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Protocol for a cluster randomized controlled trial of home cook intervention to reduce salt intake in China

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ABSTRACT

Introduction Salt intake in China twice the upper limit recommended by WHO, and nearly 80% is added during cooking. This study will develop a salt reduction package targeting home cooks and evaluate its effectiveness and feasibility for scale-up.

Methods and analysis A cluster randomized controlled trial (cRCT) design was adopted in this study. The cRCT is conducted in six provinces covering the north-, south-, and west-China. For each province, 10 communities/villages (clusters) was selected with 13 families (one cook and one adult family member) in each cluster for evaluation. In total, 780 home cooks and 780 adult family members were recruited. The home cooks in the intervention group will be provided with the intervention package, which includes community-based standardized offline and online health education and salt intake monitoring. The duration of the intervention is one year. The primary outcome is the difference between the intervention and the control group in the change of salt intake as measured by 24-hour urinary sodium from baseline to the end of the trial

and the secondary outcome is the difference between the two groups in the change of salt related KAP and blood pressure.

Ethics and dissemination The study has been approved by The Queen Mary Research Ethics Committee (QMERC2018/13) and Institutional Review Board of Chinese Center for Disease Control and Prevention (No.201801). The study findings will be disseminated widely through conference presentations and peer-reviewed publications and the general media.

Trial registration number CiChR1800016804.

Strengths and limitations of this study

- The study will develop a new approach to achieving a sustainable progressive lower salt intake for long term.
- The study will use an special intervention method which is family 7-day salt intake monitoring activity to estimate and monitor salt intake, which can support study population to implement a salt reduction programme.
- The study covers a special population which is home cooks in diverse settings, for example, northern, central and southern China.
- The results should generally be applicable to the whole Chinese population.
- The study will be carried out in China only; however, the method could potentially be adopted by many other developing countries where most of the salt in the diet is added by the consumers.

INTRODUCTION

Excess dietary salt consumption is an important risk factor for high blood pressure, stroke, cardiovascular disease and other adverse health outcomes[1-3]. As a result, in 2003 the World Health Organization (WHO) and the United Nations Food and Agriculture Organization (FAO) issued a joint report calling for a reduction in population salt intake to less than 5 g per day (<2,000 mg sodium) [4]. It has been estimated that mean salt consumption in 181 of 187 countries exceeded the daily intake of salt recommended by WHO in 2010, and 51 of these countries reported mean intakes greater than double the recommended amount[5]. In April 2019, the

Lancet published the latest series of studies on the global burden of disease[6], which found that 3 million deaths were attributable to high-salt diet in 2017. Salt reduction is highly cost-effective worldwide[7-8]. It has been estimated that a regulatory intervention to reduce salt intake by 3 g per day would save 194,000 to 392,000 quality-adjusted life-years and $10 billion to $24 billion in health care costs every year in the USA[9]. At the United Nations General Assembly in 2011, the WHO has identified population salt reduction as a priority intervention for ameliorating the global burden of non-communicable diseases (NCDs) [4]. In 2013, the WHO member states agreed on a global target of a 30% relative reduction in population salt intake to be achieved by 2025[10]. Many developed countries have introduced programmes that seek to reduce population-level salt intake, including the UK, Finland, Japan, the US and Canada[10].

In China, the current situation of salt intake is not satisfactory. High salt intake is the third leading risk factor contributing to death and DALYs[12]. A cohort of 16,869 Chinese adults aged 20–60 years over the period 1991–2009 indicated that salt intake remains at high levels, double those of World Health Organization recommendations[13].A study used two methods (24-hour urine collection and 24-hour dietary recall) to measure salt intake in rural China, the results showed that mean 24-hour urinary sodium excretion was 13g and 24-hour dietary salt intake was 10g[14]. Report on Chinese residents' chronic diseases and nutrition showed that the average daily salt intake for Chinese adults was 10.5g in 2012 which using dietary survey method[15].

In contrast with western countries, most dietary salt in China comes from salt and high–salt condiments added during cooking. The main sources of salt intake from weighed condiments recorded were from home cooking salt (74.7%) followed by soy sauce (15.0%) [16].

The Chinese government has been making great efforts in salt intake surveillance and salt reduction interventions. Shandong-MOH Action on salt and Hypertension (SMASH) project[17] and Healthy Lifestyle for All initiative[18] were two representatives. Culturally-tailored salt reduction interventions have been applied in various groups and sites, including

distributing salt restriction spoons and encouraging people to use the minimum order to reduce the amount of salt added during cooking[19]. However, the effect of such interventions needs to be evaluated in a more rigorous way[20].

Since cooking salt is the biggest source of salt intake in China, home cooks, who are responsible for purchasing food and preparing meals for their family, should be given special attention during intervention activities. In Japan, cooking classes for housewives effectively reduced salt intake from 9.57g/d to 8.95g/d after two months' intervention[21]. In China, studies specifically focusing on salt reduction among housewives are scarce and it is still unclear that which intervention is effective for family salt reduction. Hence, this study will be undertaken among home cooks in six provinces of China to explore the feasibility of reducing salt intake by means of community-based intervention, which if proven successful, will be applied to a broader scale.

Study objectives

The primary objective is to increase salt awareness in home cooks, and to reduce the amount of salt used during cooking, thus helping the population to reduce salt intake by at least 1 g/day. The specific objectives include: (1) To develop a package of salt-reduction interventions through home cook applicable for community families; (2) To evaluate the effectiveness of intervention package by carrying out a cluster randomized trial with intervention duration of 12 months.

METHODS AND ANALYSIS

Overall Study design

Using a cluster RCT design, 60 communities will be selected from 6 provinces. A baseline survey will be carried out before randomization among 1560 participants recruited from the 60 communities. The communities will be allocated into intervention or control group randomly. Information of salt related Knowledge-attitude-practice (KAP), blood pressure and 24-h urinary sodium will be collected. The intervention group will receive the salt reduction education for 1 year. (Figure 1)

Study Setting

Considering the geographical location, economic level and dietary habit, our study will be undertaken in selected counties from six provinces in Qinghai, Hebei, Heilongjiang, Sichuan, Jiangxi and Hunan. The interventions are targeted on all the home cooks and their family members in the selected communities.

Outcomes

Our primary outcome is the difference between the intervention and the control group in the change of salt intake as measured by 24-hour urinary sodium from baseline to the end of the trial.

The secondary outcome is the difference between the two groups in the change of salt related KAP and blood pressure.

Study Population

Selection of communities

A County/District will be selected from each province. And ten communities will be selected from each County/District. For the selection of communities, we will take into consideration of geographical area, urbanization, size of the populations, age structure of populations, economic status, health service resources, etc. to ensure all the communities with similar characteristics. The selected communities should have local workers to carry out the intervention activities from primary health service and supported by Neighborhood Committee (Women's federation workers). The community involved in other salt-reduction projects should be excluded.

Selection of participants

Participants will be randomly selected according to age and sex. Inclusion criteria for participants include:(1) age: 18-75 years; (2) two family members from each family are included; one of them is the major cook, and the other is selected by the order of spouse, other adult family member (adult with opposite gender); (3) both eat home-made meals at least 4 days per week; (4) participants have lived in the community for more than 6 months and have no relocation plan in the next 24 months. The exclusion criteria include: (1) women in pregnant or lactation period; (2) individuals

currently participate in any other clinical trial; (3) individuals who cannot or refuse to collect 24-hour urine.

Randomization

60 communities (clusters) will be randomly assigned (1:1) to either the intervention or the control group. Randomization will be stratified by the geographical area (urban or rural), size of populations, economic status, health service resources. The randomization will be carried out using computer generated random number system by an independent statistician who will be blind to the identity of the communities. The randomization will take place after written consents have been obtained and the baseline assessments have completed. Therefore, the participants, and the local investigators who undertake participant recruitment and data collection, will be unaware of the allocation until the point prior to the commencement of the intervention.

Intervention

The primary health staff will unite with workers from neighborhood committee and/or local women's federation to carry out the following interventions under the guidance of local CDC. In the intervention group, the salt reduction intervention package will include:

(1) Supportive environment, such as posters, videos and local broadcast, to deliver core messages of salt reduction. We will develop brochures, posters and videos about salt reduction targeting at home cooks. And Posters will be put up both in communities and markets. Videos will be played in the primary health institutions and at the community activities organized by neighborhood committees.

(2) Lectures on salt reduction knowledge and skills. We will develop a set of standard slides to disseminate the knowledge and skills to reduce salt intake for the target population. The key knowledge and skills will include the relationship between salt and health, the source of salt intake, low sodium salt, misunderstanding of salt reduction, how to reduce salt intake during cooking or when eating outside, and how to wisely choose low salt pre-packaged food. These slides will be provided for the local health institutions who participate in this programme. And they will use it to

deliver the lectures every two month.

(3) Family 7-day salt intake monitoring activity. The main function of this monitoring activity is to monitor the amount of salt intake per person per day and improve the awareness of salt reduction among target population. This activity will conduct every two months, and once for 7 consecutive days. The local CDC and local primary health institutions will regularly collect the monitoring records. We will develop an applet of WeChat/webpage ahead to type in the records and calculate the average salt intake of each family member, and the results will be fed back to each family.

