

PEER REVIEW HISTORY

BMJ Open publishes all reviews undertaken for accepted manuscripts. Reviewers are asked to complete a checklist review form ([see an example](#)) and are provided with free text boxes to elaborate on their assessment. These free text comments are reproduced below. Some articles will have been accepted based in part or entirely on reviews undertaken for other BMJ Group journals. These will be reproduced where possible.

ARTICLE DETAILS

TITLE (PROVISIONAL)	Is socioeconomic status associated with dietary sodium intake in Australian children? A cross-sectional study
AUTHORS	Grimes, Carley; Campbell, Karen; Riddell, Lynn; Nowson, Caryl

VERSION 1 - REVIEW

REVIEWER	Professor Jim Mann Professor of Human Nutrition and Medicine University of Otago Dunedin NEW ZEALAND I have no competing interests.
REVIEW RETURNED	30-Oct-2012

THE STUDY	<p>General comments: Using the Australian National Children's Nutrition and Physical Activity Survey, the authors examine the association between dietary sodium intake and socioeconomic status (SES) and whether the major dietary sources of sodium differ by socioeconomic group. The issue of diet quality in relation to SES has been extensively studied but only limited and conflicting data are available regarding dietary sodium intake. The data from this large group of children suggest a meaningful and statistically significant difference between high and low SES children aged 4 - 13, but not between those younger and older. The sources of dietary sodium are those which might intuitively have been expected but the findings are of interest and publishable.</p> <p>My main concerns relate to the description of the instrument used for assessing sodium intake and in particular the nutrient composition database (AUSNUT2007). The authors acknowledge that they are unable to assess salt added at the table and during cooking and it is generally acknowledged that total salt intake can only be assessed with reasonable accuracy by means of 24-hour urinary sodium measurement. However the reader who is unfamiliar with the methodology and nutrient databases may wonder whether it is really possible to assess sodium/salt content from foods such as processed meats, gravies, savoury sauces and pastries given that such foods must potentially contain a wide range of sodium content. Is the methodology up to it? I would suggest expansion of the description of the 24-hour instrument and the nutrient composition database in the methods section and further discussion in the section relating to limitations. This should be fully considered in this paper even if covered in reference 40.</p> <p>In similar vein, I would suggest further discussion about the method used to define SES, especially given that the secondary indicator of</p>
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	<p>SES (parental income) did not show an association with salt intake. What approaches were used for defining SES in other comparable studies?</p> <p>Minor points: I think the concluding section of the abstract should be confined to the findings of the present study and the speculative comment relating to hypertension and cardiovascular disease deleted.</p> <p>"Data" is a plural word (line 228).</p>
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REVIEWER	<p>Dr Margo Barker Human Nutrition Unit University of Sheffield UK</p> <p>I have no competing interests.</p>
REVIEW RETURNED	19-Nov-2012

THE STUDY	The limitations of assessing sodium intake by 24 hour recall have been minimised.
GENERAL COMMENTS	<p>This paper reported on a cross-sectional study of dietary sodium intake in relation to socioeconomic status in a large nationally representative sample of Australian children aged between 2 to 16 years. The study concluded that socioeconomic status [SES] was associated with sodium intake particularly in children aged 4 to 13 years, with a differential of 200mg Na/d between low and high socioeconomic groups. The differential arose from a greater intake of processed meat, gravies and savoury sauces, pastries, breakfast cereals and bars, potatoes and potato snacks. The study seems to have been carefully conducted, the paper is well presented and the analysis is sound.</p> <p>My main criticism of the study relates to the methodology of assessing sodium intake. A single 24-hour recall is likely to misclassify sodium intake on two counts. Firstly day-to day variation in intake will contribute to misclassification at an individual level. Secondly, as acknowledged in the discussion, the method does not account for salt added to food at the table or during cooking. There is therefore likely to be substantial underestimation of sodium intake. It is also possible that the amount of salt added at the table varies with socioeconomic group. A secondary analysis of Health Survey of England data reported greater use of salt at the table by lower socioeconomic groups (Millet et al 2011), and greater use of salt in cooking by Asian and Black ethnic groups. The current paper does give information as to salt use in Australian children by SES (p14, line 228), but the proportions given do not match the assertion that children from low SES are more likely to use salt at the table. Are there any precise data as to the amount of sodium from added salt in Australian children – a North American study of adults (ref 41) is cited in this context? Was there any validation of the 24-hr recall</p>

