Twenty-Four-Hour Urinary Sodium and Potassium Excretion in China: A Systematic Review and Meta-Analysis

Monique Tan, MSc; Feng J. He, PhD; Changqiong Wang, PhD; Graham A. MacGregor, MD

Background—In China, high sodium and low potassium intakes result in elevated blood pressure, a major cause of cardiovascular disease, yet the intake estimates lack accuracy and nutritional strategies remain limited.

Methods and Results—We aimed to determine sodium and potassium intake by systematically searching for and quantitatively summarizing all published 24-hour urinary sodium and potassium data (ie, the most accurate method). MEDLINE, EMBASE, Scopus, China National Knowledge Infrastructure, and Wanfang were searched up to February 2019. All studies reporting 24-hour urinary sodium or potassium in China were included; hospitalized patients were excluded. Data were pooled using random-effects meta-analysis and heterogeneity was explored with meta-regression. Sodium data were reported in 70 studies (n=26 767), 59 of which also reported potassium (n=24 738). Mean sodium and potassium excretions were 86.99 mmol/24 h (95% CI, 69.88–104.10) and 14.65 mmol/24 h (95% CI, 11.10–18.20) in children aged 3 to 6 years, 151.09 mmol/24 h (95% CI, 131.55–170.63) and 25.23 mmol/24 h (95% CI, 22.37–28.10) in children aged 6 to 16 years, and 189.07 mmol/24 h (95% CI, 182.14–195.99) and 36.35 mmol/24 h (95% CI, 35.11–37.59) in adults aged >16 years. Compared with southern China, sodium intake was higher in northern China (P<0.0001) but is declining (P=0.0066).

Conclusions—Average sodium intake in all age groups across China is approximately double the recommended maximum limits, and potassium intake is less than half that recommended. Despite a decline, sodium intake in northern China is still among the highest in the world, and the North–South divide persists. Urgent action is needed to simultaneously reduce sodium and increase potassium intake across China. **(*J Am Heart Assoc*. 2019;8:e012923. DOI: 10.1161/JAHA.119.012923.)**

Key Words: 24-hour urinary excretion • China • meta-analysis • potassium • sodium

A high-sodium, low-potassium diet leads to elevated blood pressure and ultimately cardiovascular disease,[1–3] which is the major cause of death and disability in China and the rest of the world.[4,5] The World Health Organization recommends that all adults reduce their sodium intake to <87 mmol (<5 g of salt) per day and increase their potassium intake to ≥90 mmol (≥3.5 g) per day, and the recommendations for children are adjusted for their energy requirements and age.[6,7] In China, the average diet contains too much sodium and not enough potassium,[8] and strategies to address this situation remain limited.[9] Moreover, current figures for sodium and potassium intakes in China lack accuracy, as they are often estimated with unreliable methods, such as dietary recalls, food records, or spot urines. The most accurate way to assess sodium and potassium intake is 24-hour urine collection.[10,11] A great number of studies have reported such data in China, but there has been no systematic review to comprehensively assess them.

Given the large share of the world's cardiovascular disease burden borne by China—particularly in the form of elevated blood pressure and stroke—and the need to track progress on global targets, more robust estimates of sodium and potassium intake are urgently needed. Therefore, our study aimed to determine sodium and potassium intake in China by systematically searching for and quantitatively summarizing all published data on 24-hour urinary sodium and potassium excretion in children and adults.

From the Wolfson Institute of Preventive Medicine, Barts and The London School of Medicine & Dentistry, Queen Mary University of London, London, United Kingdom.

Accompanying Datas S1, S2, Tables S1 through S5, and Figure S1 are available at https://www.ahajournals.org/doi/suppl/10.1161/JAHA.119.012923

Correspondence to: Feng J. He, PhD, Wolfson Institute of Preventive Medicine, Queen Mary University of London, Charterhouse Square, London EC1M 6BQ, United Kingdom. E-mail: f.he@qmul.ac.uk

Received April 9, 2019; accepted May 31, 2019.

Methods

The authors declare that all supporting data are available within the article and its online supplementary files.

Clinical Perspective

What Is New?

- Our study is the first to have systematically assessed and pooled all published 24-hour urinary sodium and potassium data (ie, the most accurate method to estimate sodium and potassium intake) in China.
- We found that (1) sodium intake in Chinese children, adolescents, and adults has been among the highest in the world over the past 4 decades; (2) the North–South divide in sodium intake still exists, despite there being a decline in northern China; and (3) potassium intake in all age groups has been consistently low throughout the country.

What Are the Clinical Implications?

- A coherent, workable, and nationwide strategy is urgently needed in China to simultaneously speed up the pace of sodium reduction and increase potassium intake.
- One way to achieve this dual objective is to replace regular salt with low-sodium, high-potassium salt substitutes, which have been shown to lower blood pressure and reduce cardiovascular mortality in randomized trials.

Search Strategy and Selection Criteria

We performed a systematic review and meta-analysis of the published literature. Studies were eligible for inclusion if they were conducted in China and reported summary measurements of 24-hour urinary sodium or potassium excretion. There was no restriction on study year, design, or language. For hospital-based studies, only healthy participants were included.

MEDLINE (from 1950 to February 1, 2019), EMBASE (from 1950 to February 1, 2019), Scopus (from 1980 to February 1, 2019), the China National Knowledge Infrastructure (from 1979 to February 1, 2019), and WanFang (unclear start date to February 1, 2019) were searched. The following search terms were used for MEDLINE and subsequently adapted for the other electronic databases (Data S1), with explosion whenever possible:

1. exp Sodium Chloride/OR exp Sodium/OR salt.mp OR exp Potassium/.
2. exp China/OR Chinese.mp OR exp Taiwan/.
3. dietary.mp OR intake.mp OR urinary.mp.
4. 1 AND 2 AND 3.

The reference lists of relevant articles and reviews[12–15] were manually searched to identify any other eligible studies. The literature search, data extraction, and risk of bias assessment were carried out independently by 2 authors (M.T. and C.W.). Disagreements were resolved with the help of the other authors.

Data Extraction and Analysis

Using a spreadsheet, we extracted data on participants characteristics, sample size, age, sex, geographic location, region type (urban versus rural), study design, dates and methods of data collection, the 24-hour urinary excretions of sodium, potassium, creatinine, and 24-hour urine volume (mean, SD, SEM). When information was missing, study authors were contacted; if left unanswered, the following assumptions were made: study sites were based on the authors' affiliations (n=3),[16–18] and study years were assumed to be 3 years before publication (n=20).[16–35] All measures were converted into millimoles of sodium and potassium using standard conversion values (1 mmol sodium=1 mEq sodium=23 mg sodium; 1 mmol potassium=1 mEq potassium=39.1 mg potassium). If SEM was not reported, it was calculated from the SD and the number of participants. If the period of data collection covered more than a year, the midpoint was used. If several publications reported the same study, only the publication that provided the most data was selected. In interventional studies, if both baseline and end-of-trial measurements were reported, only the former were used (n=4).[20,36–38]

The risk of bias within each study was assessed using an adapted version of a critical appraisal checklist developed for systematic reviews of prevalence (Data S2).[39] The checklist consisted of 9 questions related to the quality of sampling, reporting, measurement, analysis, and response rate. We did not formally assess for publication bias and selective outcome reporting because such a bias was highly unlikely, as the 24-hour urinary excretions were reported either in observational studies or as secondary outcomes.

Data were pooled using random-effects meta-analysis. Subgroup analyses were performed to determine sodium and potassium excretion by age group, sex, geographic location, study year, and rigor of 24-hour urine collection (24-hour collection was considered rigorous if its completeness was assessed). Evidence for differences in excretion according to these covariates was sought using meta-regression analyses. Because of small sample sizes, only univariate meta-regression analyses were performed when northern and southern China were analyzed separately. We used a North–South demarcation of China that was determined by a spatial analysis using geographic information system, based on a model of climate-, geography-, and human-related indicators.[40] Although prespecified, no subgrouping by region type was made, as only 2 studies reported urban and rural data separately.[41,42] Neither subgroup nor meta-regression analyses were performed on studies conducted in children because of the small number of studies available. A 2-sided P value of <0.05 was considered

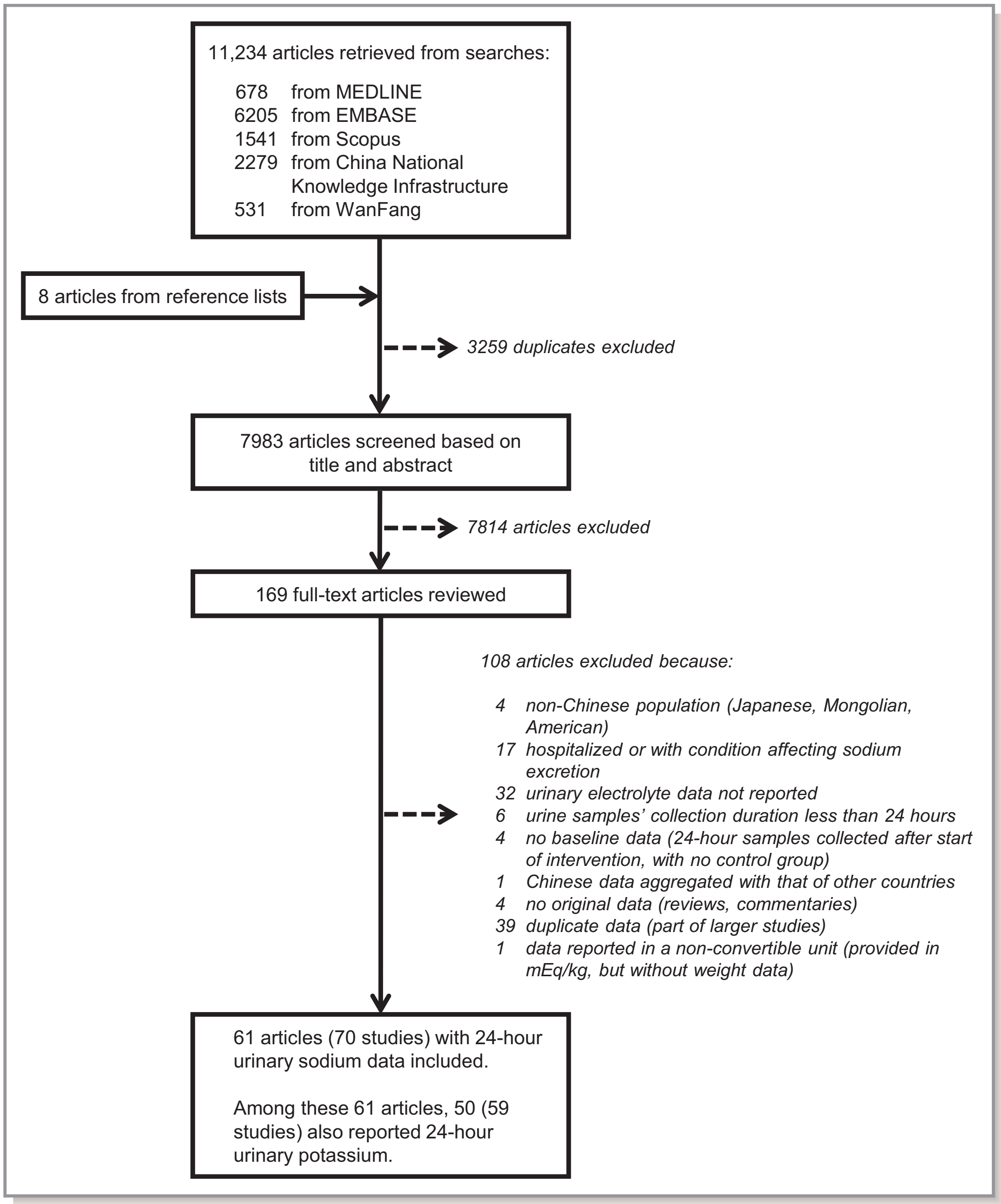


Figure 1. Study selection.

significant. All analyses were performed using R (version 3.4.3) with the packages "meta" (version 4.9-3) and "metafor" (version 1.9-9).

Results

Our search found 11 234 records. After removing the duplicates and searching the reference lists of relevant papers,[12–15] 7983 abstracts were screened, and 169 publications were selected for full-text review, of which 108 were excluded for reasons summarized in Figure 1. A total of 61 papers met the inclusion criteria and were included in our meta-analysis.[16–38,41–79] Two multisite studies reported separate estimates for each location,[45,49] and we treated each site as an individual study so as not to lose geographic information. As such, we included a total of 70 studies reporting 24-hour urinary sodium data (drawn from 890 children: 56% boys, mean age 9 years; and 25 877 adults: 50% men, mean age 46.3 years). Among the 70 studies, 59 also reported 24-hour urinary potassium data (drawn from 831 children, 56% boys, mean age 8.1 years; and 23 907 adults; 51% men, mean age 46.5 years). There was no study that reported 24-hour urinary potassium data without 24-hour urinary sodium data. The data spanned 1981 to 2016 and covered 27 of the 33 administrative regions (provinces,

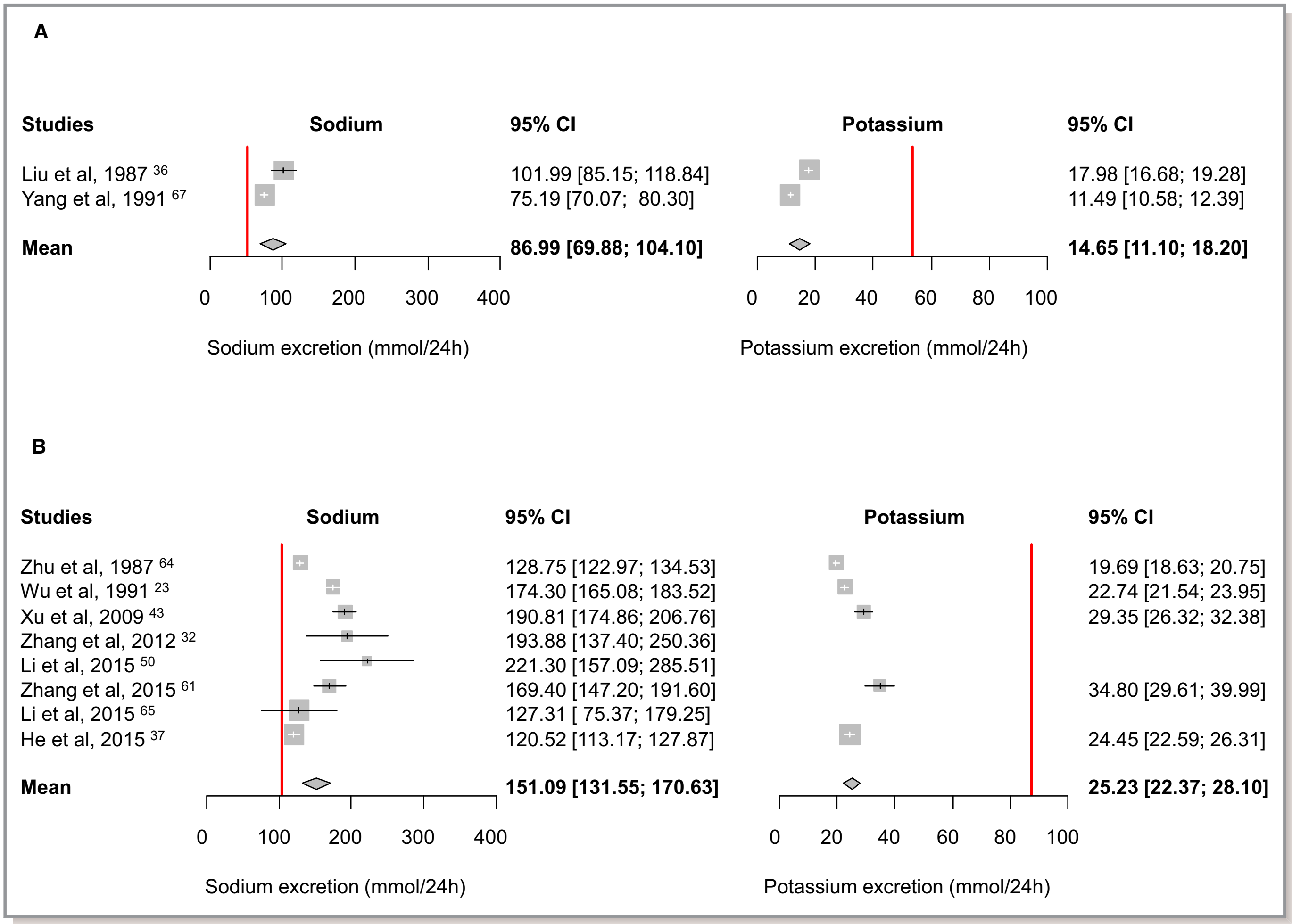


Figure 2. Mean urinary sodium and potassium excretion (mmol/24 h) by age groups. **A**, Aged 3–6 years; **B**, Aged 6–16 years; **C**, Aged ≥16 years. The red lines denote the recommended intakes for children (Chinese Proposed Intakes for Preventing Non-communicable Chronic Disease for 4–6 and 11–13 year-olds, respectively[81,82]) and adults (World Health Organization recommendations[6,7]).

autonomous regions, municipalities, and special administrative regions) of China. Only one 24-hour urine was collected per participant in 76% (n=53) of the studies reporting sodium data and 75% (n=44) of the studies with potassium data. Data collection was considered rigorous in 51% (n=36) of the studies reporting sodium data and 58% (n=34) of the studies with potassium data. The characteristics of the included studies and participants are provided in Table S1. The risk of bias of each study varied substantially across criteria (Figure S1).

In children aged 3 to 6 years, mean sodium excretion was 86.99 mmol/24 h (95% CI, 69.88–104.10), and mean potassium excretion was 14.65 mmol/24 h (95% CI, 11.10–18.20). In children aged 6 to 16 years, mean sodium excretion was 151.09 mmol/24 h (95% CI, 131.55–170.63) and mean potassium excretion was 25.23 mmol/24 h (95% CI, 22.37–28.10). In adults aged 16 years and above, mean sodium excretion was 189.07 mmol/24 h (95% CI, 182.14–195.99), and mean potassium excretion was 36.35 mmol/24 h (95% CI, 35.11–37.59) (Figure 2). Mean creatinine excretion in adults, as reported in 25 studies, was 8.69 mmol/24 h (95% CI, 8.16–9.22). Mean urine volume in adults, as reported in 16 studies, was 1447 mL (95% CI, 1408–1486).