(4) Online health education through social media. The national project team will publish the core knowledge of salt reduction through the WeChat public account to conduct health education for the public.

The salt reduction education described above will not be given to the control group.

Sample Size

Based on the School-EduSalt trial[22], assuming a standard deviation of 24-hour urinary sodium excretion is 85mmol/day, and intra-class correlation coefficient (ICC) is 0.05, we estimate that a sample size of 1426 individuals (713 home cooks and 713 family members) would provide a power of 80% (with a two-sided alpha=0.05) to detect a difference in mean 24-hour urinary sodium ≥20mmol/day (1g/d salt) between intervention and control group, allowing for a 20% drop-out rate of participants. We aim to recruit 1 home cooks and 1 family member per household, and in order to ensure that the number of households in every community remains same, 12 households in each community will be selected, resulting in a total of 720 households and 1440 individuals. In addition, considering that response rate of 24-hour urine collection is often low[23], we decided to add one more family per community, therefore 1560 individuals (780 home cooks and 780 family members) will be recruited into the study for evaluation.

Data collection

All outcome measurements and assessments will be carried out at baseline and at the end of the trial in exactly the same way in all communities for

all participants, irrespective of their assignment to intervention or control group.

The participants will be carefully instructed on how to accurately collect 24-hour urine by trained research staff. On the first day, the participants will be asked to come to the survey location. The researchers will ask the participants to empty bladder and discard the urine. The researchers will record the start time and date of the 24-hour urine collection. They will then give the participants the collection equipment including containers and collection aids. On the second day at the same time, the participants will be asked to bring the urine collection bottles back to the survey location, and they will be asked to pass the last urine into the container. The researchers will record the finish time of the 24-hour urine collection. During the 24-hour urine collection period, the participants will be asked to take spare urine containers with them when they go to work. In case that the participant misses one or more urine voids or spillage occurs, the participant will be asked to do a further 24-hour urine collection. For each participant, the 24-hour urines will be collected on the same days of the week for baseline and follow-up at the end of the trial. We will measure urine volume, sodium, potassium and creatinine. Ion-selective electrode method will be used for sodium and potassium analysis and enzymatic method for creatinine assay. Twenty-four-hour urinary creatinine together with urine volume will be used to determine if the collection is likely to be complete. The biochemist who performs the measurements of urinary electrolytes will not be told to which group the participant is allocated.

In addition to 24-hour urine collection, we will measure BP and heart rate using a validated automatic machine with the appropriate size of cuff. Three readings will be taken in the right arm at 1- to 2-min intervals at sitting position after the participant has had 10-min rest in a quiet room. Body weight, height and waist circumference will also be measured. Survey on KAP related to salt will be completed via questionnaire.

The RCT Data will be collected through a specially designed mobile device-based electronic data capture system (mEDC) by well-trained field investigators. The RCT Data includes information on demographics,

social-economic information, KAP, measurement of height, weight, waist circumference, BP, heart rate, 24-hour urine volume and electrolytes, as well as information about intervention.

And in order to ensure the quality of intervention, quality control will be set in every step of the trial using the electronic system.

Statistical methods

The difference of 24-hour sodium excretion as well as the secondary outcomes between the two groups will be compared using linear mixed models with participants nested within family units and families nested within community/village units. We will include group (intervention, control), time (baseline, end of trial), and time×group interaction, with the time×group interaction term indicating different change by group from baseline to the end of the trial. To account for missing data on continuous outcomes, we will use the likelihood based random effects model that uses all available data and provides valid estimates of the intervention effects when data are missing at random. We will adjust for the stratification variables at randomization and potential confounding variables. We will also carry out various sensitivity analyses to examine the robustness of the conclusions of the primary analysis.

SAS 9.4 will be used for the analyses. Results will be reported as mean, SD, SE, and 95% confidence interval when appropriate. All analyses were two sided, and $P<0.05$ was considered significant.

Project timelines

Recruitment of communities and participants started in October 2018. Baseline assessments were carried out between October and December 2018. As the intervention duration is 1 year, the final follow-up assessments will be carried out between October and December 2019.

Expected outcome and potential impact

The study will provide a feasible and effective approach to achieving a sustainable reduction in salt intake by covering home cooks. The offline intervention methods combined with the online intervention are particularly advantageous over the traditional methods. In addition, the results should therefore be generally applicable to the whole Chinese

population. If the programme is implemented and sustained across China, it will reduce population salt intake and thereby prevent hundreds of thousands of strokes, heart attacks and heart failure each year, and lead to major cost-savings to individuals, their families and the health service.

Although our study will be carried out in China, the programme of home cook intervention to reduce salt could potentially be adopted by many other countries where most of the salt in the diet is added by the consumers, which will have great public health implications.

ETHICS AND DISSEMINATION

Ethics

The study has been reviewed and approved by the Queen Mary Research Ethics Committee (QMERC2018/13) and Institutional Review Board of Chinese Center for Disease Control and Prevention (No.201801).

Written consent will be obtained from all participants in the research according to well-established practices. Every participant has the right to withdraw from the study at any time.

There are no substantive ethical issues associated with the conduct of our research project. The collection of the urine samples constitutes inconvenience but no risk to the individuals involved. A modest reduction in salt intake has no risk to the participants.

During this study, if a participant is found to have high BP, we will recommend him/her to see a doctor and, if he/she agrees, we will help make an appointment with a doctor in a local hospital.

Dissemination

The findings of this study will be disseminated through conference presentations, peer-reviewed publications and the general media.

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The authors would like to thank the local CDC and primary health staff who shared their opinion on the development of the intervention programme.

Contributors

Xiaochang Zhang and Xiao Hu contributed to the work equally. Jixiang Ma, Puhong Zhang, Xiaochang Zhang, Yuan Li and Fengjun He conceived the project and designed the study. Xiaochang Zhang, Xiao Hu, Yuan Li and Rong Luo designed the intervention tools. All authors contributed to the development of the intervention and evaluation. Xiaochang Zhang and Xiao Hu wrote the first draft of the manuscript. Jixiang Ma, Fengjun He, Puhong Zhang and Yuan Li revised the draft. All authors contributed to the refinement of the study protocol and approved the final manuscript.

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Competing interests

FJH is a member of Consensus Action on Salt & Health (CASH) and World Action on Salt & Health (WASH). Both CASH and WASH are nonprofit charitable organizations, and FJH does not receive any financial support from CASH or WASH. GAM is Chairman of Blood Pressure UK (BPUK), Chairman of CASH, WASH, and Action on Sugar. BPUK, CASH, WASH and Action on Sugar are nonprofit charitable organizations. GAM does not receive any financial support from any of these organizations. Other authors have no disclosures to report.

References:

1. Brown I J, Tzoulaki I, Candeias V, et al. Salt intakes around the world: implications for public health[J]. International Journal of Epidemiology, 2009, 38(3):791.

2. D. Mozaffarian, S. Fahimi, G.M. Singh. Global Sodium Consumption and Death From Cardiovascular Causes[J]. N Engl J Med. 2014, 371(7):624-634.

3 He FJ, Li J, Macgregor GA. Effect of longer term modest salt reduction on blood

pressure: Cochrane systematic review and metaanalysis of randomised trials. BMJ2013;346:f1325.

4. World Health Organization. Diet, Nutrition and the Prevention of Chronic Diseases. Report of a joint WHO/FAO expert consultation. WHO Technical report series, No. 916 [Internet]. Geneva: WHO; 2003 [cited 2011 Nov 1]. Available from: ftp://ftp.fao.org/docrep/fao/005/ac911e/ac911e00.pdf

5. Powles J, Fahimi S, Micha R, et al. 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.

6. GBD 2017 Diet Collaborators. Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017 [J]. Lancet, 2019,(4).

7. Asaria P, Chisholm D, Mathers C, Ezzati M, Beaglehole R. Chronic disease prevention: health effects and financial costs of strategies to reduce salt intake and control tobacco use. *Lancet* 2007; **370**: 2044-53.

8. Dorairaj Prabhakaran, Shuchi Anand, David Watkins, et al. Cardiovascular, respiratory, and related disorders: key messages from Disease Control Priorities, 3rd edition. The Lancet. , P1224-1236, March 24, 2018.

9. Bibbins-Domingo K, Chertow GM, et al. Projected effect of dietary salt reductions on future cardiovascular disease. N Engl J Med. 2010 Feb 18;362(7):590-9. doi: 10.1056/NEJMoa0907355.

10. World Health Organization. Global action plan for the prevention and control of NCDs 2013-2020. Geneva: WHO, 2013.

11. Trieu K, Neal B, Hawkes C, et al. Salt Reduction Initiatives around the World - A Systematic Review of Progress towards the Global Target. PLoS One2015;10:e0130247.

12. Zhou M, Wang H, Zeng X, et al. Mortality, morbidity, and risk factors in China and its provinces, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2019 Jun 24. pii: S0140-6736(19)30427-1. doi: 10.1016/S0140-6736(19)30427-1.

13. Du S, Neiman A, Batis C, et al. Understanding the patterns and trends of sodium intake, potassium intake, and sodium to potassium ratio and their effect on hypertension in China.[J]. American Journal of Clinical Nutrition, 2014, 99(2):334-43.

