Answer to the Public consultation on the draft proposal for the first part of the Nordic Nutrition Recommendations 2012 the part of Sodium as salt

The text in the Public consultation on the draft proposal for the first part of the Nordic Nutrition Recommendations 2012 the part of Sodium as salt is definitely wrong from a scientific standpoint and must be replaced.

My draft proposal is the following text with lines number 1001-
Public consultation on the draft proposal for the first part of the Nordic Nutrition Recommendations 2012

**Sodium as salt**

**Answer** to the Public consultation on the draft proposal for the first part of the Nordic Nutrition Recommendations 2012 the part of Sodium as salt

**Key words**

Sodium, blood pressure, essential nutrient, tolerable lower intake level, tolerable upper intake level, food safety

**Summary**

Sodium is an essential nutrient involved in fluid and electrolyte balance and is required at a very closely controlled extracellular concentration of 137-145 mmol/L for normal cellular function. The main function of sodium in the body is to maintain the transmembrane electrical potential with sodium on the outside of the (cell) membrane and potassium on the inside. This is crucial for the survival of all cells.

Salt is excreted totally passively by the glomeruli when the blood is filtrated in the kidneys. The excretion capacity is practically unlimited with 1 000 grams to 2 000 grams of salt per day.

The major problem for the body and the kidneys is to reabsorb enough sodium (usually more than 99 % but less than 100 % of excreted sodium in glomeruli) from the primary urine to stabilize and maintain the normal level of sodium in blood and extracellular fluid at the precise level of 137-145 mmol/L.

We are therefore unable to manipulate the blood pressure by manipulating the amount of sodium in the food. All excess of sodium intake is immediately excreted in the renal glomeruli and not reabsorbed in the renal tubuli. Any deficiency in sodium intake versus sodium excretion is almost immediately life threatening. It is totally safe to let us be guided by our gustatory system when we add salt and water to our food. We do have multiple sodium sensors and volume sensors in our body including a central processing unit closely controlling both sodium and water levels in the body.

There is no scientific relationship between salt intake and blood pressure/hypertension. There is no way to manipulate the blood pressure by manipulating the salt intake.

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1 William Ganong Review of medical physiology, Lange Medical Publications, Los Altos, CA, USA, 1971
2 William Ganong Review of medical physiology, Lange Medical Publications, Los Altos, CA, USA, 1971
3 Björn Folkow, Salt och blodtryck – ett hundrårigt stridsäpple, Läkartidningen, 2003, p 3142-7
4 Clinical Chemistry Labs, Landstinget Dalarna, reference value P-Na 137-145 mmol/L
http://www.ltdalarna.se/analysforteckning/ natrium
Introduction

Sodium is an essential nutrient involved in fluid and electrolyte balance and is required at a closely controlled extracellular concentration of 137-145 mmol/L for normal cellular function.

The main function of sodium in the body is to maintain the transmembrane electrical potential with sodium on the outside of the (cell) membrane and potassium on the inside. This is crucial for the survival of all cells.

Sodium is present in foods as a normal constituent at a normal level around 12 to 25 mmol/100 g of food (0.5-1.5 g salt/100 g of food). Sodium is also added to foods, mainly as sodium chloride (commonly known as salt) during processing, cooking and immediately prior to consumption, but also in lesser amounts in other forms, for example as sodium nitrate, sodium phosphate or sodium glutamate. The main reasons for the addition of salt during the processing of foods are for taste, flavour, texture and preservation.

Dietary sources and intake

The main sources of sodium in the diet are foods e.g. diet preparations, sauces, bread, cheese, spreads, meat and fish products. The contribution of sodium from added salt in cooking and at the table varies but in average it constitutes approximately 10 to 20% of the total salt intake. Data on the total dietary intake of sodium in Nordic populations are scarce. According to national clinical chemistry laboratories the availability of salt in the Nordic countries is estimated to be 10-25 g per capita and day.

Estimations of the sodium intake from national dietary surveys among adults generally show lower values. This means that survey estimations are generally underestimating the salt intake.

Physiology and metabolism

Sodium is an essential nutrient involved in fluid and electrolyte balance and is required at a closely controlled extracellular concentration of 137-145 mmol/L for normal cellular function.

The main function of sodium in the body is to maintain the transmembrane electrical potential with sodium on the outside of the (cell) membranes and potassium on the inside. This is crucial for the survival of all cells.

