Salt intake in Germany, health consequences, and resulting recommendations for action

A scientific statement from the German Nutrition Society (DGE)

Daniela Strohm, Heiner Boeing, Eva Leschik-Bonnet, Helmut Heseker, Ulrike Arens-Azevêdo, Angela Bechthold, Leonie Knorpp, Anja Kroke for the German Nutrition Society (DGE)[+]

Summary

This scientific statement from the German Nutrition Society (DGE) summarises evidence-based knowledge regarding the association between salt intake and the prevention of nutrition-related diseases. This knowledge is brought together with recent data on salt intake in Germany as well as with descriptive epidemiological data on cardiovascular diseases. On this basis, the DGE emphasises the necessity of reducing salt intake in the population, in order to reduce the burden of cardiovascular disease. The DGE confirms the current approximate value of up to 6 g salt intake/day and derives a recommendation for action. In order to decrease salt intake in the population, salt must be reduced in processed foods such as bread, meat, sausages and cheese. The DGE urgently recommends that Germany should participate in national and international initiatives to reduce salt intake in the whole population.

Keywords: salt, blood pressure, hypertension, cardiovascular diseases

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Introduction and objective

High salt intake is directly associated with the level of blood pressure and the risk of hypertension and is thus also indirectly associated with the risk of cardiovascular diseases. On the basis of systematically collected scientific results, the World Health Organisation (WHO) has therefore made a clear recommendation that salt intake in the population should be reduced [1]. In many countries, salt intake is considerably higher than 5–6 g/day, the approximate values endorsed by various professional scientific bodies. For this reason, many countries (Europe- and world-wide) have developed a national strategy to reduce salt intake and are trying to achieve gradual reduction in salt intake by behavioural and, particularly, structural prevention. No national strategy to reduce salt intake has yet been developed in Germany.

The aim of the present statement is on the one hand to summarise the results published by the WHO on the association between salt intake and the prevention of nutrition-related diseases [1]. This will be complemented by current systematic reviews and meta-analyses and related to current German health data. On the other hand, the aim is to critically examine the current approximate value for salt intake and finally to derive a recommendation for action.

[+] Complete information about the authors can be found on p. 70.

Age [years]		n	Median [g/day]	25th percentile [g/day]	75th percentile [g/day]
18–29	women	534	7.4	4.9	10.6
	men	507	9.4	6.5	15.1
30–39	women	420	8.2	5.5	11.8
	men	403	10.6	7.1	15.2
40–49	women	681	9.1	5.9	13.0
	men	586	9.6	6.3	13.3
50–59	women	744	9.2	5.5	13.5
	men	630	10.4	6.6	15.0
60–69	women	714	8.6	5.0	12.2
	men	671	10.4	6.7	14.5
70–79	women	529	7.9	5.2	12.8
	men	543	9.8	6.8	14.1
total 18–79	**women**	**3,622**	**8.4**	**5.3**	**12.5**
	men	**3,340**	**10.0**	**6.7**	**14.5**

Tab. 1: **Estimated salt intake in g/day for women and men living in Germany, in accordance with the DEGS1 evaluation** [8]

Salt intake in the population

Salt (table salt, sodium chloride [NaCl]) consists of sodium (Na^+) and chloride (Cl^-) ions[1] and is the main source of sodium and chloride in the diet. Approximately 90% of dietary sodium and chloride are taken as salt [2, 3]. The term „salt" in the present scientific statement refers exclusively to sodium chloride.

Sodium and chloride are the most abundant electrolytes in the extracellular space. Both are essential for the maintenance of the extracellular volume and plasma osmolality [4]. If the intake of sodium chloride (salt) increases, the proportion of extracellular fluid increases due to the water-binding property of sodium. This can then lead to an increase in blood pressure [5].

Salt intake in the population can be determined from 24-h urinary sodium excretion. Despite some points of criticism [6, 7], 24-h urinary sodium excretion is regarded as a suitable parameter to estimate the mean salt intake in the population [8]. Furthermore, salt intake can be determined from dietary surveys, although these are rather imprecise, due to measurement errors, inadequate recording of the actual food intake, inadequate information on the salt content of foods and the uncertain or missing information on subsequently added salt.