14. Anderson C A, Appel L J, Okuda N, et al. Dietary sources of sodium in China, Japan, the United Kingdom, and the United States, women and men aged 40 to 59 years: the INTERMAP study.[J]. Journal of the American Dietetic Association, 2010, 110(5):736-45.

15. National Health and Family Planning Commission of China. Report on the Nutrition and Chronic Disease Status of Chinese Residents (2015) [M]. Beijing, China: People's Medical Publishing House, 2015.

16. Xu J, Wang M, Chen Y, et al. Estimation of salt intake by 24-hour urinary sodium excretion: a cross-sectional study in Yantai, China[J]. Bmc Public Health, 2014, 14(1):136.

17. Bi Z , Liang X , Xu A , et al. Hypertension Prevalence, Awareness, Treatment, and Control and Sodium Intake in Shandong Province, China: Baseline Results From Shandong–Ministry of Health Action on Salt Reduction and Hypertension (SMASH), 2011[J]. Preventing Chronic Disease, 2014.

18. Zhang J , Astell-Burt T , Seo D C , et al. Multilevel evaluation of 'China Healthy Lifestyles for All', a nationwide initiative to promote lower intakes of salt and edible oil[J]. Preventive Medicine, 2014, 67:210-215.

19. 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 Nov 11;8(11):e78963. doi: 10.1371/journal.pone.0078963. eCollection 2013.

20. Wang M, Moran A E, Liu J, et al. A Meta-Analysis of Effect of Dietary Salt Restriction on Blood Pressure in Chinese Adults[J]. Global Heart, 2015, 10(4):291-299.e6.

21. Takada T, Imamoto M, Fukuma S, et al. Effect of cooking classes for housewives on salt reduction in family members: a cluster randomized controlled trial. Public Health. 2016;140:144–150.

22. He F J , Wu Y , Feng X X , et al. School based education programme to reduce salt intake in children and their families (School-EduSalt): cluster randomised controlled trial[J]. BMJ, 2015, 350.

23. Corinna H , Jacqui W , Murielle B . National Approaches to Monitoring Population Salt Intake: A Trade-Off between Accuracy and Practicality?[J]. PLoS ONE, 2012, 7(10):e46727-.

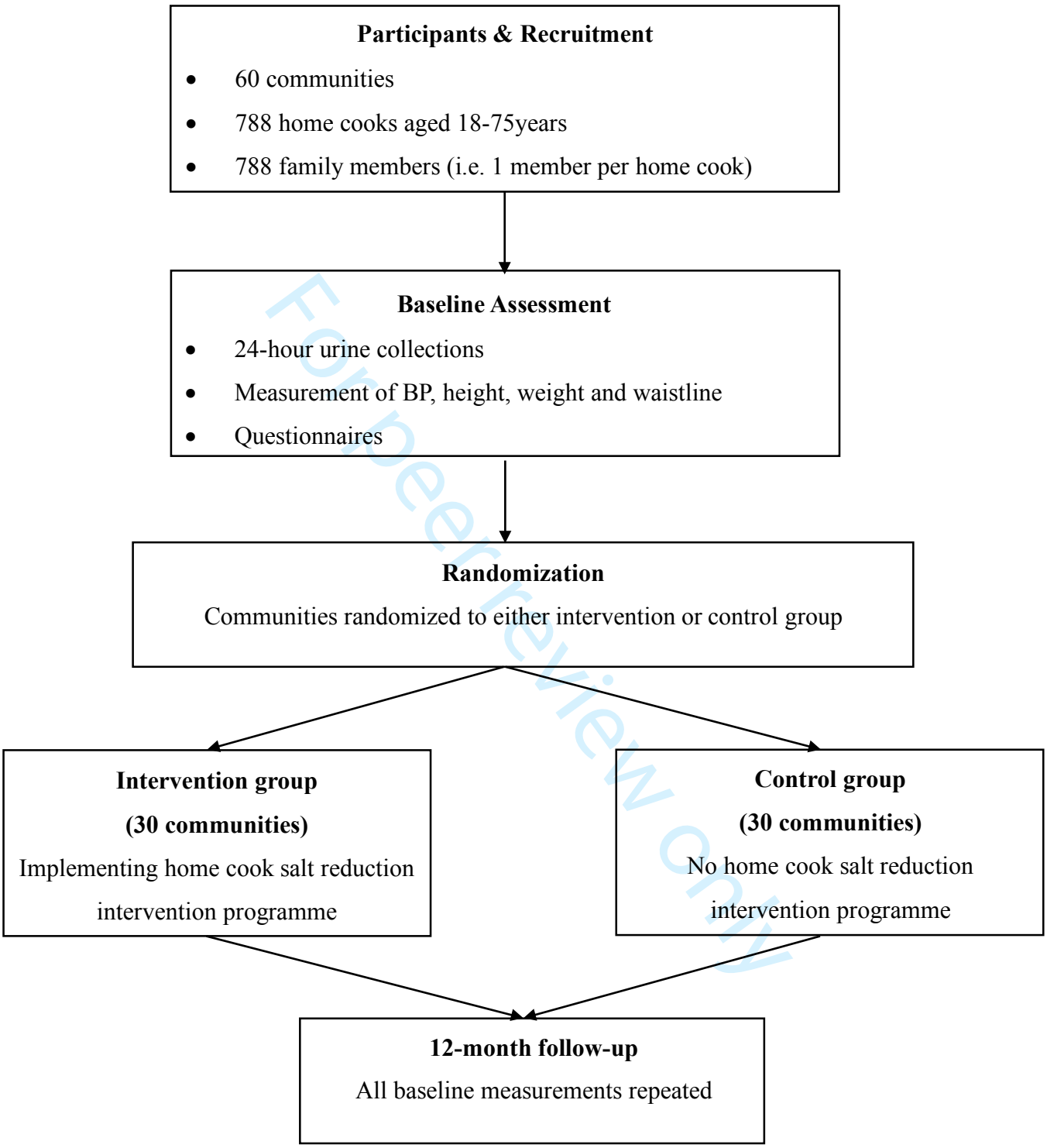

Figure 1. Home cook intervention trial design

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ABSTRACT

Introduction Salt intake in China is twice the upper limit recommended by the World Health Organization (WHO), and nearly 80% of salt is added during cooking. This study will develop a package of salt reduction interventions targeting home cooks and evaluate its effectiveness and feasibility for scale-up.

Methods and analysis A cluster randomized controlled trial (cRCT)

design is adopted in this study, which will be conducted in six provinces covering northern, central and southern China. For each province, 10 communities/villages (clusters) with 13 families (one cook and one adult family member) will be selected in each cluster for evaluation. In total, 780 home cooks and 780 adult family members will be recruited. The home cooks in the intervention group will be provided with the intervention package, including community-based standardized offline and online health education and salt intake monitoring. The duration of the intervention will be one year. The primary outcome is the difference between the intervention and control group in change in salt intake as measured by 24-hour urinary sodium from baseline to the end of the trial. The secondary outcome is the difference between the two groups in the change in salt-related KAP and blood pressure.

Ethics and dissemination The study has been approved by The Queen Mary Research Ethics Committee (QMERC2018/13) and Institutional Review Board of the Chinese Center for Disease Control and Prevention (No.201801). The study findings will be disseminated widely through conference presentations and peer-reviewed publications and the general media.

Trial registration number ChiCTR1800016804.

Strengths and limitations of this study

- A new approach will be developed to achieve long-term, sustainable progressive lower salt intake.
- A 7-day salt surveillance method will be applied to estimate the salt intake of every member of the family to motivate the target population to reduce

salt intake.

- The study covers a wide range of the population through the inclusion of home cooks and their family members from diverse areas, including northern, central and southern China.
- The results should be generally applicable to the whole Chinese population.
- The study will be carried out in China only; however, the method could potentially be adopted by many other developing countries where most of the salt in the diet is added by consumers.

INTRODUCTION

Excess dietary salt consumption is an important risk factor for high blood pressure, stroke, cardiovascular disease and other adverse health outcomes[1-3]. As a result, in 2003 the WHO and the United Nations Food and Agriculture Organization (FAO) issued a joint report calling for a reduction in salt intake in the population to less than 5 g per day (<2,000 mg sodium)[4]. It has been estimated that the mean salt consumption in 181 of 187 countries exceeded the daily intake of salt recommended by the WHO in 2010, and 51 of these countries reported mean intakes greater than double the recommended amount[5]. In April 2019, the *Lancet* published the latest series of studies on the global burden of disease[6], which found that 3 million deaths were attributable to a high-salt diet in 2017.

Salt reduction is highly cost-effective worldwide[7-8]. It has been estimated that a regulatory intervention to reduce salt intake by 3 g per day would save 194,000 to 392,000 quality-adjusted life-years and $10 to $24 billion in health care costs every year in the USA[9]. At the United Nations General

Assembly in 2011, the WHO identified population salt reduction as a priority intervention for ameliorating the global burden of non-communicable diseases (NCDs)[4]. In 2013, the WHO member states agreed on a global target of a 30% relative reduction salt intake in the population to be achieved by 2025[10]. Many developed countries have introduced programmes that seek to reduce population-level salt intake, including the UK, Finland, Japan, the US and Canada[11].

