Scientific **A**dvisory **C**ommittee on **N**utrition

Paper for discussion: **Salt Summary – Evidence Since 1994 in Adults and 1981 in Children**

Agenda Item 8

Please see attached paper for consideration.

Scientific Advisory Committee on Nutrition

Salt Summary – Evidence Since 1994 in Adults and 1981 in Children

The Committee were informed at the last meeting held 12th-13th June 2001 that requests have been made by the FSA and supported by CMO Wales, for SACN to review the evidence base supporting a reduction in population intake of salt and whether it has altered since the 1994 COMA report Nutritional Aspects of Cardiovascular Disease (Department of Health (DH) 1994).

Some industry parties continue to dispute the evidence on salt and challenge Government policy to reduce population intakes. The FSA and Health Departments consider that a systematic review of all the evidence, including that considered by COMA, may not be necessary. Therefore, the Committee is asked to consider the evidence since 1994 in adults and since 1981 for children, which is summarised in this paper.

In brief the evidence does not present any 'new' or 'novel' findings since publication of the COMA 1994 report. The one major intervention study (DASH, paragraphs 31-35) that was carried out provided data to support COMA recommendations to reduce salt intakes in the general population. However, several meta-analyses presented in this paper concluded that salt reduction advice may be more relevant to the hypertensive than normotensive individuals.

The evidence presented in this paper looking at the association between blood pressure and the salt intakes of infants, children and adolescents (paragraphs 54-63) is still insufficient to quantify what the reduction, if any, should be in the general population of children. It should be noted that some children (obese children and the children of hypertensive parents) may be more susceptible than others.

The concept that individuals can be classed as either salt sensitive or salt resistant (paragraphs 44-49) may explain the conflicting results from both the adult and infant/children studies.

There certainly is no evidence to indicate any detrimental health effects of reducing salt intakes to levels of 6 g/day.

Conclusion

Based on the summary of evidence presented in this paper the Committee is asked to:

- Review and update the previous recommendations made by COMA, inviting consultation with interested parties at an early stage.

- Consider whether or not the evidence for children should be reviewed by the Committee or a separate subgroup in order to quantify a recommended amount for the general population of children.

Background

Prevalence of hypertension in UK

1. According to the latest Health Survey for **England** (Erens & Primatesta 1998), the prevalence of high blood pressure was **40.8% for men** and **32.9% for women**. The prevalence increased with age from 16.0% in men aged 16-24 to 72.8% in those aged 75 and over. In women the corresponding rise was from 4% up to 77.6%. The same age related pattern is seen in the Scottish Health Survey 1998 (Scottish Executive Health Department 2000) where the prevalence in men aged 16-24 was 0.4% to 32.9% aged 65-74 years. In the same age groups for women the prevalence increased from 0.5% to 29.8%. In **Scotland** the overall prevalence for **men was 9.8% and 16.5% for women**. The **Welsh** Health Survey (The National Assembly for Wales 1998) has shown a small rise in the proportion of people reporting raised blood pressure from **13.6% in 1995 to 15.2% in 1998**. In **Northern Ireland**, 1/14 of the population reporting serious disabilities cites stroke as the cause (Department of Health Social Services and Public Safety, NI 2000).

2. "Observational studies indicate that both systolic and diastolic blood pressure are positively related to the risk of stroke and coronary heart disease not only among individuals who might be considered 'hypertensive' but also among those who would usually be considered 'normotensive'. In fact, within the wide ranges of blood pressure (BP) studied, there was no evidence of any 'threshold' below which lower levels of BP were not associated with lower risks of stroke and of coronary heart disease" (Erens and Primatesta 1998).

Hypertension as a risk factor for heart disease

3. Hypertension is a reversible risk factor for congestive heart failure, renal failure and peripheral vascular disease. There is agreement that cardiovascular disease can be prevented by altering diet and lifestyle and thus reducing risk factors such as high blood pressure.

4. Even small reductions in blood pressure may be beneficial. One estimate suggests that lowering the median blood pressure of the population by 2 mm Hg could be more effective in reducing the rate of cardiovascular disease than medically treating individual patients who have diastolic pressures greater than 95 mm Hg (Cook et al 1995). At age 55 the blood pressure difference for a 100 mmol/24h sodium difference is about 10 mm Hg systolic (or 5 mm Hg diastolic): this is associated with a 34% difference in mortality from stroke and a 21% difference in mortality from ischaemic heart disease (Law 1996).

Sodium and hypertension

5. The relationship between hypertension and factors such as obesity and alcohol intake are well established (Cox et al 1990; Reisin et a 1978). However, the role of other factors such as sodium, saturated fat, coffee, meat and low potassium and calcium is less

well established. The role of dietary sodium has been the subject of great debate particularly in a normotensive population.

6. The view that there is a relationship between salt intake and hypertension is not new. Suggestions of a relationship go back further than 50 years. A critical review from 1973 of published studies (Gleiberman, 1973) concluded that there was a relation between salt intake and blood pressure but it could not conclude whether salt or other cultural changes or both were responsible for the increase in blood pressure. However, criticism of most of the studies included in the review is that the methodology used to assess dietary sodium and blood pressure were inadequate (Garrow et al 2000).

7. Other EU countries also recognise a possible relationship between salt intakes and the incidence of certain diseases and so have taken steps to reduce salt intakes within their respective countries. Recommendations for salt intakes are between 5 g/day to 8 g/day (Annex 1).

Basis of current UK recommendations on sodium/salt intake

8. Table salt is sodium chloride. 6 g salt contains about 2.4 g sodium.

9. The key evidence for disease risk, particularly hypertension, stroke, and cardiovascular disease, relates to sodium but in practical terms most of our sodium intake comes from salt hence recommendations to reduce salt intake.

