

MEAN POPULATION SALT CONSUMPTION IN INDIA – A SYSTEMATIC REVIEW

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Total word count of manuscript = 2895

Number of tables = 0

Number of figures = 4

Number of supplementary digital content files = 6

ACKNOWLEDGEMENTS

BN is supported by a National Health and Medical Research Council of Australia Principal Research Fellowship (APP1106947) and holds an NHMRC Program Grant (APP1052555). CJ is supported by a National Health and Medical Research Postgraduate Scholarship (APP1074678).

SOURCES OF FUNDING

None to declare

CONFLICTS OF INTEREST

CJ, DP, TSR, AP, MAL, RNP have no conflicts of interest to declare. BN is Chair of the Australian Division of World Action on Salt and Health. BN and JW have funding from the World Health Organisation, VicHealth and Australian National Health and Medical Research Council of Australia for research on salt reduction.

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KEY WORDS

India, salt, sodium, hypertension, systematic review, meta-analysis

ABSTRACT

Member States of the World Health Organization, including India, have adopted a target 30% reduction in mean population salt consumption by 2025 to prevent non-communicable diseases. Our aim was to support this initiative by summarising existing data that describe mean salt consumption in India. Electronic databases MEDLINE via Ovid, EMBASE, CINAHL and the Cochrane Database of Systematic Reviews were searched up to November 2015 for studies that reported mean or median dietary salt intake in Indian adults aged nineteen years and older. Random effects meta-analysis was used to obtain summary estimates of salt intake. Of 1201 abstracts identified, 90 were reviewed in full text and 21 were included: 18 cross-sectional surveys (n=225,024), 2 randomised trials (n=255); and 1 case control study (n=270). Data were collected between 1986 to 2014 and reported mean salt consumption levels between 5.22 and 42.30 g/day. With an extreme outlier excluded, overall mean weighted salt intake was 10.98 g/day (95% CI 8.57-13.40). There was significant heterogeneity between the estimates for contributing studies ($I^2 = 99.97\%$) (p -homogeneity ≤ 0.001) which was likely attributable to the different measurement methods used and the different populations studied. There was no evidence of a change in intake over time (p trend=0.08). The available data leave some uncertainty about exact mean salt consumption in India but there is little doubt that population salt consumption far exceeds the WHO recommended maximum of 5g per person per day.

INTRODUCTION

Cardiovascular diseases are the leading cause of death in India responsible for about 2.3 million deaths each year, which is approximately 23% of all mortality [1]. Of these deaths, 24% are attributed to high blood pressure [2]. High blood pressure is the leading risk for non-communicable disease, in India where the prevalence rates of hypertension are anticipated to nearly double from 118 million in 2000 to 213 million by 2025 [3]. Salt is a leading cause of high blood pressure and has been associated with the risk of vascular disease as well as other serious health problems [4, 5]. The 2010 Global Burden of Disease study reported excess salt intake to be the 7th leading cause of global mortality responsible for 1.65 million deaths from cardiovascular disease [1, 3]. While there has been some debate surrounding the health effects of excess dietary salt, a large body of research is supportive of efforts to reduce population salt intake [4, 6, 7]. All Member States of the World Health Organization, including India, have adopted a 30% reduction in mean population salt consumption by 2025 as part of the '25 by 25' initiative for the control of non-communicable diseases [8].

The average Indian diet has undergone a nutrition transition over the past 30 years characterised by a decreased intake of unprocessed coarse cereals, pulses, fruits and vegetables and an increased intake of meat products and processed foods [9]. There is evidence that average intake levels of adverse nutrients such as harmful fats, sugars and salt are now above recommended levels [10]. Furthermore, excess intake of calories from energy dense foods delivered in large portions is driving a rapidly evolving obesity epidemic [11]. To develop interventions able to address India's burden of diet-related ill health will require data describing the magnitude and nature of the problem. The implementation of a national salt reduction strategy will need to be based upon the best available knowledge about salt intake levels around the country. We sought to estimate current average national consumption of salt by systematically searching for and quantitatively summarising all available data.