	<p>method against 24-hour urinary sodium? Some justification of the validity of the method to assess sodium intake would be helpful, and would strengthen the study's conclusion.</p> <p>It would also have been useful to elaborate on associations between sodium intake, BMI and energy intake. The adjusted regression models did include these possible confounding variables, and whilst therefore the association between socioeconomic group and sodium intake is independent of energy and BMI, it would be enlightening to report detail of associations between BMI, sodium and energy intake. There may well be underreporting of energy and sodium intake in relation to BMI and SES (Yang et al, 2012). These issues could be discussed.</p> <p><u>Minor points</u></p> <p>Further detail of the population proportion formula should be provided (p10 line 127)</p> <p><u>References</u></p> <p>Millett C, Lavery AA, Stylianou N, Bibbins-Domingo K, Pape UJ (2012) Impacts of a National Strategy to Reduce Population Salt Intake in England: Serial Cross Sectional Study. PLoS ONE 7(1): e29836. doi:10.1371/journal.pone.0029836</p> <p>Yang Q, Zhang Z, Kuklina EV et al (2012) Sodium intake and blood pressure amongst US children and adolescents. Paediatrics 130 611</p>
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VERSION 1 – AUTHOR RESPONSE

Reviewer 1:

General comments:

Comment 1. Using the Australian National Children's Nutrition and Physical Activity Survey, the authors examine the association between dietary sodium intake and socioeconomic status (SES) and whether the major dietary sources of sodium differ by socioeconomic group. The issue of diet quality in relation to SES has been extensively studied but only limited and conflicting data are available regarding dietary sodium intake. The data from this large group of children suggest a meaningful and statistically significant difference between high and low SES children aged 4 - 13, but not between those younger and older. The sources of dietary sodium are those which might intuitively have been expected but the findings are of interest and publishable.

Comment 2. My main concerns relate to the description of the instrument used for assessing sodium intake and in particular the nutrient composition database (AUSNUT2007). The authors acknowledge

that they are unable to assess salt added at the table and during cooking and it is generally acknowledged that total salt intake can only be assessed with reasonable accuracy by means of 24-hour urinary sodium measurement. However the reader who is unfamiliar with the methodology and nutrient databases may wonder whether it is really possible to assess sodium/salt content from foods such as processed meats, gravies, savoury sauces and pastries given that such foods must potentially contain a wide range of sodium content. Is the methodology up to it? I would suggest expansion of the description of the 24-hour instrument and the nutrient composition database in the methods section and further discussion in the section relating to limitations. This should be fully considered in this paper even if covered in reference 40.

Response:

Studies that have identified the food sources of sodium have utilised some type of dietary assessment to identify the relative contribution of different food groups. In Australia, Food Standards Australia and New Zealand is responsible for the development of national food composition databases which are used to estimate nutrient intakes for the population. AUSNUT2007 was the food composition database specifically designed for the 2007 National Children's Nutrition and Physical Activity Survey (CNPAS), the survey our study is based on has an extended database of specific food brands that enable improved accuracy in estimating dietary sodium intake and the relative contribution from different food groups. In the published report from The 2007 National Children's Nutrition and Physical Activity Survey (CNPAS) a dietary estimate of sodium intake was calculated and is similar to that found in a select population of primary school children who undertook 24-hour urine collections (Grimes, Riddell et al. 2012). The AUSNUT2007 database contains sodium nutrient information for 4,225 foods, beverages and dietary supplements consumed during the survey. It is acknowledged that the sodium content of individual food within a food group vary by brands but, for most food items the majority of the best-selling brands vary by less than 20% within each specific category e.g. white bread ranges from 395 to 523 g/100g (Grimes, Nowson et al. 2008). Further, the food group classification system used in AUSNUT2007 codes foods into distinct categories, to account for the differences in sodium content. For example the median sodium content (mg/100g) of the individual food products which are available in the database by sub-category is: fresh meats (n=424) 63 mg/100g; sausages (n=27) 673 mg/100g; processed meats (n=40) 1496 mg/100g.

We agree our description of the 24-hr dietary recall methodology and AUSNUT2007 food composition database is brief. Therefore as suggested we have revised the methods section of the manuscript to provide further detail relating to rigorous collection of 24-hr dietary recall data in the 2007 CNPAS and information relating to the development of AUSNUT2007 (line 93) "The three pass method includes the following stages i) provide a quick list of all foods and beverages ii) a series of probe questions relevant to each quick list item to gather more detailed information on time and place of consumption, any additions to the food item, portion size and brand name iii) finally, a recall review to validate information and make any necessary adjustments. Portion sizes were estimated using a validated food model booklet and standard household measures. To minimise error after data collection all interviews were reviewed by study dietitians to assess for unrealistic portion sizes, inadequate detail and typing errors. Line (103) "Sodium intake was calculated using the Australian nutrient composition database AUSNUT2007, specifically developed by the Food Standards Australia and New Zealand for the CNPAS.(Food Standards Australia and New Zealand 2009) A description of the food coding system using in this database has previously been described (Grimes, Campbell et al. 2011)."

