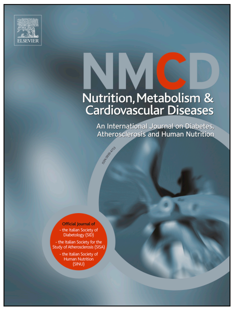
Accepted Manuscript



Associations between dietary salt, potassium and blood pressure in South African adults: WHO SAGE Wave 2 Salt & Tobacco

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PII: S0939-4753(17)30138-2

DOI: 10.1016/j.numecd.2017.06.017

Reference: NUMECD 1748

To appear in: *Nutrition, Metabolism and Cardiovascular Diseases*

Received Date: 13 March 2017

Revised Date: 14 June 2017

Accepted Date: 26 June 2017

Please cite this article as: Ware L, Charlton K, Schutte A, Cockeran M, Naidoo N, Kowal P, Associations between dietary salt, potassium and blood pressure in South African adults: WHO SAGE Wave 2 Salt & Tobacco, *Nutrition, Metabolism and Cardiovascular Diseases* (2017), doi: 10.1016/ j.numecd.2017.06.017.

Associations between dietary salt, potassium and blood pressure in South African adults: WHO SAGE Wave 2 Salt & Tobacco

Short title: Salt and blood pressure in South African adults

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Word count of text (exc. references, tables & figures): **3486**
Word count of abstract: **249**
Total number of figures/tables: **5;** Total number of references: **44**

ABSTRACT

Background & Aims: In June 2016, South Africa implemented legislation mandating maximum sodium levels in a range of processed foods with a goal of reducing population salt intake and disease burden from hypertension. Our aim was to explore the relationship between salt and blood pressure (BP) in a subsample of the World Health Organization Study on global AGEing and adult health (SAGE) Wave 2 before implementation of legislation in South Africa.

Methods & Results: Blood pressure (BP) was measured in triplicate (n=2722; median age 56 years; 33% male) and 24-hour urine collected in a nested subsample (n=526) for sodium, potassium and creatinine analysis. Hypertension prevalence was 55% in older adults (50-plus years) and 28% in younger adults (18-49 years). Median salt intake (6.8g/day) was higher in younger than older adults (8.6g vs 6.1g/day; p<0.001), and in urban compared to rural populations (7.0g vs 6.0g/day; p=0.033). Overall, 69% of participants had salt intakes above 5g/day. Potassium intakes were generally low (median 35 mmol/day) with significantly lower intakes in rural areas and older adults. Overall, 91% of adults failed to meet the daily potassium recommendation of 90 mmol/d. Salt intakes above 5g/day, and to a greater extent, a dietary sodium-to-potassium (Na:K) ratio above 2 mmol/mmol, were associated with significantly steeper regression slopes of BP with age.

Conclusion: These preliminary results indicate that high dietary Na:K ratio may lead to a greater increase in BP and hypertension risk with age. Interventions to increase potassium intakes alongside sodium reduction initiatives may be warranted.

Key Words (5-7): hypertension, sodium, potassium, salt, aging, health policy, public health, South Africa.

HIGHLIGHTS

- South Africa's new health legislation aims to reduce sodium intake & hypertension rates
- Pre-legislation data shows most adults (69%) consume more than 5g salt/day
- Additionally, 91% of adults fail to meet daily dietary potassium requirements
- Sodium-to-potassium ratio had a greater impact than salt on age-related blood pressure
- Strategies should be considered to increase potassium alongside sodium reduction initiatives

INTRODUCTION

In response to reports that high salt intake contributes to hypertension and cardiovascular disease,[1] South Africa was the first country to legislate mandatory maximum sodium levels in a range of processed foods.[2] This was implemented in June 2016 with further reductions required in sodium levels by June 2019.[3] Estimations based on current models suggest this legislation will reduce nationwide salt intake by 0.85 g/day, and result in a reduction of annual cardiovascular disease (CVD) deaths of 11%, with the potential for saving millions of dollars annually in health care costs.[4, 5] However, previous research examining the relationship between salt (measured as sodium in 24-hour (24h) urine collections) and hypertension in South Africa has produced, at best, mixed results. [6-9]

The aim of this study was to investigate the relationship between salt intake (as measured by 24h urinary sodium excretion) and blood pressure (BP) in a random sample of the South African adult population.