10. Urinary sodium excretion is the best measure of intake. The Dietary and Nutrition Survey of British Adults (Gregory et al 1990) estimated average sodium excretion in 1986/87 to be equivalent to about 9 g/day of salt. Sodium intakes are also assessed in the annual National Food Survey (NFS). The 2000 NFS survey estimated average intakes of sodium for adults and children to be 2.6 g/day, excluding sodium in food eaten out or in salt added in cooking or at the table (Ministry of Agriculture, Food and Fisheries (MAFF) 2001). This is equivalent to about 6.6 g/day of salt and is about 160% the Reference Nutrient Intake (RNI)[1] for sodium (for ages 11 to 50+).

11. COMA considered sodium in its report on Dietary Reference Values, published in 1991 (DH 1991). It set a RNI of 1.6 g sodium (equivalent to 4 g salt) as the level that is likely to meet the needs of 97% of the population. Its considerations at the time focused on the requirements for sodium as an essential nutrient and did not directly address "optimum" intakes in respect of the link between dietary sodium and blood pressure.

12. The relationship between salt and blood pressure was considered in COMA's subsequent report on the "Nutritional Aspects of Cardiovascular Disease" (DH 1994) which made dietary recommendations to reduce cardiovascular disease, including

[1] The RNI is the amount of a nutrient which is sufficient for almost all individuals. The level of intake is higher than almost all people need.

coronary heart disease and stroke, in the population. COMA concluded that sodium intake appears to be an important determinant of blood pressure in the population as a whole at least partly by influencing the rise of blood pressure with age. A diet lower in common salt, which is a major source of sodium, and higher in potassium would be expected to result in lower blood pressure and a smaller rise in blood pressure with age.

13. COMA recommended a reduction in the average intake of common salt (sodium chloride) by the adult population from the current level at the time of 9 g/day to about 6 g/day. As men eat more food than women this equates to 5 g/day in women and about 7 g/day in men. A similar proportionate reduction in the sodium content of children's diets was also recommended, although it was acknowledged that because of insufficient data it was not possible to quantify this.

Recent initiatives

14. In December 1997 a workshop was organised at the Department of Health's request by the Faculty of Public Health Medicine (FPHM) in collaboration with the British Heart Foundation (BHF) to explore the basis of the disagreements surrounding salt consumption and its effect on blood pressure and subsequent cardiovascular disease. It endorsed COMA's advice. It concluded that salt intake was one of a number of dietary and other lifestyle factors influencing blood pressure and that reducing salt intake would be an appropriate public health measure.

15. Salt is one of a number of dietary and other lifestyle factors influencing blood pressure. Recognising this the FSA/DH initiatives include:
    - To promote healthy eating, in particular increased fruit and vegetable consumption through the healthy schools programme and promotion of the "5 a day" message on fruit and vegetable consumption in pilot sites around the country
    - Development of sensible drinking messages through an alcohol health education campaign
    - To promote increased levels of physical activity (via GP referral schemes, healthy transport modes, and the National Healthy Schools programme).

16. The NHS Plan published in July 2000 stated: ***"The role of Government is to ensure people have information and proper access to healthy food wherever they live so by 2004 action will include: initiatives with the food industry - including manufacturers and caterers - to improve the overall balance of the diet including salt, fat and sugar in food, working with the Food Standards Agency"***.

Initiatives with Industry

17. It is estimated that three-quarters of the salt consumed comes from processed foods, whilst the remaining quarter comes from additions in cooking or at the table (Gregory et al 1990; Sanchez-Castillo 1987). Reductions in the levels of salt in processed foods

would therefore have a significant impact on the average consumption of salt in the population.

18. Some retailers, notably Co-op, Asda and M&S, have started to reduce salt in their own brand products. Kelloggs announced their decision in February 2000 to reduce the salt content of selected products by 30-40%. In December 1998, Tesco asked for guidance from DH to assist them in the development of policy in relation to salt. Tesco have a range of low sodium products and they have had a Healthy Eating Initiative for nearly 15 years which has always included salt. Tesco products carry a salt content statement at the bottom of the nutrition panel. The Bread industry has claimed a 10% reduction of sodium in bread in 1988 and a further 2.5% in 1989. This followed agreement by the Federation of Bakers and the Health Education Authority. However, analysis of composite samples of bread in the early 1980s (Wenlock et al 1983) compared to samples analysed in 1998 (MAFF 2000) show that there was very little change. Information provided by retailers show that since then significant reductions have taken place as a result.

19. A new adult dietary survey is currently underway in which sodium intakes will be estimated from sodium excretion. These new data will be able to give some indication of the pattern of intakes since the last survey was carried out (Gregory et al 1990). However, these data will not be available until early 2003.

Simplified labelling - EU Developments

20. In 1994 the European Commission issued its Green Paper on Food Law. As part of the UK's response MAFF proposed a number of recommendations for the improvement of nutrition labelling rules. These included a recommendation for the use of salt rather than sodium in the nutrition panel. The response highlighted that many consumers do not understand what sodium is, but are aware of dietary advice about the need to cut down on salt consumption.

21. The European Commission, in its White Paper on Food Safety, made a commitment to adopt, by July 2001, draft legislative proposal to bring the nutrition labelling directive in line with consumer expectations. Publication of the proposal has been delayed. The Commission is expected in the first instance to issue a discussion document inviting Member States views and it is hoped that a draft legislative proposal will be forthcoming before the end of this year.

22. FSA food labelling section recently met with health professionals, consumer groups and industry groups to explore their views about consumer's nutrition information requirements, with a view to identifying nutrition labelling formats for consumer testing. These discussions considered a wide range of issues including salt/sodium labelling. These views will be taken into account in forthcoming research, the results of which will be used to inform the UK's position in negotiations on the Commission's proposals.