We believe that in our current discussion we have adequately addressed the limitation relating to 24-hr dietary recall sodium likely to be an underestimate of the true value of sodium intake (line 243). However, as suggested we have revised the limitations section to include information relating to issues of sodium information within food composition databases (line 252) "Secondly, assessment of sodium intake is limited by the quality of food composition databases, which may not capture the variation within the in sodium content of different brand products within each food group (Loria,

Obarzanek et al. 2001; World Health Organization 2010).”

Comment 3. In similar vein, I would suggest further discussion about the method used to define SES, especially given that the secondary indicator of SES (parental income) did not show an association with salt intake. What approaches were used for defining SES in other comparable studies?

Response:

There are a variety of indexes that are used to define socioeconomic status (SES). There is no universal agreement on the best measure of SES. Traditional markers of SES include maternal education, income level and occupation. Maternal or primary carer level of education and household level of income are frequently used and accepted as a proxy for SES in dietary studies which include children and adolescents (Giskes, Turrell et al. 2002; Ambrosini, Oddy et al. 2009; Golley, Hendrie et al. 2011; Cribb, Warren et al. 2012). Consistent with previous studies which have used the same dataset (i.e. 2007 CNPAS) (Cameron, Ball et al. 2010; Golley, Hendrie et al. 2011) we have utilised the primary carers' level of education as the primary marker to define SES. In recognition of other markers of SES we utilised household income as a secondary indicator as this could also provide some indirect measure relating to the variation in sodium intake in relation to food cost. However we found, no such association with income. We do know that a number of expensive brands of different foods do contain high levels of added salt and this may be a contributing factor. We believe that it is of interest that income was not associated with sodium intake, but SES was indicating that potentially more expensive food items do not have lower sodium content. We also acknowledge that the sample did under-represent the low income bands.

As suggested we have revised the methods section of the paper to reflect the basis of the chosen markers of SES in this study (line 111) “.Consistent with other dietary studies in children and adolescents we have used level of education attained by the primary carer and household income as markers of SES (Cameron, Ball et al. 2010; Golley, Hendrie et al. 2011).”

Comment 4. I think the concluding section of the abstract should be confined to the findings of the present study and the speculative comment relating to hypertension and cardiovascular disease deleted.

Response:

We have deleted this sentence from the conclusion of the abstract and reworded (line 21) “Conclusion: Australian children from a low SES background have on average a 9% greater intake of sodium from food sources compared to those from a high SES background. This socioeconomic patterning of salt intake may in turn influence the SES disparity seen in hypertension and cardiovascular risk in adulthood. Understanding these the differences in socioeconomic patterning of salt intake during childhood risk provides important focus for intervention should be considered in interventions to reduce cardiovascular disease..”

Comment 5. "Data" is a plural word (line 228).

Response:

Thank you we have amended this sentence (line 249) “In a previous analysis of these is data,”

Reviewer 2:

Comment 1. The limitations of assessing sodium intake by 24 hour recall have been minimised. This paper reported on a cross-sectional study of dietary sodium intake in relation to socioeconomic status in a large nationally representative sample of Australian children aged between 2 to 16 years. The study concluded that socioeconomic status [SES] was associated with sodium intake particularly in children aged 4 to 13 years, with a differential of 200mg Na/d between low and high socioeconomic groups. The differential arose from a greater intake of processed meat, gravies and savoury sauces,

pastries, breakfast cereals and bars, potatoes and potato snacks. The study seems to have been carefully conducted, the paper is well presented and the analysis is sound.

Comment 2. My main criticism of the study relates to the methodology of assessing sodium intake. A single 24-hour recall is likely to misclassify sodium intake on two counts. Firstly day-to day variation in intake will contribute to misclassification at an individual level.

Response:

We agree there are methodological issues pertaining to the use of 24-hr dietary recall to accurately measure total daily sodium intake. A 24-hour dietary recall is routinely used to gather this information in population surveys as it has a low subject burden and can be completed in a short interview. As such we believe the use of a well-designed national survey, with standardised protocols for the completion of 24-hr dietary recalls, is a well-accepted valid method of assessing food sources of specific nutrients, including sodium.