METHODS

Study population & measures

The World Health Organization Study on global AGEing and adult health (WHO SAGE) is a multinational longitudinal study examining the health and wellbeing of adult populations and the ageing process in over 42,000 respondents from six countries (China, Ghana, India, Mexico, Russia and South Africa).[10] SAGE South Africa Wave 2 data collection was implemented in 2015 (August-December), with 24h urine sample collection included as a nested study (that is, SAGE Salt & Tobacco) described in detail elsewhere.[11] Briefly, the WHO/PAHO protocol was used for sodium, potassium, and creatinine determination in 24h urine.[12] Valid 24h urine collections were >300ml/24h with creatinine >4 mmol/24h for women or >6mmol/24h for men. Sodium (mmol/l) in the 24h urine sample was converted to salt (g/d) using the formula: Na mmol/l x 24hr volume (litres) x 23.1 (molecular weight of sodium) / 390 (390mg sodium per 1g sodium chloride (salt)). Potassium (mmol/l) in the 24h urine sample was converted to potassium (mmol/d) using the formula: K mmol/l x 24h volume (litres). Blood pressure was measured by trained nurses using wrist-worn BP devices with positioning sensor (R6, Omron, Japan). Respondents were seated for at least five minutes before three sequential measures were taken on the left arm (one minute between each measure), with the wrist resting precisely at the level of the heart and the respondent seated with legs uncrossed. Such wrist BP devices have been shown to meet the validation criteria of the European Society of Hypertension International Protocol.[13-15] BP was determined as a valid reading if: SBP>DBP; and SBP was 80-270 mmHg; and DBP was 40-180 mmHg; and SBP minus DBP (pulse pressure, PP) was ≥13 mmHg.

Anthropometry was measured and data were collected on ethnicity, tobacco and alcohol use, residential location (urban or rural), previous disease diagnosis and current medication use as previously described. [11]

All respondents provided written informed consent prior to taking part in the study. The study complied with the Declaration of Helsinki,[16] with ethical approval from the WHO Ethics Review Committee [RPC149], the North-West University Health Research Ethics Committee (Potchefstroom, South Africa) and the University of the Witwatersrand Human Research Ethics Committee (Johannesburg, South Africa). Interviewers spoke the respondents' home languages with consent forms available in the most widely spoken languages for each area.

Data capture, analysis and statistical power

SPSS version 23 was used for statistical analysis (IBM Corporation, New York). Categorical data frequencies were examined using the Pearson Chi-Square and Fisher's Exact tests. Mann-Whitney U and Kruskal-Wallis tests were used to compare non-parametric group distributions and Spearman's Rho for correlations. Linear regression was used to investigate relationships between variables. Hypertension (HTN) was determined by systolic BP ≥ 140mmHg or diastolic BP ≥ 90mmHg, or a previous HTN diagnosis/current medication use. To test regression slope equality between the three salt level groups in the models for age and blood pressure, a univariate general linear model was fitted with the LMATRIX subcommand that facilitated varying the contrast coefficient matrix for hypotheses testing. The overall test for whether the groups had different slopes was given by the p-value associated with the fixed factor-by-covariate interaction term (salt level-by-age), significant at alpha=0.05. The custom hypotheses tests were then called the F-tests for each pairwise LMATRIX contrast. To detect a 5mmHg difference in systolic blood pressure (effect size = 0.333; β = 0.10; p<0.05) between individuals with a urinary salt excretion of <5g/day and ≥9g/day, assuming a standard deviation in systolic blood pressure of 15mmHg, n=155 per group was required.

RESULTS

Interviews were completed in 2928 respondents, with successful BP readings in n=2722 (93%). In this main cohort, hypertension prevalence was 55% in older adults (50-plus years) and 28% in younger adults (18-49 years). Among respondents with hypertension (n=1252), only 22% (n=276) were taking any antihypertensive medication. Of those respondents taking medication, 48% (n=132) were classified as having uncontrolled hypertension, with a SBP ≥140 and/or DBP≥90 mmHg.

Complete 24h urine collections were received in 69% of the nested sample (n=889 of 1291). However, fewer respondents (n=526) had a complete set of urine, survey, anthropometric and BP data for these analyses. In comparison to the main cohort (n=2722; 67% women; 70% black, 15% mixed race, 11% Indian, 4% white), the nested cohort (n=526) included more women (76%), more black (73%) and mixed race (17%) respondents, and fewer Indian (8%) and white (2%) respondents (all p<0.001). No other significant differences were observed between the nested and main cohort in age, BP, body mass index (BMI), current tobacco use, recent alcohol use or prevalence of diabetes, stroke or HTN.