All results reported thereafter pertain to adults only. In men, mean sodium excretion was 194.76 mmol/24 h (95% CI, 179.27–210.25) and mean potassium excretion was 38.26 mmol/24 h (95% CI, 35.65–40.86). In women, mean sodium excretion was 181.54 mmol/24 h (95% CI, 167.10–195.99) and mean potassium excretion was 36.76 mmol/24 h (95% CI, 33.37–40.15). Among studies in which the 24-hour urine was assessed for completeness, the mean excretions were 188.04 mmol/24 h (95% CI, 175.56–200.52) for sodium and 37.45 mmol/24 h (95% CI, 34.55–40.34) for potassium. Among studies where completeness assessment was not performed or not reported, the mean excretions were 188.43 mmol/24 h (95% CI, 172.96–203.90) for sodium and 37.13 mmol/24 h (95% CI, 33.53–40.73) for potassium.

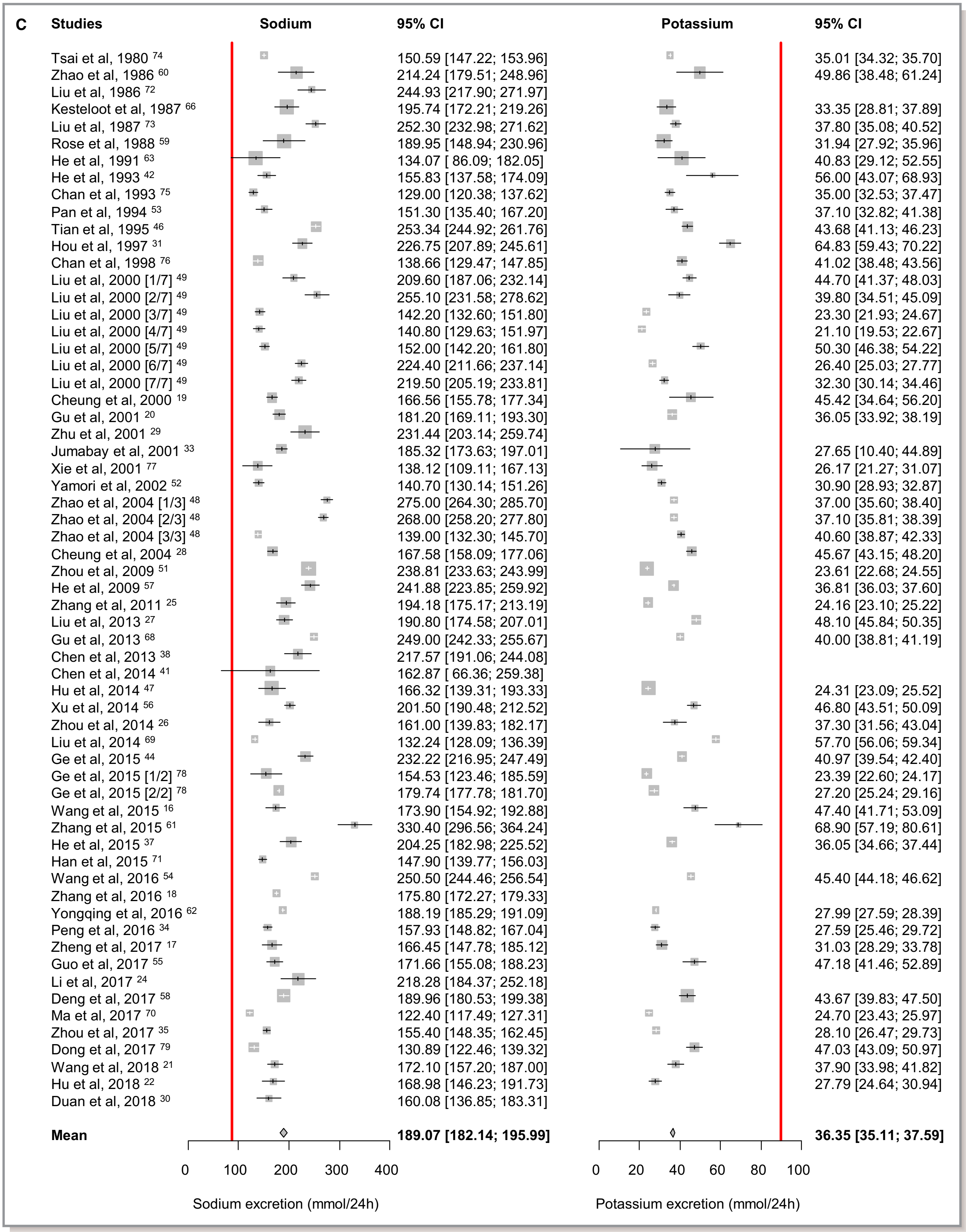


Figure 2. Continued.

There was a geographic pattern in the 24-hour urinary excretion of sodium (but not of potassium), with the highest sodium excretions found in northern China: 255.10 mmol/24 h (95% CI, 231.58–278.62) in the Tibet Autonomous Region, 250.50 mmol/24 h (95% CI, 236.99–264.01) in the Ningxia Hui Autonomous Region, and 243.79 mmol/24 h (95% CI, 230.96–256.62) in Henan Province; whereas the lowest sodium excretions were found in southern China: 135.75 mmol/24 h (95% CI, 125.11–146.38) in Guangdong Province, 138.12 mmol/24 h (95% CI, 109.11–167.13) in Hubei Province, and 142.20 mmol/24 h (95% CI, 132.60–151.80) in Guizhou Province (Figure 3). In meta-regression analyses, there was a significant association between sodium excretion and geographic location, which remained significant ($P<0.0001$) after adjusting for age, sex, study year, and rigor of 24-hour urine collection (Table).

To examine time trends in sodium and potassium excretion, we pooled the estimates per decade of data collection (Figure 4). While no time trend was apparent when considering China as a whole, subgrouping by region showed that mean sodium excretion decreased in northern China (most markedly between the 2000s and the 2010s) and increased in southern China (most markedly between the 1990s to the 2000s). Both time trends in sodium excretion were confirmed in meta-regression analyses in which study year was treated as a continuous variable ($P=0.0066$ and 0.0422, respectively). In contrast, potassium excretion has remained stable in both northern and southern China over the past 4 decades (Table, Figure 5).

Sensitivity analyses were carried out by excluding hospital-based studies, hypertensive participants, and participants belonging to ethnic minority groups (Uygur, Kazakh, Tibetan, Yi, She). We also reran all analyses placing the Tibet Autonomous Region in southern instead of northern China, as the spatial calculation we used to demarcate the country left ambiguity for this area.[40] All findings remained

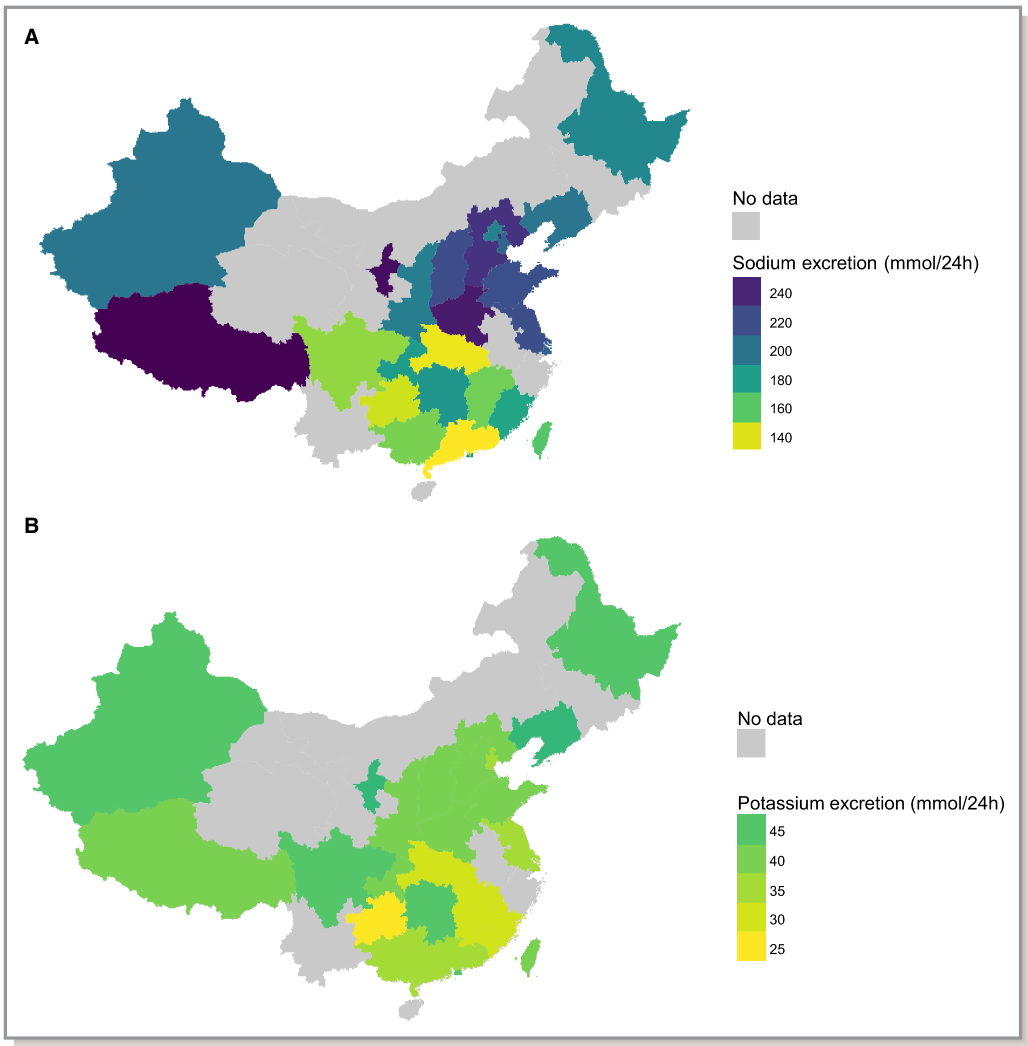


Figure 3. Mean urinary sodium and potassium excretion (mmol/24 h) in adults, per administrative region. **A**, Sodium; **B**, Potassium.

Table. Potential Effect Modifiers of Sodium and Potassium Excretion (mmol/24 h) in Adults

	Sodium				Potassium			
	Univariate		Multivariate		Univariate		Multivariate	
	Slope (95% CI)	*P* Value	Slope (95% CI)	*P* Value	Slope (95% CI)	*P* Value	Slope (95% CI)	*P* Value
Age, y	0.25 (−0.59 to 1.09)	0.5573	0.08 (−0.77 to 0.94)	0.8491	0.02 (−0.16 to 0.2)	0.8311	−0.07 (−0.31 to 0.16)	0.5363
Sex (% men)	0.53 (0.04–1.01)	0.0337	0.27 (−0.23 to 0.76)	0.2853	0.01 (−0.11 to 0.13)	0.9054	0.00 (−0.15 to 0.15)	0.9900
Geographic location (each administrative region coded from south to north)	3.25 (2.24–4.27)	<0.0001	3.15 (1.98–4.32)	<0.0001	0.15 (−0.1 to 0.41)	0.2339	0.15 (−0.16 to 0.46)	0.3348
Rigor of 24-hour urine collection (not rigorous or not reported as reference)	−12.47 (−30.22 to 5.29)	0.1665	−0.24 (−1.04 to 0.56)	0.5493	1.18 (−2.68 to 5.04)	0.5444	1.84 (−2.53 to 6.21)	0.4041
Year of data collection (whole of China)	0.18 (−0.64 to 0.99)	0.6723	−7.85 (−24.63 to 8.92)	0.3547	0.11 (−0.07 to 0.29)	0.2191	0.10 (−0.10 to 0.30)	0.3252
Year of data collection (northern China only)	−1.30 (−2.23 to −0.38)	0.0066	...	...	−0.01 (−0.24 to 0.22)	0.9284	...	...
Year of data collection (southern China only)	1.08 (0.04–2.13)	0.0422	...	...	0.20 (−0.10 to 0.51)	0.1866	...	...

unchanged, except for the trend of increase in sodium excretion in southern China, which was no longer significant (Tables S2 through S5).

Discussion

To our knowledge, this is by far the most comprehensive systematic review and meta-analysis that included all studies using the most accurate method of sodium and potassium intake assessment (ie, 24-hour urinary excretion) and covering almost all geographic locations across China. Data from 26 767 participants were used to determine sodium intake, which has been consistently high over the past 4 decades and with a North–South divide that persists despite there being a decline in northern China. Data on potassium were also reported for 24 738 participants, revealing consistently low intake levels across the country.

In their respective age group, sodium intake levels in China exceeded all recommendations (with adults consuming double their recommended maximum intake)[6,81] and were among the highest in the world.[12,15] In contrast, potassium intake levels were less than half the recommended minimum intake for each age group.[7,82]

Because of the exclusive use of 24-hour urinary data, our estimates are more robust than previous ones. It is well known that dietary methods are unreliable for the assessment of sodium and potassium intake.[10] Most of the sodium in the Chinese diet comes from the salt added during home cooking or at the table,[8] and this discretionary salt use is highly variable and difficult to quantify by dietary methods.[10] Furthermore, processed and out-of-home foods are increasingly consumed in all sociodemographic groups,[8] but their sodium content tends to be inaccurately reported in food composition tables, and they are also impractical to record[10]—to the extent that out-of-home meals were altogether excluded from some previous reports.[83] The China Health and Nutrition Survey found that the main food sources of potassium in China were wheat products, rice, and potatoes.[8] The potassium content of such foods vary greatly depending on their preparation, cooking, and processing,[84,85] which dietary surveys and food composition tables often fail to capture. The use of spot urines has also been repeatedly shown to be unreliable in estimating sodium and potassium intake.[80,86–88] This is mostly attributable to the variation in the excretion of sodium and potassium throughout the day as well as the use of formulas to extrapolate their concentrations to 24 hours, which introduces a source of systematic error.[80,89]

The geographic patterns shown in our study are in agreement with those found in the China Health and Nutrition Survey.[8] While no major regional difference was apparent for potassium intake, there was a North–South gap in sodium intake. This gap has been documented since the 1980s[8,90–93]

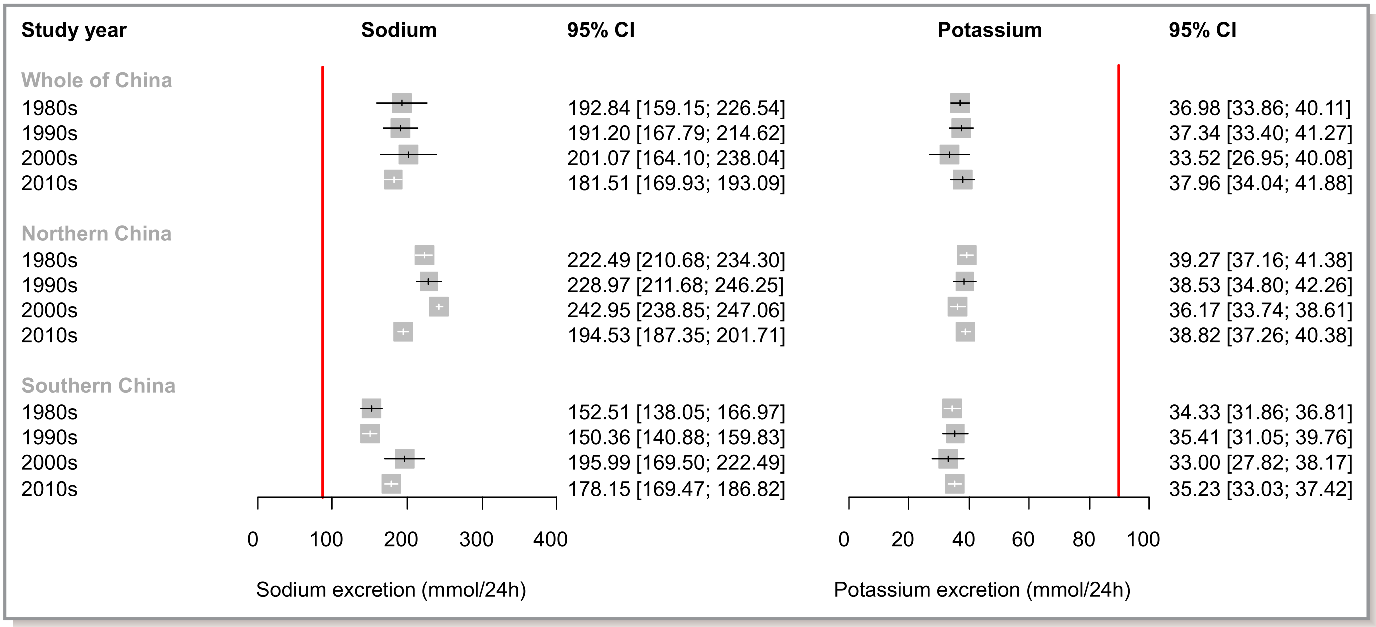


Figure 4. Mean urinary sodium and potassium excretion (mmol/24 h) in adults, per decade of data collection. The red lines denote the World Health Organization–recommended intakes for adults.[6,7]

but may be closing.[14] Our results suggested a decline in sodium intake in northern China, most markedly since the 2000s. This is likely to be the result of both governmental efforts in salt awareness education and the lessened reliance on pickles attributable to a greater year-round availability of vegetables,[8,14,94] although this did not translate into an increase in potassium intake. This trend of decreased sodium intake was not seen in southern China. This could be attributable to the growing consumption of processed foods and out-of-home meals, which could ultimately offset any decline in sodium intake achieved so far.[83] These trends partially contradict those of dietary-based studies, all of which found large declines in sodium intake across the entire country of China, at both the national[8,83,95] and the regional[8] levels. This discrepancy reflects the major limitations of dietary assessment methods, which are likely to have overestimated sodium intake in the past and underestimated it more recently. When food supplies were limited and refrigerator ownership was low, salt was the major food preservative. Older studies conducted during periods of heavy salting recorded all the salt used, even though most of it would eventually be discarded. Recent underestimates are linked to the increasing contribution of processed and out-of-home foods to sodium intake, as previously discussed. Further highlighting their unreliability, when different dietary methods were simultaneously and repeatedly used in the same provinces, opposite time trends in sodium intake were obtained in some areas.[83]

Of note, the China Health and Nutrition Survey recorded the highest sodium intakes in the provinces of Shandong, Jiangsu, and Henan, which they considered "central" China.[8] In our study, these provinces were considered to belong to "northern" China. Such inconsistency is common, as the division of China into regions often seems arbitrary. We opted for a more robust North–South demarcation.[40] To minimize the impact of our choice, we treated geographic location as a continuous variable in our meta-regression analysis by coding each administrative region from the farthest south to the farthest north using their longitude. This analysis confirmed a gradient in sodium intake, increasing from the south to the north.