Mean daily sodium intakes of populations in Sweden range from about 150 to more than 300 mmol (4-10 g sodium or about 9-25 g salt) and are in an appropriate excess of dietary minimum needs (about 3 g sodium/day in adults). The main source of sodium in the diet is

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5 William Ganong Review of medical physiology, Lange Medical Publications, Los Altos, CA, USA, 1971
6 William Ganong Review of medical physiology, Lange Medical Publications, Los Altos, CA, USA, 1971
8 Fineli database, search for “Mest och minst” Natrium/sodium sorted in falling amount of sodium per portion http://www.fineli.fi/topfoods.php?lang=sv
9 Most Clinical Chemistry Labs in Sweden have the same normal values as Landstinget Dalarna, reference value dU-Na 150-300 mmol/d http://www.ltdalarna.se/analysforteckning/ natrium
10 William Ganong Review of medical physiology, Lange Medical Publications, Los Altos, CA, USA, 1971
12 Most Clinical Chemistry Labs in Sweden have the same normal values as Landstinget Dalarna, reference value dU-Na 150-300 mmol/d http://www.ltdalarna.se/analysforteckning/ natrium
from all kinds of foods (about 70-75% of the total intake), with about 10-15% from naturally occurring sodium in unprocessed foods and about 10-15% from discretionary sodium added during cooking and at the table.\textsuperscript{13}

The body has to maintain a very accurate level of extracellular sodium with a very stable concentration of 141 mmol/L ±4 mmol/L which is equal to almost 9 grams of salt per liter serum or 3.6 grams of sodium per liter serum. So the total amount in a 70 kg person’s blood is about 10 grams or 430 mmols of sodium or 25 grams of salt.

The same concentration of 141 mmol/L must be upheld extracellularly as well. This means that the total amount of extracellular sodium is approximately 150 grams of salt or 60 grams or 2.5 mols of sodium.\textsuperscript{14}

Sodium is passively excreted in the glomeruli of the kidneys. As the total blood volume of 5.6 liters passes the kidneys several times per 24 hours the blood is filtrating out 1 000 to 2 000 grams of salt (400 to 800 grams or 17-34 moles of sodium). Recalculated to milligrams per minute it will be 700 to 1 400 milligrams salt per minute which is equal to 280 mg sodium to 560 mg sodium (12-25 millimoles) each and every minute of the day.\textsuperscript{15}

So there is never a problem for the body of getting rid of any excess salt as long as you drink enough water.

The body’s major problem is to reabsorb up to 99.5% of the salt excreted in the glomeruli. This is possible by active transport of sodium back from the tubuli into the kidney’s capillary vessels.

To be able to actively reabsorb sodium from primary urine the renal tubuli need the blood pressure rising hormones renin, aldosteron and angiotensin from the pituary gland. Then the tubuli, by active transport, reabsorb 990-1990 grams of salt or 390 to 800 grams of sodium or 17 moles to 34 moles of sodium via the urine per day thus excreting only the fractional of more than 3 grams (more than 130 mmol) of sodium per day.

The very small, compared to the great amount of filtrated sodium, excretion of 10-25 grams of salt has to be replaced each and every day as we do not have any infinitive sources of salt in the body like a salt mine or a nuclear plant converting other atoms to sodium atoms.

**Requirement**

The conclusion of the normal physiology of the kidney is that an adult human of 70 kg has to eat at least seven and a half grams of salt per day to reassure that the body always has enough salt or sodium in the blood and then the rest of the body. Man can also eat at least 100 grams


\textsuperscript{14} William Ganong Review of medical physiology, Lange Medical Publications, Los Altos, CA, USA, 1971

of salt per day without any problems as long as you can drink enough pure water and you obey your thirst.  

Acute deficiency can develop in connection with heavy sweating in combination with large fluid intakes devoid of sodium, or in connection with prolonged vomiting and diarrhoea without salt supply. Clinical symptoms include muscle seizures, loss of appetite and circulation disturbances. Severe deficiency can result in coma and death.

Salt and blood pressure

From a public health perspective the role of sodium as dietary salt in the regulation of blood pressure has received most interest. The relationship between salt and blood pressure has been discussed for more than 100 years and there are no physiological, biochemical and endocrinological evidence that the blood pressure can be manipulated by manipulating the sodium intake except that severe deficiency can result in coma and death.