23. Current Agency advice on the use of nutrition claims in food labelling and advertising is that information in the nutrition panel on sodium levels should be accompanied by an equivalent figure for salt.

Key scientific evidence referred to in the COMA 1994 recommendations

24. "[1]In the 1988 Intersalt Study, a large multinational collaboration, examined the relationship between blood pressure and sodium excretion – a marker of salt intake – in over 10,000 people without clinical hypertension from 52 populations throughout the world (Intersalt Cooperative Research Group 1988). This study demonstrated a positive but weak correlation between sodium excretion and prevailing blood pressure in their populations. A more striking finding was the correlation between sodium excretion and the rise in blood pressure with age. An age related rise in blood pressure is usual in populations such as the UK with moderately high sodium intakes, but virtually absent amongst those with very low sodium diets. In addition, the combination of high sodium excretion, low potassium excretion, high alcohol consumption and obesity appeared particularly predictive of higher blood pressures….the authors reanalysed their data to take account of statistical bias, and concluded that the relationship between sodium excretion and blood pressure in their study is stronger than previously thought (Elliot et al 1993)."

25. The Intersalt revisited study (Elliot et al 1996) found the strong, positive association of urinary sodium with systolic pressure of individuals concurs with Intersalt cross population findings. Higher urinary sodium is also associated with substantially greater differences in blood pressure in middle age compared with young adulthood.

26. "[1]Unfortunately, in the [earlier] Intersalt Study it was not possible to say whether the low blood pressures were due to low salt intakes or due to those populations being less urbanised. The populations with the lowest sodium intakes were primitive rural tribes, while those with higher sodium intakes were more urbanised. It remained possible that at least some of the correlation was due to factors other than sodium excretion itself."

27. "[1]A meta-analysis by Law *et al* (Law et al 1991) re-examined data from 24 previous studies around the world, although they did not include the Intersalt data on the grounds that the blood pressures measured in this study were lower than in other studies. Their analysis, which allowed the separation of the effects of urbanisation and of sodium, suggested that both urbanisation and sodium have independent effects throughout the range of observed blood pressures. The relationship observed in this analysis was

[1] Text taken from the Department of Health. Nutritional Aspects of Cardiovascular Disease. Report on Health and Social Subjects No 46. London HMSO, 1994

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considerably stronger than that seen in the observational studies, Law et al were able to predict the reduction seen in clinical studies of sodium restriction."

Scientific evidence for adults since 1994

Intervention Studies

28. Studies since the 1994 recommendations are still inconsistent as to whether or not a high sodium or low sodium intake will affect the blood pressure of healthy young adults and normotensive subjects. 3 controlled studies found no effect of changes in salt intake on blood pressure of young subjects with mild hypertension (Overlack et al 1995) and healthy male subjects (Schorr et al 1997; Feldman et al 1999).

29. The evidence for a relationship between sodium intake and blood pressure appears to be more consistent for hypertensives, older subjects (Arroll et al 1995; Kawano et al 1996; Cappuccio et al 1997a) and salt sensitive individuals (see paragraphs 44-49 for details of salt sensitivity studies).

30. The inconsistencies of studies carried out in normotensive subjects may be due to study population size plus the methods of assessment of sodium intakes. The DASH studies (Appel et al 1997; Sacks et al 2001) with their larger study populations did show a significant decrease in the blood pressure of their normotensive subjects.

31. The Dietary Approaches to Stop Hypertension (DASH) trial randomised 459 adults with systolic blood pressures of less than 160 mm Hg (mean 131 mmHg) and diastolic blood pressures of 80 to 95 mm Hg (mean 85 mm Hg) into one of three diets for eight weeks; the control diet, a diet rich in fruit and vegetables, or a combination diet rich in fruit and vegetables and low-fat dairy products and with a reduced total and saturated fat. The combination diet was most successful at reducing blood pressure in both adults classified as hypertensive and normotensive. Sodium intake (approximately 3 g per day), weight and alcohol consumption (two or fewer drinks per day) were constant (Appel et al 1997). However, the sodium intake, equivalent to 7.5 g sodium chloride per day, is still low when compared to the average intake.

32. The more recent DASH Sodium study (Sacks et al 2001) is a well conducted intervention, too short in duration to look at outcomes, but long enough (over three months) to detect effects of diet on blood pressure. Participants (n=412) ranging in age from 37 to 59, were randomly assigned to a control diet typical of the United States, or the DASH diet (as above). DASH Sodium included three levels of sodium intake

- **high (150 mmol sodium**, equivalent to 9 g of salt),
- **intermediate (100 mmol**, 6 g salt) and
- **low (50 mmol**, 3 g salt).

33. Results of the DASH Sodium study (Sacks et al 2001) appeared to show that reducing the sodium intake from high to intermediate reduced systolic pressures on both the control and DASH diets. Reducing the sodium intake from intermediate to low level caused additional reductions. The effects were seen in those with and without hypertension, blacks and those from other races, women and men. The DASH diet was associated with a significantly lower systolic blood pressure at each sodium level.

34. The DASH diet with a low sodium level led to a mean systolic blood pressure that was 11.5 mm Hg lower in participants with hypertension, and 7.1 mm Hg lower in participants without hypertension. Salt restriction alone lowered systolic blood pressure by 8.3 mm Hg in hypertensives and 5.6 mm Hg in those without hypertension.

35. Criticism of the latest DASH study (Sacks et a 2001) includes:

    - that it singled out the salt and blood pressure association to the exclusion of other important physiological effects (Alderman 2001).
    - the study could equally confirm that adequate mineral intake from dairy products, fruits and vegetables is far more important than salt in determining blood pressure and any effect of salt restriction on blood pressure was limited to hypertensive black females in the study population (McCarron 2001a).
    - data for an effect on blood pressure of the different groups (i.e. defined by ethnic background, presence or absence of hypertension and sex) is presented for systolic blood pressure only and not diastolic (Petitti and Freeman 2001). Petitti and Freeman (2001) argue that diastolic blood pressure may be more important in relation to the risk of stroke and cardiovascular disease.

