Scientific Advisory Committee on Nutrition

2nd MEETING OF SALT SUBGROUP
18 April 02, Food Standards Agency, Aviation House, 125 Kingsway, LONDON

MINUTES (14/05/02)

Chairman Professor Alan Jackson

Members Professor Peter Aggett
Professor Sheila Bingham
Miss Gill Fine

Secretariat Dr Lisa Jackson (FSA)
Dr Alison Tedstone (FSA)
Dr Sheela Reddy (DH)
Ms Orla Yeates (FSA)
Dr Adrienne Cullum (DH)
Ms Mamta Singh (FSA)

Chair's Introduction

1. The Chair welcomed Members to the meeting and requested them to inform him of any modifications they wished to make to the agenda.

AGENDA ITEM 1 – Minutes of last meeting SACN/SaltSub/02/min01

2. Members were invited to comment on the minutes of the previous meeting. A request was made for future minutes to express the amount of sodium/salt in both grams and mmol to ensure clarity and consistency.

3. There were no matters arising and members commented that they had found the minutes of the previous meeting very helpful.

4. The Chair felt it would be helpful if agreement could be reached on how the Subgroup should progress and agree on the key issues that needed to be considered.

5. Members agreed that it was important to:
    - state that sodium is an essential nutrient and central to water homeostasis;
    - identify the physiological range of sodium required to maintain homeostasis, i.e. the minimum intake required to match losses and the upper level beyond which the homeostatic mechanism is altered;
    - recognise that the lower and upper level varies between individuals.

6. It was recognised that sodium homeostasis may involve a number of mechanisms and that any change in diet or nutrient intake that affects renal function had the potential to exert an influence and that there were complex interactions with other food constituents such as potassium, magnesium and calcium.

7. As sodium and potassium homeostasis are energy dependent, changes in energy homeostasis are often associated with alterations in sodium homeostasis.

8. The Subgroup agreed to proceed by considering the evidence in each of the following areas:
    - Physiological requirements for sodium
    - Relative importance of chloride ion
    - Salt sensitivity
    - Morbidity and mortality outcomes.

9. There was the need to be specific about age-related changes in the above areas.

Physiological requirements for sodium

10. Much of the literature on sodium homeostasis related to the response to higher intakes and there was relatively less evidence available on lower intakes.

11. The paper by Armstrong at al (1993) *Reponses to moderate and low sodium diets during exercise-heat acclimation* and that by Hargreaves et al (1989) *Exercise tolerance in the heat on low and normal salt intakes* showed there were no adverse effects of low intakes

of sodium during heat exposure, however sodium balance had not been measured in these studies.

12. The Subgroup noted that the information needed to define a minimum safe intake might be found in the older literature and the further references cited in the above papers might be helpful in this regard:
    - Conn JW. Aldosteronism in man: Some clinical and climatological aspects. Part I. JAMA 1963; 183:775-781.
    - Consolazio CF. Nutrient requirements of troops in extreme environments. Army Research Development Magazine 1996; 11:24-27.
    - Dahl LK. Salt intake and salt need. *New Eng. J Med* 1958; 258:1152-1157.
    - de Garavilla L, Durkot MJ, Ihley TM, Leva N, Francesconi RP. Adverse effects of dietary and furosemide-induced sodium depletion on thermoregulation. Aviat Space Environ Med 1990;61:1012-7.
    - Francesconi RP, Armstrong LE, Leva N, Moore R, Szlyk PC, Matthew W, Curtis W, Hubbard RW, Askew EW. Endocrinological responses to dietary salt restriction during heat acclimation. Washington DC: National Academy Press, 1993.
    - Francesconi RP and Hubbard RW. Chronic low-sodium diet in rats: Responses to severe heat exposure. J Appl Physiol. 1985; 58:152-156.
    - McCance RA. Proceedings of the Royal Society of London. Series B--Biological Sciences, Volume 119, 1935-1936: Experimental sodium chloride deficiency in man. Nutr Rev 1990;48:145-7.
    - Strauss MB, Lamdin E, Smith WP, Bleifer. Surfeit and deficit of sodium. Arch. Intern. Med. 1958:102:527-536.
    - Taylor HL, Henschel A, Mickelson O, Keys A. The effect of sodium chloride intake on the work performance of man during exposure to dry heat and experimental heat exhaustion. Am J Physiol, 1944:140:439-451.
    - Bergoff RS, Geraci AS. The influence of sodium chloride on blood pressure. III Med J 1929; 56:395-7.
    - Cappuccio FP, MacGregor GA. Does potassium supplementation lower blood pressure? A meta-analysis of published trials. J Hypertens 1991;9:465-73.
    - Grimm RH Jr, Neaton JD, Elmer PJ et al. The influence of oral potassium chloride on blood pressure in hypertensive men on a low-sodium diet. N Engl J Med