The main strength of our study resides in the comprehensiveness of its search strategy: We used broad search terms that we exploded whenever possible; we searched both Western and Chinese databases (which have been shown to have little overlap[96,97]); and there was no restriction on study year, design, or language. We identified up to 10 times more articles reporting 24-hour urinary sodium data in China than previous reviews (1 review included 57 articles, but 52 of them reported estimates by dietary methods[14]),[12–15] resulting in a broader time and country coverage as well as a much larger number of participants. To our knowledge, this is the first time 24-hour urinary potassium data in China have been reviewed. This is also the first meta-analysis of children's 24-hour urinary sodium and potassium excretion in China.

The lack of assessment or report on the completeness of the 24-hour urine was a limitation. No single standard exists for assessing the completeness of a 24-hour urine collection, and undercollection is common.[80] Our estimates were not adjusted for nonurinary (eg, feces, sweat) losses. Therefore, our figures are underestimates of the true sodium and

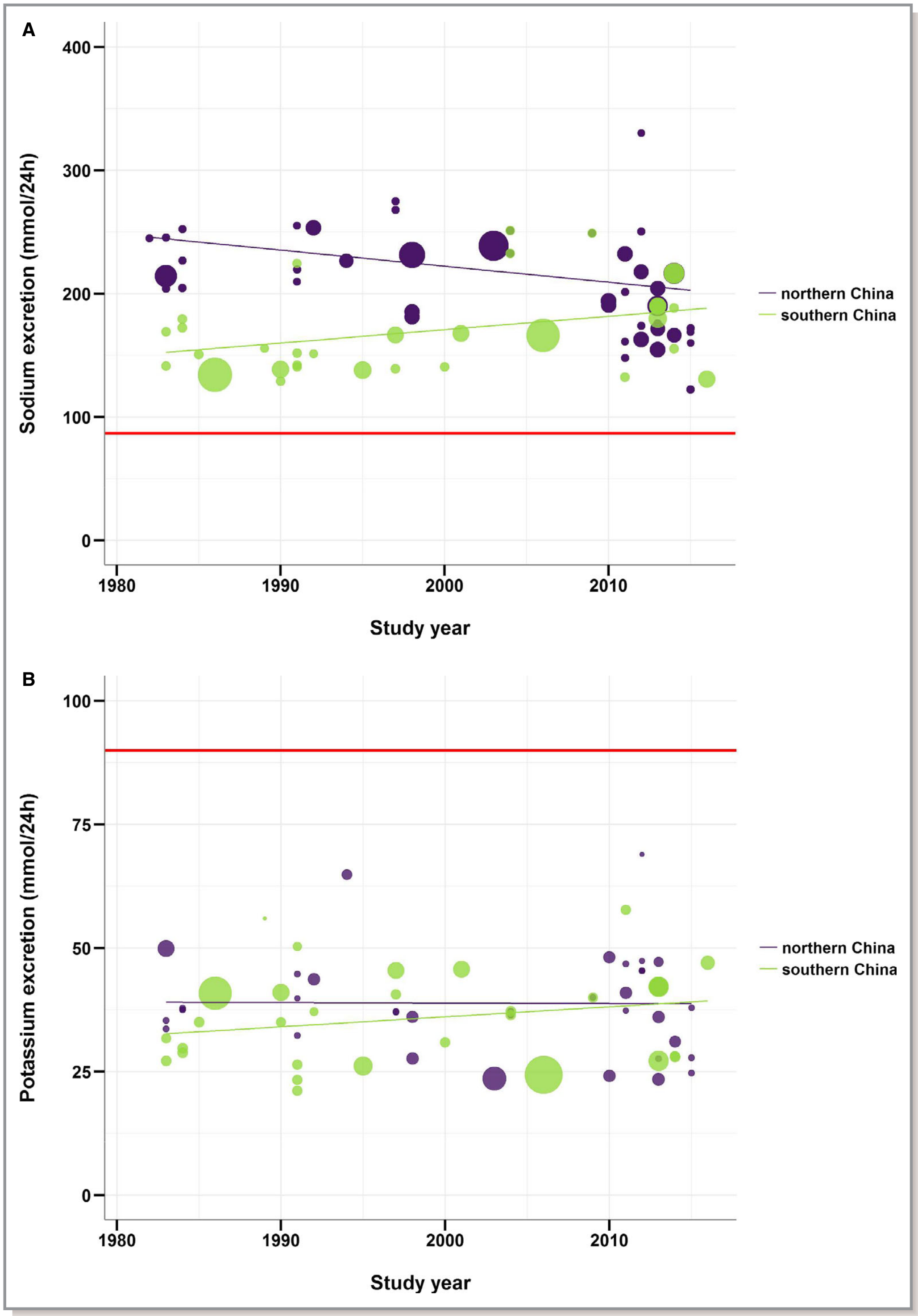


Figure 5. Time trends in adults' mean 24-hour urinary sodium and potassium excretion. **A**, Sodium; **B**, Potassium. The red lines denote the World Health Organization–recommended intakes for adults.[6,7]

potassium intakes in China. Other domains with high risks of bias (sample size calculation, sampling frame, calculation of sodium and potassium excretion) reflected reporting rather than study quality and thus did not affect our findings. Finally, the data available did not allow for province-level comparisons over time; the time trends in our report should be interpreted at the regional level.

Although sodium intake is suggested to have decreased in northern China, the most recent data show that the intake level is still more than double the maximum intake recommended by the World Health Organization; while in southern China, there is a trend of increase. Urgent action is required to accelerate sodium reduction in all regions of China. The Chinese government has made sodium reduction a key component of "Healthy Lifestyle for All," an initiative to prevent non-communicable diseases. An action group, "Action on Salt China," has taken up the task of harnessing support and participation from all regions across China to develop tailored and sustainable sodium-reduction interventions.[98] The rapid increase in the consumption of processed and out-of-home foods must be addressed before the hard-won declines in sodium intake are offset. Nevertheless, discretionary salt use still constitutes the vast majority of the sodium consumed in China. Behavior change thus remains primordial, and key periods for the formation of dietary habits are childhood and adolescence. Reducing children's sodium intake leads to a decrease in their blood pressure, which could prevent hypertension and cardiovascular disease later in life.[99,100] Replacing regular salt with low-sodium, high-potassium salt substitutes would achieve the dual objective of reducing sodium intake while simultaneously increasing potassium intake. Randomized controlled trials have demonstrated the role of salt substitutes in reducing blood pressure and cardiovascular disease mortality.[101–103] Concerns over the risk of hyperkalemia associated with the use of salt substitutes are likely to be unwarranted in the Chinese general population in view of the very low intakes of potassium. Nevertheless, potassium intakes should ideally be increased through foods. Given the sheer size of the Chinese population, achieving sodium reduction together with increasing potassium intake nationwide will result in an enormous benefit for global health.

Sources of Funding

This research was commissioned by the National Institute for Health Research (NIHR) (NIHR Global Health Research Unit Action on Salt China at Queen Mary University of London) using Official Development Assistance (ODA) funding (16/136/77). Tan and Wang are funded by the NIHR grant, He and MacGregor are partially funded by the NIHR grant. The views expressed in this publication are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care.

Disclosures

Prof He is a member of the Consensus Action on Salt & Health group, a nonprofit charitable organization, and its international branch, World Action on Salt & Health, and does not receive any financial support from the Consensus Action on Salt & Health or World Action on Salt & Health. Prof MacGregor is the Chairman of Blood Pressure UK, Chairman of the Consensus Action on Salt & Health, and Chairman of World Action on Salt & Health and does not receive any financial support from any of these organizations. Blood Pressure UK, the Consensus Action on Salt & Health, and World Action on Salt & Health are nonprofit charitable organizations. The remaining authors have no disclosures to report.

References

1. He FJ, MacGregor GA. Role of salt intake in prevention of cardiovascular disease: controversies and challenges. *Nat Rev Cardiol*. 2018;15:371–377.
2. Whelton PK, He J, Cutler JA, Brancati FL, Appel LJ, Follmann D, Klag MJ. Effects of oral potassium on blood pressure. Meta-analysis of randomized controlled clinical trials. *JAMA*. 1997;277:1624–1632.
3. He FJ, MacGregor GA. Beneficial effects of potassium. *BMJ*. 2001;323:497–501.
4. Kyu HH, Abate D, Abate KH, Abay SM, Abbafati C, Abbasi N, Abbastabar H, Abd-Allah F, Abdela J, Abdelalim A et al. Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. 2018;392:1859–1922.
5. Institute for Health Metrics and Evaluation. China. Institute for Health Metrics and Evaluation. Available at: http://www.healthdata.org/china. Accessed January 24, 2019.
6. World Health Organization. *Guideline: Sodium Intake for Adults and Children*. Geneva: World Health Organization, Department of Nutrition for Health and Development; 2012.
7. World Health Organization. *Guideline: Potassium Intake for Adults and Children*. Geneva: World Health Organization, Department of Nutrition for Health and Development; 2012.
8. Du S, Neiman A, Batis C, Wang H, Zhang B, Zhang J, Popkin BM. Understanding the patterns and trends of sodium intake, potassium intake, and sodium to potassium ratio and their effect on hypertension in China. *Am J Clin Nutr*. 2014;99:334–343.
9. Trieu K, Neal B, Hawkes C, Dunford E, Campbell N, Rodriguez-Fernandez R, Legetic B, McLaren L, Barberio A, Webster J. Salt reduction initiatives around the world—a systematic review of progress towards the global target. *PLoS One*. 2015;10:e0130247.
10. McLean RM. Measuring population sodium intake: a review of methods. *Nutrients*. 2014;6:4651–4662.
11. Clark AJ, Mossholder S. Sodium and potassium intake measurements: dietary methodology problems. *Am J Clin Nutr*. 1986;43:470–476.
12. Brown IJ, Tzoulaki I, Candeias V, Elliott P. Salt intakes around the world: implications for public health. *Int J Epidemiol*. 2009;38:791–813.
13. Shao S, Hua Y, Yang Y, Liu X, Fan J, Zhang A, Xiang J, Li M, Yan LL. Salt reduction in China: a state-of-the-art review. *Risk Manag Healthc Policy*. 2017;10:17–28.
14. Yang L, Xi B. [Secular trends in dietary sodium and potassium intakes in Chinese population, 2000–2015]. *Chin J Public Health*. 2017;33:1249–1253.
15. Powles J, Fahimi S, Micha R, Khatibzadeh S, Shi P, Ezzati M, Engell RE, Lim SS, Danaei G, Mozaffarian D; Group (NutriCoDE) on behalf of the GB of DN and CDE. Global, regional and national sodium intakes in 1990 and 2010: a systematic analysis of 24 h urinary sodium excretion and dietary surveys worldwide. *BMJ Open*. 2013;3:e003733.
16. Wang Y, Mu JJ, Geng LK, Wang D, Ren KY, Guo TS, Chu C, Xie BQ, Liu FQ, Yuan ZY. Effect of salt intake and potassium supplementation on brachial-ankle pulse wave velocity in Chinese subjects: an interventional study. *Braz J Med Biol Res*. 2015;48:83–90.
17. Zheng W-L, Chu C, Lv Y-B, Wang Y, Hu J-W, Ma Q, Yan Y, Cao Y-M, Dang X-L, Wang K-K, Mu J-J. Effect of salt intake on serum glucagon-like peptide-1 levels in normotensive salt-sensitive subjects. *Kidney Blood Press Res*. 2017;42:728–737.
18. Zhang Y, Li FX, Liu F-Q, Chu C, Wang Y, Wang D, Guo T-S, Wang J-K, Guan G-C, Ren K-Y, Mu J-J. Elevation of fasting ghrelin in healthy human subjects consuming a high-salt diet: a novel mechanism of obesity? *Nutrients*. 2016;8:E323. DOI: 10.3390/nu8060323.
19. Cheung BM, Ho SP, Cheung AH, Lau CP. Diastolic blood pressure is related to urinary sodium excretion in hypertensive Chinese patients. *QJM*. 2000;93:163–168.

20. Gu D, He J, Wu X, Duan X, Whelton PK. Effect of potassium supplementation on blood pressure in Chinese: a randomized, placebo-controlled trial. *J Hypertens*. 2001;19:1325–1331.

21. Wang Y, Chu C, Wang K-K, Hu J-W, Yan Y, Lv Y-B, Cao Y-M, Zheng W-L, Dang X-L, Xu J-T, Chen W, Yuan Z-Y, Mu J-J. Effect of salt intake on plasma and urinary uric acid levels in Chinese adults: an interventional trial. *Sci Rep*. 2018;8:1434.

22. Hu J-W, Wang Y, Chu C, Mu J-J. Effect of salt intervention on serum levels of fibroblast growth factor 23 (FGF23) in Chinese adults: an intervention study. *Med Sci Monit*. 2018;24:1948–1954.

23. Wu Y, Cai R, Zhou B, Xu X. Effects of genetic factors and dietary electrolytes on blood pressure of rural secondary school students in Hanzhong. *Chin Med Sci J*. 1991;6:148–152.

24. Li Q, Cui Y, Jin R, Lang H, Yu H, Sun F, He C, Ma T, Li Y, Zhou X, Liu D, Jia H, Chen X, Zhu Z. Enjoyment of spicy flavor enhances central salty-taste perception and reduces salt intake and blood pressure. *Hypertension*. 2017;70:1291–1299.

25. Zhang GH, Ma JX, Guo XL, Dong J, Chen X, Zhang JY, Su JY, Tang JL, Xu AQ. [Field observation on the effect of low-sodium and high-potassium salt substitute on blood pressure in the rural community-based population in China]. *Zhonghua Liu Xing Bing Xue Za Zhi*. 2011;32:859–863.

26. Zhou X, Yuan F, Ji W-J, Guo Z-Z, Zhang L, Lu R-Y, Liu X, Liu H-M, Zhang W-C, Jiang T-M, Zhang Z, Li Y-M. High-salt intake induced visceral adipose tissue hypoxia and its association with circulating monocyte subsets in humans. *Obesity*. 2014;22:1470–1476.

27. Liu Y, Wu J, Zhang L, Xu H, Liu Z, Lu J, Zhang J, Feng L, Guo Q, Zhao C, Liu J, Wei H, Cao S, Zhao H. [Influence factors of salt-sensitive hypertension and responses of blood pressure and urinary sodium and potassium excretion to acute oral saline loading among essential hypertensive patients]. *Zhonghua Xin Xue Guan Bing Za Zhi*. 2013;41:1015–1019.

28. Cheung DBMY, Law CY, McGhee SM, Ng PPY, Lau C-P, Kumana CR. The relationship between sodium and blood pressure in Hong Kong Chinese. *Clin Res Regul Aff*. 2004;21:145–154.

29. Zhu D, Liu Z, Liu J, Liu Y. Renal endogenous ET-1 and urinary sodium excretion and microalbuminuria in human salt-sensitive hypertension. *J Pharm Anal*. 2001;13:30–32.

30. Duan L, Liu W, Zhang P, Liu S, Liu X, Sang M, Liu L, Lin H, Sang Z. Salt intake of lactating women as assessed by modified food weighted records. *J Am Coll Nutr*. 2018;37:614–619.

31. Hou R, Liu Z, Liu J. [The study of sympathetic nervous activity during the period of chronic salt loading in salt-sensitive subjects]. *Chin J Cardiol*. 1997;25:414–418.

32. Zhang Q, Liao Y, Tang C, Du J, Jin H. Twenty-four-hour urinary sodium excretion and postural orthostatic tachycardia syndrome. *J Pediatr*. 2012;161:281–284.

33. Jumabay M, Kawamura H, Mitsubayashi H, Ozawa Y, Izumi Y, Kasamaki Y, Shimabukuro H, Cheng Z, Aisa M, Wang S. Urinary electrolytes and hypertension in elderly Kazakhs. *Clin Exp Nephrol*. 2001;5:217–221.

34. Peng Y, Li W, Wang Y, Chen H, Bo J, Wang X, Liu L. Validation and assessment of three methods to estimate 24-h urinary sodium excretion from spot urine samples in Chinese adults. *PLoS One*. 2016;11:e0149655.

35. Zhou L, Tian Y, Fu J-J, Jiang Y-Y, Bai Y-M, Zhang Z-H, Hu X-H, Lian H-W, Guo M, Yang Z-X, Zhao L-C. Validation of spot urine in predicting 24-h sodium excretion at the individual level. *Am J Clin Nutr*. 2017;105:1291–1296.

36. Liu LS, Zhang KH, Wang J, Zhang XE, Wu HJ, Lin MQ, Gui RL, Du JH, Gu ML. Primary prevention of hypertension by sodium restriction. *Chin Med J (Engl)*. 1987;100:899–902.

37. He FJ, Wu Y, Feng XX, Ma J, Ma Y, Wang H, Zhang J, Yuan J, Lin CP, Nowson C, MacGregor GA. School based education programme to reduce salt intake in children and their families (School-EduSalt): cluster randomised controlled trial. *BMJ*. 2015;350:h770.