Observational information

36. McCarron et al (2001b) examined the changes in blood pressure over time in 12,412 young adults entering university between 1948 and 1968. The students were divided into 5 bands according to date of birth (1925-9, 1930-4, 1935-9, 1940-4, 1945-50) and the average systolic and diastolic blood pressure for each of the bands were compared. The study found that for both men and women there was a trend for systolic and diastolic blood pressures to decrease over time (adjusted for age). The authors suggest that the reduction in blood pressure over time may be related the gradual increase in refrigerated foods and thus less consumption of salt preserved foods. Also those born during the war will have had access to more fruits and vegetables as these were not rationed hence their birth band having the lowest blood pressure.

37. Following the observation that a remote community in northern China consumes in excess of 30 g sodium chloride per day yet has virtually no instances of hypertension and coronary heart disease, Huang (1997) has proposed that high levels of dietary sodium protect against hypertension as sodium depletion will lead to an increase in glucocorticoids, angiotensin II, aldosterone, vasopressin and potassium waste, all of which can increase blood pressure. However the author makes no reference to the

possibility of genetic or environmental factors having a role in the health of the remote community.

Salt substitutes

38. Studies which have looked at the effects of a salt substitute (i.e a mix of potassium, sodium, magnesium salt in place of sodium chloride) on blood pressure have mainly been carried out in hypertensive and elderly subjects.

39. Results from most of these studies indicate that the use of salt substitutes may reduce blood pressure in hypertensive and elderly subjects (Geleijnse et al 1994; Gilleran et al 1996; Kawasaki et al 1998; Katz et al 1999). One study found no effect on the blood pressure of patients with essential hypertension (Omvik and Myking 1995) and another found no effect in the normotensive subjects studied (Kawasaki et al 1998).

[6]Meta-analysis of controlled studies

40. Conclusions reached from 3 separate meta-analyses is that evidence for an effect of low sodium intake appears to be relevant to older hypertensive subjects but is poor for normotensive populations (Midgley et al 1996; Graudal et al 1998; Alam et al 1999).

41. Midgley et al (1996) did detect a degree of publication bias suggesting that small trials showing no effect are under-reported. Ebrahim and Smith (1998) also detected a reporting bias that tended to increase the changes observed in their meta-analysis of non-pharmacological interventions for blood pressure management.

42. At the 17th International Congress of Nutrition (held August 27-31, 2001), Professor Frans Kok (Wageningen University) announced that his group in the Netherlands were working on a meta-analysis of randomised trials carried out between 1966 and 2001 which investigated the effect of sodium or potassium intake on blood pressure. The final results are awaiting publication. In addition the same group have submitted for publication a meta-analysis on the impact of dietary and lifestyle factors on hypertension in five western populations, which includes the UK.

43. Criticism of meta-analyses studies includes the difficulties in ensuring heterogeneity of the studies used in the actual analysis.

Salt sensitivity

44. There is evidence to show that the blood pressure of normotensives of some racial groups, genetic groups and particularly older subjects are susceptible to increased intakes of sodium chloride. This may be related to salt sensitivity.

[6]A meta-analysis is a statistical analysis of results from a range of studies that are grouped together. To be included into a meta-analysis the studies must have a similar study design.

45. Human studies into salt sensitivity have used varying methodologies and different criteria to define the trait. However these have generally been found to be reproducible and to yield congruent results (Weinberger 1996). The basic concept is if a subject's mean blood pressure changes significantly following high and low sodium loading then the subject is defined as salt sensitive. A subject is termed salt resistant if there is no significant change in their blood pressure. The cut off point may vary between studies.

46. Salt sensitivity in humans appears to be genetically linked (Sullivan 1991). Overlack et al (1995) found that salt sensitivity was more frequent in those with a positive family history of hypertension as well as in older subjects.

47. An increase in salt sensitivity with increasing age and a greater prevalence of salt sensitivity at lower renin levels appear to be common features to the three racial groups most commonly studied, namely, whites, blacks and Japanese.

48. Cappuccio et al (1997b) found that hypertension and diabetes are raised two to three fold in South Asians in Britain. However, the possible salt sensitivity and dietary sodium levels of Asians do not appear to have been studied.

49. Weinberger et al (2001) sought to test the hypothesis that salt sensitivity in normotensive as well as in hypertensive subjects is associated with an increased risk of cardiovascular events and reduced survival. The study found that the normotensive salt sensitive subjects aged > 25 years when initially studied were found to have a cumulative mortality similar to that of hypertensive subjects, whereas salt resistant normotensive subjects had increased chance of survival. The authors state that additional information is needed to understand the mechanisms by which salt-sensitivity may contribute to mortality.

Effect of dietary advice to reduce salt intakes

50. Intervention studies, in Finland (Korhonen et al 1999), China (Tian et al 1995) and the US (The Trials of Hypertension Prevention Collaborative Research Group, 1997) have tried to assess the effects of dietary advice to reduce salt intakes on blood pressure plus the ability of subjects to adhere to the dietary advice. The end point in all 3 studies was a change in blood pressure. At 3 years the China study noted blood pressure to be lower in the intervention group while the other two studies highlighted the difficulties subjects have in achieving and maintaining a low salt diet.

51. A salt restricted diet does not appear to have a major detrimental effect on the intake of other nutrients. Korhonen et al (2000) investigated the effects of a salt restricted diet for 20 weeks on the intake of other nutrients in free-living mildly hypertensive subjects. In men, total energy intake decreased significantly by 253 kcal/d (1059 KJ/d) and alcohol, potassium, and vitamin D intakes decreased, but there were no significant changes in energy adjusted potassium and vitamin D intakes. In women, total potassium intake increased, but the potassium density of the diet remained unchanged. Total selenium intake and energy adjusted intake of selenium both decreased significantly in women.