1990;322:569-74.

- Costill DL, Branam G, Fink W, Nelson R. Exercise induced sodium conservation: changes in plasma renin and aldosterone. Med Sci Sports 1976;8:209-13.
- Convertino VA, Keil LC, Bernauer EM, Greenleaf JE. Plasma volume, osmolality, vasopressin, and renin activity during graded exercise in man. J Appl Physiol 1981;50:123-8.

Action: Secretariat

13. It was also noted that there was little information available on the physiological ranges of sodium required by infants. Much of the literature in this area related to neonates and pre-term infants. For the term infants, the sodium content of breast milk could be considered to be safe and adequate.

14. In considering the paper by Chevalier (2001), *The moth and the aspen tree: sodium in early postnatal development*, the Subgroup requested the following references which might provide further information on the physiological requirements for children:

- Al-Dahhan J, Haycock GB, Chantler C, Stimmler L. Sodium homeostasis in term and preterm neonates. I. Renal aspects. Arch Dis Child 1983;58:335-42.
- Al-Dahhan J, Haycock GB, Chantler C, Stimmler L. Sodium homeostasis in term and preterm neonates. II. Gastrointestinal aspects. Arch Dis Child 1983;58:343-5.
- Al-Dahhan J, Haycock GB, Nichol B, Chantler C, Stimmler L. Sodium homeostasis in term and preterm neonates. III. Effect of salt supplementation. Arch Dis Child 1984;59:945-50.
- Crystal SR, Bernstein IL. Infant salt preference and mother's morning sickness. Appetite 1998;30:297-307.
- Crystal SR, Bernstein IL. Morning sickness: impact on offspring salt preference. Appetite 1995;25:231-40.
- Bueva A, Guignard JP. Renal function in preterm neonates. Pediatr Res 1994;36:572-7.
- Ross B, Cowett RM, Oh W. Renal functions of low birth weight infants during the first two months of life. Pediatr Res 1977;11:1162-4.
- Dean RFA, McCance RA. The renal responses of infants and adults to the administration of hypertonic solutions of sodium chloride and urea. J Physiology

(Lond) 1949; 109:81-97

- Spitzer A. The role of the kidney in sodium homeostasis during maturation. Kidney Int 1982;21:539-45.
- Gomez RA, Norwood VF. Developmental consequences of the renin-angiotensin system. Am J Kidney Dis 1995;26:409-31.
- Weil J, Bidlingmaier F, Dohlemann C, Kuhnle U, Strom T, Lang RE. Comparison of plasma atrial natriuretic peptide levels in healthy children from birth to adolescence and in children with cardiac diseases. Pediatr Res 1986;20:1328-31.

Action: Secretariat

15. The Sub-group requested the following references cited in the paper by Geleijnse et al (1990) *Sodium and potassium intake and blood pressure change in childhood:*
    - Cooper R, Liu K, Trevisan M, Miller W, Stamler J. Urinary sodium excretion and blood pressure in children: absence of a reproducible association. Hypertension 1983;5:135-9.
    - Liu K, Cooper RS, Soltero I, Stamler J. Variability in 24-hour urine sodium excretion in children. Hypertension 1979;1:631-6.