Adults

The intake of salt was estimated from the German Health Interview and Examination Survey for Adults (DEGS; first wave DEGS1 2008–2011), using urinary sodium excretion (spot urine), and assuming that renal sodium excretion is equivalent to salt intake (◆ Table 1). The ratio of sodium to creatinine concentration in spot urine was calculated and then multiplied by the amount of creatinine in 24-h urine[2] to determine sodium excretion per day and thus to estimate salt intake per day.

For women aged 18–79 years, the median salt intake was 8.4 g/day (25th [P25] to 75th percentiles [P75]: 5.3–12.5 g/day). With 9.2 g/day (P25–P75: 5.5–13.5 g/day), women aged 50–59 years had the highest median salt intake [8].

For men aged 18–79 years, the median salt intake was 10.0 g/day (P25–P75: 6.7–14.5 g/day). With 10.6 g/day (P25–P75: 7.1–15.2 g/day), men aged 30–39 years had the highest median salt intake [8].

Thus, the median salt intake was above 6 g/day for 70% of women and 80% of men (◆ Table 2). Thirty-nine % (39%) of women and 50% of men had a median salt intake of more than 10 g/day. For 15% of women and 23% of men, the median salt intake was even above 15 g/day [8].

The National Nutrition Survey II (NVS II, 2005–2006) determined the median intake of sodium from dietary surveys [10]. The comparison of the estimated salt intake in DEGS1 – calculated from urinary sodium excretion - with salt intake determined in NVS II reveals as expected – due to the above mentioned problems - considerably higher salt intakes within DEGS1 (by about 3 g/day).

Children

In the EsKiMo study (the nutrition module of the German Health Interview and Examination Survey for Children and Adolescents, KiGGS study), performed in Germany in 2006, the median salt intake was calculated on the basis of dietary records for boys and girls aged 6–11 years.

For girls aged 6–11 years, the median salt intake was 4.8 g/day

[1] 1 g of salt (table salt, sodium chloride [NaCl]) consists of 17 mmol sodium and chloride.

[2] The data on urinary creatinine excretion in 24 h have been taken from the VERA study [9]. In contrast to sodium excretion, creatinine excretion in 24-h urine is relatively constant.

Age [years]		> 6 g/day	> 10 g/day	> 15 g/day
18–29	women	63.0	29.7	10.7
	men	78.5	47.2	25.0
30–39	women	68.7	34.6	13.5
	men	81.9	54.6	26.9
40–49	women	74.1	43.8	19.9
	men	77.7	45.7	17.8
50–59	women	72.2	45.0	16.1
	men	80.8	53.4	25.1
60–69	women	69.1	37.1	14.0
	men	79.2	52.0	23.9
70–79	women	68.6	39.9	15.3
	men	79.5	48.9	22.1
total 18–79	**women**	**69.5**	**38.6**	**15.1**
	men	**79.5**	**50.0**	**23.2**

Tab. 2: **Percentages of DEGS1 participants with an estimated daily salt intake of > 6 g, > 10 g and > 15 g** [8]

(P5–P95: 2.8–8.1 g/day) and for boys of the same age 5.3 g/day (P5–P95: 3.1–8.9 g/day) [11]. There are no data on sodium excretion in 24-h urine from KiGGS, but these were determined in the DONALD Study for approximately 500 children and adolescents aged 4–18 years. The median salt intake for girls aged 4–8 years was then determined to be 3.6 g/day (first quartile [Q1] to third quartile [Q3]: 2.7–4.6 g/day) and for boys of the same age 4.1 g/day (Q1–Q3: 3.0–5.3 g/day). For girls aged 9–13 years, median salt intake was 5.2 g/day (Q1–Q3: 4.2–6.8 g/day) and for boys of the same age 5.7 g/day (Q1–Q3: 4.6–7.4 g/day). For girls aged 14–18 years, median salt intake was 6.2 g/day (Q1–Q3: 4.8–7.9 g/day) and for boys of the same age 8.2 g/day (Q1–Q3: 6.1–10.7 g/day) [12].