In the nested subsample with linked survey and urine results data (n=526), sodium excretion varied widely, with a group median of 2.7g sodium/day or 6.8g salt/day (IQR 6.0; mean 8.4g ± 6.1): higher in the younger compared to the older group (median 8.6g salt/day (IQR 8.8); 6.1g salt/day (4.6); p<0.001); and in urban compared to rural respondents (median 7.0g salt/day (IQR 6.5); 6.0g salt/day (4.4); p=0.033). There was no significant difference in salt intake between men and women. Comparing characteristics by salt tertile (low <5g/day; medium 5-9g/day; high >9g/day; **Table 1**) also showed that the high salt group was younger, with a higher proportion of urban respondents, and a lower percentage of self-reported diabetes (all $p<0.05$). Overall, 69% of adults (n=362) had salt intakes above the WHO recommendation of 5g/day, with 28% consuming more than twice this level (≥10g/day; n=147) and 11% consuming at least three times the recommended level (≥15g/day; n=58). Sensitivity analysis removing all individuals with salt intake >20g/day (n=26; 5%), while leading to small reductions in median daily salt intakes of approximately 0.2g salt/day, did not significantly change the findings. The exception was that salt intake was no longer significantly different between urban and rural groups.

Urinary sodium and potassium excretion were highly positively correlated (Spearman's Rho: $r_s = 0.647$, $p<0.001$). Linear regression showed that sodium excretion explained more than half of the variation in potassium excretion ($R^2=0.512$; $F(1, 524)=550$, $p<0.001$). Potassium excretion increased by 0.24 mmol/day for each 1 mmol/day increase in sodium, such that the median sodium-to-potassium (Na:K) ratio was significantly lower in the low-salt group (2.7 mmol/mmol) compared to the high-salt group (3.7 mmol/mmol; $p<0.001$). Only 9% of adults (n=47) met the WHO recommended potassium intake of ≥90 mmol/day, with 4% (n=21) achieving the Na:K ratio of <1.0 mmol/1.0 mmol, equivalent to the respective WHO recommendations for sodium and potassium intake.[17]

A Spearman's rank order correlation, excluding all respondents on antihypertensive treatment (n=61 excluded, n=465 included in analysis), found no significant association between sodium excretion, potassium excretion, or the Na:K ratio with SBP, DBP, or pulse pressure. However, analysis of the effect of sodium on the regression slope of blood pressure with age (**Figure 2**) showed that in comparison to the low salt group (<5g/day), the high salt group (>9g/day) had a significantly steeper regression slope for SBP (p=0.002). There was no significant difference between the regression slopes comparing the low-medium or medium-high salt groups. The slope of DBP with age was significantly steeper in the high compared to the low (p<0.001) and medium salt groups (p=0.016). Adjusting for sex, potassium excretion and alcohol intake, the low salt group showed a change of 0.03 mmHg SBP and -0.81 mmHg DBP over 10 year age groups, while the high salt group showed an increase of 2.74 mmHg SBP and 2.87 mmHg DBP in the same period (p<0.03). Slopes for pulse pressure with age were not significantly different by salt level. Greater effects were observed when comparing the slopes of BP with age by Na:K ratio (**Figure 3**). The slope of SBP with age was significantly steeper in the high compared to the low (p<0.001) and normal Na:K ratio groups (p=0.005), and in the normal compared to the low Na:K ratio group (p=0.008). The slope of DBP with age was significantly steeper in the high compared to the low (p=0.008) and normal Na:K ratio groups (p=0.045). Following adjustment for sex and alcohol intake, the low Na:K group showed a change of -0.42 mmHg SBP and -0.79 mmHg DBP over 10 year age groups, while the high N:Ka group showed an increase of 5.16 mmHg SBP (p=0.013) and 1.06 mmHg DBP (p=0.074). The slope of pulse pressure with age was also significantly steeper in the high compared to the low (p<0.001) and normal Na:K ratio groups (p=0.029), and in the normal compared to the low Na:K ratio group (p=0.011). Higher Na:K ratios (**Table 2**) were observed in: younger adults (p=0.044); black compared to Indian, white and mixed race adults (p=0.002); and rural compared to urban adults (p=0.001), with significantly lower potassium intakes in rural men and women compared to their urban counterparts (p<0.001). While 10% of adults in urban areas met the guidelines for potassium intake, this fell to 5% for adults in rural areas (p=0.042).

DISCUSSION

This study identified high salt intake and high dietary sodium-to-potassium ratio to be associated with a significantly steeper regression slope for increase in blood pressure with age. No linear associations were found between salt or potassium intake or the Na:K ratio with BP.