METHODS

This was a systematic review and meta-analysis of published data describing salt intake levels in populations drawn from India. Publications were included if they reported prior to 1st November 2015.

Data sources and search strategy

Electronic databases MEDLINE (via Ovid from 1950 to 1st November 2015), EMBASE, CINAHL and Cochrane Database of Systematic Reviews were searched for studies that reported dietary salt intake in Indian adults (nineteen years and older). Search terms used were "India, salt (intake ingest, eat,

consume, diet), sodium (Na) urine (excretion)” (Supplementary material). The search was limited to studies done in humans and reported in the English language.

Identified abstracts were reviewed by two authors (C.J and D.P) and full text reports were sought for abstracts deemed potentially eligible by either. These two authors then reviewed the full text reports for eligibility and searched the reference lists for further studies. Additionally, all authors inquired amongst peers about unpublished literature and data specific to India which might have been included in larger international studies. Several National Indian government reports were also requested and searched for salt intake data [12-14].

Inclusion/ exclusion criteria

Studies were included if they reported salt or sodium intake in populations living in India recorded using any recognised estimation methodology regardless of sample size, population group or geographical location within India. Studies were excluded if they did not describe salt intake using standard statistics (mean or median), only reported a range of intake [15-17] or reported salt intake only by stating intake was less than or more than a given level per 24-hours for a proportion of the study population [18-23].

Data extraction and quality assessment

Standard data about study characteristics, population type, sample size, age, gender (men, women, mixed), geographic location, region (urban/rural/mixed), blood pressure (hypertensive, non-hypertensive/mixed), salt consumption estimation method, and mean salt intake in g/day (with uncertainty measure) were extracted. If salt intake was reported in sodium in mg or mmol, the values were converted into salt (g/day) using standard conversion values [24]. Data were extracted independently by two authors (C.J and D.P) with discrepancies resolved by consensus.

Outcome

The primary outcome was estimated mean population salt intake in g/day. Secondary outcomes were the estimated mean salt intake levels amongst population subsets defined by sex, urban or rural location, presence or absence of hypertension and method used to estimate salt intake.

Analysis

The characteristics of the studies were tabulated and the mean salt intake (and 95% confidence interval) was estimated overall and for each subgroup of interest using random effects meta-analysis with weighting by study sample size. Differences between salt intake estimates in subgroups were assessed by calculating a p-value for homogeneity. Primary analyses were done with data from 20

studies after excluding one study identified as an extreme outlier [25]. Sensitivity analyses were done including and excluding the one study identified as an extreme outlier [25] as well as two very large studies that otherwise dominated the estimates obtained [12, 13]. Evidence for differences in salt consumption over time, according to mean body mass index (BMI) and mean age was sought using meta-regression and testing for a non-zero slope of the line relating the variable of interest to mean salt intake. Analysis was done in Excel 2010 and R (release 3.2.2 The R Foundation) and p-values of <0.05 were considered unlikely to have arisen by chance.