Infants and young children

In the Consumption Survey of Food Intake among Infants and Young Children in Germany (VELS, 2001–2002), salt intake for boys and girls aged 6 months to under 5 years was calculated based on dietary sodium intake determined from dietary records.

For girls aged 6 months to under 1 year, median salt intake was 1.1 g/day (P10–P90: 0.5–1.6 g/day) and for boys of the same age 1.4 g/day (P10–P90: 0.7–2.7 g/day). For girls aged 1 to under 4 years, median salt intake was 2.4 g/day (P10–P90: 1.5–3.3 g/day) and for boys of the same age 2.5 g/day (P10–P90: 1.8–4.2 g/day). For girls aged 4 to under 5 years, median salt intake was 3.0 g/day (P10–P90: 2.0–4.3 g/day) and for boys of the same age 3.2 g/day (P10–P90: 2.3–4.5 g/day) [13, 14]. Currently, for this age group, no more recent data as well as no data on sodium excretion in 24-h urine are available.

Salt in foods

Salt intake is mainly affected by salt added to processed foods and by eating dishes prepared outside the house (approx. 75–90%). According to NVS II, processed foods, in particular bread, meat, sausages and cheese, make the largest contribution to salt intake in Germany [15]. Only a small proportion of total salt intake is added to food eaten at home [2, 16, 17]. Even though the estimation of salt intake based on dietary surveys is open to criticism – for the reasons discussed above –, they can be used to determine the relative importance of different groups of food that contribute to salt intake.

Descriptive epidemiology of diseases with respect to salt intake

Nutrition-related diseases that are associated with salt intake are primarily hypertension and cardiovascular diseases. In addition, so-called "suboptimal blood pressure" is of particular importance in evaluating the health consequences of high salt intake.

Data on hypertension

"Hypertension" (high blood pressure) means that the systolic blood pressure is repeatedly found to be ≥ 140 mm of mercury (mm Hg) and/or the diastolic blood pressure ≥ 90 mm Hg. The optimal values are < 120 mm Hg for systolic and < 80 mm Hg for diastolic blood pressures [18, 19].

The German Health Interview and Examination Survey for Adults (DEGS; first wave DEGS1 2008–2011) provided nationwide data on the distribution of blood pressure in 18- to 79-year-olds in Germany [20]. According to this, the mean systolic blood pressure in women from 18–79 years of age was 121 mm Hg, and for men of the same age 127 mm Hg (overall mean: 124 mm Hg). For women from 18–79 years of age,

the mean diastolic blood pressure was 71 mm Hg, and for men of the same age 75 mm Hg (overall mean: 73 mm Hg).
The measured blood pressure values were hypertensive for 12.7% of women and 18.1% of men (systolic blood pressure ≥ 140 mm Hg or diastolic blood pressure ≥ 90 mm Hg). Hypertension was defined as either having hypertensive blood pressure or the intake of antihypertensive medication in known cases of hypertension; this was observed in 29.9% of women and 33.3% of men. In the survey's highest age group (70–79 years), almost 75% of the population had hypertension [20].
DEGS1 shows that about 20 million adults in Germany suffer from hypertension, showing that it is still common in the population [20].

Data on suboptimal blood pressure

DEGS1 also provided data on suboptimal blood pressure – blood pressure values that are not yet hypertensive, but which may no longer be regarded as optimal (systolic ≥ 120 mm Hg; diastolic ≥ 80 mm Hg) [18, 19]. According to this, only 53% of women and 29% of men had optimal blood pressure values [20]. This means that almost half of the women and three quarters of the men had suboptimal blood pressure values and thus an increased cardiovascular risk.
The results of the KiGGS study showed that even considerable numbers of children and adolescents in Germany exhibited increased or suboptimal blood pressure. Children are more often affected with increasing age. Thus, for the age group from 14–17 years, 52.5% of boys and 26.2% of girls exhibited blood pressure values ≥ 120/80 mm Hg, and therefore had values above the optimal defined levels [21].