Previous studies also found no correlation between sodium intake and BP in black, white and mixed ancestry South African adults (n=325),[9] in urban and rural dwelling Xhosa South Africans, or in urban dwelling descendants of Nguni and Sotho tribes (n=635).[6, 7] The variability in dietary salt intake and Na:K ratio may explain why cross-sectional studies do not always find a significant association with BP. Human diets vary considerably in sodium content from day to day.[18] Even in controlled environments when salt intake is kept constant in adults for prolonged periods, variability exists in daily sodium excretion rates.[19] However, a single 24h urine collection remains a valid method in larger studies to assess population intakes [20] while spot urine may be adequate for assessment of Na:K ratios.[21] Our findings also agree with a recent analysis of 24h urine in three different South African populations (n=692) reporting that 77% of adults consume ≥5g salt/day, while 93% do not achieve potassium recommendations with a median Na:K ratio of 3.5.[22] That study also reported a marginally higher median salt intake of 7.1g/day, possibly related to the lower mean age of the population sampled (30.3 ± 11 years), which is in line with the significantly higher salt intakes observed in younger compared to older adults in the current study. With the exception of the work by Swanepoel *et al*. (2016)[22], much of the evidence for sodium intake assessed by 24h urine collection in the South African population is now more than 10 years old.[23] For example, Maseko *et al*. (2006) analysed sodium intakes in black adults living in the city of Johannesburg (n=291; data collected 2002-2006) reporting a mean intake of 114 mmol (2.6g) sodium/day[24]. Our data shows a median of 2.7g sodium/day for our entire sample, with a lower median (2.0 g/d) but higher mean (2.8 g/d) sodium intake specifically for urban black participants (n=349). Research conducted in Cape Town around the same time (n=325) also suggests that urban black, white and mixed race adults had higher sodium intakes (as assessed by 24h urine collection) at that time (3.12, 3.42 and 3.81g/day, respectively) than our study.[25] Studies conducted in the 1980s in urban South African populations show similarly higher sodium intakes. One study in Johannesburg (n=105; 1985) reported sodium intakes of 2.9 and 3.9 g/day for black and white adults respectively.[26] Another study in urban and rural Zulu adults, again showed higher sodium intakes (4.4 and 4.8 g/day respectively).[27] That same study also collected 24h urine from urban Indian adults, reporting a lower sodium intake (2.8 g/day) than their Zulu counterparts. Taken together, this seems to suggest that, in certain populations, sodium intakes in urban areas may have been decreasing over the last 30 years. Interestingly, a review of data from the Southern Africa region between 1980 and 2008 suggests that age-standardised systolic blood pressure has also reduced, albeit minimally (mean -0.8 mmHg, 95% CI -3.0 to 1.3; -0.7 mmHg, -3.0 to 1.7 in men and women, respectively) during this period.[28] However, the impact of different populations, sample sizes and methods must be considered.

The two studies that found a positive association between urinary sodium and BP in South African adults (the PURE study[29] and a study of black urban dwelling adults in the Free State (n=339)[30]) estimated daily sodium excretion from spot urine samples, giving less reliable estimates than 24h urine analysis.[31, 32] Also using data from the PURE study (all 49 countries; n=113 118), Mente *et al*. (2016) found an increased risk of cardiovascular events and death with low salt intakes (<3g/day).[33] In our cohort, 9.5% (n=50) excreted <3g salt/day. While, as discussed below, salt intake may be underestimated even by 24h urine collection, ongoing monitoring of these individuals over time is warranted.

INTERSALT, one of the largest international investigations of 24h urinary sodium excretion and BP, also found sodium excretion and the Na:K ratio to be consistently and positively associated with the regression slope of BP with age.[34] This was observed in 48 of the 52 centres across the world, in 10 079 adults aged 20-59 years. Other variables known to influence blood pressure, such as psychosocial stress,[35] male sex and urbanisation,[36-38] are also shown to influence the slope of blood pressure with age. INTERSALT remains the major study to evaluate the effect of sodium on this relationship, the INTERSALT data is now more than 25 years old and new data for Africa is needed, not only because of the recently implemented local sodium legislation, but also because of the changing food environment.[39] Our finding of lower potassium excretion in rural populations is not consistent with the findings of Hoosen *et al*. (1985) who reported no difference in urinary potassium between rural and urban Zulu South Africans. [27] However, more recent data investigating dietary intakes in urban and rural South African adults (n=1710) also suggests that potassium (and fruit and vegetable) intakes are higher in urban populations.[40] Further research is needed in urban and rural populations to guide appropriate dietary interventions.

