Cost and health consequences of reducing the population intake of salt


Abstract

Study objective—The aim was to estimate health and economic consequences of interventions aimed at reducing the daily intake of salt (sodium chloride) by 6 g per person in the Norwegian population. Health promotion (information campaigns), development of new industry food recipes, declaration of salt content in food and taxes on salty food/subsidies of products with less salt, were possible interventions.

Design—The study was a simulation model based on present age and sex specific mortality in Norway and estimated impact of blood pressure reductions on the risks of myocardial infarction and stroke as observed in Norwegian follow-up studies. A reduction of 2 mm Hg systolic blood pressure (range 1–4) was assumed through the actual interventions. The cost of the interventions in themselves, welfare losses from taxation of salty food/subsidising of food products with little salt, cost of avoided myocardial infarction and stroke treatment, cost of avoided antihypertensive treatment, hospital costs in additional life years and productivity gains from reduced morbidity and mortality were included.

Results—The estimated increase in life expectancy was 1.8 months in men and 1.4 in women. The net discounted (5%) cost of the interventions was minus $118 millions (that is, cost saving) in the base case. Sensitivity analyses indicate that the interventions would be cost saving unless the systolic blood pressure reduction were less than 2 mm Hg, productivity gains were disregarded or the welfare losses from price interventions were high.

Conclusion—Population interventions to reduce the intake of salt are likely to improve the population’s health and save costs to society.

Methods

The model

We developed a dynamic simulation model with alive and dead as the two principal health states. The population, aged 40 and older, was exposed to age and sex specific yearly risks of myocardial infarction (MI) and cerebral stroke, both fatal and non-fatal, and mortality.
from all other causes. New generations enter the model as they reach the age of 40. The baseline population was the Norwegian population as of 1 January 1995. We assumed interventions over 25 years and that the effects appear gradually over five years from the onset of intervention. Potential life years saved after 25 years of interventions were estimated applying pre-intervention mortality rates.

An overview of the model parameters with baseline and alternative assumptions is shown in table 1.

**HEALTH PARAMETERS**

Reductions of MI and stroke mortality were modelled as a function of systolic blood pressure (see below) while mortality from other causes was kept constant at current levels.

The risk of fatal MI and stroke was taken from mortality statistics. We assumed, according to the Finnmark Study, that two non-fatal cases of MI occurred for each fatal case, and according to the Innherred Study three non-fatal cases of stroke occurring for each fatal one.

In the base case we assumed full reversibility of the risk as calculated from the blood pressure-mortality associations in the Bergen Study. The regression coefficients were adjusted upwards by a factor of 1.4 in women and 1.5 in men to take account of regression dilution bias.

**ECONOMIC PARAMETERS**

All costs were measured in 1997 Kr (S1=Kr7). The cost of information campaigns and development of new industry food products with less salt ($2.9 millions per year through seven years, later $1.4 millions per year) were based on expert opinions. The welfare losses ($14 million/y) from taxes on salty food/subsidies on food products with little salt, were estimated on the basis of the annual weight of purchased salty food, the cost per kilo of such food and on the price elasticity of supply and demand of such products.

The annual cost of antihypertensive drugs is about $86 millions in Norway for 250 000 patients. Additionally, about $43 millions are spent on physician consultations. Cost reductions from less antihypertensive treatment were estimated assuming that costs decrease proportional to the number of patients. Expected reductions in the number of patients on treatment were estimated from a logistic model for the associations between the odds of being treated and blood pressure in the Tromsø Study.

Cost savings from avoided events were based on the predicted number of events and their unit costs. Hospital costs were based on DRG data (table 1). We used an average of $7143 per avoided case of MI which is in line with a Swedish cost study and for stroke an average of $10 714 per avoided case of stroke.