Action: Secretariat

16. The Sub-group requested the following references cited in the paper by Falkner & Michel (1997) *Blood pressure response to sodium in children and adolescents:*
    - Hofman A, Valkenburg HA, Vaandroger GT. Increased blood pressure in school children related to high levels in drinking water. J Epidemiol Commun Health 1980;34:179-81.
    - Hofman A, Hazelbrock A, Valkenburg HA. A randomized trial of sodium intake and blood pressure in newborn infants. JAMA 1983;250:370-3.

Action: Secretariat

17. The Sub-group requested the following references cited in the paper by Simons-Morton and Orbazanek (1997) *Diet and blood pressure in children and adults:*
    - Ellison RC, Sosenko JM, Harper GP, Gibbons L, Pratter FE, Miettinen OS. Obesity, sodium intake, and blood pressure in adolescents. Hypertension 1980;2:78-82.
    - Liebman M, Chopin LF, Carter E et al. Factors related to blood pressure in a biracial

adolescent female population. Hypertension 1986;8:843-50.

- Gillman MW, Oliveria SA, Moore LL, Ellison RC. Inverse association of dietary calcium with systolic blood pressure in young children. JAMA 1992;267:2340-3.
- Faust HS. Effects of drinking water and total sodium intake on blood pressure. Am J Clin Nutr 1982;35:1459-67.
- Zhu K, He S, Pan X, Zheng X, Gu Y. The relation of urinary cations to blood pressure in boys aged seven to eight years. Am J Epidemiol 1987;126:658-663.
- Cooper R, Soltero I, Liu K, Berkson D, Levinson S, Stamler J. The association between urinary sodium excretion and blood pressure in children. Circulation 1980;62:97-104.
- Watson RL, Langford HG, Abernethy J, Barnes TY, Watson MJ. Urinary electrolytes, body weight, and blood pressure. Pooled cross- sectional results among four groups of adolescent females. Hypertension 1980;2:93-8.
- Wu Y, Cai R, Zu B, Xu X. Effects of genetic factors and dietary electrolytes on blood pressure of rural secondary school students in Hanzhong. Hin Med Sci J 1991;6:148-152.

Action: Secretariat

Relative importance of chloride ion

18. It was noted that the papers by Kotchen et al suggested that chloride did not exert an independent effect on blood pressure but did so only when combined with sodium. In practice, sodium is predominantly consumed as sodium chloride.

19. The Subgroup requested the following references cited in the paper by Kotchen & McCarron (1998) *Dietary electrolytes and blood pressure: A statement for healthcare professionals from the American Heart Association Nutrition Committee:*

- Denton D, Weisinger R, Mundy NI et al. The effect of increased salt intake on blood pressure of chimpanzees. Nat Med 1995;1:1009-16.
- Grim CE, Wilson. Salt, slavery and survival: physiological principles underlying the hypothesis of salt-sensitive hypertension in western hemisphere blacks. In Fray JCS, Douglas JG, eds. Pathophysiology of hypertension in Blacks. New York, NY: Oxford

University Press; 1993:25-49.

- Whelton PK, He J, Cutler JA, Brancati FL, Appel LJ, Follmann D, Klag MJ. Effects of oral potassium on blood pressure: meta-analysis of randomized controlled clinical trials. JAMA 1997;277:1624-1632.

Action: Secretariat

Salt Sensitivity

20. The Subgroup noted that there seemed to be no general agreement on a definition of salt sensitivity. Salt sensitivity has been characterised as a limitation in the capacity of the kidney to handle a sodium load.

21. Two important factors which appear to determine salt sensitivity are the intrinsic renal to sodium threshold itself and the different factors that influence it, i.e. the intrinsic ability of the kidney, habitual exposure to sodium and acute responses to a sodium load, and how these change with age.