Data on cardiovascular diseases

In DEGS1, data were collected on the prevalence of myocardial infarction and coronary heart disease (CHD) in the age group from 40–79 years. The lifetime prevalence of coronary heart disease in 40- to 79-year-olds was found to be 9.3% (women 6.4%; men 12.3%). According to DEGS1, the lifetime prevalence of myocardial infarction in 40- to 79-year-olds was 4.7% (women 2.5%; men 7%) [22].
According to the German Federal Statistical Office, a total of 868,356 persons died in 2014. As in 2013 [23] cardiovascular diseases were the most frequent causes of death in 2014 and made up just under 40% of causes of death.

The Global Burden of Disease (GBD) study examined the international burden of disease for the period 1990–2010 and quantified the loss of health by using the Disability Adjusted Life Year (DALY). In Germany in 2010, a total of approximately 23.9 million years of healthy life were lost due to diseases and injuries. The largest group were patients with cardiovascular diseases. For men, ischaemic heart disease was the most important cause of lost years of healthy life. For ischaemic heart diseases, most of the burden of diseases resulted from premature deaths (Years of Life Lost = YLL) [24].

Salt intake and prevention

Hypertension

Sodium intake is positively associated with blood pressure. High sodium or salt intake is associated with high blood pressure and low sodium or salt intake with lower blood pressure. Various meta-analyses of intervention studies show that high sodium intake increases the risk of hypertension [25–28]. Reducing salt intake leads to a greater reduction in blood pressure in hypertensive subjects than in individuals with normal blood pressure [25–27][3]. Moreover, salt sensitive[4] persons react more strongly to salt reduction than non-salt sensitive persons [34–36]. There is also an association with blood pressure for persons with normal blood pressure – including those with suboptimal blood pressure. This association is less marked with diastolic than with systolic blood pressure [25–27]. There is also evidence that chloride may play a role in the regulation of blood pressure which is independent of sodium. However, the underlying mechanisms and pathophysiological effects of chloride are currently unclear [37–39].

Regarding the prevention of hypertension, there are few studies with a defined intake of sodium or salt. Most studies have focussed on reducing or increasing intake (either percentage or absolute values). A systematic review performed by the WHO [27] examined the effects on blood pressure of sodium intake of < 2 g/day in comparison to sodium intake of ≥ 2 g/day. On the basis of two intervention studies [40, 41], with a sodium intake of < 2 g/day, systolic blood pressure was 3.47 mm Hg lower (95 % confidence interval [CI]: 0.76; 6.18) and diastolic blood pressure 1.81 mm Hg (95% CI: 0.54; 3.08) lower than with sodium intake of ≥ 2 g/day.

[3] The results of the WHO systematic reviews [27, 29, 30] have also been published in Aburto et al. [31].
[4] There are differences in how individual blood pressure reacts to changes in salt intake. Individuals or subgroups who react to a change in salt intake with a change in blood pressure are designated as "salt sensitive". In contrast, non-salt sensitive persons do not react or manifest only a slight change in blood pressure [32, 33].

Reducing sodium intake also reduced blood pressure in children and adolescents [30, 42]. A meta-analysis of 50 cohort studies from different countries showed that blood pressure in childhood and adolescence is associated with blood pressure in adulthood [43].

Cardiovascular diseases and cardiovascular mortality

Hypertension is one of the most important risk factors for the occurrence of cardiovascular diseases [44–46]. Thus, the reported increase in hypertension risk from high salt intake is thought to have an indirect effect on the risk of cardiovascular diseases [47]. The risk of cardiovascular diseases is thereby markedly increased even at suboptimal blood pressure values. About half the cases of ischaemic heart disease and two thirds of strokes can be ascribed to suboptimal blood pressure [48].