RESULTS

A total of 1201 abstracts were retrieved from the search of which 1,111 were excluded as ineligible on the basis of the title or content of the abstract. There were 90 studies reviewed as full text and 21 confirmed to meet the inclusion criteria (Appendix 1). Of the 21 studies, there were 18 cross-sectional studies, [12, 13, 25-40] 2 randomised controlled trials [41, 42] and 1 case control study [43] including a total of 227,214 individuals. Two very large studies, one done in 1988 [13] and the other in 2010 [12] accounted for the majority of participants (92%). Studies spanned the years 1986 to 2015 and provided information about dietary salt intake amongst populations drawn from 29 states and 7 territories in India. The methodology used to assess salt intake was 24hr urine collection in 5 studies ($n=1,205$ [26, 27, 35, 36, 43]), 24-hr dietary recall surveys in 4 studies ($n=104,979$ [12, 32, 37, 39]), food frequency questionnaires in 3 studies ($n=8747$ [29, 31, 38]), food diaries and/or survey questions on added salt or salt intake in the household in 6 studies ($n=2,409$ [25, 28, 34, 40-42]), salt weighing in 2 studies ($n=108,145$ [13, 33]) and food testing in one study ($n=250$ [30]). Two studies were done in men alone ($n=586$ [29, 40]) and one of the remaining studies ($n=1497$ [28]) reported mean salt intake separately for each sex. The mean proportion of women in all studies was 36%. Eight studies included only urban populations ($n=53,715$ [28, 30, 31, 35, 36, 38, 41, 43]), 6 only rural populations ($n=64,156$ [25, 29, 33, 34, 40, 42]) and 7 included both ($n=107,864$ [12, 13, 26, 27, 32, 37, 39]). Two studies included only patients with hypertension ($n=1,018$ [41, 42]) and the remainder were likely a mix of hypertensive and non-hypertensive individuals (Appendix 3.)

Estimated overall mean daily salt intake

In the primary analysis based upon 20 studies the mean weighted salt intake was 10.98 g/day (95% CI 8.57 to 13.40) with mean salt intake in contributing studies ranging from 4.5 to 25.8 g/day (p homogeneity ≤ 0.001) (Figure 1). Including the extreme outlying study which reported an estimated mean intake of 42.3 g/day, resulted in an overall estimate of 12.48 g/day (95% CI 8.76 to 16.20; p homogeneity ≤ 0.001). Excluding the two large studies resulted in an estimated mean daily intake of

12.67 g/day (95% CI 8.58 to 16.75; p homogeneity ≤ 0.001) and excluding the extreme outlying study and the two large studies resulted in an estimate of 11.02 g/day (95% CI 8.37 to 13.66; p homogeneity ≤ 0.001).

Estimated mean intake in subgroups of studies and over time

Separate estimates of salt intake by gender were available for only 3 studies (2 done in only men) and a total of 8,708 individuals and there was no evidence that salt intake varied by gender (p homog=0.731) (Figure 3). For the 19 studies (225,735 individuals) with available data, estimated mean salt intake was not different in rural (9.63 gm/day, 95% CI 6.56 to 12.70 gm/day) compared to urban populations (9.69 gm/day, 95% CI 7.47 to 11.92 gm/day) (p homog= 0.348). A large cross-sectional study [12] done in all states and territories using 24hr dietary surveys to estimate mean daily salt intake showed a geographic pattern of higher salt intake in Southern and Eastern states compared to Northern and Western areas (Figure 2). Mean salt intake in the two studies done exclusively in patients with hypertension (n=1,018) was 10.64 gm/day (95% CI 7.36 to 13.92 gm/day) compared to 8.72 gm/day (95% CI 4.73 to 12.71 gm/day) in non-hypertensive participants (1,928 individuals) and 10.05 gm/day (95% CI 7.71 to 12.38 gm/day) in the remaining 18 studies of mixed hypertensive and non-hypertensive individuals (p homogeneity = 0.670). Finally, there was no evidence that estimated mean intake varied with the method of measurement used (p homogeneity = 0.97) or that salt intake had changed over the period in which the studies were done (p value for trend=0.08) (Figure 4). This was also true when separate analyses were done amongst subsets of studies that utilised the same methodology for assessing salt intake at different time points. Meta-regressions identified no association between mean BMI of the study population and mean salt intake (p=0.369) or mean age of the study population and mean salt intake (p=0.388) (Appendices 5 and 6).

DISCUSSION

Every measure of salt intake made in India except one has provided an estimate above the World Health Organization maximum recommended consumption level of 5g/day and the best estimate obtained by this meta-analysis suggests that average salt intake in India is about double that. There is therefore little doubt that India needs to take steps to reduce population salt intake if it is to deliver upon its commitment to the 25 by 25 goal of reducing non-communicable disease mortality. The data also identify marked variation across the studies done to date and there is significant uncertainty about the extent to which this is likely to reflect true differences in salt intake levels across the studies or biases inherent in the different methods employed to select participants and make the assessments. India is a large and diverse country with varied dietary patterns and salt intake clearly

varies across geographies and population groups, although differences as extreme as those suggested by some contributing studies seem unlikely.