Our data suggests that both salt intake and Na:K ratio may influence the change in BP with age, and that the Na:K ratio potentially may have greater effects. However, we appreciate that some of the group sizes used in the Na:K analysis were smaller than those used in the salt analysis. Our study does have other limitations. While 24h urine collection remains the gold standard for estimating population sodium intake, studies in controlled environments indicate that not all dietary sodium is recovered from urine (around 92% recovery)[41] potentially leading to underestimates in dietary sodium intakes. Additionally, multiple repeated 24h urine collections have been shown to improve the accuracy of assessing salt intake in individuals.[41] However, this approach is less viable in larger population studies where multiple sampling may result in refusals, more incomplete samples [20] and potential underestimates of salt intake.[42]

Also, the recruitment strategy for the sub-study was designed to generate a population representative sample, particularly in the 50-plus age group as is the aim of WHO-SAGE.[10] Comparing the final sub-study sample to national data [43] suggests an oversampling of the 50-plus age group as intended (66% of sample compared to approximately 26% of the national adult population) and an oversampling of women (76% compared to 51% in the population). The increased willingness of women to participate in research compared to men has been documented previously [44] and can also be observed in the South African 24h urine data presented by Swanepoel *et al.* (2016).[22] Neither study presents pre-legislation analysis of salt intake data for children. Our data also included oversampling of the Indian and mixed race populations (25% compared to approximately 12% of the general adult population), with undersampling of the South African white population (2% of substudy compared to approximately 10% of the adult general population). Reports from the fieldwork teams suggest this was in part due to limited access to individuals living in gated communities, an ongoing challenge to population studies within South Africa. Sampling in the Black African population, the largest national ethnic group, was similar to national population data (73% of substudy sample and approximately 77% of the general adult population).

A further limitation is that the data is cross-sectional and longitudinal data is needed to assess the impact of dietary sodium and potassium on BP and cardiovascular events. Planned follow-up of the cohort will take place in 2017 as part of WHO SAGE Wave 3. Our findings suggest that adults with high salt intake and low potassium intake (from fruit, vegetables and dairy foods) may experience greater increases in BP with age. This has considerable implications for hypertension risk with increasing age, and supports recommendations to reduce salt intake. Our research highlights the importance of promoting increased potassium intakes to reduce the sodium-to-potassium ratio in the diet as a further strategy to delay or prevent new cases of hypertension.

Acknowledgements: The authors thank all participants for contributions and acknowledge Dr Stephen Rule, Dr Robin Richards and Mr Godfrey Dlulane of Outsourced Insight who were subcontracted to conduct the surveys and coordinate data collection within South Africa. Authors' contributions were as follows – KC, PK, NN designed research; LJW implemented research; LJW, AES, MC, PK, KC wrote the paper; KC takes responsibility for the contents of this article. All authors read and approved the final manuscript.

Funding: This work is supported by an agreement with the CDC Foundation with financial support provided by Bloomberg Philanthropies, and a Partnerships & Research Development Fund (PRDF) grant from the Australia Africa Universities Network. SAGE is supported by WHO and the Division of Behavioral and Social Research (BSR) at the National Institute on Aging (NIA), US National Institutes of Health, through Interagency Agreements with WHO [OGHA 04034785; YA1323-08-CN-0020; Y1-AG-1005-01] and a Research Project Grant [R01AG034479].

Conflicts of interest: The authors declare that they have no competing interests.

Disclaimer: The content of this manuscript is solely the responsibility of the authors and does not necessarily represent the official views of the World Health Organization or the funding bodies.

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Figure legends

Figure 1. Study flow diagram.

Figure 2. Slope of systolic, diastolic and pulse pressure with age in low (<5g/day, n=145), medium (5-9g/day, n=171) and high (≥9g/day, n=149) salt groups excluding those on blood pressure medication.

Figure 3. Slope of systolic, diastolic and pulse pressure with age in low (<2mmol/mmol, n=71), normal (2-5 mmol/mmol, n=301) and high (>5 mmol/mmol, n=93) sodium-to-potassium (Na:K) ratio groups excluding those on blood pressure medication.

Table 1. Characteristics of the nested salt study cohort by 24-hour sodium excretion level in the low sodium (<5g salt/day), medium sodium (5-9g salt/day) and high sodium (>9g/day) groups, SAGE South Africa Wave 2 (2015).