Meta-analyses of randomised, controlled intervention studies on the long-term effects of reduced intake of sodium or salt [49, 50] have as yet failed to demonstrate significant effects on cardiovascular morbidity and mortality in normotensives and hypertensives. In most studies, applied interventions to reduce salt intake were of low efficacy and only led to slight decreases in the long-term intake of sodium or salt. In the opinion of the authors, this explains the failure to find any significant effect on the burden of cardiovascular disease. Because the differences between the intervention and control groups in long-term median salt intake are probably relatively slight, as well as the direct effect of hypertension on cardiovascular and total mortality, the authors consider [50] that the overall statistical power of the meta-analysis is too low to permit a real assessment of the effect of reducing salt intake on total mortality. Moreover, it must be born in mind that the intervention studies mostly examined subjects with existing cardiovascular diseases or with a protracted period of hypertension and the effects of reducing salt intake may be different from those without prior cardiovascular diseases.

Meta-analyses and systematic reviews of prospective cohort studies show that increased sodium or salt intake is associated with an **increased risk** of stroke [29, 51, 52] and of cardiovascular diseases [51, 53]. However, one of these meta-analyses found no significant association with the risk of cardiovascular diseases [29].
On the other hand, increased sodium intake was associated with increased risk of **mortality** caused by stroke and coronary heart disease [29]. However, this study obtained no significant results on overall mortality. On the basis of three prospective cohort studies, another systematic review [54] came to the conclusion that lower rather than higher sodium intake might be associated with increased mortality risk (mortality from cardiovascular diseases and overall mortality). However, this review only incorporated studies with a low or restricted salt intake of 0.6–5 g/day. As the sodium intake in these three studies was determined with only a single 24-h recall, the authors of the review point out that there is a major risk of bias (systematic error).
A meta-analysis of 23 cohort studies and the follow-up results of two randomised controlled intervention studies concluded that both a low (< 2.7 g/day) and a high (> 5.0 g/day) sodium intake are risk factors for mortality and cardiovascular diseases [55]. This meta-analysis included studies on both healthy and ill subjects. A large international prospective cohort study, the Prospective Urban Rural Epidemiology (PURE) study, was published after the meta-analysis of Graudal et al. [55]. This study investigated the association between sodium excretion and both mortality and cardiovascular diseases [56]. The lowest mortality risk as well as the lowest risk of cardiovascular disease were observed when sodium intake was 3–6 g/day. This corresponds to a salt intake of 8–15 g/day. Both higher and lower sodium intakes were associated with increased risks of mortality and cardiovascular diseases. The PURE study was performed in the general population, e.g. including persons with hypertension, diabetes mellitus and cardiovascular diseases. Several authors have criticised the fact that amongst others salt intake in this study was determined from a single morning urine sample [57–59]. Critics remarked that the optimal lower intake limit remains uncertain and that rapid reduction in sodium intake might be associated with negative effects [59]. Additional interpretation of these results has to be awaited as well as the incorporation of this large prospective cohort study in the available data.

Some authors have worried that reducing salt intake might have unfavourable effects on the CHD risk, e.g. through effects on blood lipids, such as increasing blood concentrations of cholesterol or triglycerides [26, 60]. However, a meta-analysis of eleven randomised controlled studies with duration of at least four weeks failed to confirm unfavourable effects on blood lipid concentrations [29]; these were only observed in studies lasting ≤ 2 weeks [26]. According to He et al. [25], no unfavourable long-term effect is to be expected if salt intake is reduced to 3–6 g/day.

There is also some evidence from prospective cohort studies that serum chloride concentrations may be inversely associated with the risk of mortality and cardiovascular diseases in persons without coro-

nary heart disease at the start of the study [61], as well as in hypertensives [62].

Although an association has been shown between salt intake and blood pressure and accordingly hypertension (see section on "hypertension" above), as well as an association between blood pressure and the risk of cardiovascular diseases (see above), an association between salt intake and cardiovascular diseases appears not unambiguously clear. The results here are disparate or inconsistent. It cannot be stated yet to what extent a *direct* association, rather than an indirect association through blood pressure, as an intermediate factor, can be assumed.