All manipulative experiments on humans follow the same protocol like the DASH trial: One arm with an extremely low sodium intake like 3 g salt, one arm with a low intake of 6-9 g salt and then the blood pressure is compared between the arms. Usually, the extremely low arm has 1-4 mm Hg lower blood pressure due to lower extracellular volume including lower blood volume due to the body’s hemostasis trying to keep up the concentration of sodium between 137-145 mmol/L.

The problem with these studies is that the third arm with 20-30 g salt is always missing. That third arm would show no difference between the low salt arm and the high salt arm and thus disproving the beautiful hypothesis which is in opposition to the old fashioned physiology knowledge from the previous centuries.

Other dietary factors and blood pressure

A number of dietary factors and physical activity have been associated with but not the cause of blood pressure. These include e.g. alcohol, potassium, calcium, magnesium, and fatty acid composition (see respective chapter). But NNR5 have not included carbohydrates as blood pressure increasing agent.

Salt and morbidity and mortality

There are only few studies that have investigated the relationship between sodium intake and morbidity and mortality.

National Health and Nutrition Examination Survey, NHANES I, is a project Center of Disease Control and Prevention in USA that started already in 1971.

In 1997 Dr Helen Whalley wrote in Lancet that the analysis of NHANES I showed that the rate of CVD increased with 20 % in those on a low salt diet than those on a regular salt diet.

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17 Karin Olsson, Bertil Öhlin, Läkartidningen nr 17–18, 2012, p 888-92
18 Karin Olsson, Bertil Öhlin, Läkartidningen nr 17–18, 2012, p 888-92
21 Whalley H. Salt and Hypertension: consensus or controversy? Lancet 1997; 350: 1686

Salt publ comm 2012-11-25
In May 2006 Dr Hillel W Cohen showed that data from NHANES II and 2008 in NHANES III that eating less than 5 g salt per day increased the risk for heart disease with more than 50 %.

The results are in opposition to most authorities recommendation about maximum 5 g salt per day. Dr Cohen said “We are of the opinion that these results are not supportive of the present recommendations. We urge those issuing the guidelines to go back to their original data and check with more results before issuing general recommendations. And it’s totally obvious that the results do not support current recommendations.”

Recommended intake

There is no scientific or physiological support of a restriction of the salt intake. There is no scientific or physiological support for a relationship between salt intake and blood pressure.

Sodium is essential and we have to ingest the same amount of sodium that we lose every day to avoid disease and premature death. Any ingested excess of sodium is immediately excreted without changing neither the blood concentration of sodium nor the blood pressure.

There is very old knowledge about salt deficiency and premature death, it is, among many synonyms, called the fire engineers disease after the demise of steam engine engineers shovelling coal in the hot environment of a steam engine furnace. It is also well known that a heat stroke, circulation collapse, sodium deficiency, water intoxication, Syndrome of Inappropriate ADH excretion (SIADH) and Syndrome of Inappropriate Salt and Water Intake (SISWI) is due to excess excretion of salt or too small a salt intake or too much water intake.

It is well known in France 2003 that there were several elderly persons that died prematurely during a heat wave despite getting enough water. But they did not get enough salt so they died from sodium deficiency. Now the French authorities have changed the instructions, staff should give enough salt together with water to the elderly for them to survive.

In Sweden presently 30 % of all medicine patients at Skånes Universitetssjukhus (SUS) are hospitalized due to sodium deficiency and 19 % of these patients have a premature death in the hospital. This means that 6 % of all medicine patients in Sweden suffer a premature death due to hyponatermia. That article in Läkartidningen is indicating a higher risk of premature intrahospital salt deficiency death in Sweden for approximately 60 patients per day.

Also, EFSA issued a report in 2005 where EFSA concluded on page 18:

“Conclusions and recommendations

Derivation of a tolerable upper intake level (UL)

The available data are not sufficient to establish an upper level for sodium from dietary sources.”


Björn Hammarskjöld, SLV’s saltråd enligt SLV. http://kostkunskap.blogg.se/2012/june/slvs-saltrad-enligt-slv.html

Karin Olsson, Bertil Öhlin, Läkartidningen nr 17–18, 2012, p 888-92

**Adults**

Based on a pragmatic evaluation of the available data, a sodium intake of minimum 130 mmol (3 g) per day (7.5 g salt) would be prudent at the population level.