Relationship between sodium intake and cardiovascular disease

52. Recent studies looking at the relationship between cardiovascular disease and sodium intake include the cross-sectional National Health and Nutrition Examination Survey (NHANES). 11,000 subjects originally surveyed during 1971-75 were followed up. The results indicated that all-cause mortality and cardiovascular disease mortality were both inversely associated with sex-specific quartiles of sodium intake, whereas dietary sodium/calorie ratio was directly associated with both mortality rates (Alderman et al 1998).

53. A prospective study Tuomilehto et al (2001) looked at sodium excretion and cardiovascular risk factors in Finnish adult males and females (n=2436). The end points were an incident of coronary and stroke event, and death from coronary heart disease, cardiovascular disease, and any cause. The study found that high sodium intake was associated with an increase risk of coronary heart disease which was independent of other cardiovascular risk factors, including blood pressure. The authors suggested that these results provided direct evidence of the harmful effects of high salt intake in the adult population.

Association between blood pressure and salt intake in infants, children, and adolescents – evidence since 1981.

54. The National Diet and Nutrition Survey: young people 4-18 years in 1997 showed that the average sodium intake from food (i.e **excluding** sodium from salt added in cooking or at the table) for young people aged 4-18 years was 2.63 g/day for boys (6.7 g salt) and 2.16 g/day (5.5 g salt) for girls (Gregory et al 2000).

55. A closer look at the distribution of sodium intakes shows that 1% of boys in the 11-14 year group and 8% of 15-18 year old boys had intakes at 4.5 g sodium (11.4 g salt) or more. None of the girls or younger boys had intakes at this level. So there were a few older boys in the survey with salt intakes (excluding salt added in cooking or at the table) at around 12 g.

56. In 1994 COMA recommended a reduction in the sodium content of children's diets, however because of insufficient data it was not possible to quantify what the reduction should be (see paragraph 13). Since 1994 the number of investigations and the extent of the data on dietary sodium and blood pressure are still greater for older populations than for young. As this is the case key evidence for the last 20 years has been summarised in this paper.

57. Three short term studies which looked at the effects of sodium intake on blood pressure in new born infants found differing results. Hofman et al (1983) found that at 25 weeks the infants fed the low sodium diet had lower systolic blood pressure than the infants fed

a normal-sodium diet. In preterm infants fed high sodium preterm infant formula, Lucas et al (1988) found no change in arterial blood pressure at 18 months. Smith et al (1995) carried out a study to determine whether there is a relationship between blood pressure and dietary salt intake during the first year of life in Sowetan infants and found no conclusive evidence of a link.

58. Some of the infants from Hofman's study (1983) were followed up 15 years later and the systolic but not the diastolic blood pressure was significantly lower in those originally assigned to the low sodium group compared with the control group (Geleijnse et al 1996). The preterm infants from Lucas et al (1988) were followed up 8 years later and no differences in blood pressure were noted (Lucas and Morley 1994). Similarly in another study in infants followed up at 13-16 years of age no differences were found in the blood pressure of children given the standard term and preterm formulas at birth even though there was a substantial difference in their sodium content (4.5 g/L vs 1.9 g/L respectively). Blood pressure, however, was lower in the children who were assigned banked breast milk at birth (Singhal et al 2001).

59. In a study of older children (mean age 13, age range 5-17) followed for 7 years the authors (Geleijnse et al (1990) concluded that dietary potassium and the dietary sodium to potassium ratio are related to a rise in blood pressure in childhood and may be important in the early pathogenesis of primary hypertension.

60. Short term intervention studies in adolescents given high and/or low sodium diets for up to 4 weeks found no effects on blood pressure (Howe et al 1991; Cooper et al 1984). The argument could be that up to 4 weeks is an insufficient time to see any effects, however, in a 3 year intervention study, which required intensive diet education and reinforcement, there was no significant difference in blood pressure. However, there also was no significant difference in urinary sodium excretion (Sinaiko et al 1993).

61. Key determinants of whether an adolescent is susceptible to developing hypertensive disease as an adult may be related to genetic factors and obesity. One study investigated the blood pressure response of normotensive adolescents to 14 days of a high salt diet. Some of these subjects were the offspring of hypertensive parents. The mean blood pressure change after 2 weeks of the high salt diet was significantly greater in the offspring of hypertensive parents (Falkner et al 1981).

62. Rocchini et al (1989) found that obese adolescents showed a marked decrease in blood pressure following a low sodium diet compared to the non-obese adolescents. The blood pressure response to sodium intake in the obese adolescents correlated with plasma insulin concentrations. After a weight reduction intervention those adolescents who lost weight and in whom plasma insulin concentrations were also lowered had a reduced sodium sensitivity (i.e. difference in the change in blood pressure during a high salt diet to that during a low salt diet). The authors concluded that the blood pressure

response in these obese adolescents appeared to be related to hyperinsulinaemia. Falkner et al (1992) also found a relationship between sodium sensitivity and plasma insulin concentrations in young African Americans.

Fetal origins and maternal nutrition

63. It has been reported that infants with lower average birth weights, which may be a sign of fetal undernutrition, are more prone to hypertension in adulthood than infants with higher than average birth weights (Eriksson et al 2000). Also the maternal nutritional state during pregnancy may affect blood pressure in childhood and thus the prevalence of adult hypertension (Roseboom et al 2001). In contrast, premature infants, who have a low birth weight, irrespective of salt and other nutrient intake had no higher blood pressures at 8 years of age than normal infants (Lucas and Morley 1994).