22. Members considered the paper by Svetkey et al (2001) *Angiotensinogen genotype and blood pressure response in the Dietary Approaches to Stop Hypertension (DASH) study* and concluded that although genotype was clearly an important factor in explaining the variability in salt sensitivity, many other factors also played a part. The Sub-group also requested the following reference cited in this paper:

- Hunt SC, Cook NR, Oberman A et al. Angiotensinogen genotype, sodium reduction, weight loss, and prevention of hypertension: trials of hypertension prevention, phase II. Hypertension 1998;32:393-401.

Action: Secretariat

23. Members expressed their interest in learning whether the genotype of subjects in the DASH Sodium trial had been examined and it was agreed that the authors should be contacted.

Action: Secretariat to draft letter for Chair to sign

24. The Subgroup requested the following reference cited in the paper by Chiolero et al (2001) *Renal determinants of the salt sensitivity of blood pressure:*
    - Watt GCM. Does salt sensitivity exist? Klin Wochenschr 1991;69[Suppl XXV]:30-35.

Action: Secretariat

25. The Subgroup requested the following references cited in the paper by Weinberger (1996) *Salt sensitivity of blood pressure in humans*:
    - Luft FC, Rankin LI, Bloch R, Weyman AE, Willis LR, Murray RH, Grim CE, Weinberger MH. Cardiovascular and humoral responses to extremes of sodium intake in normal black and white men. Circulation 1979;60:697-706.
    - Miller JZ, Daugherty SA, Weinberger MH, Grim CE, Christian JC, Lang CL. Blood pressure response to dietary sodium restriction in normotensive adults. Hypertension 1983;5:790-795.

Action: Secretariat

26. A recent paper by Weinberger et al (2001) *Salt sensitivity, pulse pressure and death in normal and hypertensive humans* was circulated.

27. The Subgroup recognised it would be of value to know the prevalence of salt sensitivity in the population and the change in prevalence with age.

Action: Secretariat

Morbidity and Mortality Outcomes

Exposure in terms of diet

28. The Subgroup agreed that in considering dietary exposure to sodium, it was necessary to assess the patterns of consumption associated with different eating patterns:
    - Consuming different quantities of processed/fast food;
    - Adding salt during cooking and at the table.

29. Members felt it was important to know how these different exposures related to the scale of intakes - inadequate, appropriate and excessive. It would also be necessary to consider these exposures in the context of other dietary recommendations.

30. The Subgroup were informed that the Food and Drink Federation (FDF) survey had reported ranges of salt contents of various product categories and that it may be possible to obtain data from this source. The Secretariat agreed to find out what information will be available in the forthcoming National Diet and Nutrition Survey (NDNS) on adults. The Secretariat agreed to find out if a cluster analysis for dietary patterns had been carried out for this and previous Surveys. It was suggested that if such data were not available then the FSA should proceed to commission this analysis. The Subgroup felt it would be particularly useful to know the dietary patterns for children across the different age groups.

Action: Secretariat

31. Members were informed of a report by Verner Wheelock Associates in which the salt content of some categories of products from different retail outlets had been assessed. It was agreed that these data should be requested.

Addition of sodium to foods

32. It was noted that salt was also added to foods for reasons other than for its preservative function, e.g. for fermentation, flavouring, texture. The Subgroup could comment about general principles in this area and make recommendations for the potential options, e.g. a step by step reduction.

33. It was noted that some companies have reduced salt levels in certain food products. While the salt levels in some food products differ between countries, international comparative data were not available. It was agreed that multinational companies should be asked if they could provide an example of a case study of the approaches used.

34. Gill Fine pointed out that a related issue was that reducing the salt content of products was only one aspect considered in product development and that any product specification changes would involve reformulation costs and label changes; therefore companies would need to be confident of the consumer acceptability of the product before implementing such changes.