38. Chen J, Tian Y, Liao Y, Yang S, Li Z, He C, Tu D, Sun X. Salt-restriction-spoon improved the salt intake among residents in China. *PLoS One*. 2013;8:e78963.

39. Munn Z, Moola S, Lisy K, Riitano D, Tufanaru C. Methodological guidance for systematic reviews of observational epidemiological studies reporting prevalence and cumulative incidence data. *Int J Evid Based Healthc*. 2015;13:147–153.

40. Zhang J, Liu X, Tan Z, Chen Q. Mapping of the north-south demarcation zone in China based on GIS. *J Lanzhou Univ Nat Sci*. 2012;48:28–33.

41. Chen J, Liao Y, Li Z, Tian Y, Yang S, Tu D, He C, Sun X. Analysis of the determinants of salt-restriction behavior among urban and rural residents in Beijing with health belief model. *Beijing Da Xue Xue Bao Yi Xue Ban*. 2014;46:242–246.

42. He J, Klag MJ, Whelton PK, Chen JY, Mo JP, Qian MC, Coresh J, Mo PS, He GQ. Agreement between overnight and 24-hour urinary cation excretions in southern Chinese men. *Am J Epidemiol*. 1993;137:1212–1220.

43. Xu XJ, Liang XH, Hu GM, Mao XM, Quan YY, Ozawa Y, Zhang XY, Dilixiati, Maimaiti-Yasen. Ambulatory blood pressure and biochemical indicator analysis of 9-10 years old Kazakhstan Clan children in Xinjiang Baliken area. *J Clin Rehabil Tissue Eng Res*. 2009;13:1379–1382.

44. Ge Z, Guo X, Chen X, Tang J, Yan L, Ren J, Zhang J, Lu Z, Dong J, Xu J, Cai X, Liang H, Ma J. Association between 24 h urinary sodium and potassium excretion and the metabolic syndrome in Chinese adults: the Shandong and Ministry of Health Action on Salt and Hypertension (SMASH) study. *Br J Nutr*. 2015;113:996–1002.

45. Xu J, Chen X, Ge Z, Liang H, Yan L, Guo X, Zhang Y, Wang L, Ma J. Associations of usual 24-hour sodium and potassium intakes with blood pressure and risk of hypertension among adults in China's Shandong and Jiangsu Provinces. *Kidney Blood Press Res*. 2017;42:188–200.

46. Tian HG, Nan Y, Shao RC, Dong QN, Hu G, Pietinen P, Nissinen A. Associations between blood pressure and dietary intake and urinary excretion of electrolytes in a Chinese population. *J Hypertens*. 1995;13:49–56.

47. Hu BC, Li Y, Liu M, Li LH, Sheng CS, Zhang Y, Wang JG. Blood pressure and urinary sodium excretion in relation to 16 genetic polymorphisms in the natriuretic peptide system in Chinese. *Endocr J*. 2014;61:861–874.

48. Zhao L, Stamler J, Yan LL, Zhou B, Wu Y, Liu K, Daviglus ML, Dennis BH, Elliott P, Ueshima H, Yang J, Zhu L, Guo D. Blood pressure differences between northern and southern Chinese: role of dietary factors: the International Study on Macronutrients and Blood Pressure. *Hypertension*. 2004;43:1332–1337.

49. Liu L, Mizushima S, Gao M. Body mass index, urinary sodium excretion, and blood pressure in seven Chinese populations: results from the WHO Cardiovascular Diseases and Alimentary Comparison Study. *CVD Prev*. 2000;3:11–17.

50. Li J, Zhang Q, Liao Y, Zhang C, Du J. Clinical value of 24-hour urinary sodium determination in children with postural tachycardia syndrome. *Zhonghua Er Ke Za Zhi*. 2015;53:203–207.

51. Zhou X, Liu JX, Shi R, Yang N, Song DL, Pang W, Li YM. Compound ion salt, a novel low-sodium salt substitute: from animal study to community-based population trial. *Am J Hypertens*. 2009;22:934–942.

52. Yamori Y, Liu L, Mu L, Zhao H, Pen Y, Hu Z, Kuga S, Negishi H, Ikeda K; Japan-China Cooperative Study Group: Chongqing Project. Diet-related factors, educational levels and blood pressure in a Chinese population sample: findings from the Japan-China Cooperative Research Project. *Hypertens Res*. 2002;25:559–564.

53. Pan WH, Chen JY, Chen YC, Tsai WY. Diurnal electrolyte excretion pattern affects estimates of electrolyte status based on 24-hour, half-day, and overnight urine. *Chin J Physiol*. 1994;37:49–53.

54. Wang X, Li X, Vaartjes I, Neal B, Bots ML, Hoes AW, Wu Y. Does education level affect the efficacy of a community based salt reduction program?—a post-hoc analysis of the China Rural Health Initiative Sodium Reduction Study (CRHI-SRS). *BMC Public Health*. 2016;16:759.

55. Guo TS, Dai Y, Ren KY, Mu JJ, Ren J, Wang D, Wang Y, Chu C, Li Y, Yuan ZY. Effects of salt loading and potassium supplement on the circadian blood pressure profile in salt-sensitive Chinese patients. *Blood Press Monit*. 2017;22:307–313.

56. Xu J, Wang M, Chen Y, Zhen B, Li J, Luan W, Ning F, Liu H, Ma J, Ma G. Estimation of salt intake by 24-hour urinary sodium excretion: a cross-sectional study in Yantai, China. *BMC Public Health*. 2014;14:136.

57. He J, Gu D, Chen J, Jaquish CE, Rao DC, Hixson JE, Chen JC, Duan X, Huang JF, Chen CS, Kelly TN, Bazzano LA, Whelton PK. Gender difference in blood pressure responses to dietary sodium intervention in the GenSalt study. *J Hypertens*. 2009;27:48–54.

58. Deng T, Mai Z, Cai C, Duan X, Zhu W, Zhang T, Wu W, Zeng G. Influence of weight status on 24-hour urine composition in adults without urolithiasis: a nationwide study based on a Chinese Han population. *PLoS One*. 2017;12:e0184655.

59. Intersalt Cooperative Research Group. Intersalt: an international study of electrolyte excretion and blood pressure. Results for 24 hour urinary sodium and potassium excretion. *BMJ*. 1988;297:319–328.

60. Zhao GS, Yuan XY, Gong BQ, Wang SZ, Cheng ZH. Nutrition, metabolism, and hypertension. A comparative survey between dietary variables and blood pressure among three nationalities in China. *J Clin Hypertens*. 1986;2:124–131.

61. Zhang L, Zhao F, Zhang P, Gao J, Liu C, He FJ, Lin CP. A pilot study to validate a standardized one-week salt estimation method evaluating salt intake and its sources for family members in China. *Nutrients*. 2015;7:751–763.

62. Yongqing Z, Ming W, Jian S, Pengfei L, Xiaoqun P, Meihua D, Peian L, Jianmei D, Guoyu Z, Jie Y, Ping L, Yan X. Prevalence, awareness, treatment and control of hypertension and sodium intake in Jiangsu Province, China: a baseline study in 2014. *BMC Public Health*. 2016;16:56.
63. He J, Tell GS, Tang YC, Mo PS, He GQ. Relation of electrolytes to blood pressure in men. The Yi people study. *Hypertension*. 1991;17:378–385.
64. Zhu KM, He SP, Pan XQ, Zheng XR, Gu YA. The relation of urinary cations to blood pressure in boys aged seven to eight years. *Am J Epidemiol*. 1987;126:658–663.
65. Li J, Liao Y, Du J, Zhang Q. Relationship between 24-hour urinary sodium and renin-angiotensin-aldosterone system in children with postural tachycardia syndrome. *Zhonghua Yi Xue Za Zhi*. 2015;95:2928–2932.
66. Kesteloot H, Huang DX, Li YL, Geboers J, Joossens JV. The relationship between cations and blood pressure in the People's Republic of China. *Hypertension*. 1987;9:654–659.
67. Yang Y. Renal function of cations excretion in children predisposed to essential hypertension. *Zhonghua Yu Fang Yi Xue Za Zhi*. 1991;25:152–154.
68. Gu D, Zhao Q, Chen J, Chen JC, Huang J, Bazzano LA, Lu F, Mu J, Li J, Cao J, Mills K, Chen CS, Rice T, Hamm LL, He J. Reproducibility of blood pressure responses to dietary sodium and potassium interventions: the GenSalt study. *Hypertension*. 2013;62:499–505.
69. Liu ZM, Ho SC, Tang N, Chan R, Chen YM, Woo J. Urinary sodium excretion and dietary sources of sodium intake in Chinese postmenopausal women with prehypertension. *PLoS One*. 2014;9:e104018.
70. Ma W, Yin X, Zhang R, Liu F, Yang D, Fan Y, Rong J, Tian M, Yu Y. Validation and assessment of three methods to estimate 24-h urinary sodium excretion from spot urine samples in high-risk elder patients of stroke from the rural areas of Shaanxi Province. *Int J Environ Res Public Health*. 2017;14:E1211. DOI: 10.3390/ijerph14101211.
71. Han W, Sun N, Chen Y, Wang H, Xi Y, Ma Z. Validation of the spot urine in evaluating 24-hour sodium excretion in Chinese hypertension patients. *Am J Hypertens*. 2015;28:1368–1375.
72. Liu LS, Zheng DY, Lai SH, Wang GQ, Zhang YL. Variability in 24-hour urine sodium excretion in Chinese adults. *Chin Med J (Engl)*. 1986;99:424–426.
73. Liu LS, Zheng DY, Jin L, Liao YL, Liu K, Stamler J. Variability of urinary sodium and potassium excretion in north Chinese men. *J Hypertens*. 1987;5:331–335.
74. Tsai TJ, Su CJ, Chen YM, Hsieh BS, Chen WY, Yen TS. Urinary kallikrein excretion in chronic renal disease with respect to salt intake and renal reserve. *J Formos Med Assoc*. 1991;90:525–530.
75. Chan EL, MacDonald D, Ho SC, Swaminathan R. Potassium intake and urinary calcium excretion in healthy subjects. *Miner Electrolyte Metab*. 1993;19:36–38.
76. Chan TY, Chan AY, Lau JT, Critchley JA. Sodium and potassium intakes and blood pressure in Chinese adults in Hong Kong: a comparison with southern China. *Asia Pac J Clin Nutr*. 1998;7:33–36.
77. Xie J, Liu L, Kesteloot H. Blood pressure and urinary cations in a low-fat intake Chinese population sample. *Acta Cardiol*. 2001;56:163–168.
78. Ge Z, Zhang J, Chen X, Guo X, Yan L, Tang J, Cai X, Xu J, Hou L, Ma J. Association between 24 h urinary sodium to potassium ratio and metabolic syndrome in Chinese adults. *Chinese Journal of Epidemiology*. 2015;36(8):790–793.
79. Dong W, Zhang Q, Jiang J, Chen H, Chen X, Shao S, Liu J, Ji Y. Evaluating the sodium intake of community residents in Shantou city by 24-h urine method. *Chin J Prev Contr Chron Di*. 2017;25(7):481–484.
80. Cogswell ME, Maalouf J, Elliott P, Loria CM, Patel S, Bowman BA. Use of urine biomarkers to assess sodium intake: challenges and opportunities. *Annu Rev Nutr*. 2015;35:349–387.
81. Chinese Nutrition Society. *Chinese Dietary Guidelines (2016) [M]*. Beijing: China Science Publishing and Media Ltd; 2016.
82. Chinese Nutrition Society. *Chinese Dietary Reference Intakes (2013 Edition) [M]*. Beijing: Science Press; 2014.
83. Hipgrave DB, Chang S, Li X, Wu Y. Salt and sodium intake in China. *JAMA*. 2016;315:703–705.
84. Kimura M, Itokawa Y. Cooking losses of minerals in foods and its nutritional significance. *J Nutr Sci Vitaminol (Tokyo)*. 1990;36(suppl 1):S25–S32; discussion S33.
85. Burrowes JD, Ramer NJ. Changes in potassium content of different potato varieties after cooking. *J Ren Nutr*. 2008;18:530–534.
86. Huang L, Crino M, Wu JHY, Woodward M, Barzi F, Land M-A, McLean R, Webster J, Enkhtungalag B, Neal B. Mean population salt intake estimated from 24-h urine samples and spot urine samples: a systematic review and meta-analysis. *Int J Epidemiol*. 2016;45:239–250.
87. Mente A, O'Donnell MJ, Dagenais G, Wielgosz A, Lear SA, McQueen MJ, Jiang Y, Xingyu W, Jian B, Calik KBT, Akalin AA, Mony P, Devanath A, Yusufali AH, Lopez-Jaramillo P, Avezum A, Yusoff K, Rosengren A, Kruger L, Orlandini A, Rangarajan S, Teo K, Yusuf S. Validation and comparison of three formulae to estimate sodium and potassium excretion from a single morning fasting urine compared to 24-h measures in 11 countries. *J Hypertens*. 2014;32:1005–1015.
88. Cogswell ME, Mugavero K, Bowman BA, Frieden TR. Dietary sodium and cardiovascular disease risk-measurement matters. *N Engl J Med*. 2016;375:580–586.
89. Campbell NRC, He FJ, Tan M, Cappuccio FP, Neal B, Woodward M, Cogswell ME, McLean R, Arcand J, MacGregor G, Whelton P, Jula A, L'Abbe MR, Cobb LK, Lackland DT. The International Consortium for Quality Research on Dietary Sodium/Salt (TRUE) position statement on the use of 24-hour, spot, and short duration (<24 hours) timed urine collections to assess dietary sodium intake. *J Clin Hypertens*. 2019;21:700–709.
90. Liu L, Mizushima S, Ikeda K, Hattori H, Miura A, Gao M, Nara Y, Yamori Y. Comparative studies of diet-related factors and blood pressure among Chinese and Japanese: results from the China-Japan Cooperative Research of the WHO-CARDIAC Study. Cardiovascular Disease and Alimentary Comparison. *Hypertens Res*. 2000;23:413–420.
91. Stamler J, Elliott P, Dennis B, Dyer AR, Kesteloot H, Liu K, Ueshima H, Zhou BF. INTERMAP: background, aims, design, methods, and descriptive statistics (nondietary). *J Hum Hypertens*. 2003;17:591–608.
92. Li L, Rao K, Kong L, Yao C, Xiang H, Zhai F, Ma G, Yang X; Technical Working Group of China National Nutrition and Health Survey. [A description on the Chinese national nutrition and health survey in 2002]. *Zhonghua Liu Xing Bing Xue Za Zhi*. 2005;26:478–484.
93. Hu D, Reardon T, Rozelle S, Timmer P, Wang H. The emergence of supermarkets with Chinese characteristics: challenges and opportunities for China's agricultural development. *Dev Policy Rev*. 2004;22:557–586.
94. Zhai FY, Du SF, Wang ZH, Zhang JG, Du WW, Popkin BM. Dynamics of the Chinese diet and the role of urbanicity, 1991–2011. *Obes Rev*. 2014;15 (suppl 1):16–26.
95. Yu D, He Y, Fang H, Xu X, Wang X, Yu W, Jia F, Yang X, Ma G, Zhao L. Salt intake among Chinese adults in 2010–2012. *Zhonghua Yu Fang Yi Xue Za Zhi*. 2016;50:217–220.
96. Xia J, Wright J, Adams CE. Five large Chinese biomedical bibliographic databases: accessibility and coverage. *Health Info Libr J*. 2008;25:55–61.
97. Cohen JF, Korevaar DA, Wang J, Spijker R, Bossuyt PM. Should we search Chinese biomedical databases when performing systematic reviews? *Syst Rev*. 2015;4:23.
98. He FJ, Zhang P, Li Y, MacGregor GA. Action on salt China. *Lancet*. 2018;392:7–9.
99. He FJ, MacGregor GA. Importance of salt in determining blood pressure in children: meta-analysis of controlled trials. *Hypertension*. 2006;48:861–869.
100. Chen X, Wang Y. Tracking of blood pressure from childhood to adulthood: a systematic review and meta-regression analysis. *Circulation*. 2008;117:3171–3180.
101. Chang HY, Hu YW, Yue CSJ, Wen YW, Yeh WT, Hsu LS, Tsai SY, Pan WH. Effect of potassium-enriched salt on cardiovascular mortality and medical expenses of elderly men. *Am J Clin Nutr*. 2006;83:1289–1296.
102. Peng YG, Li W, Wen XX, Li Y, Hu JH, Zhao LC. Effects of salt substitutes on blood pressure: a meta-analysis of randomized controlled trials. *Am J Clin Nutr*. 2014;100:1448–1454.
103. Newberry SJ, Chung M, Anderson CAM, Chen C, Fu Z, Tang A, Zhao N, Booth M, Marks J, Hollands S, Motala A, Larkin J, Shanman R, Hempel S. Effects of dietary sodium and potassium intake on chronic disease outcomes and related risk factors. Agency for Healthcare Research and Quality (AHRQ); 2018. Report No.: 18-EHC009-EF.