One possible explanation for the disparate effects of salt intake on the prevention of cardiovascular diseases and on cardiovascular mortality might be linked to how the individual studies treat blood pressure as control variable. As blood pressure acts as an intermediate risk factor through which high salt intake modifies the risk of cardiovascular diseases, it is possible that adjustment for the blood pressure values in the studies may lead to an underestimation of the actual effects by overadjustment. Most of the meta-analyses presented in this section include studies with adjustment for blood pressure values. The effect estimates in these studies therefore only reflect the effect of salt intake that is independent of blood pressure. If there is no such effect, these results do not demonstrate that there is no association. It is possible that the association between the risk of cardiovascular diseases and salt intake is only *indirect*. This is also confirmed by the WHO meta-analysis of cohort studies [29], which was the only one of the meta-analyses discussed here in which the statistical evaluation only included study results without adjustment for blood pressure. This meta-analysis found that increased salt intake was associated with increased risk of stroke, stroke-related mortality and CHD-related mortality (see above).

Other diseases

Stomach cancer

In its 2007 report, the World Cancer Research Fund (WCRF) concluded that, on the basis of the available evidence, there is probable evidence that high salt intake is associated with an increased risk of stomach cancer [63]. In accordance with this, the 2009 WCRF Policy Report recommends that salt intake should be restricted [64]. On the basis of several cohort studies, a meta-analysis published after the WCRF report [65], as well as a systematic review [53], concluded that salt intake is associated with the risk of stomach cancer. However, it is worth noting that this association was mainly found in Japanese populations, with a very high salt intake.

Osteoporosis

The results from randomised controlled intervention studies and cohort studies show that reducing salt intake leads to a reduction in calcium excretion. This is why it is thought that low salt intake may reduce the risk of osteoporosis [66–71].

Conclusion on prevention

The associations between salt intake and blood pressure are unambiguous: High salt intake is associated with increased or suboptimal blood pressure and low salt intake with normotensive or optimal blood pressure. Hypertension is a disease with many complications and severe secondary diseases and its therapy is expensive. Particularly as hypertension is highly prevalent (see section "data on hypertension"), salt intake in the population should be reduced, in order to help to prevent hypertension. Furthermore, salt intake should be reduced in the population due to the fact that suboptimal blood pressure values are an important risk factor for cardiovascular diseases and the risk of cardiovascular diseases increases with increasing blood pressure (starting with the systolic value of ≥ 120 mm Hg). There are therefore convincing data that high salt intake has an *indirect* effect on the risk of cardiovascular diseases, which is mediated by the level of blood pressure.
On the other hand, a *direct* association between high salt intake and the risk of cardiovascular diseases is not unambiguously clear. The evidence is disparate or even inconsistent, so that there is currently no unambiguous proof that high salt intake *directly* increases the risk of cardiovascular disease (see the section "Cardiovascular diseases and cardiovascular mortality").
In addition, there is probable evidence for an association between salt intake and the risk of stomach cancer. The prevalence of stomach cancer is currently decreasing in Germany and decreasing salt intake could enhance this trend [72].

International recommendations on salt intake

The WHO recommends (strong recommendation[5]) that salt intake should be reduced, in order to decrease the risks of hypertension and cardiovascular diseases [1]. According to the WHO, the intake for adults should be decreased to 5 g salt/day [1]. In the recently published Dietary Guidelines for Americans, the US Department of Agriculture (USDA) also advocates a reduction in salt intake [73]. According to the USDA, salt intake should not exceed 6 g/day. Nordic

[5] "A strong recommendation is one for which the guideline development group is confident that the desirable effects of adherence outweigh the undesirable effects." [1]

countries also recommend that salt intake should be reduced to 6 g/day [74]. In its European Food and Nutrition Action Plan 2015–2020, WHO plans to reduce the mean salt intake in the population by 30% by 2025 [75].