Conclusion

64. Based on the summary of evidence presented in this paper the Committee is asked to:

- Review and update the previous recommendations made by COMA, inviting consultation with interested parties at an early stage.
- Consider whether or not the evidence for children should be reviewed by the Committee or a separate subgroup in order to quantify a recommended amount for the general population of children.

SACN Secretariat
September 2001

References: The following papers are available on request from the Secretariat:

1. Alam S, Johnson AG.) A meta-analysis of randomised controlled trials (RCT) among healthy normotensive and essential hypertensive elderly patients to determine the effect of high salt (NaCl) diet of blood pressure. J Hum Hypertens 13[6], 367-74. 1999.

2. Alderman M. Letter. NEJM. 344:22, 1716. 2001.

3. Alderman MH, Cohen H, Madhavan S. Dietary sodium intake and mortality: the National Health and Nutrition Examination Survey (NHANES I). Lancet 351[9105], 781-5 1998.

4. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Cutler JA, Windhauser MM, Lin PH, Karanja N. (1997) A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. N Engl J Med 336[16], 1117-24. 1997.

5. Arroll B, Beaglehole R. Salt restriction and physical activity in treated hypertensives. N Z Med J 108[1003], 266-8. 1995.

6. Cappuccio FP, Markandu ND, Carney C, Sagnella GA, MacGregor GA. Double-blind randomised trial of modest salt restriction in older people. Lancet 350[9081], 850-4. 1997a.

7. Cappuccio FP, Cook DG, Atkinson RW, Strazzullo P. Prevalence, detection, and management of cardiovascular risk factors in different ethnic groups in south London. Heart 78[6], 555-63. 1997b.

8. Cook NR, Cohen J, Hebert PR, Taylor JO, Hennekens CH. Implications of small reductions in diastolic blood pressure for primary prevention. Arch Intern Med 10;155[7]:701-709. 1995.

9. Cooper R, Van Horn L, Liu K, Trevisan M, Nanas S, Ueshima H, Larbi E, Yu CS, Sempos C, LeGrady D, et al. A randomized trial on the effect of decreased dietary sodium intake on blood pressure in adolescents. J Hypertens 2[4], 361-6. 1984.

10. Cox KL, Puddey IB, Morton AR, Masarei JR, Vandongen R, Beilin LJ. Controlled comparison of effects of exercise and alcohol on blood pressure and serum high density lipoprotein cholesterol in sedentary males. Clin Exp Pharmacol Physiol 17[4], 251-5. 1990.

11. Department of Health. Nutritional Aspects of Cardiovascular Disease. Report on Health and Social Subjects No 46. London HMSO, 1994.

12. Department of Health. Dietary Reference Values for Food, Energy and Nutrients for the United Kingdom. Report on Health and Social Sciences No 41. London: HMSO, 1991.

13. Ebrahim S, Smith GD. Lowering blood pressure: a systematic review of sustained effects of non-pharmacological interventions. J Public Health Med 20[4], 441-8. 1998.

14. Elliott P, Dyer A, Stamler R, Stamler J. Correcting for regression dilution in INTERSALT. Lancet. 342[8879], 1123. 1993.

15. Elliott P, Stamler J, Nichols R, Dyer AR, Stamler R, Kesteloot H, Marmot M. Intersalt revisited: further analyses of 24 hour sodium excretion and blood pressure within and across populations. Intersalt Cooperative Research Group. BMJ 312[7041], 1249-53. 1996.

16. Eriksson J, Forsen T, Tuomilehto J, Osmond C, Barker D. Fetal and childhood growth and hypertension in adult life. Hypertension 36[5], 790-4. 2000.

17. Erens B, Primatesta P Eds. Health Survey for England, Cardiovascular Disease 1998. TSO, London. 1999.

18. Falkner B, Hulman S, Kushner H. Hyperinsulinemia and blood pressure sensitivity to sodium in young blacks. J Am Soc Nephrol 3[4], 940-6. 1992.

19. Falkner B, Onesti G, Angelakos E. Effect of salt loading on the cardiovascular response to stress in adolescents. Hypertension 3[6 Pt 2], II-195-9. 1981.

20. Feldman RD, Schmidt ND. Moderate dietary salt restriction increases vascular and systemic insulin resistance. Am J Hypertens 12[6], 643-7. 1999.

21. Garrow JS, James WPT, Ralph A. Eds. Human Nutrition and Dietetics 10th edition. Churchill Livingstone, London 2000.

22. Geleijnse JM, Grobbee DE, Hofman A. Sodium and potassium intake and blood pressure change in childhood. BMJ 300[6729], 899-902. 1990.

23. Gleiberman L. Blood pressure and dietary salt in human populations. Ecology of Food and nutrition 2:143-156. 1973.

24. Geleijnse JM, Hofman A, Witteman JCM, Hazebroek AAJM, Valkenburg HA, Grobbee DE. Long-term effects of neonatal sodium restriction on blood pressure. Hypertension. 29:913-917. 1996.

25. Geleijnse JM, Witteman JC, Bak AA, den Breeijen JH, Grobbee DE. Reduction in blood pressure with a low sodium, high potassium, high magnesium salt in older

subjects with mild to moderate hypertension. BMJ 309[6952], 436-40. 1994.

26. Gilleran G, O'Leary M, Bartlett WA, Vinall H, Jones AF, Dodson PM. Effects of dietary sodium substitution with potassium and magnesium in hypertensive type II diabetics: a randomised blind controlled parallel study. J Hum Hypertens 10[8], 517-21. 1996.

27. Graudal NA, Galloe AM, Garbed P. Effects of sodium restriction on blood pressure, rennin, aldosterone, catecholamines, cholesterols, and triglyceride: a meta-analysis. JAMA 279[17], 1383-91. 1998.