The average salt intake estimate for India obtained from this study is aligned with estimates of salt intake made for Indians living overseas [44], for other countries in the region and for a large modelling study recently reported [1]. The latter of these studies also estimated that in 2010 there were 370,000 deaths in India attributable to salt consumption above the WHO target of 5 g/day [1]. While the number of attributable deaths has been disputed [45, 46], the central role of excess salt consumption in the causation of high blood pressure is not and there are already some 140 million people in India with blood pressure levels meeting the diagnostic criteria for hypertension. This figure is projected to rise to 214 million by 2030 [47] and management will require enormous resources unless effective prevention strategies are put in place.

Prior studies have typically reported higher levels of salt intake in men than women and in urban compared to rural areas [2]. The grouped data available for this review provided limited capacity to address salt levels in different population subsets and findings may also have been confounded by the use of different measurement methods and recruitment strategies across the groups of interest. Increasing consumption of processed foods is likely to be pushing up mean salt intake, particularly in urban areas, while continued widespread use of salted pickles in rural areas may account for relatively high consumption levels in rural regions [9, 48]. Variation between mean intake levels determined by different measurement techniques would be anticipated and real variation may have been excluded by the fairly crude analysis methods that can be used on grouped data. Complete 24hr urine collections are considered the gold standard method of estimation although under-collection is a well-recognised problem and the method does not capture the approximate 10% of salt excreted through non-urinary routes [49]. Within individual variability in day-to-day salt intake should not have affected the estimates of mean population intake reported here. Dietary questionnaires are also prone to under-reporting of calorie intake and in turn can result in significant under-estimation of salt intake. Salt weighing methods by contrast can lead to marked over-estimation because household salt is used for non-culinary purposes and salt used in food preparation is not always consumed. One or more of these issues is likely to have affected many of the studies included.

We elected to exclude one extreme outlier [25] because the findings seemed very unlikely to be representative of India as a whole. Ultimately, the overall estimate from the sensitivity analysis that included that study did not change markedly because it was only a small proportion of all the data available. While the overall estimate did drop when both the extreme outlier and the two very large studies were excluded [12, 13], the mean level was still double the 5g/day target and the primary

conclusion of our work remains unchanged. Future studies will benefit from the inclusion of urine-based methods of estimation and the more complete reporting of salt intake estimates for participant subgroups. Factors including age and BMI are known to impact salt intake levels [50] and while analyses conducted in this overview showed no association of salt intake with these variables the power of the meta-regression analyses to detect such associations was very limited.

The absence of any clear evidence for a change in mean population salt intake over time is also unsurprising – the methodological differences between the surveys done over the years and the differences in the populations studied all conspire against the detection of change. Further, in the absence of any concerted effort to modify salt intake in India there is no reason to expect that a difference would be detected. It is possible that changes in intake levels in different parts of the population may have been missed – for example there may have been recent increases in urban intake due to more widespread access to processed and restaurant foods and corresponding decreases in rural areas due to the wider availability of non-salt based preservation methods.

While the limitations of the current study are substantial, the conclusion that salt intake levels are well above that recommended is unlikely to be wrong. The data provide a strong rationale for the implementation of a national salt reduction program in India.

CONCLUSION

The World Health Organization recommends that all Member States implement a salt reduction program on the basis of the evidence linking salt, blood pressure and vascular risk [51, 52]. India, like many other countries, has national recommended dietary allowances for salt but adherence to them is limited [53]. This is unsurprising since control of salt consumption has proved challenging in every country that provides such advice. It is clear that to achieve a change in national salt intake levels will require the implementation of supporting policies that change the broader food environment as well as educating individuals about how to control intake. Each country that seeks to achieve the recommended 30% reduction in dietary salt by 2025 [8] will require a specific program aligned with the particular local circumstances [54]. Our data show that this should be a priority for India and suggest that very large numbers of premature heart attacks, strokes and other blood pressure-related diseases could be averted if an effective program was implemented.