In China, the current salt intake situation is not satisfactory. High salt intake is the third leading risk factor contributing to death and DALYs[12]. A cohort of 16,869 Chinese adults aged 20–60 years over the period of 1991–2009 indicated that salt intake remains at high levels, double those of World Health Organization recommendations[13]. A study used two methods (24-hour urine collection and 24-hour dietary recall) to measure salt intake in rural China, and the results showed that mean 24-hour urinary sodium excretion was 13 g and 24-hour dietary salt intake was 10 g[14]. In 2012, a report examining Chinese residents' chronic diseases and nutrition using a dietary survey showed that the average daily salt intake for Chinese adults was 10.5g[15].

In contrast to Western countries, in China, most dietary salt comes from salt and high-salt condiments that are added during cooking. A survey involving nine provinces of China showed that in 2006 the main sources of dietary sodium were from salt in home cooking (71.5%) followed by soy sauce (8.3%)[16].

The Chinese government has been making great efforts in salt intake surveillance and salt reduction interventions. The Shandong-MOH Action on Salt and Hypertension (SMASH) project[17] and Healthy Lifestyle for All initiative[18] are two representative interventions. Culturally tailored salt

reduction interventions have been applied in various groups and sites, including the distribution of salt restriction spoons and the encouragement of people to use the minimum amount of salt to reduce the amount of salt added during cooking[19]. However, the effect of such interventions must be evaluated in a more rigorous way[20].

Since cooking salt is the largest source of salt intake in China, home cooks, who are responsible for purchasing food and preparing meals for their families, should be given special attention during intervention activities. In Japan, cooking classes for housewives effectively reduced salt intake from 9.57 g/d to 8.95 g/d after a two-month intervention[21]. In China, studies specifically focusing on salt reduction among housewives are scarce, and the type of interventions that are effective for family salt reduction remain unclear. Hence, this study will be undertaken among home cooks in six provinces of China to explore the feasibility of reducing salt intake by means of community-based intervention, which, if proven successful, will be applied on a broader scale.

Study objectives

The primary objective is to increase salt awareness in home cooks and to reduce the amount of salt used during cooking, thus helping the population reduce salt intake by at least 1 g/day. The specific objectives include the following: (1) to develop a package of salt reduction interventions through home cooks that are applicable to community families and (2) to evaluate the effectiveness of the intervention package by carrying out a cluster randomized trial with an intervention duration of 12 months.

METHODS AND ANALYSIS

Overall Study design

Using a cluster RCT design, 60 communities will be selected from 6 provinces. A baseline survey will be carried out before randomization among 1560 participants recruited from the 60 communities. The communities will be allocated randomly to the intervention or control group. Information on salt-related KAP, blood pressure and 24-h urinary sodium will be collected. The intervention group will receive the salt reduction intervention for 1 year. (Figure 1)

Study Setting

Considering the geographical location, economic level and dietary habits, our study will be undertaken in selected counties from six provinces in Qinghai, Hebei, Heilongjiang, Sichuan, Jiangxi and Hunan. The interventions will be targeted to all home cooks and their family members in the selected communities.

Outcomes

The primary outcome is the difference between the intervention and control group in the change in salt intake as measured by 24-hour urinary sodium from baseline to the end of the trial.

The secondary outcome is the difference between the two groups in the change in salt-related KAP and blood pressure.

Study Population

Selection of communities

A county/district will be selected from each province, and ten communities will be selected from each county/district. For the selection of communities, we will take into consideration the geographical area, urbanization, size of

the populations, age structure of the populations, economic status, and health service resources, among others, to ensure all the communities have similar characteristics. The selected communities should have local workers to carry out the intervention activities from the primary health service supported by the neighbourhood committee (women's federation workers). Communities involved in other salt reduction projects should be excluded.

Selection of participants

Participants will be randomly selected according to age and sex. Inclusion criteria for participants include the following: (1) age of 18-75 years; (2) two family members from each family, one of whom is the major cook and the other of whom is another adult family member (better to be of different gender, spouse is preferred); (3) consumption of homemade meals at least 4 days per week by both of the family members; and (4) residence in the community for more than 6 months and no relocation plans in the next 24 months. The exclusion criteria include the following: (1) women who are pregnant or lactating; (2) individuals currently participating in any other clinical trial; and (3) individuals who cannot or refuse to collect 24-hour urine.

Randomization

Sixty communities (clusters) will be randomly assigned (1:1) to either the intervention or the control group. Randomization will be stratified by the geographical area (urban or rural), size of the population, economic status, and health service resources. Randomization will be carried out using a computer-generated random number system by an independent statistician who will be blinded to the identity of the communities. The randomization will be implemented after receiving written consent and completing the

baseline assessments. Therefore, the participants and the local investigators who undertake participant recruitment and data collection will be unaware of the allocation until commencement of the intervention.

Intervention

The intervention group will receive the salt reduction intervention package developed in this study, while the control group will not receive any of the interventions. The primary health staff will collaborate with workers from the neighbourhood committee and/or local women's federation to carry out the following interventions under the guidance of the local CDC.The salt reduction intervention package will include the following.

(1) A supportive environment, such as posters, brochures, videos and local broadcasts, to deliver core messages regarding salt reduction. We will develop brochures, posters, videos and audio materials about salt reduction targeting home cooks. Additionally, posters will be put up in communities and markets. Videos will be played in primary health institutions and at community activities organized by neighbourhood committees.

(2) Lectures on salt reduction knowledge and skills. We will develop a set of standard slides to disseminate knowledge and skills to reduce salt intake for the target population. In the intervention communities, these slides will be provided for the local health institutions. They will organize and deliver lectures to the participants, especially the home cooks, once every two months. A total of 6 training lectures will be delivered in 12 months. The brief contents of the six courses will include salt-related health outcomes, sources of salt intake, low-sodium salt, misunderstandings of salt reduction, how to reduce salt intake during cooking or when eating outside the home, and how to wisely choose low-salt pre-packaged food.

(3) A 7-day salt intake monitoring activity. This method will be used to estimate the amount of salt intake for every member of the family and improve the awareness of salt reduction among the target population. Participants will record the frequency of dining out, consumption of processed foods and amount of salt added during cooking. The added salt will be assessed by weighing salt, soy sauce and other primary salty condiments on the first and last day of the evaluation period[22]. Additionally, the local CDCs and primary health institutions will help participants with the results estimated by this method and remind the families about their salt intake in relation to the set targets and highlight further action plans.

(4) Online health education. The national project team will publish core knowledge on salt reduction through the WeChat public account to conduct health education for the public.

Sample Size

Based on the School-EduSalt trial[23], assuming a standard deviation of 24-hour urinary sodium excretion of 85 mmol/day and an intra-class correlation coefficient (ICC) of 0.05, we estimated that a sample size of 1426 individuals (713 home cooks and 713 family members) would provide a power of 80% (with a two-sided alpha=0.05) to detect a difference in mean 24-hour urinary sodium ≥20 mmol/day (1 g/d salt) between the intervention and control group, allowing for a 20% drop-out rate of participants. We aim to recruit 1 home cook and 1 family member per household to ensure that the number of households in every community remains the same. We will select 12 households in each community, resulting in a total of 720 households and 1440 individuals. In addition, considering that the response rate of 24-hour urine collection is often low[24], we have decided to add one more family per community, resulting in the

recruitment of 1560 individuals (780 home cooks and 780 family members) into the study for evaluation.

Data collection

All outcome measurements and assessments will be carried out at baseline and at the end of the trial in exactly the same way in all communities for all participants, irrespective of their assignment to the intervention or control group.

The participants will be carefully instructed on how to accurately collect 24-hour urine by trained research staff. On the first day, the participants will be asked to visit the survey location. The researchers will ask the participants to empty their bladders and discard the urine. The researchers will record the start time and date of the 24-hour urine collection. They will then supply the participants with collection equipment including containers and collection aids. At the same time, on the second day, the participants will be asked to bring the urine collection bottles back to the survey location and to pass the last urine into the container. The researchers will record the finish time of the 24-hour urine collection. During the 24-hour urine collection period, the participants will be asked to take spare urine containers with them to work. In case the participant misses one or more urine voids or spillage occurs, the participant will be asked to perform an additional 24-hour urine collection. For each participant, the 24-hour urine will be collected on the same days of the week for the baseline visit and follow-up visit at the end of the trial. We will measure urine volume, sodium, potassium and creatinine. An ion-selective electrode method will be used for sodium and potassium analysis and an enzymatic method for the creatinine assay. The 24-hour urinary creatinine together with the urine volume will be used to determine if the collection is likely to be complete.

The biochemist who performs the measurements of urinary electrolytes will be unaware of the group to which the participant is allocated.

In addition to 24-hour urine collection, we will measure BP and heart rate using a validated automatic machine with the appropriate cuff size. Three readings will be taken for the right arm at 1 to 2-min intervals in a sitting position after the participant has rested for 10 min in a quiet room. Body weight, height and waist circumference will also be measured. A survey on KAP related to salt will be completed via questionnaire.

The RCT data will be collected through a specially designed mobile device-based electronic data capture system (mEDC) by well-trained field investigators. The RCT data include information on demographics, social-economic information, KAP, measurements of height, weight, waist circumference, BP, heart rate, 24-hour urine volume and electrolytes, as well as information about the intervention.

Additionally, to ensure the quality of the intervention, quality control will be established at every step of the trial using the electronic system.