Although there can be large day to day variation in sodium intake and a single 24-hr recall, in this analysis we assessed dietary sodium at a group level, approximately 1500 participants in each low, mid and high SES group). Please refer to previous response to Reviewer 1, Comment 2 for further explanation of the chosen methodology.

Comment 3. Secondly, as acknowledged in the discussion, the method does not account for salt added to food at the table or during cooking. There is therefore likely to be substantial underestimation of sodium intake. It is also possible that the amount of salt added at the table varies with socioeconomic group. A secondary analysis of Health Survey of England data reported greater use of salt at the table by lower socioeconomic groups (Millet et al 2011), and greater use of salt in cooking by Asian and Black ethnic groups. The current paper does give information as to salt use in Australian children by SES (p14, line 228), but the proportions given do not match the assertion that children from low SES are more likely to use salt at the table. Are there any precise data as to the amount of sodium from added salt in Australian children – a North American study of adults (ref 41) is cited in this context?

Response:

Thank you for noting the error in our discussion relating to the frequency of Australian children who report using salt at the table by SES group, this has been amended (Line 246) “In a previous analysis of these is data, we found that children from low SES background (3325%) were more likely to report adding salt at the table than children from high SES (2533%).(Grimes, Campbell et al. 2011)”.

Unfortunately there is limited data relating to salt intake or salt practices in Australian children. To our knowledge there is not data relating to the actual amount of sodium that comes from the salt shaker in Australian children, or children from other nationalities. As such we have used the US reference to describe the amount of salt derived from that added at the table and cooking.

We acknowledge the potential underestimation of dietary sodium using dietary assessment (line 240) “Firstly, this method which fails to capture the amount of salt coming from salt added at the table and during cooking and therefore is likely to underestimate the true value of salt intake.(Loria, Obarzanek et al. 2001)”.

Comment 4. Was there any validation of the 24-hr recall method against 24-hour urinary sodium? Some justification of the validity of the method to assess sodium intake would be helpful, and would strengthen the study's conclusion.

Response:

The 2007 National Children's Nutrition and Physical Activity Survey (CNPAS) did not include validation of the 24-hr recall method against the gold standard 24-hr urinary sodium. This study

utilised data from a national nutrition survey, which utilised 24-hr dietary recall to assess nutrient, including sodium, intake. We do think that the estimated sodium intake using this method provides an indication of total sodium intake, we have found in a sample of 238 5-13 year old Australian schoolchildren that the mean sodium intake (estimated from 24-hr urine collections) was 103 mmol/d (salt equivalent 6.0 g/d) which is comparable to the mean estimate of sodium intake from the CNPAS estimated from 24-hr recalls which is 6.4 g/d in this age group.

Please refer to previous Responses Reviewer 1, Comment 2 and Reviewer 2, Comment 2 for discussion relating to the limitations of this methodology to assess salt intake. To help clarify that the observed differences in sodium intake are related to differences in sodium from food sources only (i.e. not total daily sodium intake) and be consistent with our existing conclusion within the abstract we have revised the following sections of the manuscript.

Line 184, discussion “In a nationally representative sample of Australian children aged 2-16 years, we found children of low SES background consumed 9% more dietary sodium, from food sources, than those of high SES background”

Line 254, conclusion “In summary, the findings of higher salt intakes from food sources in children of lower SES background, within in a nationally representative sample, provides focus for concern regarding salt related disease across the life course.”

Comment 5. It would also have been useful to elaborate on associations between sodium intake, BMI and energy intake. The adjusted regression models did include these possible confounding variables, and whilst therefore the association between socioeconomic group and sodium intake is independent of energy and BMI, it would be enlightening to report detail of associations between BMI, sodium and energy intake.

Response:

Thank you for your interesting comment, however we feel that examining the association between sodium intake, energy and BMI is outside of the scope of the present paper.

Comment 6. There may well be underreporting of energy and sodium intake in relation to BMI and SES (Yang et al, 2012). These issues could be discussed.