35. The Chair summarised the information needed by the Subgroup :
    - Patterns of consumption
    - Significant food sources of salt and options for change
    - Examples of practice

Outcomes

36. The Subgroup observed that although the most commonly used outcome measure was hypertension, another possible outcome could be salt sensitivity. It was noted that there was very little information on the relationship between salt and mortality or of altered physiology.

37. It was noted that some studies had used other outcome measures, including stomach cancer mortality and Left Ventricular Hypertrophy (LVH). However, it was unclear whether vascular health as an outcome was secondary to hypertension. With respect to LVH, the Secretariat agreed to obtain details of a study by Schmieder et al and information regarding the Treatment of Mild Hypertension Study (TOMHS) which had investigated changes in left ventricular mass in relation to dietary salt intake.

Action: Secretariat

38. Members agreed that more information was required regarding salt and mortality outcomes and requested that a search be conducted for further information.

Action: Secretariat

39. The Sub-group requested the following papers which examined the relationship between sodium and mortality:
    - 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.
    - Alderman MH, Cohen H, Madhaven S. Dietary sodium intake and mortality: the National Health and Nutrition Examination Survey. *Lancet* 1998; 351:781-785.

Action: Secretariat

Other Factors

40. Four other factors which the Subgroup need to consider are the effects of:

- Genotype
- Early life experience
- Body composition
- Other dietary factors.

41. Members discussed each of these items in turn and consider the evidence available in each area.

Genes

42. The Secretariat would check for additional information.

Action: Secretariat

Early life experience

43. The consideration relates to the evidence which relates size at birth and risk of developing hypertension.

44. The evidence suggests that:

- Smaller babies had higher blood pressure in later life;
- Exposure to dietary sodium in early life may be related to the development of higher blood pressure later in life.

45. The Subgroup observed that the available evidence showed associations, which may play a part in a person's susceptibility to high blood pressure, but the evidence for direct causation was less strong.

Body composition

46. In this complex area, the important issues that needed to be considered by the Subgroup were:

- Overweight and obesity
- Inactivity and activity
- Glucose and insulin homeostasis

47. It was noted that as all these issues were inter-related. The results of the DASH trial might be of particular help.

48. The intervention diets in the DASH trial were only of 4 weeks duration, but each had demonstrated that dietary sodium was one factor which had an influence on blood pressure.

49. The DASH intervention was of relatively short duration; the *Trials of Hypertension Prevention* examined longer-term effects of weight loss and dietary sodium reduction on blood pressure and reached similar conclusions.

50. The evidence regarding the benefits of increased intake of fruit and vegetable diets on blood pressure had been very consistent and that the results of the DASH trial had further strengthened this evidence base.

51. The mechanisms by which fruit and vegetables could reduce blood pressure were discussed.

52. With regard to the relationship between physical activity, salt, and blood pressure, there was some evidence for an association, however possible mechanisms were not clear.

53. As smoking and alcohol are also related to hypertension, it would be helpful to find out if any studies had examined sodium homeostasis and renal excretion in relation to these factors.

Action: Secretariat

54. With regard to other nutrients, potassium, calcium, and magnesium have specifically been credited with having significant effects on blood pressure. An important consideration was whether these effects are pharmacological or physiological. It was noted that there was also an effect of saturated fat.

55. Before closing the meeting, the Chair summarised what had been achieved by the second meeting of the Salt Subgroup:

- The Subgroup had assessed the extent to which the literature they had was appropriate to their task and identified the literature required for further deliberations.
- Various Members of the Subgroup agreed to lead on the following topics:

  Physiological requirements

  Salt sensitivity

  Epidemiology of health outcomes and mortality

  Sodium in foods and the influence of different dietary patterns on intake

56. The Chair hoped that after the next meeting the Subgroup would be in the position to begin structuring a report of their findings.

57. The Chair thanked members of the Subgroup for attending the meeting and confirmed the date of the next meeting as 10.00am on **21 May**.