SUPPLEMENTAL MATERIAL

Data S1. Search strategies

Database: **MEDLINE** (via Ovid)

Dates: from 1946 to 1st February 2019

Search terms: 1. exp Sodium Chloride/ OR exp Sodium/ OR salt.mp OR exp Potassium/

2. exp China/ OR Chinese.mp OR exp Taiwan/

3. dietary.mp OR intake.mp OR urinary.mp

4. 1 AND 2 AND 3

Database: **EMBASE**

Dates: from 1974 to 1st February 2019

Search terms: 1. 'sodium chloride'/exp OR 'sodium chloride' OR 'sodium'/exp OR 'sodium' OR ‘salt’ OR ‘potassium’/exp OR ‘potassium’

2. 'china'/exp OR 'china' OR 'chinese'/exp OR 'chinese' OR 'taiwan'/exp OR 'taiwan'

3. 'dietary' OR 'intake' OR 'urinary'

4. 1 AND 2 AND 3

Database: **Scopus**

Dates: from 1980 to 1st February 2019

Search terms: 1. 'sodium chloride' OR 'sodium' OR ‘salt’ OR ‘potassium

2. 'china' OR 'chinese' OR 'taiwan'

3. 'dietary' OR 'intake' OR 'urinary'

4. 1 AND 2 AND 3

Database: **China National Knowledge Infrastructure (CNKI)**

Dates: from 1979 to 1st February 2019

Search terms: 1. SU = ('盐' + '钠' + '食用盐' + '食用钠' + '钾')

2. SU = ('中国' + '中国人' + '我国' + '台湾')

3. SU = ('消耗' + '摄入' + '食用' + '尿')

4. 1 * 2 * 3

Database: **WanFang**

Dates: unclear start date, to 1st February 2019

Search terms: 1. 主题: ('盐' + '钠' + '食用盐' + '食用钠' + '钾')

2. 主题: ('中国' + '中国人' + '我国' + '台湾')

3. 主题: ('消耗' + '摄入' + '食用' + '尿')

4. 1 * 2 * 3

Data S2. Quality analyses of the studies included in the systematic review and meta-analysis

- Appropriate sample frame? Whether the sample frame was appropriate to address the target population (eg, if the target population consisted of the Chinese adult population, choosing the outpatient department of a single hospital was not considered an appropriate sampling frame and was therefore marked as ‘high risk’).
- Appropriate sampling method**?** Whether the sample was representative of the population (eg, convenience samples were not considered appropriate and was therefore marked as ‘high risk’).
- Adequate sample size (sample size calculation)? Whether a sample size calculation to detect a difference in sodium or potassium intake was made (eg, a sample size calculation to detect a difference in systolic blood pressure was not considered to be appropriate and was therefore marked as ‘high risk’).
- Detailed description of subjects and setting? Whether the study sample was described in sufficient details so that other researchers can determine if it is comparable to the population of interest to them (eg, not providing study sites was not to be considered appropriate and was therefore marked as ‘high risk’).
- Sufficient coverage of the data analysis? Coverage bias: whether all subgroups of the identified sample responded at the same rate (if separate response rates were not provided for the different subgroups of the sample, this was marked as ‘unclear risk’).
- Valid data collection methods (completeness of samples assessed)? Measurement bias: whether the completeness of the urine samples was assessed or not (if not reported in the article, this was marked as ‘unclear risk’).
- Standardised data collection (staff trained, instructions given)? Whether the study staff were trained in 24h urine samples collection and whether the participants were given

clear instructions for collection (both criteria had to be met for this domain to be marked as ‘low risk’)

- Appropriate calculation of sodium or potassium excretion? Whether enough details were provided on how the sodium or potassium excretion values were obtained from the urine samples.
- Adequate response rate? Whether there was a minimum of 80% response rate (if not, this was marked as ‘high risk’).

Table S1. Characteristics of included studies

Children aged 3–6 years

Study	Design	Site	Study dates	Population		n	Sodium excretion ±SE, mmol/24h	Potassium excretion ±SE, mmol/24h	Creatinine excretion ±SE, mmol/24h	Urine volume ±SE, ml/24h	Assessment of 24h urine completeness
Liu et al, 1987[1]	Non-randomised controlled trial	Two kindergartens of the Capital Iron and Steel Company, Beijing	Apr-May 1984	Children aged 3-5 years	Experimental group (baseline)	36	108.9±4.39	18.3±0.9	2.02±0.15		NR
					Control group (baseline)	37	91.3±9.27	17.6±0.98	1.24±0.1		
Yang et al, 1991[2]	Pre-post trial	Wuhan	NR	Children aged 4-6 years	Before saline load: family history of essential hypertension	35	71.89±3.89	11.28±0.72			NR
					Before saline load: without family history of essential hypertension	51	77.25±2.92	11.63±0.6			

Children aged 6–16 years

Study	Design	Site	Study dates	Population		n	Sodium excretion ±SE, mmol/24h	Potassium excretion ±SE, mmol/24h	Creatinine excretion ±SE, mmol/24h	Urine volume ±SE, ml/24h	Assessment of 24h urine completeness
Zhu et al, 1987[3]	Cross-sectional	Two community primary schools in Wuhan, China	1984-85	Second-grade boys aged 7-8 years		148	128.75±2.95	19.69±0.54	3.66±0.06		Ascertained each day; specimens with 24h creatinine <10 mg/kg body weight discarded and an additional one was collected
			NR		Male	94	181.5±6.69	23.84±0.85			Not assessed

Wu et al, 1991[4]	Cross-sectional	Rural district of Hanzhong municipality, Shaanxi Province		Secondary school students aged 12-16 years	Female	87	166.5±6.55	21.54±0.88			
					Total	181	174.3±4.71	22.74±0.62			
Xu et al, 2009[5]	Cross-sectional	Xinjiang Baliken area	Aug-Sep 2005	Kazakhstan Clan children aged 9-10 years		49	190.81±8.14	29.35±1.55	11.34±0.63		NR
Zhang et al, 2012[6]	Pre-post trial	Department of Pediatrics of Peking University First Hospital	NR	Healthy controls, mean age 13 years (SD=3)	Control group	10	193.88±28.81				NR
Li et al, 2015[7]	Pre-post trial	Peking University First Hospital	Jun 2012-May 2014	Healthy controls, mean age 11. 0years (SD=4.0)	Control group	10	221.3±32.76				NR
Zhang et al, 2015 [children][8]	Cross-sectional	Huairou District, Beijing	Apr 2012	Mean age 10.0 years (SD=3.2) in children, 42.3 years (SD=9.4) in adults	Children	16	169.4±11.33	34.8±2.65	6±1	1037±66	
Li et al, 2015[9]	Cross-sectional	Department of Pediatrics, Peking University First Hospital	Jun 2012-Feb 2014	Children with postural tachycardia syndrome, mean age 11.2 years (SD=2.0); healthy controls, mean age 11.1 years (SD=2.4)	24h Una ≥124 mmol/24h	18	154±5.42				NR
					24h Una ≤124 mmol/24=h	21	101±3.06				
He et al, 2015	Randomised controlled trial	Primary schools in urban	May 2013-Dec 2013	School-EduSalt: fifth-graders (mean age	Control group - children (baseline)	138	116.7±5.2	25.4±0.9	4.9±0.2	862±38	New collection if missed one or more urine voids or spilt

[children][10]		Changzhi, northern China		10.1 years, SD=0.5) and adult members of their families (mean age 43.8 years, SD=12.2)	Intervention group - children (baseline)	140	124.2±5.1	23.5±0.9	4.7±0.2	952±38	>10% of the total 24h urine volume

Adults aged >16 years

Study	Design	Site	Study dates	Population		n	Sodium excretion ±SE, mmol/24h	Potassium excretion ±SE, mmol/24h	Creatinine excretion ±SE, mmol/24h	Urine volume ±SE, ml/24h	Assessment of 24h urine completeness
Tsai et al, 1980[11]	Cross-sectional	Department of Internal Medicine of the National Taiwan University Hospital	Aug 1983-Aug 1987	Healthy controls, aged 39.06 years (SD=2.01)	Healthy controls	36	150.59±1.72	35.01±0.35			Checked by daily urine creatinine excretion
Zhao et al, 1986[12]	Cross-sectional	Xinjiang Autonomous Region	NR	Men aged 40-59 years from communities with little migration and eating traditional foods	Kazak	92	248±9.59	39.9±1.86			NR
					Han	82	188±9.06	57.7±2.93			
					Uygur	83	207±9.55	52.5±2.9			
Liu et al, 1986[13]	Cross-sectional	Fuwai Hospital	1981-83	Healthy male doctors and technicians, aged 30-50 years	1st day	49	231.2±12.84				Each participant was asked to return the specimens with assurance of correct collection. If a mistake was made in the collection, it had to be done over again.
					2nd day	49	249.5±13.3				
					3rd day	49	262.5±13.81				
					4th day	49	236.5±13.94				
					5th day	49	253.5±15.2				
					6th day	49	236.4±13.67				
	Cross-sectional	Northern China:	Nov 1984-	Northern China: mean age 40.4	Men - North	498	226.9±3.98	37.5±0.71	11.11±0.18		Not assessed
					Men - South	504	179.4±3.25	28.8±0.58	11.28±0.14		

Kesteloot et al, 1987[14]		region of Beijing; South China: region of Fuchow	Jan 1985	years (SD=14.4) in men, 40.2 years (SD=14.4) in women; South China: 40.4 years (SD=14.4) in men, 40.5 years (SD=14.3) in women.	Women - North	505	204.6±3.65	37.5±0.76	7.77±0.13		
					Women - South	501	172.4±3.15	29.7±0.52	7.62±0.09		
Liu et al, 1987[15]	Cross-sectional	Fu-Wai Hospital, Beijing	1984	Healthy normotensive male employees, aged 27-50 years (mean 35)	50	252.3±9.86	37.8±1.39	6±0.16		Not assessed	
Rose et al, 1988[16]	Cross-sectional	Beijing, Nanning, Tianjin, Taiwan	1982-85	INTERSALT: aged 20-59 years	Beijing	200	204.1±4.7	35.3±0.74	9.5±0.11	1370±36	Assessed by a standardised interview
					Nanning	200	169.2±4.32	27.2±0.59	9.4±0.11	1220±36	
					Tianjin	200	245.6±5.89	33.6±0.74	9.6±0.13	1700±42	
					Taiwan	181	141.4±4.47	31.7±1.11	8.7±0.22	1160±36	
He et al, 1991[17]	Cross-sectional	Puge County, Southern China	1986	Yi People Study - four male population groups: high-mountain Yi farmers at ~2,750 m above sea level (mean age 30.9 years, SD=11.5), mountainside Yi farmers at ~1,800 m elevation level (mean age 36.4 years, SD=14.3), Yi people who migrated to the county seat (mean age 39.3 years, SD=12.7), and native Han people of the county seat	High-mountain Yi farmers	119	73.9±4.61	58.6±2.84			Participants questioned about the completeness of the collection by a local physician
					Mountainside Yi farmers	114	117.9±5.19	48.5±2.63			
					County seat Yi migrants	89	159.4±6.64	28.3±1.44			
					County seat Han people	97	186±7.41	29±1.06			

				(mean age 36.4 years, SD=12.1)							
He et al, 1993[18]	Cross-sectional	Liangshan Yi People Autonomous Prefecture (Liangshan), Southwestern China	Apr 1989	Yi Migrant Study: men aged 19-55 years	Rural sample: Yi farmers, day 1	30	119.5±12.56	84±11.05			Subjects asked to repeat collection if reported to be incomplete, or a timing error exceeding 30 minutes was noted
					Rural sample: Yi farmers, day 2	30	136.6±15.06	88.7±13.27			
					Rural sample: Yi farmers, day 3	30	138.3±13	83.2±10.41			
					Urban sample: Yi migrants and Han people, day 1	33	171.6±11.12	29.1±2.12			
					Urban sample: Yi migrants and Han people, day 2	33	172.7±14.41	29.3±2.3			
					Urban sample: Yi migrants and Han people, day 3	33	188.9±9.35	30.7±2.33			
					Total, day 1	63	146.8±8.92	55.2±6.36			
					Total, day 2	63	155.5±10.58	57.6±7.41			
					Total, day 3	63	165.2±8.44	55.2±6.02			
Chan et al, 1993[19]	Cross-sectional	NR	NR	Healthy female university students and visitors of a family clinic, mean age 24.1 years (SD=7.09)		142	129±4.4	35±1.26	7.5±0.17		Not assessed
Pan et al, 1994[20]	Cross-sectional	Taiwan	Mar-Apr 1992	Research staff of the Insitute of Biomedical Sciences, Academia Sinica, in their 20s		40	151.3±8.11	37.1±2.18			NR
Tian et al, 1995[21]	Cross-sectional	Tianjin City	1992	Mean age 43.6 years (SD=13.6) in men, 43.5 years (SD=13.3) in women	Male	328	257.8±4.75	42.4±0.94			
					Female	335	249.2±4.45	45±0.99			
	Pre-post trial	NR	NR	Graduate school students and staff	Salt sensitive subjects	9	221±13.33	66.97±4.04			NR

Hou et al, 1997[22]				members, aged 23-40 years	Non-salt sensitive subjects	14	233±13.9	62.97±3.76			
Chan et al, 1998[23]	Cross-sectional	Hong Kong	Oct 1989-May 1991	Healthy subjects, aged 20-65 years	Men	42	145.2±7.51	40.4±2.33			Undercollection = creatinine output < 5.3 mmol in women and < 7.1 mmol in men; overcollection = creatinine output > 15.9 mmol in women and 17.7 mmol in men
					Women	84	135.3±5	41.3±1.56			
Liu et al, 2000[24]	Cross-sectional	Taiwan, Shanghai, Urumiqi, Lhasa, Guizang, Guangzhou, Shijiazhuang	1985-97	WHO-CARDIAC: aged 48-65 years	Total	1389	189.5±3	32.1±0.6	9.06±0.09		Assessed by urinary creatinine excretion in relation to weight
					Urumigi	200	209.6±11.5	44.7±1.7	9.86±0.44		
					Lhasa	125	255.1±12	39.8±2.7	7.39±0.26		
					Guiyang	206	142.2±4.9	23.3±0.7	7.74±0.18		
					Guangzhou	217	140.8±5.7	21.1±0.8	9.06±0.26		
					Taiwan	200	152±5	50.3±2	10.65±0.35		
					Shanghai	225	224.4±6.5	26.4±0.7	9.77±0.18		
					Shijianzhuang	216	219.5±7.3	32.3±1.1	8.27±0.18		
Cheung et al, 2000[25]	Cross-sectional	Queen Mary Hospital, Hong Kong	NR	Hypertensive outpatients: individuals referred to the hypertension outpatient clinic, mean age 46 years (SD=14); normotensive controls: mean age 41 years (SD=12)	Hypertensive patients - total	70	172±7.65	40±1.91			NR
					Hypertensive patients - male	43	176±10.52	43±2.74			
					Hypertensive patients - female	27	165±10.78	35±2.12			
					Normotensive controls - total	47	161±7.73	51±2.33			
					Normotensive controls - male	21	175±10.47	54±3.49			
					Normotensive controls - female	26	149±10.79	48±3.14			
Gu et al, 2001[26]	Randomised	North of Beijing	NR	Aged 45-64 years	Assigned to potassium	75	175.6±7.44	35.8±1.79	6.25±0.24		NR

	controlled trial				supplementation (baseline)						
					Assigned to placebo (baseline)	75	188±8.37	36.2±1.37	6.83±0.26		
Zhu et al, 2001[27]	Cross-sectional	Department of Cardiology, First Hospital of Xi'an Jiaotong University	NR	Outpatients, mean age 48 years (SD=6) in hypertensives, 47 years (SD=8) in normotensives	High blood pressure - salt sensitive	17	239±17.22				NR
					High blood pressure - salt resistant	15	270±23.75				
					Non-high blood pressure - salt sensitive	8	231±16.97				
					Non-high blood pressure - salt resistant	13	193±18.86				
Jumabay et al, 2001[28]	Cross-sectional	Barkol area in the Xinjiang region	NR	Kazakh and Han people aged 65-70 years	Kazakh subjects	117	181.4±7.17	18.9±0.8			NR
					Han subjects	50	194.1±10.73	36.5±1.6			
Xie et al, 2001[29]	Cross-sectional	Farming village in Hubai Province (North China)	Mar 1995	Mean age 40.0 years (SD=16.5) in men, 36.7 years (SD=15.7) in women	Men	179	152.9±4.67	28.7±1.29	6.6±0.33		Not assessed
					Women	153	123.3±4.79	23.7±1.16	5.1±0.23		
Yamori et al, 2002[30]	Cross-sectional	Daping District of Chongqing	Oct 2000	Extension of WHO-CARDIAC: men aged 43-55 years		118		140.7±5.39	30.9±1		NR
Zhao et al, 2004[31]	Cross-sectional	Pinggu County, Beijing; Yu County, Shanxi Province; Wuming County, Guangxi Zhuang	Sep 1997-Jan 1998	INTERMAP: rural populations, mean age 48.9 years (SD=5.8) in the North, 49.1 years (SD=5.7) in the South	Beijing (North)	272	275±5.46	37±0.72			Specimens rejected if collection time fell outside the range 22-26 h, if the participant responded that collection was incomplete, or he/she had lost 'more than a few
					Shanxi (North)	289	268±5	37.1±0.66			
					North	561	271±3.72	37.1±0.49			
					Guangxi (South)	278	139±3.42	40.6±0.88			

		Autonomous Region									drops' of urine, or if total volume was less than 250 ml. The participant was then asked to repeat the collection.
Cheung et al, 2004[32]	Cross-sectional	Hong Kong	NR	Mean age 40.3 years (SD=12.7) in normotensive subjects, 51.0 years (SD=12.2) in hypertensive subjects	All subjects	190	167.4±4.85	45.7±1.29			Not assessed
					Normotensive	151	166.6±5.57	46.2±1.46			
					Hypertensive	39	170.6±9.8	43.9±2.69			
Zhou et al, 2009[33]	Randomised controlled trial	Rural Hedong District, Tianjin	Sep 2003-May 2004	Rural communities, participants aged 50-80 years	Hypertensives on compound ion salt	62	238±4.89	23.5±0.91			NR
					Hyper-tensivse on normal salt	64	241±5.78	24.6±1.02			
					Normotensives on compoud ion salt	57	237±6.62	22.8±0.95			
					Normotensives on normal salt	65	239±4.54	23.7±0.97			
He et al, 2009[34]	Crossover trial	Rural areas in north China: Hebei, Henan, Shandong, Shaanxi, and Jiangsu provinces	Oct 2003-Jul 2005	GenSalt: mean age 39.3 years (SD=9.6) in men, 38.1 years (SD=9.4) in women	Men	1010	251.1±2.2	37.2±0.3	9.31±0.07		NR
					Women	896	232.7±2.06	36.4±0.33	7.83±0.06		
Zhang et al, 2011[35]	Pre-post trial	Laiwu city, Shandong Province	2010	Rural communities, participants aged 30-60 years	High blood pressure	195	204±4.44	24.8±0.79			NR
					Non-high blood pressure	216	184.6±3.86	23.7±0.65			
Liu et al, 2013[36]	Pre-post trial	Jinxi Second Community Service	NR	Hypertensives Han people, mean	Salt-sensitive hypertensive patients	63	179.47±11.04	47.98±2.47			If incomplete collection, participant asked