28. Gregory J, Foster K, Tyler H, Wiseman M. The dietary and nutritional survey of British adults: a survey of the dietary behaviour, nutritional status and blood pressure of adults aged 16 to 64 living in Great Britain. Office of Population Census and Surveys. Social Survey Division. London: HMSO, 1990.

29. Gregory J, Lowe S et al. National Diet and Nutrition Survey young people aged 4-18 years. Office of National Statistics. TSO, London. 2000.

30. Hofman A, Hazebroek A, Valkenburg HA. A randomized trial of sodium intake and blood pressure in newborn infants. JAMA 250[3], 370-3. 1983.

31. Howe PR, Cobiac L, Smith RM. Lack of effect of short-term changes in sodium intake on blood pressure in adolescent schoolchildren. J Hypertens 9[2], 181-6. 1991.

32. Huang YW. Sodium Chloride and Hypertension. Med. Hypotheses 49:221-228. 1997.

33. Intersalt Cooperative Research Group. Intersalt: an international study of electrolyte excretion and blood pressure. Results for 24 hour urinary sodium and potassium excretion. BMJ 297:319-28. 1988.

34. Katz A, Rosenthal T, Maoz C, Peleg E, Zeidenstein R, Levi Y. Effect of a mineral salt diet on 24-h blood pressure monitoring in elderly hypertensive patients. J Hum Hypertens 13[11], 777-80. 1999.

35. Kawano Y, Abe H, Kojima S, Yoshimi H, Sanai T, Kimura G, Matsuoka H, Takishita S, Omae T. Different effects of alcohol and salt on 24-hour blood pressure and heart rate in hypertensive patients. Hypertens Res 19[4], 255-61. 1996.

36. Kawasaki T, Itoh K, Kawasaki M. Reduction in blood pressure with a sodium-reduced, potassium- and magnesium-enriched mineral salt in subjects with mild essential hypertension. Hypertens Res 21[4], 235-43. 1998.

37. Korhonen MH, Jarvinen RM, Sarkkinen ES, Uusitupa MI. Effects of a salt-restricted diet on the intake of other nutrients. Am J Clin Nutr 72[2], 414-20. 2000.

38. Korhonen MH, Litmanen H, Rauramaa R, Vaisanen SB, Niskanen L, Uusitupa M. Adherence to the salt restriction diet among people with mildly elevated blood pressure. Eur J Clin Nutr 53[11], 880-5. 1999.

39. Law MR, Frost CD, Wald NJ. By how much does dietary salt reduction lower blood pressure? III--Analysis of data from trials of salt reduction. BMJ 302[6780], 819-24. 1991.

40. Law MR. Evidence on salt is consistent. BMJ 312:1284-1285. 1996

41. Lucas A, Morley R, Cole TJ, Gore SM. A randomised multicentre study of human milk versus formula and later development in preterm infants. Arch Dis Child Fetal Neonatal Ed 70[2], F141-6. 1994.

42. Lucas A, Morley R, Hudson GJ, Bamford MF, Boon A, Crowle P, Dossetor JF, Pearse R. Early sodium intake and later blood pressure in preterm infants. Arch Dis Child 63[6], 656-7. 1988.

43. McCarron DA. Letter. NJEM. 344:22, 1717. 2001a

44. McCarron P, Okasha M, McEwen J, Smith GD. Changes in blood pressure among students attending Glasgow University between 1948 and 1968: analyses of cross sectional surveys. BMJ 322[7291], 885-9. 2001b.

45. Midgley JP, Matthew AG, Greenwood CM, Logan AG. Effect of reduced dietary sodium on blood pressure: a meta-analysis of randomized controlled trials. JAMA 275[20], 1590-7. 1996.

46. Ministry of Agriculture, Fisheries and Food. Nutrient Analysis of Bread and Morning Goods Food Surveillance Information Sheet 194. 2000.

47. Ministry of Agriculture, Fisheries and Food. National Food Survey Statistics News Release, 5 March 2001

48. The National Assembly for Wales. Welsh Health Survey 1998. Government Statistical Service 1999.

49. Department of Health Social Services and Public Safety. Consultation Paper Investing for Health, Northern Ireland, November 2000.

50. Omvik P and Myking OL. Unchanged central hemodyanmics after six months of moderate sodium restriction with or without potassium supplement in essential hypertension. Blood Pressure 4, 32-41. 1995.

51. Overlack A, Ruppert M, Kolloch R, Kraft K, Stumpe KO. Age is a major determinant

of the divergent blood pressure responses to varying salt intake in essential hypertension. Am J Hypertens 8[8], 829-36. 1995.

52. Petitti DB & Freedman D. Letter. NEJM. 344:22, 1717. 2001

53. Reisin E, Abel R, Modan M, Silverberg DS, Eliahou HE, Modan B. Effect of weight loss without salt restriction on the reduction of blood pressure in overweight hypertensive patients. N Engl J Med 298[1], 1-6. 1978.

54. Rocchini AP, Key J, Bondie D, Chico R, Moorehead C, Katch V, Martin M. The effect of weight loss on the sensitivity of blood pressure to sodium in obese adolescents. N Engl J Med 321[9], 580-5. 1989.

55. Roseboom TJ, van der Meulen JH, van Montfrans GA, Ravelli AC, Osmond C, Barker DJ, Bleker OP. Maternal nutrition during gestation and blood pressure in later life. J Hypertens 19[1], 29-34. 2001.

56. Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D, Obarzanek E, Conlin PR, Miller ER 3rd, Simons-Morton DG, Karanja N, Lin PH. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. N Engl J Med 344[1], 3-10. 2001.

57. Sanchez-Castillo CP, Warrender S, Whitehead TP, James WP. An assessment of the sources of dietary salt in a British population. Clin Sci (Colch) 72[1], 95-102. 1987.