Data collection

All cleaned and locked datasets together with the study design, questionnaire, code list and definition of database and variables will be stored with a unique ID number attached but no personal identifiers, in the China CDC, following an established standard operating procedure for data security. To guarantee the data security, the mobile app developer must follow the 'Mobile Application Information Service Regulation' issued by the Cyberspace Administration of China in 2016. Although personal data are accessible to the app developer, the disclosure of such information is prohibited. In addition to the development and maintenance

of a mEDC, an information technology team will also provide the data management service during the study to guarantee the safety, integrity and proper use of the data collected through the mEDC.

Statistical methods

The difference in 24-hour sodium excretion as well as the secondary outcomes between the two groups will be compared using linear mixed models with participants nested within family units and families nested within community/village units. We will include group (intervention, control), time (baseline, end of trial), and time×group interactions, with the time×group interaction term indicating different changes by group from baseline to the end of the trial. To account for missing data on continuous outcomes, we will use the likelihood-based random effects model that uses all available data and provides valid estimates of the intervention effects when data are missing at random. We will adjust for the stratification variables at randomization and potential confounding variables. We will also carry out various sensitivity analyses to examine the robustness of the conclusions of the primary analysis.

SAS 9.4 will be used for the analyses. The results will be reported as the mean, SD, SE, and 95% confidence interval when appropriate. All analyses will be two-sided, and $P<0.05$ will be considered significant.

Project timelines

Recruitment of communities and participants was started in October 2018. Baseline assessments were carried out between October and December 2018. As the intervention duration is 1 year, the final follow-up assessments will be carried out between October and December 2019.

Expected outcome and potential impact

The study will provide a feasible and effective approach to achieving a sustainable reduction in salt intake by targeting home cooks. The offline intervention methods combined with the online intervention are particularly advantageous over traditional methods. Therefore, the results should be generally applicable to the whole Chinese population. If the programme is implemented and sustained across China, it will reduce population salt intake and thereby prevent hundreds of thousands of strokes, heart attacks and heart failure each year, leading to major cost-savings to individuals, their families and health services.

Although our study will be conducted in China, the home cook intervention programme to reduce salt could potentially be adopted by many other countries where most of the salt in the diet is added by consumers, which will have great public health implications.

Patient and Public Involvement

No patient involved.

ETHICS AND DISSEMINATION

Ethics

The study has been reviewed and approved by the Queen Mary Research Ethics Committee (QMERC2018/13) and the Institutional Review Board of the Chinese Center for Disease Control and Prevention (No.201801).

Written consent will be obtained from all participants in the research according to well-established practices. Every participant has the right to withdraw from the study at any time.

There are no substantive ethical issues associated with the conduct of our

research project. The collection of urine samples constitutes inconvenience but no risk to the individuals involved. A modest reduction in salt intake has no risk to the participants.

During this study, if a participant is found to have high BP, we will recommend that he/she sees a doctor, and if he/she agrees, we will help make an appointment with a doctor in a local hospital.

Dissemination

The findings of this study will be disseminated through conference presentations, peer-reviewed publications and the general media.

Acknowledgements

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Contributors

Xiaochang Zhang and Xiao Hu contributed to this work equally. Jixiang Ma, Puhong Zhang, Xiaochang Zhang, Yuan Li, Fengjun He, and Graham A MacGregor conceived the project and designed the study. Xiaochang Zhang, Xiao Hu, Yuan Li and Rong Luo designed the intervention tools. All authors contributed to the development of the intervention and evaluation. Xiaochang Zhang and Xiao Hu wrote the first draft of the manuscript. Jixiang Ma, Fengjun He, Puhong Zhang, Yuan Li, Graham A MacGregor, Jinglei Wang, and Zhaoxue Yin revised the manuscript draft. All authors contributed to the refinement of the study protocol and

approved the final manuscript.

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Competing interests

FJH is a member of Consensus Action on Salt & Health (CASH) and World Action on Salt & Health (WASH). Both CASH and WASH are nonprofit charitable organizations, and FJH has not received any financial support from CASH or WASH. GAM is Chairman of Blood Pressure UK (BPUK), Chairman of CASH, WASH, and Action on Sugar. BPUK, CASH, WASH and Action on Sugar are nonprofit charitable organizations. GAM has not received receive any financial support from any of these organizations. The other authors have no disclosures to report.

References:

1. Brown I J, Tzoulaki I, Candeias V, et al. Salt intakes around the world: implications for public health[J]. International Journal of Epidemiology, 2009, 38(3):791.

2. D. Mozaffarian, S. Fahimi, G.M. Singh. Global Sodium Consumption and Death From Cardiovascular Causes[J]. N Engl J Med. 2014, 371(7):624-634.

3 He FJ, Li J, Macgregor GA. Effect of longer term modest salt reduction on blood pressure: Cochrane systematic review and metaanalysis of randomised trials. BMJ2013;346:f1325.

4. World Health Organization. Diet, Nutrition and the Prevention of Chronic Diseases. Report of a joint WHO/FAO expert consultation. WHO Technical report series, No. 916 [Internet]. Geneva: WHO; 2003 [cited 2011 Nov 1]. Available from: ftp:// ftp.fao.org/docrep/fao/005/ac911e/ac911e00.pdf

5. Powles J, Fahimi S, Micha R, et al. 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.

6. GBD 2017 Diet Collaborators. Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017 [J]. Lancet, 2019,(4).

7. Asaria P, Chisholm D, Mathers C, Ezzati M, Beaglehole R. Chronic disease prevention: health effects and financial costs of strategies to reduce salt intake and control tobacco use. *Lancet* 2007; **370**: 2044-53.

8. Dorairaj Prabhakaran, Shuchi Anand, David Watkins, et al. Cardiovascular, respiratory, and related disorders: key messages from Disease Control Priorities, 3rd edition. The Lancet. , P1224-1236, March 24, 2018.

9. Bibbins-Domingo K, Chertow GM, et al. Projected effect of dietary salt reductions on future cardiovascular disease. N Engl J Med. 2010 Feb 18;362(7):590-9. doi: 10.1056/NEJMoa0907355.

10. World Health Organization. Global action plan for the prevention and control of NCDs 2013-2020. Geneva: WHO, 2013.

11. Trieu K, Neal B, Hawkes C, et al. Salt Reduction Initiatives around the World - A

Systematic Review of Progress towards the Global Target. PLoS One2015;10:e0130247.

12. Zhou M, Wang H, Zeng X, et al. Mortality, morbidity, and risk factors in China and its provinces, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2019 Jun 24. pii: S0140-6736(19)30427-1. doi: 10.1016/S0140-6736(19)30427-1.

13. Du S, Neiman A, Batis C, et al. Understanding the patterns and trends of sodium intake, potassium intake, and sodium to potassium ratio and their effect on hypertension in China.[J]. American Journal of Clinical Nutrition, 2014, 99(2):334-43.

14. Anderson C A, Appel L J, Okuda N, et al. Dietary sources of sodium in China, Japan, the United Kingdom, and the United States, women and men aged 40 to 59 years: the INTERMAP study.[J]. Journal of the American Dietetic Association, 2010, 110(5):736-45.

15. Disease Control Bureau of National Health and Family Planning Commission of China. Report on Chinese Residents' Chronic Disease and Nutrition (2015) [M]. Beijing, China: People's Medical Publishing House, 2016.

16. Zhang J, Zhang B, Wang Z, et al. The status of dietary sodium intake of Chinese population in nine provinces (autonomous region) from 1991 to 2006 [J]. Chinese Journal of Prevention Medicine, 2011, 45(4):310-312.

17. Bi Z , Liang X , Xu A , et al. Hypertension Prevalence, Awareness, Treatment, and Control and Sodium Intake in Shandong Province, China: Baseline Results From Shandong–Ministry of Health Action on Salt Reduction and Hypertension (SMASH), 2011[J]. Preventing Chronic Disease, 2014.

18. Zhang J , Astell-Burt T , Seo D C , et al. Multilevel evaluation of 'China Healthy Lifestyles for All', a nationwide initiative to promote lower intakes of salt and edible oil[J]. Preventive Medicine, 2014, 67:210-215.

19. 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 Nov 11;8(11):e78963. doi: 10.1371/journal.pone.0078963. eCollection 2013.

20. Wang M, Moran A E, Liu J, et al. A Meta-Analysis of Effect of Dietary Salt Restriction on Blood Pressure in Chinese Adults[J]. Global Heart, 2015, 10(4):291-299.e6.

21. Takada T, Imamoto M, Fukuma S, et al. Effect of cooking classes for housewives on salt reduction in family members: a cluster randomized controlled trial. Public Health. 2016;140:144–150.

22. Zhang L, Zhao F, Zhang P, et al. 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;7:751–63

23. He F J , Wu Y , Feng X X , et al. School based education programme to reduce salt intake in children and their families (School-EduSalt): cluster randomised controlled trial[J]. BMJ, 2015, 350.

24. Corinna H , Jacqui W , Murielle B . National Approaches to Monitoring Population Salt Intake: A Trade-Off between Accuracy and Practicality?[J]. PLoS ONE, 2012, 7(10):e46727-.

Figure Legends

Figure1. Home cook intervention trial design.