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Figure 1. Mean daily salt intake (g/day) for all studies overall, for each individual study and for subsets of studies excluding an extreme outlier and very large studies

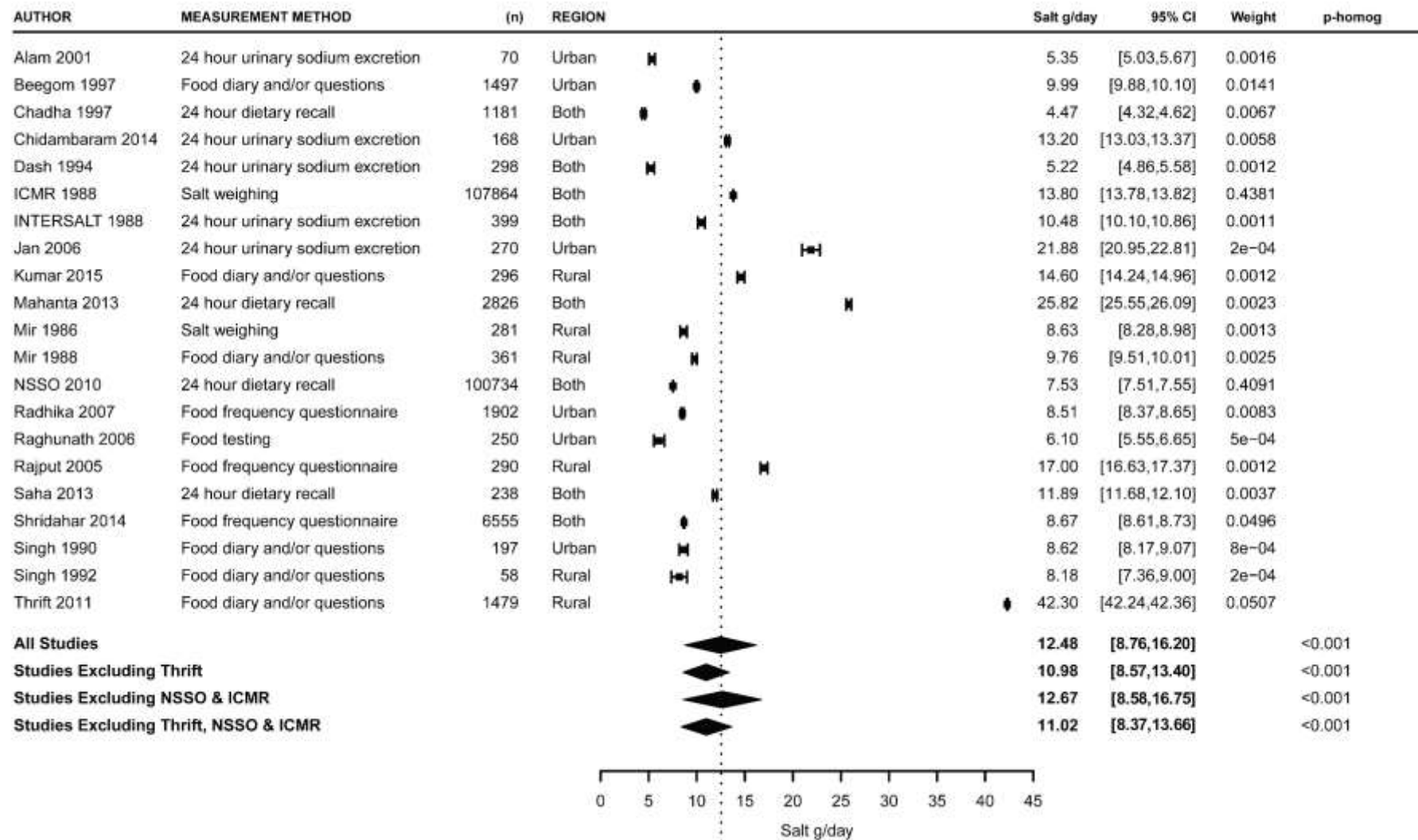


Figure 2. Mean salt intake (gm/day) in rural and urban states and territories of India