	Low salt <5g/day n=164	Medium salt 5-9g/day n=195	High salt >9g/day n=167	*P* value
Age, years	59 (18)	57 (19)	49 (26)	<0.001
Sex female, n (%)	129 (79)	152 (78)	119 (71)	0.212
Ethnicity, n (%)				
Black African	110 (71)	133 (72)	121 (75)	0.884
Coloured, mixed race	27 (18)	32 (18)	26 (16)	
Indian	14 (9)	13 (7)	13 (8)	
White	3 (2)	6 (3)	2 (1)	
Rural, n (%)	51 (31)	64 (33)	35 (21)	0.030
Education, years	9 (5)	8 (6)	10 (5)	0.029
BMI, kg/m2	28.0 (9.8)	28.5 (8.1)	30.4 (10.6)	0.062
Salt intake, grams/day	3.7 (1.7)	6.8 (2.2)	12.8 (7.0)	<0.001
Potassium intake, mmol/day	22.2 (16.4)	33.0 (24.2)	67.0 (43.2)	<0.001
Sodium-to-potassium ratio (mmol/mmol)	2.7 (2.3)	3.6 (2.1)	3.7 (2.4)	<0.001
Systolic BP, mmHg	132 (25)	127 (25)	128 (24)	0.482
Diastolic BP, mmHg	81 (17)	78 (16)	80 (16)	0.549
Pulse pressure, mmHg	50 (18)	50 (19)	49 (17)	0.510
Hypertensive (HTN), n (%)	80 (49)	89 (46)	65 (39)	0.181
AHT use, n (% of HTN)	19 (24)	24 (27)	18 (28)	0.269
Previous stroke, n (%)	2 (2)	1 (1)	3 (2)	0.543
Diabetic, n (%)	24 (18)	10 (7)	11 (9)	0.006
Current tobacco use, n (%)	25 (19)	19 (13)	12 (9)	0.067
Spot urine cotinine, ng/ml	45 (1159)	21 (636)	12 (224)	0.006
Alcohol use, n (%)	16 (12)	23 (15)	13 (10)	0.386

All data is shown as median (IQR, interquartile range) unless otherwise indicated. Tobacco use/exposure identified by self-report and urinary cotinine analysis; Hypertensive categorised as BP≥140/90mmHg or previous diagnosis; BMI, body mass index; AHT, antihypertensive medication use in last 2 weeks; alcohol use within last month. Continuous variables compared using Independent Samples Kruskal-Wallis test; categorical variables compared using Pearson Chi-Square test and Fisher's Exact Test.

Table 2. Characteristics of the nested salt study cohort by urinary sodium-to-potassium (Na:K) ratio level in the low (<2 mmol/mmol), normal (2-5 mmol/mmol) and high (>5 mmol/mmol) groups (n=526), SAGE South Africa Wave 2 (2015).

	Low Na:K <2 n=83	Normal Na:K 2 – 5 n=339	High Na:K >5 n=104	*P* value
Age, years	60 (18)	55 (24)	54 (25)	0.044
Sex female, n (%)	63 (76)	259 (76)	78 (75)	0.957
Ethnicity, n (%)				
Black African	44 (60)	234 (72)	86 (85)	0.002
Coloured, mixed race	17 (23)	61 (19)	7 (7)	
Indian	8 (11)	25 (8)	7 (7)	
White	5 (7)	5 (1)	1 (1)	
Rural, n (%)	19 (23)	87 (26)	44 (43)	0.001
Education, years	9 (5)	9 (6)	9 (5)	0.700
BMI, kg/m2	26.0 (10.9)	29.5 (9.0)	29.1 (10.9)	0.065
Salt intake, grams/day	4.0 (4.2)	7.1 (6.1)	8.6 (6.1)	<0.001
Potassium intake, mmol/day	51 (45)	37 (37)	20 (17)	<0.001
Sodium-to-potassium ratio (mmol/mmol)	1.5 (0.7)	3.2 (1.3)	6.1 (2.3)	<0.001
Systolic BP, mmHg	130 (23)	129 (24)	128 (34)	0.741
Diastolic BP, mmHg	80 (13)	80 (16)	79 (17)	0.840
Pulse pressure, mmHg	50 (19)	50 (18)	49 (20)	0.894
Hypertensive (HT), n (%)	41 (49)	151 (45)	42 (40)	0.468
AHT current use, n (% of HT)	12 (24)	38 (25)	11 (26)	0.623
Previous stroke, n (%)	1 (2)	5 (2)	0	0.476
Diabetic, n (%)	11 (17)	31 (12)	3 (4)	0.044
Current tobacco use, n (%)	12 (17)	30 (11)	14 (18)	0.165
Spot urine cotinine, ng/ml	25 (822)	15 (783)	23 (632)	0.483
Alcohol use, n (%)	10 (15)	31 (12)	11 (14)	0.704

All data is shown as median (IQR, interquartile range) unless otherwise indicated. Tobacco use/exposure identified by self-report and urinary cotinine analysis; Hypertensive categorised as BP≥140/90mmHg or previous diagnosis; BMI, body mass index; AHT, antihypertensive medication use in last 2 weeks; alcohol use within last month. Continuous variables compared using Independent Samples Kruskal-Wallis test; categorical variables compared using Pearson Chi-Square test and Fisher's Exact Test.