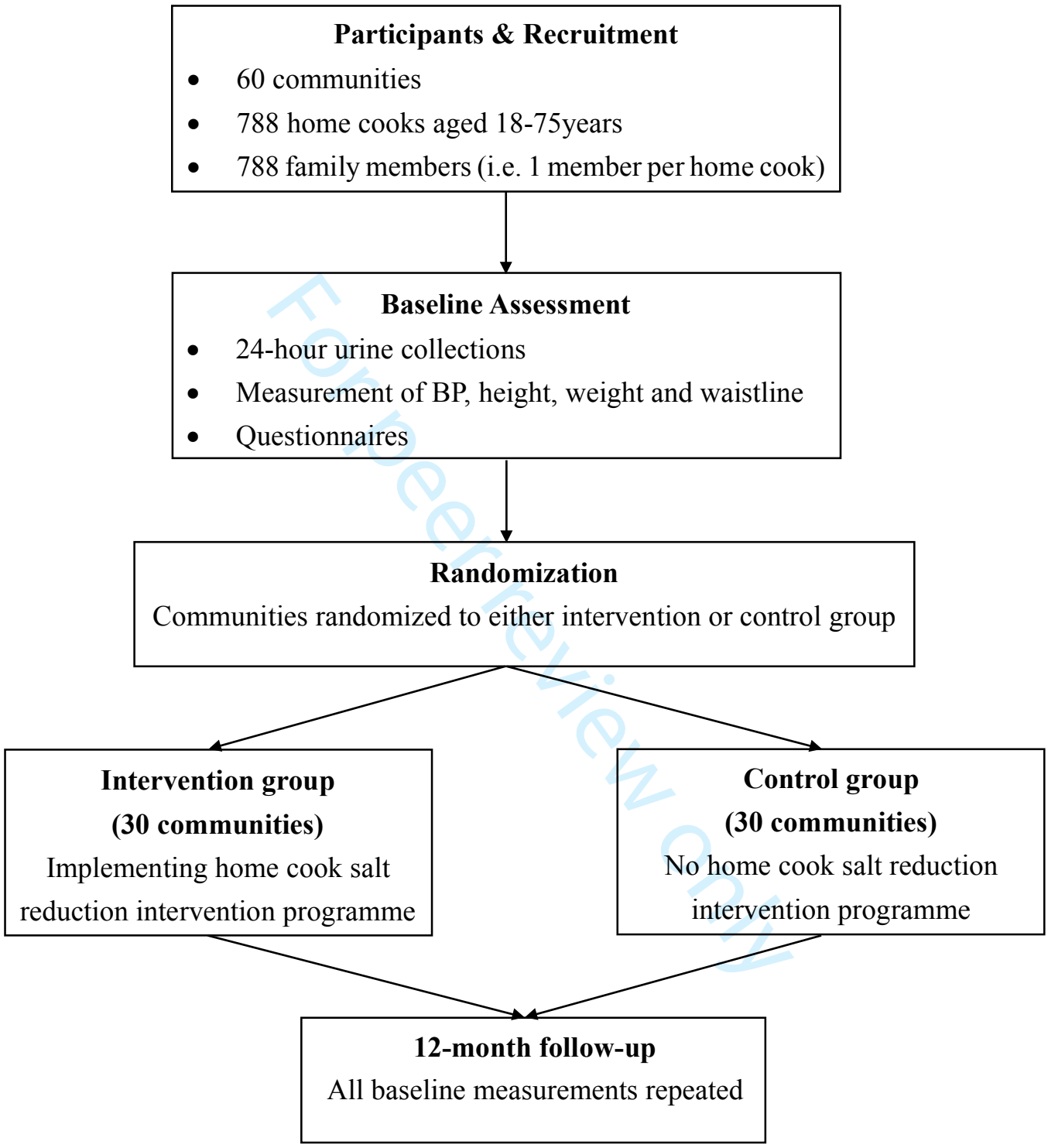

Figure 1 Home cook intervention trial design.

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Protocol for a cluster randomized controlled trial of home cook intervention to reduce salt intake in China

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Protocol for a cluster randomized controlled trial of home cook intervention to reduce salt intake in China

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ABSTRACT

Introduction Salt intake in China is twice the upper limit recommended by the World Health Organization (WHO), and nearly 80% of salt is added during cooking. This study will develop a package of salt reduction interventions targeting home cooks and evaluate its effectiveness and feasibility for scale-up.

Methods and analysis A cluster randomized controlled trial (cRCT) design is adopted in this study, which will be conducted in six provinces covering northern, central and southern China. For each province, 10 communities/villages (clusters) with 13 families (one cook and one adult family member) will be selected in each cluster for evaluation. In total, 780 home cooks and 780 adult family members will be recruited. The home cooks in the intervention group will be provided with the intervention package, including community-based standardized offline and online health education and salt intake monitoring. The duration of the intervention will be one year. The primary outcome is the difference between the intervention and control group in change in salt intake as

measured by 24-hour urinary sodium from baseline to the end of the trial. The secondary outcome is the difference between the two groups in the change in salt-related knowledge, attitude and practice (KAP) and blood pressure.

Ethics and dissemination The study has been approved by The Queen Mary Research Ethics Committee (QMERC2018/13) and Institutional Review Board of the Chinese Center for Disease Control and Prevention (No.201801). The study findings will be disseminated widely through conference presentations and peer-reviewed publications and the general media.

Trial registration number ChiCTR1800016804.

Strengths and limitations of this study

- A new approach will be developed to achieve long-term, sustainable progressive lower salt intake.
- A 7-day salt surveillance method will be applied to estimate the salt intake of every member of the family to motivate the target population to reduce salt intake.
- The study covers a wide range of the population through the inclusion of home cooks and their family members from diverse areas, including northern, central and southern China.
- The study will be carried out in China only; however, the method could potentially be adopted by many other developing countries where most of the salt in the diet is added by consumers.

INTRODUCTION

Excess dietary salt consumption is an important risk factor for high blood pressure, stroke, cardiovascular disease and other adverse health outcomes[1-3]. As a result, in 2003 the WHO and the United Nations Food and Agriculture Organization (FAO) issued a joint report calling for a reduction in salt intake in the population to less than 5 g per day (<2,000 mg sodium)[4]. It has been estimated that the mean salt consumption in 181 of 187 countries exceeded the daily intake of salt recommended by the

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Salt reduction is highly cost-effective worldwide[7-8]. It has been estimated that a regulatory intervention to reduce salt intake by 3 g per day would save 194,000 to 392,000 quality-adjusted life-years and $10 to $24 billion in health care costs every year in the USA[9]. At the United Nations General Assembly in 2011, the WHO identified population salt reduction as a priority intervention for ameliorating the global burden of non-communicable diseases (NCDs)[4]. In 2013, the WHO member states agreed on a global target of a 30% relative reduction salt intake in the population to be achieved by 2025[10]. Many developed countries have introduced programmes that seek to reduce population-level salt intake, including the UK, Finland, Japan, the US and Canada[11].

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In contrast to Western countries, in China, most dietary salt comes from salt and high-salt condiments that are added during cooking. A survey involving nine provinces of China showed that in 2006 the main sources of dietary sodium were from salt in home cooking (71.5%) followed by soy sauce (8.3%)[16].

The Chinese government has been making great efforts in salt intake surveillance and salt reduction interventions. The Shandong-MOH Action

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Study objectives

The primary objective is to increase salt awareness in home cooks and to reduce the amount of salt used during cooking, thus helping the population reduce salt intake by at least 1 g/day. The specific objectives include the following: (1) to develop a package of salt reduction interventions through home cooks that are applicable to community families and (2) to evaluate the effectiveness of the intervention package by carrying out a cluster randomized trial with an intervention duration of 12 months.

METHODS AND ANALYSIS

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Considering the geographical location, economic level and dietary habits, our study will be undertaken in selected counties from six provinces in Qinghai, Hebei, Heilongjiang, Sichuan, Jiangxi and Hunan. The interventions will be targeted to all home cooks and their family members in the selected communities.

Outcomes

The primary outcome is the difference between the intervention and control group in the change in salt intake as measured by 24-hour urinary sodium from baseline to the end of the trial.

The secondary outcome is the difference between the two groups in the change in salt-related KAP and blood pressure.

Study Population

Selection of communities

A county/district will be selected from each province, and ten communities will be selected from each county/district. For the selection of communities, we will take into consideration the geographical area, urbanization, size of the populations, age structure of the populations, economic status, and health service resources, among others, to ensure all the communities have similar characteristics. The selected communities should have local workers to carry out the intervention activities from the primary health service supported by the neighbourhood committee (women's federation workers). Communities involved in other salt reduction projects should be excluded.

Selection of participants

Participants will be randomly selected according to age and sex. Inclusion criteria for participants include the following: (1) age of 18-75 years; (2) two family members from each family, one of whom is the major cook and the other of whom is another adult family member (better to be of different gender, spouse is preferred); (3) consumption of homemade meals at least

4 days per week by both of the family members; and (4) residence in the community for more than 6 months and no relocation plans in the next 24 months. The exclusion criteria include the following: (1) women who are pregnant or lactating; (2) individuals currently participating in any other clinical trial; and (3) individuals who cannot or refuse to collect 24-hour urine.