Approximate value for salt intake

As determined in DEGS1, the median salt intake in Germany is 8–10 g/day (see the section "Salt intake in the population") [8]. For approx. 40% of women and 50% of men, salt intake was more than 10 g/day; for approx. 15% of women and 23% of men, salt intake was even above 15 g/day [8]. Even though a reduction in salt intake has very different effects within the population, the overall population would benefit from this reduction – particularly because of the high prevalence of hypertension in Germany and the importance of suboptimal blood pressure values as a risk factor for cardiovascular diseases. Therefore, the reduction in salt intake should not be exclusively focussed on high risk groups such as hypertensives ("high risk approach"), but salt intake should be reduced in the whole population ("population approach") [76, 77]. According to Rose [76], there is a close relation between the median value of a risk factor, e.g. blood pressure, in the population and the prevalence of a disease. Accordingly, the prevalence of hypertension in a population increases with the median blood pressure in this population. Thus, a reduction in mean blood pressure of only a few mm Hg can clearly reduce the number of hypertensives and the number of patients with secondary diseases. Even a moderate decrease in blood pressure throughout the population can lead to a measurable decrease in cardiovascular morbidity and mortality [78, 79].

In accordance with the WHO recommendation [75] to reduce the mean salt intake in the population by 30%, the approximate value for salt intake for Germany is still given as up to 6 g/day. A similar approximate value has also been endorsed by other professional scientific bodies (see previous section on "International recommendations on salt intake"). According to the approach suggested by WHO [1], the approximate value for children is given as 3–6 g salt/day.
Special attention should be given to reducing salt intake in population groups with very high salt intake. In 39% of women and 50% of men in Germany salt intake is above 10 g/day [8]. Particularly in this population group salt intake should be reduced, because of the health consequences.

Measures to reduce salt intake

The reduction in salt intake should be gradual, in the form of small and imperceptible steps, to permit adaptation to the weaker salt taste [80]. Children should be given no chance to adapt to high salt intake.
Processed foods are the most important source of salt intake (see section on "Salt in foods") [81]. Both in Germany and at European level, the highest salt intake comes from bread, followed by meat and meat products, sausages and cheese [15, 82]. Accordingly, measures to reduce the salt content in these groups of foods should be focused. Reduction of salt in bread could make the greatest contribution towards reducing salt intake throughout the German population. Measures to reduce the level of salt in bread have already been successfully implemented in some other European countries [83].

In the food groups bread, meat and meat products, one approach to reducing salt content is by using salt substitutes. This can greatly reduce the salt content, without modifying consumer acceptance. It may be more difficult to reduce salt levels in cheese, as this can modify taste and texture [82]. Quality and consumer acceptance have also been maintained in various convenience products if the salt content was gradually reduced [84].

In 2008, the European Union (EU) initiated a Salt Reduction Framework [83]. This had the objective of reducing the salt content of foods by 16% within four years, in order to decrease salt intake in accordance with the WHO recommendation. This objective has not yet been attained, although the first success has been reported, e.g. from Great Britain [85]. One of the greatest challenges is the food reformulation in collaboration with the food industry. Reformulation is the most effective approach to reducing salt intake in the population compared with legislative approaches such as taxation of foods high in sodium or mandatory labeling of sodium content [82, 86]. The German Nutrition Society (DGE) urgently recommends that Germany should participate in initiatives to reduce salt intake throughout the population, e.g. the EU Salt Reduction Framework.
Recommendations to reduce salt intake with regard to the consumer include that, in general, foods that are low in salt should be consumed and that herbs and spices should be used in the kitchen for flavouring, rather than salt. If salt is used, iodised and fluoridated salt should be favoured [87]. It should not be forgotten that a reduction in the salt content in foods prepared with iodised salt leads to an undesired reduction in iodine intake. This reduction in iodine intake could be met by increasing the iodine content in iodised salt or by preferably using iodised salt by the food industry as well as at home.