Figure 1. Study flow diagram.

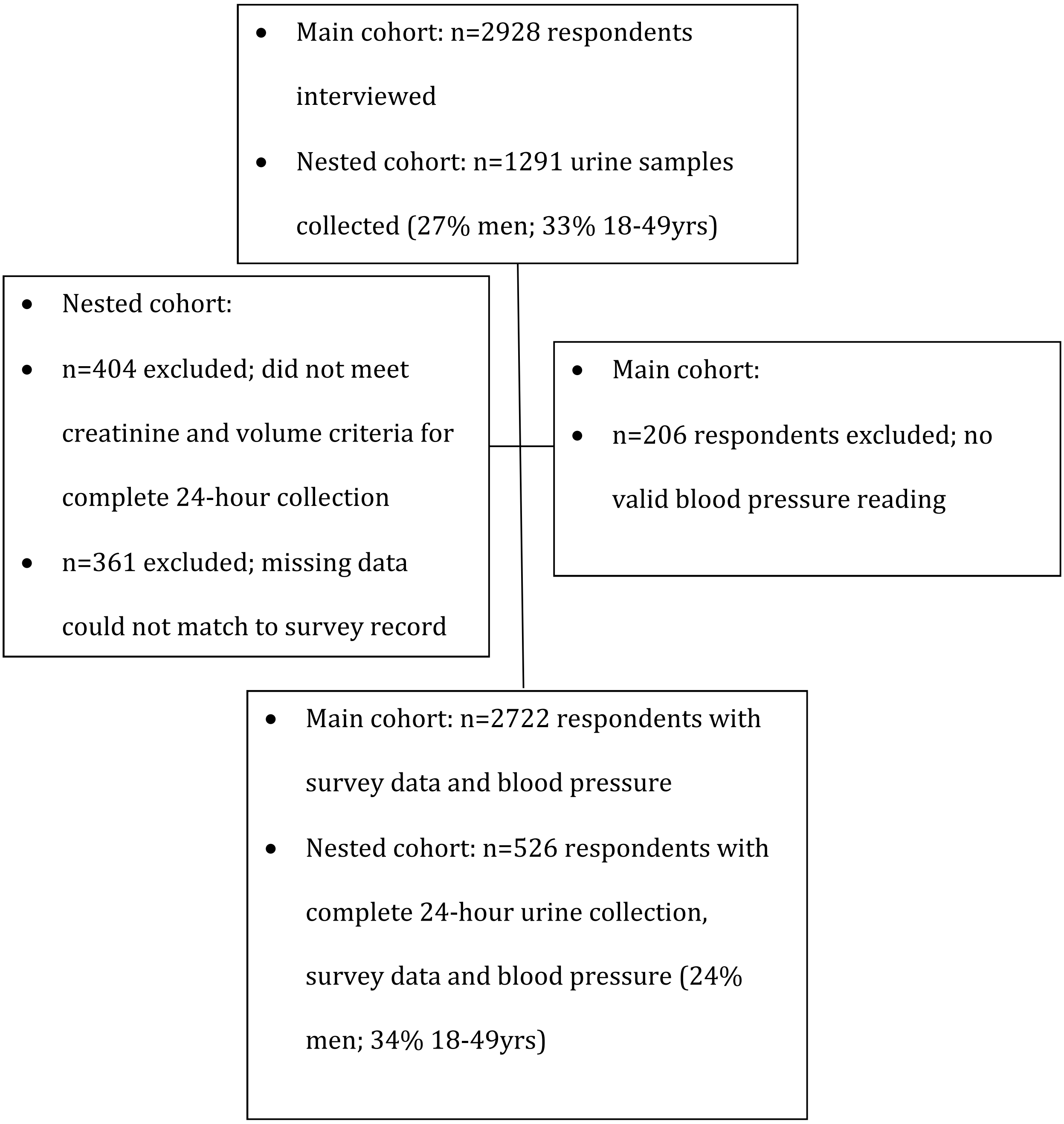

Figure 2. Slope of systolic, diastolic and pulse pressure with age in low (<5g/day, n=145), medium (5-9g/day, n=171) and high (≥9g/day, n=149) salt groups excluding those on blood pressure medication.