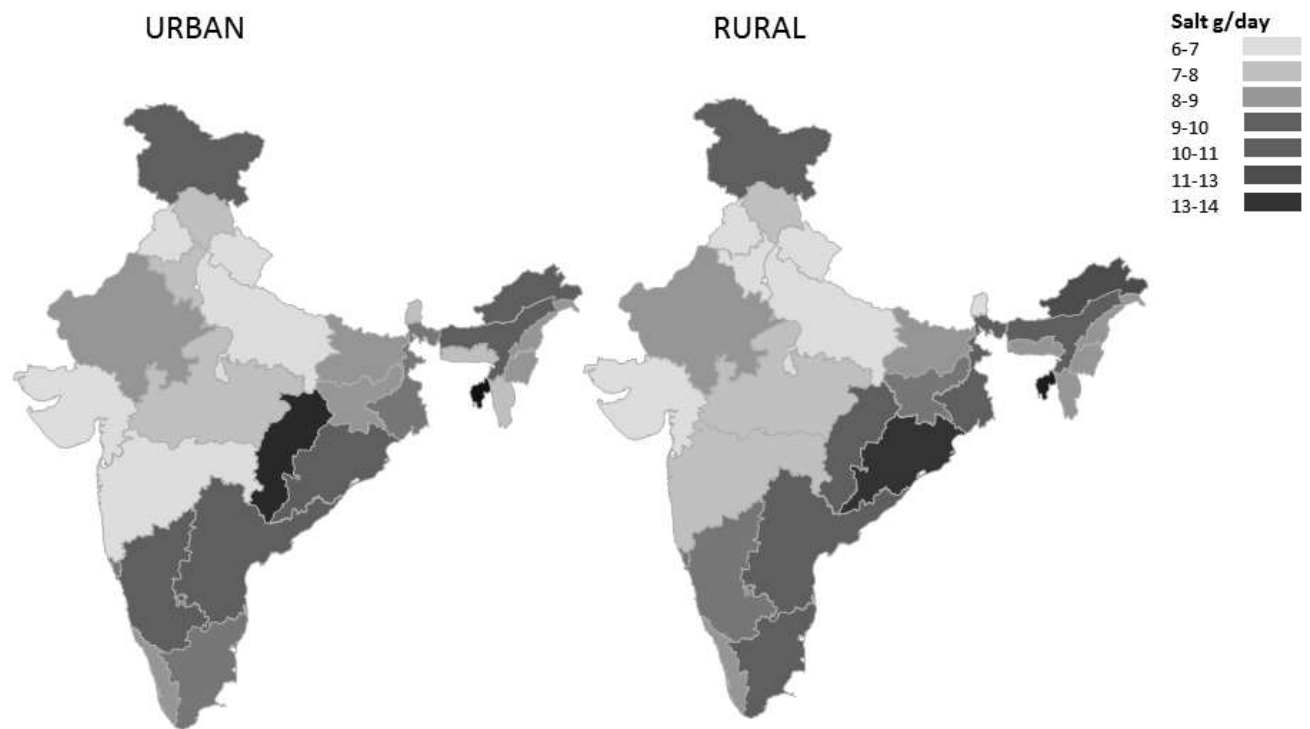


Figure 3. Mean salt intake (gm/day) for subgroups of studies defined by measurement method, sex, region and blood pressure. P-value is for homogeneity across the subsets of studies