Randomization

Sixty communities (clusters) will be randomly assigned (1:1) to either the intervention or the control group. Randomization will be stratified by the geographical area (urban or rural), size of the population, economic status, and health service resources. Randomization will be carried out using a computer-generated random number system by an independent statistician who will be blinded to the identity of the communities. The randomization will be implemented after receiving written consent and completing the baseline assessments. Therefore, the participants and the local investigators who undertake participant recruitment and data collection will be unaware of the allocation until commencement of the intervention.

Intervention

The intervention group will receive the salt reduction intervention package developed in this study, while the control group will not receive any of the interventions. The primary health staff will collaborate with workers from the neighbourhood committee and/or local women's federation to carry out the following interventions under the guidance of the local CDC.The salt reduction intervention package will include the following.

(1) A supportive environment, such as posters, brochures, videos and local broadcasts, to deliver core messages regarding salt reduction. We will develop brochures, posters, videos and audio materials about salt reduction targeting home cooks. Additionally, posters will be put up in communities and markets. Videos will be played in primary health institutions and at community activities organized by neighbourhood committees.

(2) Lectures on salt reduction knowledge and skills. We will develop a set of standard slides to disseminate knowledge and skills to reduce salt intake for the target population. In the intervention communities, these slides will

be provided for the local health institutions. They will organize and deliver lectures to the participants, especially the home cooks, once every two months. A total of 6 training lectures will be delivered in 12 months. The brief contents of the six courses will include salt-related health outcomes, sources of salt intake, low-sodium salt, misunderstandings of salt reduction, how to reduce salt intake during cooking or when eating outside the home, and how to wisely choose low-salt pre-packaged food.

(3) A 7-day salt intake monitoring activity. This method will be used to estimate the amount of salt intake for every member of the family and improve the awareness of salt reduction among the target population. Participants will record the frequency of dining out, consumption of processed foods and amount of salt added during cooking. The added salt will be assessed by weighing salt, soy sauce and other primary salty condiments on the first and last day of the evaluation period[22]. Additionally, the local CDCs and primary health institutions will help participants with the results estimated by this method and remind the families about their salt intake in relation to the set targets and highlight further action plans.

(4) Online health education. The national project team will publish core knowledge on salt reduction through the WeChat public account to conduct health education for the public.

Sample Size

Based on the School-EduSalt trial[23], assuming a standard deviation of 24-hour urinary sodium excretion of 85 mmol/day and an intra-class correlation coefficient (ICC) of 0.05, we estimated that a sample size of 1426 individuals (713 home cooks and 713 family members) would provide a power of 80% (with a two-sided alpha=0.05) to detect a difference in mean 24-hour urinary sodium ≥20 mmol/day (1 g/d salt) between the intervention and control group, allowing for a 20% drop-out rate of participants. We aim to recruit 1 home cook and 1 family member per household to ensure that the number of households in every community remains the same. We will select 12 households in each community, resulting in a total of 720 households and 1440 individuals. In addition, considering that the response rate of 24-hour urine collection is often low[24],

we have decided to add one more family per community, resulting in the recruitment of 1560 individuals (780 home cooks and 780 family members) into the study for evaluation.

Data collection

All outcome measurements and assessments will be carried out at baseline and at the end of the trial in exactly the same way in all communities for all participants, irrespective of their assignment to the intervention or control group.

The participants will be carefully instructed on how to accurately collect 24-hour urine by trained research staff. On the first day, the participants will be asked to visit the survey location. The researchers will ask the participants to empty their bladders and discard the urine. The researchers will record the start time and date of the 24-hour urine collection. They will then supply the participants with collection equipment including containers and collection aids. At the same time, on the second day, the participants will be asked to bring the urine collection bottles back to the survey location and to pass the last urine into the container. The researchers will record the finish time of the 24-hour urine collection. During the 24-hour urine collection period, the participants will be asked to take spare urine containers with them to work. In case the participant misses one or more urine voids or spillage occurs, the participant will be asked to perform an additional 24-hour urine collection. For each participant, the 24-hour urine will be collected on the same days of the week for the baseline visit and follow-up visit at the end of the trial. We will measure urine volume, sodium, potassium and creatinine. An ion-selective electrode method will be used for sodium and potassium analysis and an enzymatic method for the creatinine assay. The 24-hour urinary creatinine together with the urine volume will be used to determine if the collection is likely to be complete. The biochemist who performs the measurements of urinary electrolytes will be unaware of the group to which the participant is allocated.

In addition to 24-hour urine collection, we will measure BP and heart rate using a validated automatic machine with the appropriate cuff size. Three readings will be taken for the right arm at 1 to 2-min intervals in a sitting

position after the participant has rested for 10 min in a quiet room. Body weight, height and waist circumference will also be measured. A survey on KAP related to salt will be completed via questionnaire.

The RCT data will be collected through a specially designed mobile device-based electronic data capture system (mEDC) by well-trained field investigators. The RCT data include information on demographics, social-economic information, KAP, measurements of height, weight, waist circumference, BP, heart rate, 24-hour urine volume and electrolytes, as well as information about the intervention.

Additionally, to ensure the quality of the intervention, quality control will be established at every step of the trial using the electronic system.

Data management

All cleaned and locked datasets together with the study design, questionnaire, code list and definition of database and variables will be stored with a unique ID number attached but no personal identifiers, in the China CDC, following an established standard operating procedure for data security. To guarantee the data security, the mobile app developer must follow the 'Mobile Application Information Service Regulation' issued by the Cyberspace Administration of China in 2016. Although personal data are accessible to the app developer, the disclosure of such information is prohibited. In addition to the development and maintenance of a mEDC, an information technology team will also provide the data management service during the study to guarantee the safety, integrity and proper use of the data collected through the mEDC.

Statistical methods

The difference in 24-hour sodium excretion as well as the secondary outcomes between the two groups will be compared using linear mixed models with participants nested within family units and families nested within community/village units. We will include group (intervention, control), time (baseline, end of trial), and time×group interactions, with the time×group interaction term indicating different changes by group from baseline to the end of the trial. To account for missing data on continuous outcomes, we will use the likelihood-based random effects model that uses

all available data and provides valid estimates of the intervention effects when data are missing at random. We will adjust for the stratification variables at randomization and potential confounding variables. We will also carry out various sensitivity analyses to examine the robustness of the conclusions of the primary analysis.

SAS 9.4 will be used for the analyses. The results will be reported as the mean, SD, SE, and 95% confidence interval when appropriate. All analyses will be two-sided, and $P<0.05$ will be considered significant.

Project timelines

Recruitment of communities and participants was started in October 2018. Baseline assessments were carried out between October and December 2018. As the intervention duration is 1 year, the final follow-up assessments will be carried out between October and December 2019.

Expected outcome and potential impact

The study will provide a feasible and effective approach to achieving a sustainable reduction in salt intake by targeting home cooks. The offline intervention methods combined with the online intervention are particularly advantageous over traditional methods. Therefore, the results should be generally applicable to the whole Chinese population. If the programme is implemented and sustained across China, it will reduce population salt intake and thereby prevent hundreds of thousands of strokes, heart attacks and heart failure each year, leading to major cost-savings to individuals, their families and health services.

Although our study will be conducted in China, the home cook intervention programme to reduce salt could potentially be adopted by many other countries where most of the salt in the diet is added by consumers, which will have great public health implications.

Patient and Public Involvement

No patient involved.

ETHICS AND DISSEMINATION

Ethics

The study has been reviewed and approved by the Queen Mary Research

Ethics Committee (QMERC2018/13) and the Institutional Review Board of the Chinese Center for Disease Control and Prevention (No.201801).

Written consent will be obtained from all participants in the research according to well-established practices. Every participant has the right to withdraw from the study at any time.

There are no substantive ethical issues associated with the conduct of our research project. The collection of urine samples constitutes inconvenience but no risk to the individuals involved. A modest reduction in salt intake has no risk to the participants.

During this study, if a participant is found to have high BP, we will recommend that he/she sees a doctor, and if he/she agrees, we will help make an appointment with a doctor in a local hospital.

Dissemination

The findings of this study will be disseminated through conference presentations, peer-reviewed publications and the general media.

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Contributors

Xiaochang Zhang and Xiao Hu contributed to this work equally. Jixiang Ma, Puhong Zhang, Xiaochang Zhang, Yuan Li, Fengjun He, and Graham A MacGregor conceived the project and designed the study. Xiaochang Zhang, Xiao Hu, Yuan Li and Rong Luo designed the intervention tools. All authors contributed to the development of the intervention and evaluation. Xiaochang Zhang and Xiao Hu wrote the first draft of the manuscript. Jixiang Ma, Fengjun He, Puhong Zhang, Yuan Li, Graham A MacGregor, Jinglei Wang, and Zhaoxue Yin revised the manuscript draft. All authors contributed to the refinement of the study protocol and approved the final manuscript.

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Competing interests

FJH is a member of Consensus Action on Salt & Health (CASH) and World Action on Salt & Health (WASH). Both CASH and WASH are nonprofit charitable organizations, and FJH has not received any financial support from CASH or WASH. GAM is Chairman of Blood Pressure UK (BPUK), Chairman of CASH, WASH, and Action on Sugar. BPUK, CASH, WASH and Action on Sugar are nonprofit charitable organizations. GAM has not received receive any financial support from any of these organizations. The other authors have no disclosures to report.

