcer than in the plain area[38,39]. This situation resulted in different lifestyles, customs and habits between these two groups. For instance, Teochew speakers prefer eating light food, while Hakka speakers in the Chaoshan area are likely to preserve food using salt because of previous lack of food. In the long term, they even thought that salt could give food flavour and bring out the best in food. Moreover, people speaking Teochew drink Kongfu tea prepared by brewing dried tea leaves with hot water[19], whereas Hakka speakers usually drink 'grinding tea' prepared by brewing dried tea leaves with salt, rice, sesame seeds, orange peel, other raw materials and hot water. All of these habits led to a high level of salt intake in Hakka speakers. Interestingly, the salt intake of Teochew–Hakka was intermediate between that of Teochew and Hakka. It was probably a result of the unique culture of Teochew–Hakka speakers that blends the lifestyle and dietary patterns of Teochew and Hakka.

In this survey, fewer people had a Na:K ratio <1·0, the target recommended by the WHO[40], and only 14 % of participants had a ratio <2·0. Dietary K partly offsets the effect of high dietary Na intake. Meanwhile, we found a correlation between Na:K ratio and hypertension for Hakka speakers, because they prefer eating salty food with a strong taste and that they do not eat much fruit and vegetables, a factor that could easily lead to excessive Na and insufficient K intake. A high Na and low K diet is one of the major risk factors of hypertension and CVD[41]. It is probably related to increased IL-6 levels caused by a high-salt diet and high Na:K ratio[42]. Along with dialect and hypertension, education is the main determining factor of Na:K ratio in our study. A previous study in New York has found a lower Na:K ratio in people with higher than lower educational attainment[43]. This finding suggests that residents should pay attention to the balance of Na and K in their diet, and health education plays an important role in controlling BP of residents in communities.

A population study has found that dietary habits are healthier in people with a high dietary self-efficacy[44]. Only a small proportion of our respondents recognised that they ate too much salt, and one-quarter knew the recommended maximum level of salt intake. The Chaoshan region is located in the coastal area, so people would easily ignore their salt intake from potential foods, such as seafood and spices, which might explain why most residents thought their salt intake was moderate or less than the recommended level. Studies have found that residents' awareness of salt control could help reduce their salt intake[45]. Overall, 16·6 % of our participants declared that food labels are helpful in choosing low-salt food, whereas only 12·8 % read these labels when buying, which was lesser compared with the results of Claro *et al.*[46]. Of note, Nasreddine *et al.*[47] have found that nearly half the consumers do not change their idea of choosing high-salt foods even if the salt content is marked on the food bag. A 'traffic light' system is widely used in UK; the system marks packages with different colours (red, yellow, green) to distinguish the amount of salt or Na in food. It significantly improved the understanding of nutritional information and enhanced the awareness of choosing healthy foods among consumers compared with the traditional labelling method[48].

There are two strengths in the current study. First, we provided the first epidemiologic data for salt intake in community residents in the Chaoshan region of southern China. Second, 24-h urine collection combined with a qualitative questionnaire was used to evaluate the level of salt intake in a relatively large sample of community residents, instead of either a dietary survey or spot urine sampling alone.

Because of inconvenience in the respondents carrying the urine container, 24-h urine collection is challenging. A limitation of the study was that we collected urine on only a single 24-h period from each participant, whose results may be less accurate than a continuous 24-h sampling because of day-to-day variations. However, most participants were older and remained at home, whereas young people were unable to meet 24-h urine collection because they may have been at work. In addition, the age of people speaking different dialects was not balanced, so the univariate analysis was affected by age. However, during the multivariable analysis, we adjusted for age, so we mainly refer to the results of multiple linear regressions. A larger sample whose age and sex are balanced should be investigated in the future.

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Conclusions

The average daily salt consumption of the Chaoshan population, especially those speaking Teochew–Hakka and Hakka dialects, exceeded the upper limit recommended by the WHO. Residents' knowledge and self-awareness as well as behaviours related to salt intake were poor. Local governments and medical institutions should take measures to improve the awareness and dietary lifestyles of residents with a view to decrease salt intake and increase potassium intake.

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Supplementary material

For supplementary material accompanying this paper visit https://doi.org/10.1017/S136898001900507X

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