		Centre in Chaoyang District, Beijing		age 57.5 years (SD=8.5)	Non-salt-sensitive hypertensive patients	279	196.84±5.48	48.13±1.30			to re-collect the next day
Gu et al, 2013[37]	Crossover trial	18 of the 45 GenSalt study villages in rural areas in northern China	Aug 2008-Nov 2009	Follow-up to the GenSalt study: mean age 44.3 years (SD=8.7)		487	249±3.4	40±0.61			NR
Chen et al, 2013[38]	Randomised controlled trial	Two villages in the suburban area of Beijing	Jun 2012 - Jan 2013	Mean age 54.69 years (SD=12.30) in intervention group, 51.90 years (SD=13.54) in control group	Intervention group (baseline)	99	204.28±10.65				Not assessed
					Control group (baseline)	74	231.34±11.24				
Chen et al, 2014[39]	Cross-sectional	Xicheng and Shunyi districts in Beijing	Jul 2012	Mean age 57.7 years (SD=13.8)	Urban respondents	396	113.7±3.65				NR
					Rural respondents	403	212.18±5.23				
Hu et al, 2014[40]	Cross-sectional	JingNing County	2003-09	Primary study: mean age 46.5 years (SD=15.9) in men, 43.5 years (SD=15.0) in women; age of validation study's participants NR.	Primary study - Gene and polymorphism rs3811544 (NPPC), CC	902	178.4±2.83	24.8±0.34		1240±1	Urinary samples less than 600 mL were excluded
					Primary study - Gene and polymorphism rs3811544 (NPPC), CC±TT	49	205.8±11.6	26.6±1.38		1390±11	
					Validation study - Gene and polymorphism rs3811544 (NPPC), CC	1273	140.2±2.05	23.4±0.35		1110±0	
					Validation study - Gene	82	145.1±8.71	23±1.5		1160±7	

					and polymorphism rs3811544 (NPPC), CC±TT						
Xu et al, 2014[41]	Cross-sectional	Yantai, Shandong Province	Jul 2011	SMASH pilot: mean age 42.3 years (SD=13.5)	Men	98	218.3±8.22	45.9±1.81	11±0.23		Creatinine [mg/day]/body weight [kg] of 14.4 to 33.6 in men and 10.8 to 25.2 in women were classified as indicating an Acceptable 24h urine collection
					Women	93	183.8±7.24	47.7±2.87	7.6±0.17		
					Total	191	201.5±5.62	46.8±1.68	9.4±0.19	1442±42	
Zhou et al, 2014[42]	Crossover trial	NR	NR	Mean age 27.3 years (SD=0.84)	Day 3 (baseline)	23	161±10.8	37.3±2.93	9.73±0.99	1898±38	NR
Liu et al, 2014[43]	Cross-sectional	Hong Kong	2011	Postmenopausal women with prehypertension aged 48-70 years	Sensitivity analyses	569	132.24±2.12	57.7±0.83	8.5±0.11	2082±27	Sensitivity analyses excluded subjects with missed voids and subjects with 30% or higher coefficients of variation in weight-corrected creatinine (24h creatinine excretion in milligrams divided by body weight in kilograms)
Ge et al, 2015[44]	Cross-sectional	Shandong (Gaomi and Fushan sites) and Jiangsu (Xinyi and Ganyu sites)	Jun-Jul 2011	SMASH participants: mean age 39.7 years (SD=13.9) in those without metabolic syndrome, 46.1 years (SD=13.0)	Without metabolic syndrome	1435	224.8±2.12	40.4±0.52			
					With metabolic syndrome	471	240.4±4.05	41.9±0.9			

				in those with metabolic syndrome							
Ge et al, 2015[45]	Cross-sectional	Gaomi and Fushan in Shandong Province, Xinyi and Ganyu in Jiangsu Province	2013	SMASH: mean age 42.1 years (SD=13.4)	Total	2281	166.9±0.54	25.3±0.07			Incomplete urine collection defined as either a 24h urinary volume less than 500 ml or a 24h urinary creatinine volume that was ± 2 SD outside of the sex-specific mean
					Male	1135	172.4±0.86	25.3±0.11			
					Female	1146	161.6±0.65	25.3±0.09			
					Fushan	551	170.4±1.57	23.8±0.18			
					Gaomi	568	138.7±0.99	23±0.12			
					Xinyi	598	178.8±0.75	26.2±0.09			
					Ganyu	564	180.8±0.9	28.2±0.12			
Wang et al, 2015[46]	Crossover trial	Northern China	NR	Rural community, mean age 49.0 years (SD=7.9)	Baseline	48	173.9±9.69	47.4±2.9			NR
Zhang et al, 2015 [adults][8]	Cross-sectional	Huairou District, Beijing	Apr 2012	Mean age 10.0 years (SD=3.2) in children, 42.3 years (SD=9.4) in adults	Adults	10	330.4±17.27	68.9±5.98	13.8±2.9	2079±167	NR
He et al, 2015 [adults][10]	Randomised controlled trial	Primary schools in urban Changzhi, northern China	May 2013-Dec 2013	School-EduSalt: fifth-graders (mean age 10.1 years, SD=0.5) and adult members of their families (mean age 43.8 years, SD=12.2)	Control group - adults (baseline)	273	215.1±6.7	36±1	9.5±0.2	1636±61	Participant asked to do another 24h collection if missed one or more urine voids or spilt >10% of the total 24h urine volume
					Intervention group - adults (baseline)	275	167.13±11.46	45.41±5.09	9.85±0.72	1200±27	
Han et al, 2015[47]	Cross-sectional	Department of Hypertension at Peking University People's Hospital, Beijing	Mar 2010-Feb 2012	Regular hypertensive visitors, mean age 58.4 years (SD=14.5)		222	147.9±4.15		11.0±0.04		Complete 24-hour urine collection was defined as urine volume ≥500 ml as measured by a technician, recorded collection of ≥20 hours, and reports of spilling urine or missing a

											void no more than once in 24 hours
Wang et al, 2016[48]	Randomised controlled trial	Northern rural China: Hebei, Liaoning, Shanxi, Shaanxi, Ningxia Autonomous Region	May 2011-Nov 2012	CRHI-SRS controls: mean age 53.9 years (SD=14.1)	Controls	928	250.5±3.08	45.4±0.62			Urine collections excluded if participants reported missing more than one void, a collection period less than 22 h or longer than 26 h, suspected spillage of more than 10 % of the total volume, volume < 500 ml or > 6000 ml, urinary creatinine < 4.0 mmol/day or > 25 mmol/day for women or urinary creatinine < 6.0 mmol/day or > 30 mmol/day for men
Zhang et al, 2016[49]	Crossover trial	Northern China	NR	Rural community, mean age 50.6 years (SD=2.1)	Baseline	38	175.8±1.80				NR
Yongqing et al, 2016[50]	Cross-sectional	Jiangsu Province	Dec 2013-May 2014	Mean age 41.55 years (SD=13.797)	Male	1069	196.36±2.21	28.37±0.31			Assessed based on creatinine excretion
					Female	1133	180.47±1.95	27.64±0.27			
					Urban	823	205.23±2.49	29.97±0.35			
					Rural	1379	178.02±1.78	26.81±0.24			
					Aged 18-34 years	625	189.55±2.8	26.47±0.35			
					Aged 35-49 years	731	190.91±2.65	28.34±0.37			
					Aged 50-59 years	846	184.82±2.31	28.81±0.33			

					Total	2202	188.19±1.48	27.99±0.2			
Peng et al, 2016[51]	Cross-sectional	Shanxi Province	NR	PURE substudy: mean age 53.16 years, SD=8.09		116	157.93±4.65	27.59±1.09		1869±76	Participants with incomplete urine collections or missing data were excluded from this analysis
Zheng et al, 2017[52]	Crossover trial	Northern China	NR	Rural community, mean age 52.2 years (SD=1.8) in salt-sensitive subjects, 50.8 years (SD=2.4) in salt-resistant subjects	Salt-sensitive subjects (baseline)	13	156.2±13.9	29±2.4			NR
					Salt-resistant subjects (baseline)	25	175.3±12.9	32±1.6			
Guo et al, 2017[53]	Crossover trial	Rural area of Shaanxi Province	Jul-Aug 2013	Mean age 51.3 years (SD=2.5) in salt-sensitive subjects, 49.6 years (SD=1.4) in non-salt-sensitive subjects	Salt-sensitive subjects (baseline)	14	167.13±11.46	45.41±5.09	9.85±0.72	1200±27	NR
					Non-salt-sensitive subjects (baseline)	35	177.07±12.53	48.04±3.56	9.51±0.49	1160±12	
					Baseline	38	180.53±8.47	40.91±0.85	9.93±0.18	1445±32	
Li et al, 2017[54]	Cross-sectional	Shenyang, Jinan, Chengdu, Chongqing	NR	Mean age 39.0 years (SD=10.5) in low-salt preference group, 39.7 years (SD=9.8) medium-salt preference group, 44.0 years (SD=8.4) in high-salt preference group	Low-Salt Preference Group	416	191.4±4.03				NR
					Medium-Salt Preference Group	94	221.9±9.33				
					High-Salt Preference Group	96	243.2±8.18				
Deng et al, 2017[55]	Cross-sectional	Shanghai, Chongqing, Harbin, Shaoyang,	May 2013-Jul 2014	Han adults: mean age 48.86 years (SD=16.25) in the standard weight	Standard weight adults	376	207.93±52.97	41.41±2.82	9.46±0.55	1296±87	Exclusion: incomplete urine samples (urine
					Under-weight adults	24	194.79±6.75	47.54±1.89	9.95±0.23	1523±55	

		Lanzhou, Changshi		group, 53.96 years (SD=19.28) in the underweight group, 52.14 years (SD=14.25) in the overweight group, 50.03 years (SD=12.84) in the obese group	Overweight adults	149	192.66±11.96	45.66±3.32	10.46±0.45	1451±114	creatinine < 600 μg/24 h)
					Obese adults	35	193.4±6.7	36.1±1	9.3±0.2	1577±61	
Ma et al, 2017[56]	Cross-sectional	Rural areas of Chenggu and Qishan counties, Shaanxi Province	Feb 2015-Feb 2016	SSaSS substudy: with elevated risk of stroke, mean age 67.5 years (SD=6.8)		365	122.4±2.51	24.7±0.65	6.43±0.14	1419±29	Excluded from analysis if collection time fell outside the range of 22–26 h, total 24h urine volume was less than 500 mL or greater than 6000 mL, and 24h creatinine excretion was less than 3 mmol or greater than 25 mmol in women or less than 6 mmol or greater than 30 mmol in men
Zhou et al, 2017[57]	Cross-sectional	Dexing City, Jiangsi Province	NR	Mean age 51.1 years (SD=8.2)		141	155.4±3.6	28.1±0.83	5.6±0.19	1487±56	Excluded if an incomplete 24h urine collection was reported, the collection time fell outside the range of 22–26 h, or the total volume of urine was <500 mL
Dong et al, 2017[58]	Cross-sectional	Chenghai district, Longhu district and	Mar-Nov 2016	Mean age 56.3 years (SD=17.4)	Male	128.12±8.77	43.21±4.22	8.53±0.36	1792±115		Excluded: urine volume less than 500ml/24h, missed 1 void, 24h urine

		Jinping distict in Shantou city			Female	131.77±4.94	48.09±2.08	7.16±0.21	1663±51		creatinine <4 mmol (in women) or <6 mmol (in men)
Wang et al, 2018[59]	Crossover trial	Liquan and Lantian Counties, Shaanxi Province	NR	Mean age 50.5 years (SD=1.1)	Baseline	90	172.1±7.6	37.9±2			Any urine collection less than 500 mL or with a creatinine excretion lower than the population mean minus two standard deviations was discarded
Hu et al, 2018[60]	Crossover trial	Lantian, Shaanxi Province	NR	Rural community, mean age 51.2 years (SD=12.4)	Baseline	44	168.98±11.61	27.79±1.61			NR
Duan et al, 2018[61]	Cross-sectional	Cities of Tianjin and Luoyang	NR	Healthy lactating women aged 20-39 years	30	160.08±11.85				NR	Duan et al, 2018[61]

NR: not reported; SD: standard deviation; SE: standard error.

CRHI-SRS: China Rural Health Initiative Sodium Reduction Study; GenSalt: Genetic Epidemiology Network of Salt Sensitivity; INTERMAP: International Study of Macro-and Micro-Nutrients; PURE: Prospective Urban and Rural Epidemiological; School Edu-Salt: School-based Education Program to Reduce Salt Intake in Children and Their Families; SMASH: Shandong and Ministry of Health Action on Salt and Hypertension; SSaSS: Salt Substitute and Stroke Study; WHO CARDIAC: World Health Organization Cardiovascular Diseases and Alimentary Comparison.

Table S2. Mean sodium excretion (mmol/24h) for subgroups of studies – sensitivity analyses

	Base analysis	Excluding hospital-based studies	Excluding hypertensive participants	Excluding ethnic minorities	Placing Tibet in southern China
Age groups					
- 3–6 years	86.99 (69.88–104.1)	86.99 (69.88–104.1)	86.99 (69.88–104.1)	86.99 (69.88–104.1)	–
- 6–16 years	151.09 (131.55–170.63)	144.46 (123.53–165.39)	146.99 (128.51–165.46)	145.58 (126.41–164.76)	–
- >16 years	189.07 (182.14–195.99)	187.28 (180.24–194.33)	187.01 (180.26–193.75)	190.58 (183.61–197.56)	–
Sex					
- Female	181.54 (167.10– 195.99)	178.39 (164.50– 192.29)	166.08 (152.65– 179.51)	181.54 (167.10– 195.99)	–
- Male	194.76 (179.27– 210.25)	187.91 (172.11– 203.70)	181.57 (166.97– 196.17)	202.57 (187.40– 217.74)	–
Geographical location					
- Northern China	205.81 (193.15– 218.46)	202.33 (189.61– 215.06)	208.05 (195.18– 220.92)	205.43 (192.75– 218.11)	205.13 (192.21– 218.04)
- Southern China	156.97 (145.96– 167.99)	157.54 (144.90– 170.18)	157.92 (146.73– 169.10)	158.84 (147.94– 169.75)	161.45 (150.52– 172.39)
Rigour of 24h urine collection					
- Completeness not assessed / reported	188.43 (172.96– 203.90)	186.15 (170.41– 201.89)	181.95 (168.70– 195.20)	187.88 (172.34– 203.43)	–
- Completeness assessed	188.04 (175.56– 200.52)	185.50 (172.41– 198.59)	193.42 (180.78– 206.06)	189.09 (176.71– 201.48)	–

Table S2 (continued)

	Base analysis	Excluding hospital-based studies	Excluding hypertensive participants	Excluding ethnic minorities	Placing Tibet in southern China
Study year (whole of China)					
- 1980s	192.84 (159.15– 226.54)	179.06 (152.46– 205.66)	192.84 (159.15– 226.54)	194.76 (166.82– 222.70)	–
- 1990s	191.20 (167.79– 214.62)	188.16 (165.10– 211.21)	190.48 (165.47– 215.49)	191.65 (167.80– 215.50)	–
- 2000s	201.07 (164.10– 238.04)	201.07 (164.10– 238.04)	178.23 (125.28– 231.18)	201.07 (164.10– 238.04)	–
- 2010s	181.51 (169.93– 193.09)	181.51 (169.93– 193.09)	186.80 (176.90– 196.70)	181.51 (169.93– 193.09)	–
Study year (northern China)					
- 1980s	222.49 (210.68– 234.30)	217.69 (205.53– 229.85)	222.49 (210.68– 234.30)	218.60 (205.45– 231.74)	222.49 (210.68– 234.30)
- 1990s	228.97 (211.68– 246.25)	223.90 (203.02– 244.77)	230.94 (213.46– 248.42)	232.46 (215.29– 249.63)	225.89 (207.43– 244.35)
- 2000s	242.95 (238.85– 247.06)	242.95 (238.85– 247.06)	238.36 (233.17– 243.55)	242.95 (238.85– 247.06)	242.95 (238.85– 247.06)
- 2010s	194.53 (187.35– 201.71)	194.53 (187.35– 201.71)	197.56 (190.39– 204.72)	194.53 (187.35– 201.71)	194.53 (187.35– 201.71)
Study year (southern China)					
- 1980s	152.51 (138.05– 166.97)	152.55 (134.59– 170.51)	152.51 (138.05– 166.97)	168.16 (158.35– 177.98)	152.51 (138.05– 166.97)
- 1990s	150.36 (140.88– 159.83)	150.82 (141.21– 160.42)	149.34 (139.99– 158.70)	150.36 (140.88– 159.83)	155.81 (145.13– 166.48)
- 2000s	195.99 (169.50– 222.49)	195.99 (169.50– 222.49)	167.00 (153.29– 180.70)	195.99 (169.50– 222.49)	195.99 (169.50– 222.49)
- 2010s	178.15 (169.47– 186.82)	178.15 (169.47– 186.82)	180.13 (173.34– 186.92)	178.15 (169.47– 186.82)	178.15 (169.47– 186.82)

Table S3. Mean potassium excretion (mmol/24h) for subgroups of studies – sensitivity analyses