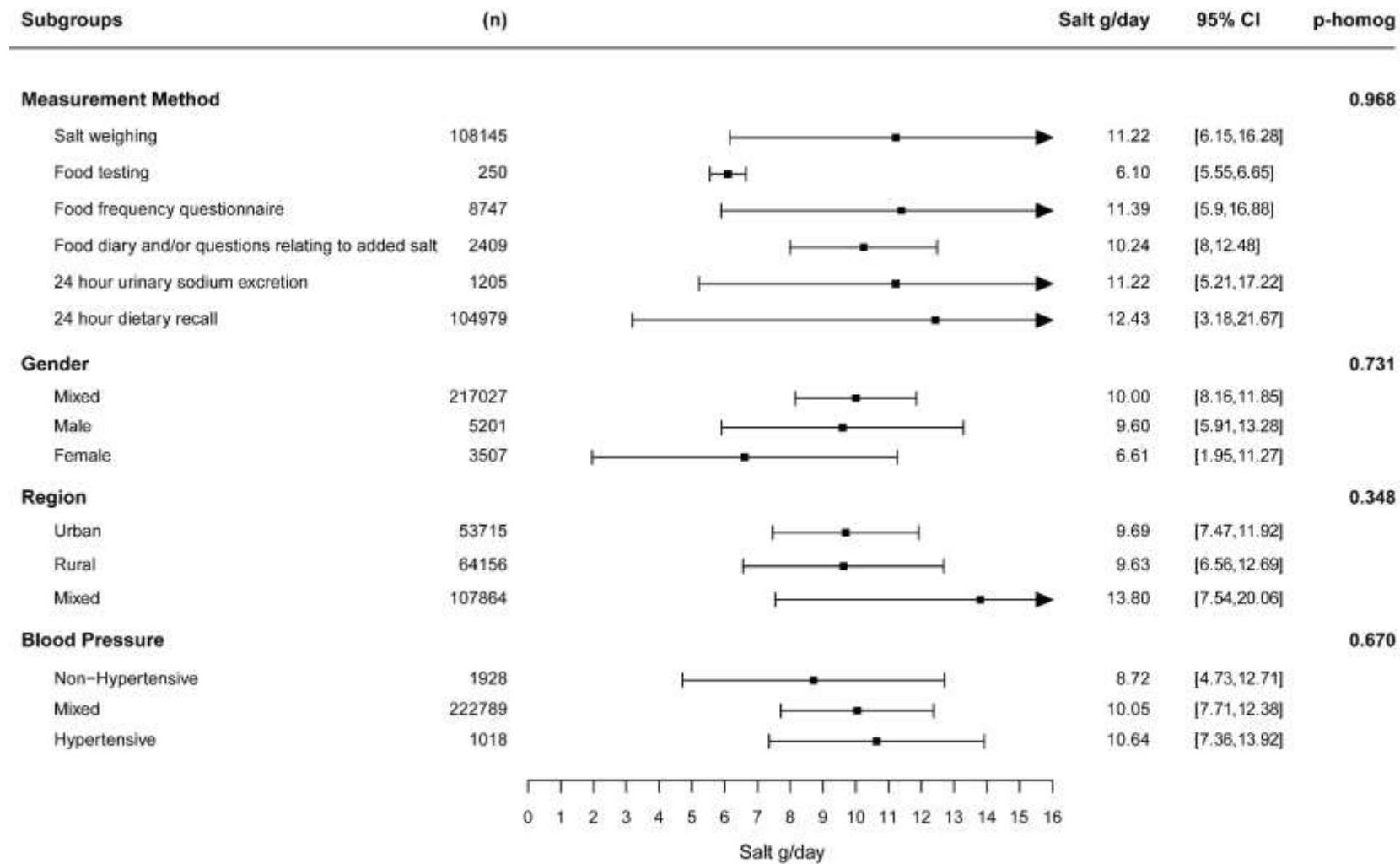


Figure 4. Salt intake (g/day) of all studies by calendar year