Response:

We appreciate that underreporting may have occurred within the sample and did consider the occurrence of this and possible implications when drafting the manuscript. We used the accepted Goldberg cut-off method to assess the level of underreporting at the individual level (Livingstone and Black 2003) To apply this method, estimated basal metabolic rate (estBMR) was calculated for each participant. (Schofield 1985) The ratio of each participants reported energy intake to estBMR (EI:estBMR), was then compared to the published Goldberg cut-off value. (Goldberg, Black et al. 1991; Gibson 2005) A participant with an EI:estBMR below the <0.90 cut-point was deemed to be an under-reporter. On this basis 267 participants (5.9%) were classified as under-reporters. The number of identified under-reporters did not differ significantly by SES group (High SES n=82 (5.5%); Mid SES n=87 (5.5%); Low SES n=98 (6.9%); $\chi^2= 0.97$; $P=0.68$). As there was no difference in underreporting across SES groups we did not exclude any participants on the basis of under-reporting.

We did not assess under-reporting in relation to BMI as this study does not report on the association between sodium intake and BMI.

5. Further detail of the population proportion formula should be provided (p10 line 127)

Response:

We have amended the methods section of the paper to include a description of the population proportion formula (line X) "The population proportion formula (Krebs-Smith, Kott et al. 1989) is outlined below:

% of sodium from food group = [sum of sodium from food group (mg) / total sum of sodium from all foods (mg)] X 100"

References from reviewer 2

Millett C, Laverty AA, Stylianou N, Bibbins-Domingo K, Pape UJ (2012) Impacts of a National Strategy to Reduce Population Salt Intake in England: Serial Cross Sectional Study. PLoS ONE 7(1): e29836. doi:10.1371/journal.pone.0029836
Yang Q, Zhang Z, Kuklina EV et al (2012) Sodium intake and blood pressure amongst US children and adolescents. Paediatrics 130 611

Additional changes made by the author:

- We wish to revise the final statement in the article summary to "The socioeconomic disparity of sodium intake reported in this study is attributable to differences in sodium intake from food sources only. Further research is required to understand how SES impacts on raising sodium intake. on total daily sodium intake. "

Author References

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Cameron, A. J., K. Ball, et al. (2010). "Socioeconomic variation in diet and activity-related behaviours of Australian children and adolescents aged 2–16 years." *Pediatr Obes* 7: 329-342.
Cribb, V. L., J. M. Warren, et al. (2012). "Contribution of inappropriate complementary foods to the salt intake of 8-month-old infants." *Eur J Clin Nutr* 66: 104-110.
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Grimes, C. A., L. J. Riddell, et al. (2012). "Dietary salt intake assessed by 24 h urinary sodium excretion in Australian schoolchildren aged 5-13 years." *Public Health Nutr* DOI: 10.1017/S1368980012003679: 1-7.
Krebs-Smith, S. M., P. S. Kott, et al. (1989). "Mean proportion and population proportion: two answers to the same question?" *J Am Diet Assoc* 89: 667-672.
Livingstone, B. E. and A. E. Black (2003). "Markers of the validity of reported energy intake." *J Nutr* 133: 8955-9205.
Loria, C. M., E. Obarzanek, et al. (2001). "The Dietary Guidelines: Surveillance Issues and Research

Needs. Choose and Prepare Foods with Less Salt: Dietary Advice for All Americans." J Nutr 131: 536S-551S.

Schofield, W. N. (1985). "Predicting basal metabolic rate, new standards and review of previous work." Hum Nutr Clin Nutr 39C(Suppl 1): 5-41.

World Health Organization (2010). Creating an enabling environment for population-based salt reduction strategies. Report of a joint technical meeting held by WHO and the Food Standards Agency, United Kingdom, July 2010. United Kingdom, World Health Organization.

VERSION 2 – REVIEW

REVIEWER	Margo Barker Human Nutrition Unit Dept of Oncology University of Sheffield
REVIEW RETURNED	11-Jan-2013

RESULTS & CONCLUSIONS	The association between BMI, sodium intake and energy intake should be provided through i a correlation matrix. Since the multiple regression models had energy intake and BMI as covariates it is important that the relationship between these variables is explicitly stated. This information was requested at first review, but the authors declined.
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VERSION 2 – AUTHOR RESPONSE

Response to reviewers BMJ Open

Reviewer 1:

Comment 1. The association between BMI, sodium intake and energy intake should be provided through i a correlation matrix. Since the multiple regression models had energy intake and BMI as covariates it is important that the relationship between these variables is explicitly stated. This information was requested at first review, but the authors declined.

Response:

As requested we have included information relating to the correlation between sodium intake, energy intake and BMI in the methods (page 10, line 128) "Pearson correlation coefficient was used to assess the association between sodium intake, energy intake and BMI." and results section (page 11, line 153) "There was a significant positive correlation between sodium intake and energy intake ($r = 0.69$, $P < 0.001$) and sodium intake and BMI ($r = 0.22$, $P < 0.001$)."