	Base analysis	Excluding hospital-based studies	Excluding hypertensive participants	Excluding ethnic minorities	Placing Tibet in southern China
Age groups					
- 3–6 years	14.65 (11.1–18.2)	14.65 (11.1–18.2)	14.65 (11.1–18.2)	14.65 (11.1–18.2)	–
- 6–16 years	25.23 (22.37–28.1)	26.03 (22.08–29.99)	26.03 (22.08–29.99)	24.35 (21.52–27.18)	–
- >16 years	36.35 (35.11 to 37.59)	35.97 (34.73 to 37.22)	36.02 (34.83 to 37.22)	36.09 (34.82 to 37.36)	–
Sex					
- Female	36.76 (33.37–40.15)	36.01 (32.69–39.33)	35.33 (32.51–38.16)	36.76 (33.37–40.15)	–
- Male	38.26 (35.65–40.86)	37.95 (35.35–40.56)	38.65 (36.05–41.26)	36.65 (33.88–39.41)	–
Geographical location					
- Northern China	38.19 (35.16–41.21)	38.00 (34.90–41.10)	38.42 (34.89–41.95)	38.62 (35.60–41.63)	38.14 (35.06–41.21)
- Southern China	36.66 (33.01–40.32)	36.67 (32.53–40.81)	35.74 (32.78–38.70)	36.13 (32.56–39.71)	36.80 (33.23–40.37)
Rigour of 24h urine collection					
- Completeness not assessed / reported	37.13 (33.53–40.73)	36.94 (33.24–40.63)	37.53 (33.02–42.03)	37.83 (34.24–41.41)	–
- Completeness assessed	37.45 (34.55–40.34)	37.38 (34.22–40.53)	36.65 (34.01–39.29)	37.11 (34.25–39.97)	–

Table S3 (continued)

	Base analysis	Excluding hospital-based studies	Excluding hypertensive participants	Excluding ethnic minorities	Placing Tibet in southern China
Study year (whole of China)					
- 1980s	36.98 (33.86– 40.11)	40.45 (33.02– 47.88)	36.98 (33.86– 40.11)	38.26 (33.82– 42.70)	–
- 1990s	37.34 (33.40– 41.27)	36.78 (32.83– 40.74)	37.83 (33.62– 42.04)	37.54 (33.71– 41.38)	–
- 2000s	33.52 (26.95– 40.08)	33.52 (26.95– 40.08)	31.05 (23.69– 38.41)	33.52 (26.95– 40.08)	–
- 2010s	37.96 (34.04–41.88)	37.96 (34.04–41.88)	36.82 (33.33– 40.32)	37.96 (34.04–41.88)	–
Study year (northern China)					
- 1980s	39.27 (37.16– 41.38)	39.49 (37.22– 41.76)	39.27 (37.16– 41.38)	39.42 (37.01– 41.82)	39.27 (37.16– 41.38)
- 1990s	38.53 (34.80– 42.26)	37.14 (33.09– 41.20)	38.72 (34.74– 42.70)	39.93 (37.39– 42.47)	38.45 (34.58– 42.32)
- 2000s	36.17 (33.74– 38.61)	36.17 (33.74– 38.61)	23.24 (22.30– 24.18)	36.17 (33.74– 38.61)	36.17 (33.74– 38.61)
- 2010s	38.82 (37.26–40.38)	38.82 (37.26–40.38)	38.97 (37.39– 40.54)	38.82 (37.26–40.38)	38.82 (37.26–40.38)
Study year (southern China)					
- 1980s	34.33 (31.86– 36.81)	33.94 (31.57– 36.30)	34.33 (31.86– 36.81)	30.46 (28.36– 32.57)	34.33 (31.86– 36.81)
- 1990s	35.41 (31.05– 39.76)	34.83 (30.62– 39.05)	36.75 (32.24– 41.27)	35.41 (31.05– 39.76)	35.65 (31.42– 39.88)
- 2000s	33.00 (27.82– 38.17)	33.00 (27.82– 38.17)	30.14 (24.33– 35.94)	33.00 (27.82– 38.17)	33.00 (27.82– 38.17)
- 2010s	35.23 (33.03– 37.42)	35.23 (33.03– 37.42)	33.14 (31.70– 34.58)	35.23 (33.03– 37.42)	35.23 (33.03– 37.42)

Table S4 Potential effect modifiers of adults' sodium excretion (mmol/24h) – sensitivity analyses

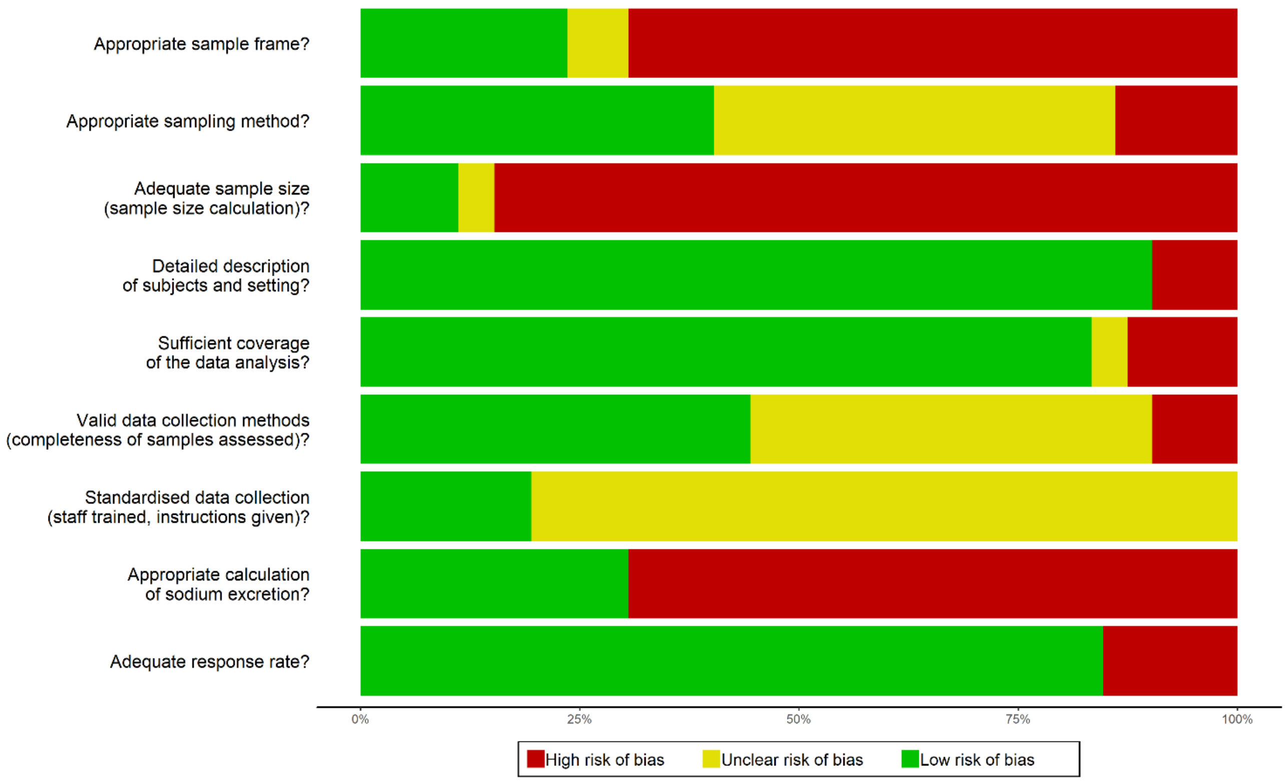
	Univariate		Multivariate	
	Slope (95% CI)	p-value	Slope (95% CI)	p-value
Excluding hospital-based studies				
Age (year)	0.25 (-0.59 to 1.1)	0.5553	0.11 (-0.77 to 0.98)	0.8121
Sex (% men)	0.45 (-0.09 to 0.98)	0.0994	0.25 (-0.28 to 0.78)	0.3452
Geographical location (each administrative region coded from South to North)	3.1 (2.05 to 4.16)	<0.0001	2.98 (1.77 to 4.20)	<0.0001
Rigour of 24h urine collection (not rigorous or not reported as reference)	-13.05 (-31.03 to 4.93)	0.1526	-0.15 (-0.99 to 0.69)	0.7219
Year of data collection (whole of China)	0.35 (-0.51 to 1.21)	0.4149	-9.13 (-26.55 to 8.28)	0.2999
Year of data collection (northern China only)	-1.21 (-2.26 to -0.17)	0.0239	–	–
Year of data collection (southern China only)	1.07 (-0.02 to 2.16)	0.0533	–	–
Excluding hypertensive participants				
Age (year)	1.03 (0.19 to 1.88)	0.0172	0.43 (-0.34 to 1.20)	0.2694
Sex (% men)	0.36 (-0.14 to 0.86)	0.1563	0.11 (-0.34 to 0.56)	0.6408
Geographical location (each administrative region coded from South to North)	3.31 (2.35 to 4.28)	<0.0001	3.38 (2.32 to 4.45)	<0.0001
Rigour of 24h urine collection (not rigorous or not reported as reference)	12.22 (-7.49 to 31.92)	0.2206	-0.54 (-1.24 to 0.17)	0.1331
Year of data collection (whole of China)	0.13 (-0.68 to 0.95)	0.7457	12.31 (-3.99 to 28.61)	0.1363
Year of data collection (northern China only)	-1.22 (-2.15 to -0.29)	0.0112	–	–
Year of data collection (southern China only)	0.76 (-0.04 to 1.56)	0.0603	–	–
Excluding ethnic minorities				
Age (year)	0.23 (-0.61 to 1.07)	0.5887	0.04 (-0.81 to 0.89)	0.9229
Sex (% men)	0.52 (0.05 to 0.99)	0.0312	0.25 (-0.23 to 0.74)	0.2996
Geographical location (each administrative region coded from South to North)	3.2 (2.19 to 4.21)	<0.0001	3.11 (1.94 to 4.28)	<0.0001
Rigour of 24h urine collection (not rigorous or not reported as reference)	-11.39 (-28.97 to 6.2)	0.2016	-0.22 (-1.01 to 0.58)	0.5877
Year of data collection (whole of China)	0.16 (-0.65 to 0.97)	0.6970	-6.59 (-23.26 to 10.08)	0.4345
Year of data collection (northern China only)	-1.21 (-2.14 to -0.28)	0.0117	–	–
Year of data collection (southern China only)	0.95 (-0.09 to 2.00)	0.0719	–	–
Placing Tibet in southern China				
Age (year)	0.25 (-0.59 to 1.09)	0.5573	0.08 (-0.77 to 0.94)	0.8491
Sex (% men)	0.53 (0.04 to 1.01)	0.0337	0.27 (-0.23 to 0.76)	0.2853
Geographical location (each administrative region coded from South to North)	3.25 (2.24 to 4.27)	<0.0001	3.15 (1.98 to 4.32)	<0.0001
Rigour of 24h urine collection (not rigorous or not reported as reference)	-12.47 (-30.22 to 5.29)	0.1665	-0.24 (-1.04 to 0.56)	0.5493
Year of data collection (whole of China)	0.18 (-0.64 to 0.99)	0.6723	-7.85 (-24.63 to 8.92)	0.3547
Year of data collection (northern China only)	-1.26 (-2.2 to -0.31)	0.0101	–	–
Year of data collection (southern China only)	0.93 (-0.2 to 2.06)	0.1033	–	–

Table S5 Potential effect modifiers of adults' potassium excretion (mmol/24h) – sensitivity analyses

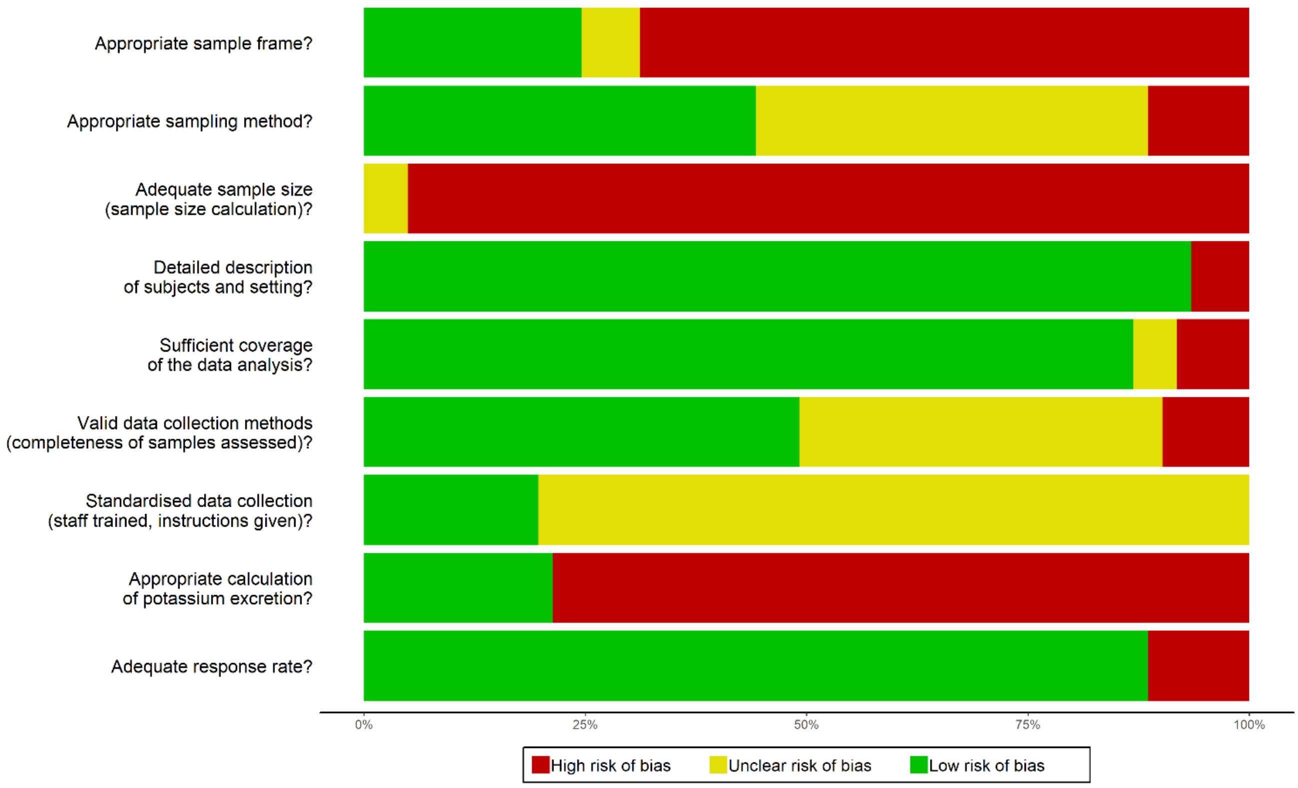
	Univariate		Multivariate	
	Slope (95% CI)	p-value	Slope (95% CI)	p-value
Excluding hospital-based studies				
Age (year)	0.02 (-0.17 to 0.2)	0.8474	-0.07 (-0.31 to 0.17)	0.5445
Sex (% men)	0.01 (-0.12 to 0.14)	0.9029	0.00 (-0.16 to 0.16)	0.9982
Geographical location (each administrative region coded from South to North)	0.16 (-0.11 to 0.42)	0.2476	0.14 (-0.17 to 0.46)	0.3693
Rigour of 24h urine collection (not rigorous or not reported as reference)	1.24 (-2.74 to 5.21)	0.5379	1.77 (-2.73 to 6.27)	0.4347
Year of data collection (whole of China)	0.12 (-0.06 to 0.31)	0.1927	0.11 (-0.1 to 0.32)	0.2961
Year of data collection (northern China only)	0.00 (-0.25 to 0.25)	0.9858	–	–
Year of data collection (southern China only)	0.21 (-0.11 to 0.52)	0.1867	–	–
Excluding hypertensive participants				
Age (year)	0.01 (-0.21 to 0.22)	0.9532	-0.04 (-0.31 to 0.23)	0.7616
Sex (% men)	0.08 (-0.06 to 0.22)	0.2842	0.08 (-0.09 to 0.24)	0.3680
Geographical location (each administrative region coded from South to North)	0.21 (-0.08 to 0.51)	0.1538	0.15 (-0.2 to 0.5)	0.3872
Rigour of 24h urine collection (not rigorous or not reported as reference)	1.02 (-4.11 to 6.16)	0.6914	1.25 (-4.38 to 6.88)	0.6585
Year of data collection (whole of China)	0.09 (-0.11 to 0.29)	0.3560	0.1 (-0.13 to 0.33)	0.3932
Year of data collection (northern China only)	0.01 (-0.27 to 0.28)	0.9702	–	–
Year of data collection (southern China only)	0.12 (-0.2 to 0.44)	0.4515	–	–
Excluding ethnic minorities				
Age (year)	0.04 (-0.14 to 0.22)	0.6547	-0.03 (-0.27 to 0.2)	0.7773
Sex (% men)	0 (-0.11 to 0.12)	0.9483	0 (-0.15 to 0.14)	0.9725
Geographical location (each administrative region coded from South to North)	0.19 (-0.07 to 0.45)	0.1520	0.18 (-0.13 to 0.49)	0.2594
Rigour of 24h urine collection (not rigorous or not reported as reference)	0.56 (-3.37 to 4.48)	0.7785	0.95 (-3.45 to 5.35)	0.6685
Year of data collection (whole of China)	0.1 (-0.07 to 0.28)	0.2510	0.08 (-0.13 to 0.28)	0.4434
Year of data collection (northern China only)	-0.05 (-0.29 to 0.18)	0.6512	–	–
Year of data collection (southern China only)	0.23 (-0.07 to 0.53)	0.1244	–	–
Placing Tibet in southern China				
Age (year)	0.02 (-0.16 to 0.2)	0.8311	-0.07 (-0.31 to 0.16)	0.5363
Sex (% men)	0.01 (-0.11 to 0.13)	0.9054	0 (-0.15 to 0.15)	0.9900
Geographical location (each administrative region coded from South to North)	0.15 (-0.1 to 0.41)	0.2339	0.15 (-0.16 to 0.46)	0.3348
Rigour of 24h urine collection (not rigorous or not reported as reference)	1.18 (-2.68 to 5.04)	0.5444	1.84 (-2.53 to 6.21)	0.4041
Year of data collection (whole of China)	0.11 (-0.07 to 0.29)	0.2191	0.1 (-0.1 to 0.3)	0.3252
Year of data collection (northern China only)	-0.01 (-0.25 to 0.23)	0.9449	–	–
Year of data collection (southern China only)	0.19 (-0.11 to 0.49)	0.2005	–	–

Figure S1. Risk of bias in the included studies

A. Studies reporting sodium data



B. Studies reporting potassium data



Grading details provided on the next page (text S2).