Data sharing

The de-identified participant-level data, research forms and statistical code generated and/or analysed during this study are not publicly available due to confidentiality requirements but are available from the corresponding author on reasonable request after April 1st, 2022. Also, any data cross-border transfer must obtain official approval for relevant governmental authorities. Any data/dataset sharing with other parties will be recorded and formulated in written contractual agreements.

References:

1. Brown I J, Tzoulaki I, Candeias V, et al. Salt intakes around the world: implications for public health[J]. International Journal of Epidemiology, 2009, 38(3):791.

2. D. Mozaffarian, S. Fahimi, G.M. Singh. Global Sodium Consumption and Death From Cardiovascular Causes[J]. N Engl J Med. 2014, 371(7):624-634.

3 He FJ, Li J, Macgregor GA. Effect of longer term modest salt reduction on blood pressure: Cochrane systematic review and metaanalysis of randomised trials.

BMJ2013;346:f1325.

4. World Health Organization. Diet, Nutrition and the Prevention of Chronic Diseases. Report of a joint WHO/FAO expert consultation. WHO Technical report series, No. 916 [Internet]. Geneva: WHO; 2003 [cited 2011 Nov 1]. Available from: ftp:// ftp.fao.org/docrep/fao/005/ac911e/ac911e00.pdf

5. Powles J, Fahimi S, Micha R, et al. 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.

6. GBD 2017 Diet Collaborators. Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017 [J]. Lancet, 2019,(4).

7. Asaria P, Chisholm D, Mathers C, Ezzati M, Beaglehole R. Chronic disease prevention: health effects and financial costs of strategies to reduce salt intake and control tobacco use. *Lancet* 2007; **370**: 2044-53.

8. Dorairaj Prabhakaran, Shuchi Anand, David Watkins, et al. Cardiovascular, respiratory, and related disorders: key messages from Disease Control Priorities, 3rd edition. The Lancet. , P1224-1236, March 24, 2018.

9. Bibbins-Domingo K, Chertow GM, et al. Projected effect of dietary salt reductions on future cardiovascular disease. N Engl J Med. 2010 Feb 18;362(7):590-9. doi: 10.1056/NEJMoa0907355.

10. World Health Organization. Global action plan for the prevention and control of NCDs 2013-2020. Geneva: WHO, 2013.

11. Trieu K, Neal B, Hawkes C, et al. Salt Reduction Initiatives around the World - A Systematic Review of Progress towards the Global Target. PLoS One2015;10:e0130247.

12. Zhou M, Wang H, Zeng X, et al. Mortality, morbidity, and risk factors in China and its provinces, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2019 Jun 24. pii: S0140-6736(19)30427-1. doi: 10.1016/S0140-6736(19)30427-1.

13. Du S, Neiman A, Batis C, et al. Understanding the patterns and trends of sodium intake, potassium intake, and sodium to potassium ratio and their effect on hypertension in China.[J]. American Journal of Clinical Nutrition, 2014, 99(2):334-43.

14. Anderson C A, Appel L J, Okuda N, et al. Dietary sources of sodium in China,

Japan, the United Kingdom, and the United States, women and men aged 40 to 59 years: the INTERMAP study.[J]. Journal of the American Dietetic Association, 2010, 110(5):736-45.

15. Disease Control Bureau of National Health and Family Planning Commission of China. Report on Chinese Residents' Chronic Disease and Nutrition (2015) [M]. Beijing, China: People's Medical Publishing House, 2016.

16. Zhang J, Zhang B, Wang Z, et al. The status of dietary sodium intake of Chinese population in nine provinces (autonomous region) from 1991 to 2006 [J]. Chinese Journal of Prevention Medicine, 2011, 45(4):310-312.

17. Bi Z , Liang X , Xu A , et al. Hypertension Prevalence, Awareness, Treatment, and Control and Sodium Intake in Shandong Province, China: Baseline Results From Shandong–Ministry of Health Action on Salt Reduction and Hypertension (SMASH), 2011[J]. Preventing Chronic Disease, 2014.

18. Zhang J , Astell-Burt T , Seo D C , et al. Multilevel evaluation of 'China Healthy Lifestyles for All', a nationwide initiative to promote lower intakes of salt and edible oil[J]. Preventive Medicine, 2014, 67:210-215.

19. 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 Nov 11;8(11):e78963. doi: 10.1371/journal.pone.0078963. eCollection 2013.

20. Wang M, Moran A E, Liu J, et al. A Meta-Analysis of Effect of Dietary Salt Restriction on Blood Pressure in Chinese Adults[J]. Global Heart, 2015, 10(4):291-299.e6.

21. Takada T, Imamoto M, Fukuma S, et al. Effect of cooking classes for housewives on salt reduction in family members: a cluster randomized controlled trial. Public Health. 2016;140:144–150.

22. Zhang L, Zhao F, Zhang P, et al. 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;7:751–63

23. He F J , Wu Y , Feng X X , et al. School based education programme to reduce salt intake in children and their families (School-EduSalt): cluster randomised controlled trial[J]. BMJ, 2015, 350.

24. Corinna H , Jacqui W , Murielle B . National Approaches to Monitoring Population Salt Intake: A Trade-Off between Accuracy and Practicality?[J]. PLoS ONE, 2012,

7(10):e46727-.

Figure Legends

Figure1. Home cook intervention trial design.

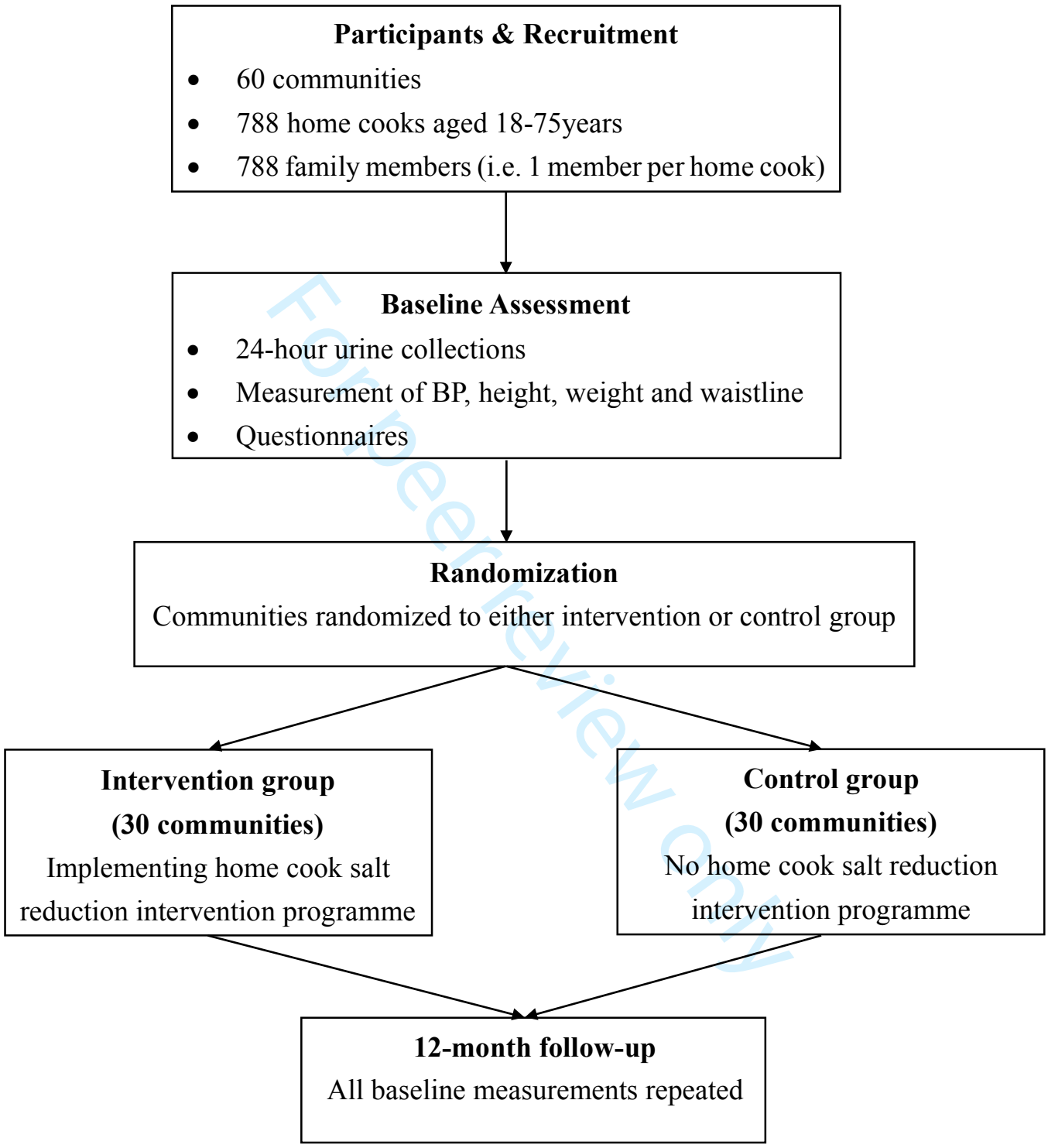

Figure 1 Home cook intervention trial design.