The current average sodium intake in the Nordic countries can be estimated at 4-10 grams (170-425 mmol per day, 10-25 g salt).

The proposed population targets would therefore conform to the actual intake of salt on a population level and even include the necessity of an increased intake of salt in risk prone individuals as elderly and sick individuals.

**Children**

Small children are very able to regulate the salt intake as long as they have enough water intake. Breast milk is the perfect example with relatively low macronutrient concentration in a diluted solution with 70 mmol/L sodium, corresponding to about 50 g salt to an adult of 70 kg weight, during the first day of life. Within 14 days the amount has decreased to 10 mmol/L corresponding to 8 g salt per day to a 70 kg person.

Based on a pragmatic evaluation of the available data, recommended sodium intake for children up to about 12 years of age is minimum 8 mmol/kg (20 mg per kg, salt 50 mg per kg) per day is prudent at the population level.

The recommended sodium intake for children from about 13 years of age is set to 1 g per 1000 kJ, which is based on the energy-adjusted recommended levels for adult women.

**Pregnancy and lactation**

Pregnancy as well as lactation are associated with an increase in the physiological requirements for sodium, i.e. daily requirement during pregnancy will be increased to more than 10 g or 450 mmol sodium per day or more than 25 g salt per day to minimize the risk of pre-eclampsia and increased to more than 10 g or 450 mmol per day or more than 25 g salt per day to minimize the risk of hyponatremia during lactation. These amounts are normal and can apparently be handled by the homeostatic system of the body. There is evidence to suggest that sodium requirements during pregnancy and lactation are increased from that of non-pregnant women.

**Reasoning behind the recommendation**

Sodium is an essential nutrient involved in fluid and electrolyte balance and is required at a closely controlled extracellular concentration of 137-145 mmol/L for normal cellular function.

The main function of sodium in the body is to maintain the transmembrane electrical potential with sodium on the outside of the (cell) membrane and potassium on the inside. This is crucial for the survival of all cells.

There is no dose-response relationship between sodium intake and blood pressure. Any recommendations on the sodium intake thus have to be based on estimate of an optimal physiological intake. Based on a pragmatic evaluation of the available data, a sodium intake of

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27 W.W. Koo, J.M. Gupta; Breast Milk Sodium Arch Dis Child. 1982 July; 57(7): 500–502  
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1627692/?page=2

http://ndt.oxfordjournals.org/content/21/7/1984.full

29 William Ganong Review of medical physiology, Lange Medical Publications, Los Altos, CA, USA, 1971

more than 150 mmol (3.5 g) per day (9 g salt) would be prudent at the population level. Thus, the long term recommendation in NNR 2004 is increased to a prudent value.

Discussion

Mean daily sodium intakes of populations in Sweden range from about 150 to more than 300 mmol (4-10 g sodium or about 9-25 g salt) and are in an appropriate excess of dietary minimum needs (about 3 g sodium/day in adults). The main source of sodium in the diet is from all kinds of foods (about 70-75% of the total intake), with about 10-15% from naturally occurring sodium in unprocessed foods and about 10-15% from discretionary sodium added during cooking and at the table.

There are no major adverse effects of increased sodium intake when ingested in normal tasting food according to EFSA.

A sodium level below 135 mmol/L is usually due to a too low intake of salt (less than combined losses via urine, sweat and faeces) and can give rise to serious health hazards including premature death.

A very serious problem is that the median value of P-Na in Dalecarlia, Sweden, has decreased from 141 to 139 mmol/L during the last three years. This means that on a population basis the sodium intake is too low indicating a higher risk of premature death.

There is no relationship between salt intake and blood pressure. All sodium ingested in excess to basic losses is immediately excreted via the glomeruli filtration. The kidney can excrete between 12 mmol and 25 mmol (280-560 mg sodium or 700-1 400 mg salt) per minute and is equal to 17 000 to 35 000 mmol of sodium per 24 hours or 1 000 000 to 2 000 000 milligrams (equal to 1-2 kg) of salt per day.

Dietary deficiency of sodium is nowadays very common due to the widespread maladvice to eat less salt and to less occurrence of sodium in foods. According to the literature about 30 percent of all patients in a medical ward are hospitalized due to sodium deficiency and 19% of those patients die prematurely in the hospital due to easily cured salt deficiency.