58. Schorr U, Turan S, Distler A, Sharma AM. Relationship between ambulatory and resting blood pressure responses to dietary salt restriction in normotensive men. J Hypertens 15[8], 845-9. 1997.

59. Scottish Executive Health Department. The Scottish Health Survey 1998. Joint Surveys Unit, November 2000. TSO.

60. Sinaiko AR, Gomez-Marin O, Prineas RJ. Effect of low sodium diet or potassium supplementation on adolescent blood pressure. Hypertension 21[6 Pt 2], 989-94. 1993.

61. Singhal A, Cole TJ, Lucas A. Early nutrition in preterm infants and later blood pressure: two cohorts after randomised trials. Lancet 357[9254], 413-9. 2001.

62. Smith RE, Kok A, Rothberg AD, Groeneveld HT. Determinants of blood pressure in Sowetan infants. S Afr Med J 85[12 Pt 2], 1339-42. 1995.

63. Sullivan JM. Salt sensitivity. Definition, conception, methodology, and long-term issues. Hypertension 17[1 Suppl], I61-8. 1991.

64. Tian HG, Guo ZY, Hu G, Yu SJ, Sun W, Pietinen P, Nissinen A. Changes in sodium intake and blood pressure in a community-based intervention project in China. J Hum Hypertens 9[12], 959-68. 1995.

65. The Trials of Hypertension Prevention Collaborative Research Group. Effects of weight loss and sodium reduction intervention on blood pressure and hypertension incidence in overweight people with high-normal blood pressure. The Trials of Hypertension Prevention, phase II. Arch Intern Med 157[6], 657-67. 1997.

66. Tuomilehto J, Jousilahti P, Rastenyte D, Moltchanov V, Tanskanen A, Pietinen P, Nissinen A. Urinary sodium excretion and cardiovascular mortality in Finland: a prospective study. Lancet 357[9259], 848-51. 2001.

67. Weinberger MH. Salt sensitivity of blood pressure in humans. Hypertension 27[3 Pt 2], 481-90. 1996.

68. Weinberger MH, Fineberg NS, Fineberg SE, Weinberger M. Salt sensitivity, pulse pressure, and death in normal and hypertensive humans. Hypertension 37[2], 429-32. 2001.

69. Weinberger MH, Miller JZ, Luft PC, Grim CE, Fineberg NS. Definitions and characteristics of sodium sensitivity and blood pressure resistance. Hypertension 8 [suppl II]:II-127-II-134. 1986.

70. Wenlock RW, Sivell LM, King RT, Scuffam D. and Wiggins R.A. The Nutritional Composition of British Bread - a Nationwide Study Journal of Science, Food and Agriculture; 34, 1302-1318. 1983.

Annex 1

Country	***Estimated Intakes***	***Govt Recommendations***	***Govt programmes and/or initiatives with/without industry***
Andorra	Follow recommendations of WHO (www.who.int/ncd/cvd/ht-guide.html#c534) which are: reduce dietary sodium to achieve an intake of less than 100 mmol (5.8 g/d of sodium or less than 6 g/d of salt); avoid salted foods, particularly processed foods, and eat more meals cooked directly from natural ingredients. The high sodium – low potassium content of many preserved foods is drawn to the attention of the food industry		
Austria		The Nutrition Society recommends no more than 6 g/d salt	General information available to public encouraging them to reduce dietary salt intake
Denmark (NNR*)		5 g/d salt (2 g/d sodium) no more than this children < 5yr	none
Finland		5 g/d salt. Children <3 yr no more than 3 g/d salt	No specific government run programs but do support NGOs e.g. The Heart Association. The National Nutrition Council recommends Finns to decrease their sodium intake. Labelling regulations state that the % salt by weight of the product must be labelled. National standards have been established for the categories of "low salt" (voluntary) and "high salt" (obligatory) –claims concerning certain food groups, main sources of salt in Finnish diet. Since 80s the food industry have been active in developing low salt products.
France	Adults, 9-10 g/d sodium Children 3-15 yr, 5.9 g/d sodium	No recommendations on salt at present but provisory advice issued by AFSSA for 6-8 g/d salt (with range among population at 5-12 g/d) Official advice is intended for next year	L'AFSSA (food security agency) is involved in a working group made up scientific experts and members of industry (e.g. bakery, cheese manufacturers, and salted meats). The group are trying to think of ways to reduce salt in processed foods as well as keep consumers informed through labelling etc. The working group plan to give recommendations by end of 2001.
Germany		The Nutrition Society recommend 6 g/d salt and also recommend to use salt sparingly and use spices and herbs instead.	None. Only initiative so far involves replacing salt with iodized salt in processed foods.

* Nordic Nutrition Recommendations

Luxembourg		No specific recommendations other than 'use salt with moderation' Gvt do recommend the use of iodized salt 5 g/d and recommend industry to use it also (no mention of restriction)	none
Netherlands	3.7 g/d (sodium)	Reduce intakes by 1 g/d sodium (2.5 g/d of salt)	none

Country	***Estimated Intakes***	***Govt Recommendations***	***Govt programmes and/or initiatives with/without industry***
Norway (NNR)	Intake is "about double the desired level"	5 g/d salt (2 g/d sodium) no more than this children < 5yr	none
Sweden (NNR)	Adults dietary survey indicate: 2.8 g/d women 3.6 g/d men But estimate actual intake to be 20-25% higher	5 g/d salt (2g/d sodium) no more than this children < 5yr	Official diet and health recommendations include recommendations to the food industry and catering sector to limit the use of salt. The recommendations are used in health promotion activities at the regional and local level. The National Food Administration has, through the national Expert Group for Diet and Health, arranged seminars with e.g. the food industry to promote reduced use of salt in food production. Actions directed to the public have been limited. Health promotion is carried out at the regional and local level.

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