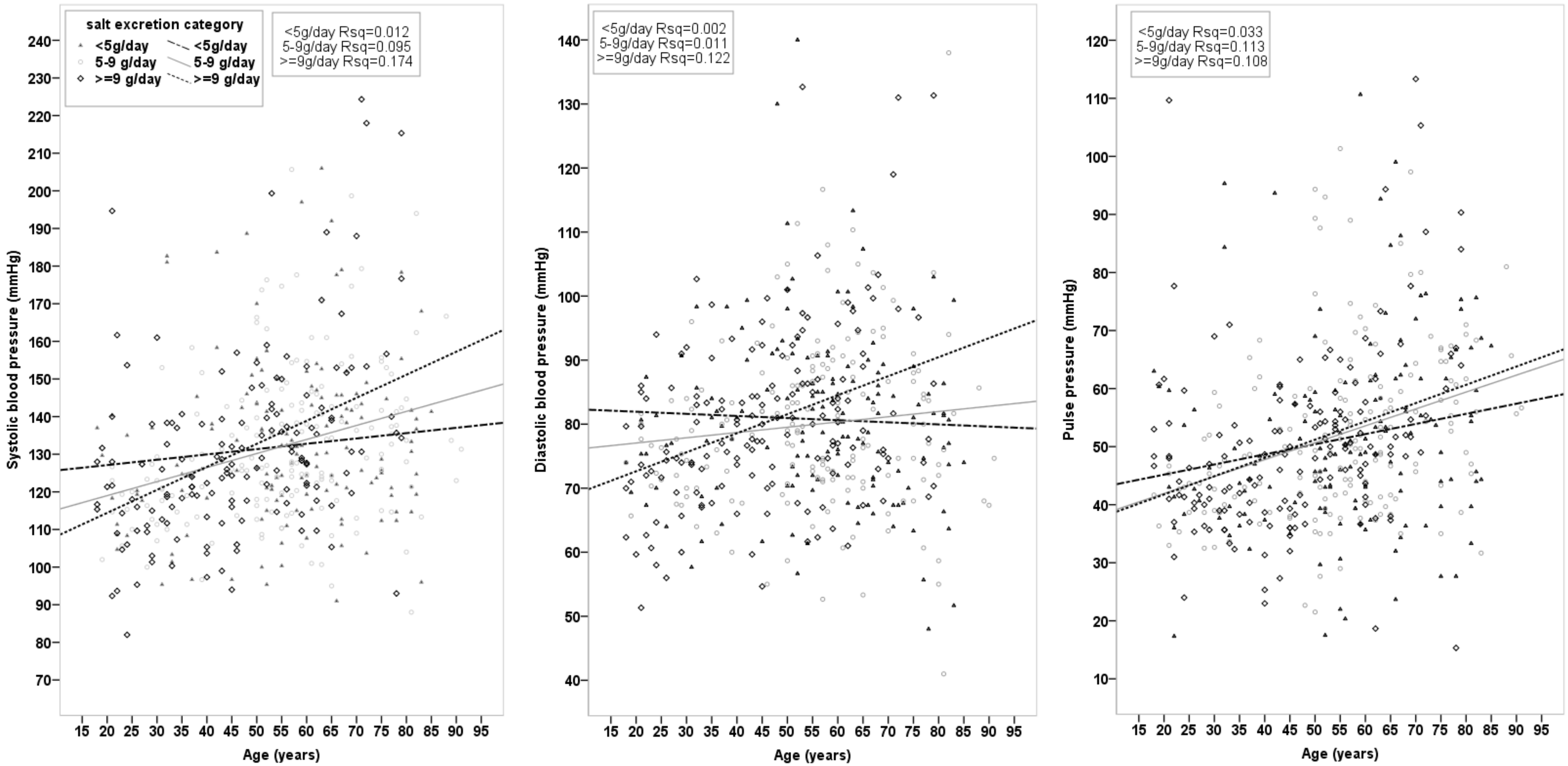

Figure 3. Slope of systolic, diastolic and pulse pressure with age in low (<2mmol/mmol, n=71), normal (2-5 mmol/mmol, n=301) and high (>5 mmol/mmol, n=93) sodium-to-potassium (Na:K) ratio groups excluding those on blood pressure medication.