Supplemental References

1. Liu LS, Zhang KH, Wang J, Zhang XE, Wu HJ, Lin MQ, Gui RL, Du JH, Gu ML. Primary prevention of hypertension by sodium restriction. *Chinese Medical Journal*. 1987;100(11):899–902.
2. Yang Y. [Renal function of cations excretion in children predisposed to essential hypertension]. *Zhonghua Yu Fang Yi Xue Za Zhi [Chinese Journal of Preventive Medicine]*. 1991;25(3):152–154.
3. Zhu KM, He SP, Pan XQ, Zheng XR, Gu YA. The relation of urinary cations to blood pressure in boys aged seven to eight years. *American Journal of Epidemiology*. 1987;126(4):658–663.
4. Wu Y, Cai R, Zhou B, Xu X. Effects of genetic factors and dietary electrolytes on blood pressure of rural secondary school students in Hanzhong. *Chinese Medical Sciences Journal = Chung-Kuo I Hsueh K'o Hsueh Tsa Chih*. 1991;6(3):148–152.
5. Xu X.-J., Liang X.-H., Hu G.-M., Mao X.-M., Quanyangyi, Ozawa Y., Zhang X.-Y., Dilixiati, Maimaiti-Yasen. Ambulatory blood pressure and biochemical indicator analysis of 9-10 years old Kazakhstan Clan children in Xinjiang Baliken area. *Journal of Clinical Rehabilitative Tissue Engineering Research*. 2009;13(7):1379–1382.
6. Zhang Q, Liao Y, Tang C, Du J, Jin H. Twenty-four-hour urinary sodium excretion and postural orthostatic tachycardia syndrome. *The Journal of Pediatrics*. 2012;161(2):281–284.
7. Li J., Zhang Q., Liao Y., Zhang C., Du J. Clinical value of 24-hour urinary sodium determination in children with postural tachycardia syndrome. *Zhonghua er ke za zhi = Chinese journal of pediatrics*. 2015;53(3):203–207.
8. Zhang L., Zhao F., Zhang P., Gao J., Liu C., He F.J., Lin C.-P. A pilot study to validate a standardized one-week salt estimation method evaluating salt intake and its sources for family members in China. *Nutrients*. 2015;7(2):751–763.
9. Li J., Liao Y., Du J., Zhang Q. Relationship between 24-hour urinary sodium and renin-angiotensin-aldosterone system in children with postural tachycardia syndrome. *National Medical Journal of China*. 2015;95(36):2928–2932.
10. He FJ, Wu Y, Feng X-X, Ma J, Ma Y, Wang H, Zhang J, Yuan J, Lin C-P, Nowson C, MacGregor GA. School based education programme to reduce salt intake in children and their families (School-EduSalt): cluster randomised controlled trial. *BMJ (Clinical research ed.)*. 2015;350:h770.
11. Tsai TJ, Su CJ, Chen YM, Hsieh BS, Chen WY, Yen TS. Urinary kallikrein excretion in chronic renal disease with respect to salt intake and renal reserve. *Journal of the Formosan Medical Association = Taiwan Yi Zhi*. 1991;90(6):525–530.
12. Zhao GS, Yuan XY, Gong BQ, Wang SZ, Cheng ZH. Nutrition, metabolism, and hypertension. A comparative survey between dietary variables and blood pressure among three nationalities in China. *Journal of Clinical Hypertension*. 1986;2(2):124–131.
13. Liu LS, Zheng DY, Lai SH, Wang GQ, Zhang YL. Variability in 24-hour urine sodium excretion in Chinese adults. *Chinese Medical Journal*. 1986;99(5):424–426.
14. Kesteloot H, Huang DX, Li YL, Geboers J, Joossens JV. The relationship between cations and blood pressure in the People's Republic of China. *Hypertension (Dallas, Tex.: 1979)*. 1987;9(6):654–659.
15. Liu LS, Zheng DY, Jin L, Liao YL, Liu K, Stamler J. Variability of urinary sodium and potassium excretion in north Chinese men. *Journal of Hypertension*. 1987;5(3):331–335.
16. Intersalt Cooperative Research Group. Intersalt: an international study of electrolyte excretion and blood pressure. Results for 24 hour urinary sodium and potassium excretion. *BMJ : British Medical Journal*. 1988;297(6644):319–328.

17. He J, Tell GS, Tang YC, Mo PS, He GQ. Relation of electrolytes to blood pressure in men. The Yi people study. *Hypertension (Dallas, Tex.: 1979)*. 1991;17(3):378–385.
18. He J, Klag MJ, Whelton PK, Chen JY, Mo JP, Qian MC, Coresh J, Mo PS, He GQ. Agreement between overnight and 24-hour urinary cation excretions in southern Chinese men. *American Journal of Epidemiology*. 1993;137(11):1212–1220.
19. Chan EL, MacDonald D, Ho SC, Swaminathan R. Potassium intake and urinary calcium excretion in healthy subjects. *Mineral and Electrolyte Metabolism*. 1993;19(1):36–38.
20. Pan WH, Chen JY, Chen YC, Tsai WY. Diurnal electrolyte excretion pattern affects estimates of electrolyte status based on 24-hour, half-day, and overnight urine. *The Chinese Journal of Physiology*. 1994;37(1):49–53.
21. Tian HG, Nan Y, Shao RC, Dong QN, Hu G, Pietinen P, Nissinen A. Associations between blood pressure and dietary intake and urinary excretion of electrolytes in a Chinese population. *Journal of Hypertension*. 1995;13(1):49–56.
22. Hou R, Liu Z, Liu J. [The study of sympathetic nervous activity during the period of chronic salt loading in salt-sensitive subjects]. *Chinese Journal of Cardiology*. 1997;25(6):414–418.
23. Chan TY, Chan AY, Lau JT, Critchley JA. Sodium and potassium intakes and blood pressure in Chinese adults in Hong Kong: A comparison with southern China. *Asia Pacific Journal of Clinical Nutrition*. 1998;7(1):33–36.
24. Liu L, Mizushima S, Gao M. Body mass index, urinary sodium excretion, and blood pressure in seven Chinese populations: results from the WHO Cardiovascular Diseases and Alimentary Comparison Study. *CVD Prev*. 2000;3:11–17.
25. Cheung BM, Ho SP, Cheung AH, Lau CP. Diastolic blood pressure is related to urinary sodium excretion in hypertensive Chinese patients. *QJM: monthly journal of the Association of Physicians*. 2000;93(3):163–168.
26. Gu D, He J, Wu X, Duan X, Whelton PK. Effect of potassium supplementation on blood pressure in Chinese: a randomized, placebo-controlled trial. *Journal of Hypertension*. 2001;19(7):1325–1331.
27. Zhu D, Liu Z, Liu J, Liu Y. Renal endogenous ET-1 and urinary sodium excretion and microalbuminuria in human salt-sensitive hypertension. *Journal of Pharmaceutical Analysis*. 2001;13(1):30–32.
28. Jumabay M, Kawamura H, Mitsubayashi H, Ozawa Y, Izumi Y, Kasamaki Y, Shimabukuro H, Cheng Z, Aisa M, Wang S. Urinary electrolytes and hypertension in elderly Kazakhs. *Clinical and Experimental Nephrology*. 2001;5(4):217–221.
29. Xie J, Liu L, Kesteloot H. Blood pressure and urinary cations in a low-fat intake Chinese population sample. *Acta Cardiologica*. 2001;56(3):163–168.
30. Yamori Y, Liu L, Mu L, Zhao H, Pen Y, Hu Z, Kuga S, Negishi H, Ikeda K, Japan-China Cooperative Study Group: Chongqing Project. Diet-related factors, educational levels and blood pressure in a Chinese population sample: findings from the Japan-China Cooperative Research Project. *Hypertension Research: Official Journal of the Japanese Society of Hypertension*. 2002;25(4):559–564.
31. Zhao L, Stamler J, Yan LL, Zhou B, Wu Y, Liu K, Daviglus ML, Dennis BH, Elliott P, Ueshima H, Yang J, Zhu L, Guo D, INTERMAP Research Group. Blood pressure differences between northern and southern Chinese: role of dietary factors: the International Study on Macronutrients and Blood Pressure. *Hypertension (Dallas, Tex.: 1979)*. 2004;43(6):1332–1337.
32. Cheung DBMY, Law CY, McGhee SM, Ng PPY, Lau C-P, Kumana CR. The Relationship Between Sodium and Blood Pressure in Hong Kong Chinese. *Clinical Research and Regulatory Affairs*. 2004;21(2):145–154.

33. Zhou X., Liu J.-X., Shi R., Yang N., Song D.-L., Pang W., Li Y.-M. Compound ion salt, a novel low-sodium salt substitute: From animal study to community-based population trial. *American Journal of Hypertension*. 2009;22(9):934–942.
34. He J., Gu D., Chen J., Jaquish C.E., Rao D.C., Hixson J.E., Chen J.-C., Duan X., Huang J.-F., Chen C.-S., Kelly T.N., Bazzano L.A., Whelton P.K. Gender difference in blood pressure responses to dietary sodium intervention in the GenSalt study. *Journal of Hypertension*. 2009;27(1):48–54.
35. Zhang G, Ma J, Guo X, Dong J, Chen X, Zhang J, Su J, Tang J, Xu A. [Field observation on the effect of low-sodium and high-potassium salt substitute on blood pressure in the rural community-based population in China]. *Zhonghua Liu Xing Bing Xue Za Zhi*. 2011;32(9):859–863.
36. Liu Y, Wu J, Zhang L, Xu H, Liu Z, Lu J, Zhang J, Feng L, Guo Q, Zhao C, Liu J, Wei H, Cao S, Zhao H. [Influence factors of salt-sensitive hypertension and responses of blood pressure and urinary sodium and potassium excretion to acute oral saline loading among essential hypertensive patients]. *Zhonghua Xin Xue Guan Bing Za Zhi*. 2013;41(12):1015–1019.
37. Gu D, Zhao Q, Chen J, Chen J-C, Huang J, Bazzano LA, Lu F, Mu J, Li J, Cao J, Mills K, Chen C-S, Rice T, Hamm LL, He J. Reproducibility of blood pressure responses to dietary sodium and potassium interventions: the GenSalt study. *Hypertension (Dallas, Tex.: 1979)*. 2013;62(3):499–505.
38. Chen J, Tian Y, Liao Y, Yang S, Li Z, He C, Tu D, Sun X. Salt-Restriction-Spoon Improved the Salt Intake among Residents in China. *PLoS ONE*. 2013;8(11).
39. Chen J, Liao Y, Li Z, Tian Y, Yang S, Tu D, He C, Sun X. [Analysis of the determinants of salt-restriction behavior among urban and rural residents in Beijing with health belief model]. *Beijing Da Xue Xue Bao. Yi Xue Ban = Journal of Peking University. Health Sciences*. 2014;46(2):242–246.
40. Hu B.-C., Li Y., Liu M., Li L.-H., Sheng C.-S., Zhang Y., Wang J.-G. Blood pressure and urinary sodium excretion in relation to 16 genetic polymorphisms in the natriuretic peptide system in Chinese. *Endocrine Journal*. 2014;61(9):861–874.
41. Xu J., Wang M., Chen Y., Zhen B., Li J., Luan W., Ning F., Liu H., Ma J., Ma G. Estimation of salt intake by 24-hour urinary sodium excretion: a cross-sectional study in Yantai, China. *BMC public health*. 2014;14((Xu J.)):136.
42. Zhou X, Yuan F, Ji W-J, Guo Z-Z, Zhang L, Lu R-Y, Liu X, Liu H-M, Zhang W-C, Jiang T-M, Zhang Z, Li Y-M. High-salt intake induced visceral adipose tissue hypoxia and its association with circulating monocyte subsets in humans. *Obesity (Silver Spring, Md.)*. 2014;22(6):1470–1476.
43. Liu Z-M, Ho SC, Tang N, Chan R, Chen Y-M, Woo J. Urinary sodium excretion and dietary sources of sodium intake in Chinese postmenopausal women with prehypertension. *PloS One*. 2014;9(8):e104018.
44. Ge Z., Guo X., Chen X., Tang J., Yan L., Ren J., Zhang J., Lu Z., Dong J., Xu J., Cai X., Liang H., Ma J. Association between 24 h urinary sodium and potassium excretion and the metabolic syndrome in Chinese adults: The Shandong and Ministry of Health Action on Salt and Hypertension (SMASH) study. *British Journal of Nutrition*. 2015;113(6):996–1002.
45. Ge Z, Zhang J, Chen X, Guo X, Yan L, Tang J, Cai X, Xu J, Hou L, Ma J. [Association between 24 h urinary sodium to potassium ratio and metabolic syndrome in Chinese adults]. *Chinese Journal of Epidemiology*. 2015;36(8):790–793.
46. Wang Y, Mu JJ, Geng LK, Wang D, Ren KY, Guo TS, Chu C, Xie BQ, Liu FQ, Yuan ZY. Effect of salt intake and potassium supplementation on brachial-ankle pulse wave velocity in Chinese subjects: an interventional study. *Brazilian Journal of Medical and*

Biological Research = Revista Brasileira De Pesquisas Medicas E Biologicas. 2015;48(1):83–90.

47. Han W., Sun N., Chen Y., Wang H., Xi Y., Ma Z. Validation of the spot urine in evaluating 24-hour sodium excretion in Chinese hypertension patients. *American Journal of Hypertension*. 2015;28(11):1368–1375.
48. Wang X., Li X., Vaartjes I., Neal B., Bots M.L., Hoes A.W., Wu Y. Does education level affect the efficacy of a community based salt reduction program? - A post-hoc analysis of the China Rural Health Initiative Sodium Reduction Study (CRHI-SRS). *BMC public health*. 2016;16(1):759.
49. Zhang Y., Li F.X., Liu F.-Q., Chu C., Wang Y., Wang D., Guo T.-S., Wang J.-K., Guan G.-C., Ren K.-Y., Mu J.-J. Elevation of fasting ghrelin in healthy human subjects consuming a high-salt diet: A novel mechanism of obesity? *Nutrients*. 2016;8(6).
50. Yongqing Z., Ming W., Jian S., Pengfei L., Xiaoqun P., Meihua D., Peian L., Jianmei D., Guoyu Z., Jie Y., Ping L., Yan X. Prevalence, awareness, treatment and control of hypertension and sodium intake in Jiangsu Province, China: a baseline study in 2014. *BMC public health*. 2016;16((Yongqing Z.) Jiangsu provincial Center for Disease Control and Prevention, 210009, Nanjing, China. zyq6943@163.com):56.
51. Peng Y, Li W, Wang Y, Chen H, Bo J, Wang X, Liu L. Validation and Assessment of Three Methods to Estimate 24-h Urinary Sodium Excretion from Spot Urine Samples in Chinese Adults. *PloS One*. 2016;11(2):e0149655.
52. Zheng W-L, Chu C, Lv Y-B, Wang Y, Hu J-W, Ma Q, Yan Y, Cao Y-M, Dang X-L, Wang K-K, Mu J-J. Effect of Salt Intake on Serum Glucagon-Like Peptide-1 Levels in Normotensive Salt-Sensitive Subjects. *Kidney & Blood Pressure Research*. 2017;42(4):728–737.
53. Guo T-S, Dai Y, Ren K-Y, Mu J-J, Ren J, Wang D, Wang Y, Chu C, Li Y, Yuan Z-Y. Effects of salt loading and potassium supplement on the circadian blood pressure profile in salt-sensitive Chinese patients. *Blood Pressure Monitoring*. 2017;22(6):307–313.
54. Li Q, Cui Y, Jin R, Lang H, Yu H, Sun F, He C, Ma T, Li Y, Zhou X, Liu D, Jia H, Chen X, Zhu Z. Enjoyment of Spicy Flavor Enhances Central Salty-Taste Perception and Reduces Salt Intake and Blood Pressure. *Hypertension (Dallas, Tex.: 1979)*. 2017;70(6):1291–1299.
55. Deng T, Mai Z, Cai C, Duan X, Zhu W, Zhang T, Wu W, Zeng G. Influence of weight status on 24-hour urine composition in adults without urolithiasis: A nationwide study based on a Chinese Han population. *PloS One*. 2017;12(9):e0184655.
56. Ma W, Yin X, Zhang R, Liu F, Yang D, Fan Y, Rong J, Tian M, Yu Y. Validation and Assessment of Three Methods to Estimate 24-h Urinary Sodium Excretion from Spot Urine Samples in High-Risk Elder Patients of Stroke from the Rural Areas of Shaanxi Province. *International Journal of Environmental Research and Public Health*. 2017;14(10).
57. Zhou L, Tian Y, Fu J-J, Jiang Y-Y, Bai Y-M, Zhang Z-H, Hu X-H, Lian H-W, Guo M, Yang Z-X, Zhao L-C. Validation of spot urine in predicting 24-h sodium excretion at the individual level. *The American Journal of Clinical Nutrition*. 2017;105(6):1291–1296.
58. Dong W, Zhang Q, Jiang J, Chen H, Chen X, Shao S, Liu J, Ji Y. [Evaluating the sodium intake of community residents in Shantou city by 24-h urine method]. *Chin J Prev Contr Chron Di*. 2017;25(7):481–484.
59. Wang Y, Chu C, Wang K-K, Hu J-W, Yan Y, Lv Y-B, Cao Y-M, Zheng W-L, Dang X-L, Xu J-T, Chen W, Yuan Z-Y, Mu J-J. Effect of Salt Intake on Plasma and Urinary Uric Acid Levels in Chinese Adults: An Interventional Trial. *Scientific Reports*. 2018;8(1):1434.

60. Hu J-W, Wang Y, Chu C, Mu J-J. Effect of Salt Intervention on Serum Levels of Fibroblast Growth Factor 23 (FGF23) in Chinese Adults: An Intervention Study. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research*. 2018;24:1948–1954.
61. Duan L, Liu W, Zhang P, Liu S, Liu X, Sang M, Liu L, Lin H, Sang Z. Salt Intake of Lactating Women as Assessed by Modified Food Weighted Records. *Journal of the American College of Nutrition*. 2018;37(7):614–619.