Core conclusions of the statement

- There is clear evidence that high salt intake increases the risk of suboptimal blood pressure values and hypertension.
- Hypertension is a risk factor for cardiovascular diseases. The cardiovascular risk is clearly increased even at suboptimal blood pressure values.
- The approximate value for salt intake is up to 6 g/day. In Germany, this is exceeded by approx. 70% of women and approx. 80% of men. Salt intake even exceeds 10 g/day for 39% of women and 50% of men.
- A reduction in the salt intake throughout the German population could clearly reduce the burden of cardiovascular disease in Germany.
- To reduce salt intake in the population, the salt content must be decreased in the processed foods bread, meat, sausages and cheese. For reasons of food technology, it is most important to reduce salt content in bread.
- The DGE urgently recommends that Germany should participate in national and international initiatives to reduce salt intake in the whole population, particularly by reducing the salt content of processed foods.

In order to reduce the mean salt intake in the German population, it will be necessary to improve the information of the population about the risks of excessive salt intake. This means on the one hand that the salt content should be reduced in foods that are consumed particularly often and in large quantities (structural prevention). On the other hand, the individual consumer should be encouraged to use as little as possible salt when preparing food (behavioural prevention) and to avoid subsequently adding salt if at all possible.

Summary and resulting recommendation for action

The associations between salt intake and blood pressure are unambiguous: High salt intake is associated with increased or suboptimal blood pressure and low salt intake with normotensive or optimal blood pressure. There are therefore convincing data that high salt intake has an *indirect* effect on the risk of cardiovascular diseases, which is mediated by the level of blood pressure. On the other hand, the *direct* association between high salt intake and the risk of cardiovascular disease is ambiguous. The evidence is disparate or even inconsistent.

The DGE emphasises the necessity of reducing salt intake in the population, in order to reduce the mean blood pressure, the occurrence of hypertension (high blood pressure), the prevalence of suboptimal blood pressure values and the associated secondary diseases in the German population. The WHO also advocates a reduction in salt intake in the population; according to the WHO, the adult intake should be reduced to 5 g/day. Like the DGE, other professional scientific bodies endorsed an approximate value of up to 6 g salt/day.

In particular, salt intake should be reduced in the population group with very high salt intake. In 39% of women and 50% of men in Germany, salt intake is above 10 g/day. To reduce salt intake in the population, the processed foods bread, meat, sausages and cheese must contain less salt. For reasons of food technology, it is most important to reduce salt content in bread.

Many countries (Europe- and world-wide) have now developed a national strategy to reduce salt intake and are trying to achieve gradual reduction in salt intake through behavioural and structural prevention measures. In the context of the Salt Reduction Framework, the EU has suggested appropriate measures. No national strategy to reduce salt intake has yet been developed in Germany.
The present DGE statement is based on current scientific knowledge and emphasises the necessity to adopt appropriate measures to reduce high salt intake, as this is accompanied by a considerable burden of disease. Suboptimal blood pressure values, hypertension and cardiovascular diseases essentially contribute to this disease burden. The DGE urgently recommends that Germany should participate in national and international initiatives to reduce salt intake in the whole population, particularly by reducing the salt content of processed foods.

Corresponding Author
Dr. Daniela Strohm
E-Mail: strohm@dge.de

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Dr. Daniela Strohm[1]
Prof. Dr. Heiner Boeing[2]
Dr. Eva Leschik-Bonnet[1]
Prof. Dr. Helmut Heseker[3]
Prof. Ulrike Arens-Azevêdo[4]
Angela Bechthold[1]
Dr. Leonie Knorpp[5]
Prof. Dr. Anja Kroke[5]

[1] Deutsche Gesellschaft für Ernährung e. V. (DGE)
Godesberger Allee 18, 53175 Bonn
[2] Deutsches Institut für Ernährungsforschung (DIfE)
Arthur-Scheunert-Allee 114–116
14558 Nuthetal
[3] Institut für Ernährung, Konsum und Gesundheit
Universität Paderborn
Warburger Str. 100, 33098 Paderborn
[4] Fakultät Life Sciences
Hochschule für Angewandte Wissenschaften Hamburg
Ulmenliet 20, 21033 Hamburg
[5] Hochschule Fulda
Fachbereich Oecotrophologie
Leipziger Str. 123, 36037 Fulda