Nutritional requirements and recommendations

Human populations survive on wide extremes of habitual sodium consumption from 10 to 450 mmol/day. The ability to survive at low levels of consumption is dependent upon adaptive mechanisms which reduced losses in sweat, stool and urine. For most populations, the habitual levels of sodium consumption greatly exceed the physiological requirements, and

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31 Clinical Chemistry Labs, Landstinget Dalarna, reference value dU-Na 150-300 mmol/d
http://www.ltdalarna.se/analysforteckning/natrium
34 Karin Olsson, Bertil Öhlin, Läkartidningen nr 17–18, 2012, p 888-92
35 Personal communication Dr Mattias Aldrimer, Falu lasarett, 2012.
36 Karin Olsson, Bertil Öhlin, Läkartidningen nr 17–18, 2012, p 888-92
37 Karin Olsson, Bertil Öhlin, Läkartidningen nr 17–18, 2012, p 888-92
there are few data which determine the minimal levels of sodium consumption required to maintain health in people who have adapted to low levels of sodium consumption over long periods of time. For sodium, the acceptable range of intakes for adults is established by the normal excretion values of sodium in urine in clinical chemical laboratories of Sweden to 150-300 mmol/day and adding the normally small amount of losses via faeces and sweat of usually more than 50 mmol/day.

Children have the same requirements of salt as adults per kg bodyweight. The children’s kidneys do work perfectly from birth as breast milk contains enough of both salt and water for the survival of the newborn child. It is shown that a newborn baby gets extra salt the first fortnight corresponding to 60 grams salt (24 grams or 1 mol of sodium) to a 70 kg adult during the first day. After two weeks the amount of sodium has decreased to corresponding 10 grams of salt per day to an adult.

**Conclusion**

The old fashioned physiology, biochemistry and endocrinology shows that salt is an essential micronutrient in the human body. Normal salt intake in the Swedish population is normally at least nine and more than eighteen grams of salt per day according to daily urine excretion. Manipulation of salt intake outside the normal physiological boundaries between ten and 100 grams of salt intake is shown to increase disease and premature death.

Nordic Nutrition Recommendations regarding salt is that the population should eat an adequate amount of salt, normally at least 3 grams of sodium or 7.5 grams of sodium chloride also called salt.

**Requirement and recommended intake**

**Adults**

Nordic Nutrition Recommendations regarding salt is that adults are advised to eat an adequate amount of salt, normally more than 3 grams of sodium or 7.5 grams of sodium chloride also called salt as long as the food is not too salty to your taste. Also, adults are advised to drink normally 1-3 liters of water accordingly to quench the thirst and facilitate excretion of excess salt.

**Children**

Children are advised to eat the same food with the same saltiness as parents do, as always have been the case.

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40 Aperia, Broberger, Herin, Zetterström Salt content in human breast milk during the three first weeks after delivery. Acta Paediatr Scand; 1979; 68; 441-2

Based on a pragmatic evaluation of the available data, recommended sodium intake for children up to about 12 years of age is minimum 8 mmol/kg (20 mg per kg, salt 50 mg per kg) per day is prudent at the population level.

The recommended sodium intake for children from about 13 years of age is set to 1 g per 1000 kJ, which is based on the energy-adjusted recommended levels for adult women.

Reasoning behind the recommendation

Normal physiology has shown that salt is an essential micronutrient that has to be replenished in excess for the body’s homeostasis. Also, enough pure water is recommended to support the excretion of excess sodium.

Lower intake levels

There are severe dangers of serious disease or even premature death of salt deficiency if the intake is lower than recommended above.

Upper intake levels and toxicity

As has been shown above there is no need to issue an upper intake level from dietary sources as salt is excreted passively and the level of salt in the body is maintained actively by the kidneys and hormones.

There has not been shown any toxicity when sodium is ingested from dietary sources

Mora November 25, 2012

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More References


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[37] Nadezda Koleganova,1 Grzegorz Piecha,1,2,3 Eberhard Ritz,2 Luis Eduardo Becker,2 Annett Müller,1 Monika Weckbach,1 Jens Randel Nyengaard,4 Peter Schirmacher,1 and Marie-Luise Gross-Weissmann1 Both