### Table 1: Parameters of the Markov model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Base case assumptions</th>
<th>Alternative assumptions</th>
<th>Source</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Health parameters</strong></td>
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<td></td>
</tr>
<tr>
<td>Mortality from MI and from stroke (current rates)</td>
<td>Age/sex specific rates Norway 1994</td>
<td>Low: 25% lower</td>
<td>Statistics Norway</td>
<td>10</td>
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<tr>
<td></td>
<td>High: 25% higher</td>
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<tr>
<td>Ratio of non-fatal to fatal MIs</td>
<td>Low: 1:1</td>
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<tr>
<td></td>
<td>High: 3:1</td>
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<tr>
<td>Ratio of non-fatal to fatal strokes</td>
<td>Low: 2:1</td>
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<tr>
<td></td>
<td>High: 4:1</td>
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<tr>
<td>Reversibility of the risk of MIs</td>
<td>100%</td>
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<tr>
<td>Reversibility of the risk of cerebral strokes</td>
<td>100%</td>
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<tr>
<td>Reduction in systolic blood pressure</td>
<td>2 mm Hg</td>
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<tr>
<td></td>
<td>Low: 1 mm Hg</td>
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<td></td>
<td>High: 4 mm Hg</td>
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<tr>
<td><strong>Economic parameters</strong></td>
<td></td>
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<tr>
<td>Cost of information campaigns and development of new products with less salt (new recipes)</td>
<td>$2.9 mill/year</td>
<td>Low: $1.4 mill</td>
<td>Expert judgement</td>
<td>12</td>
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<tr>
<td></td>
<td>High: $5.7 mill</td>
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<tr>
<td>Welfare losses from taxation/subsidising</td>
<td>$14 mill/year</td>
<td>Low: $0 mill/year</td>
<td>Expert judgement</td>
<td>12</td>
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<td></td>
<td>Middle: $25 mill/year</td>
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<tr>
<td></td>
<td>High: $143 mill/year</td>
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<tr>
<td>Cost savings from reduced antihypertensive treatment</td>
<td>$6 mill per 2 mm Hg reduction in systolic blood pressure</td>
<td>Low: 0</td>
<td>Tromsø Study</td>
<td>10, 19</td>
</tr>
<tr>
<td></td>
<td>High: $9 mill per 2 mm reduction in systolic blood pressure</td>
<td>$7 143</td>
<td>DRG price list</td>
<td>20</td>
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<tr>
<td></td>
<td>High: $10 714</td>
<td></td>
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<tr>
<td>Cost of in hospital care for MI</td>
<td>$14 286</td>
<td>Low: $7 143</td>
<td>DRG price list and public accounts</td>
<td>20</td>
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<tr>
<td></td>
<td>High: $21 429</td>
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<td></td>
<td>High: $4 643</td>
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<tr>
<td>Cost of care for fatal stroke</td>
<td>$7 857</td>
<td>Low: $11 071</td>
<td>National DRG statistics</td>
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<tr>
<td></td>
<td>High: 50%</td>
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<td></td>
<td>High: 200%</td>
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<tr>
<td>Cost of in hospital care during extended life</td>
<td>Age/sex specific DRG utilisation rates</td>
<td>Low: 50%</td>
<td>National DRG statistics</td>
<td>20</td>
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<td></td>
<td>High: $10 714</td>
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<tr>
<td>Mean annual income incl. employer tax</td>
<td>$31 429</td>
<td>Low: $25 714</td>
<td>Statistics Norway</td>
<td>23</td>
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<tr>
<td></td>
<td>High: $37 143</td>
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<tr>
<td>Proportion non-retired employer tax</td>
<td>Age/sex specific rates</td>
<td>Low: 10% lower</td>
<td>Statistics Norway</td>
<td>23</td>
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<tr>
<td></td>
<td>High: 10% higher</td>
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<tr>
<td>Elasticity factor</td>
<td>0.8</td>
<td>Low: 1.0</td>
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<tr>
<td></td>
<td>1.0</td>
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<td></td>
<td>0%</td>
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<td>3.5%</td>
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<td></td>
<td>7%</td>
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<tr>
<td>Discount rate</td>
<td>5%</td>
<td>Low: 0.0</td>
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<tr>
<td></td>
<td>High: 1.0</td>
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<td>High: 0%</td>
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<td>High: 3.5%</td>
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<td>High: 10%</td>
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</table>

Source: Ministry of Health and Social Affairs, Oslo, Norway.
of $7857.22 Avoiding strokes also means avoiding lengthy stays in nursing home for some of the patients. One year stay in nursing home may cost in the order of $42 857.22 Lacking information on the proportion of patients admitted to nursing homes and their average length of stay, we assumed that the cost savings from one avoided non-fatal stroke would be $14 286 (no savings in subsequent years).

Cost of hospital care in additional life years was included in the total programme costs (table 2), but we deducted costs of hospitalisation for MI and stroke because they were already accounted for.

Productivity gains from reduced mortality were estimated on the basis of age and sex specific retirement rates and average annual income in Norway including payroll tax. The productivity gains were adjusted downwards by 20% according to the friction costs method (elasticity factor=0.8). Time costs avoided because fewer patients are on antihypertensive treatment were estimated from national hourly income in Norway including payroll tax. The estimated net savings of the programme were $270 millions, or $120 millions when discounted at 5% rate.

### Results

#### REDUCTIONS IN THE RISK OF STROKE AND MI

The overall expected risk reduction was 4.2 per cent for stroke and 3.8 per cent for MI when systolic blood pressure is reduced by 2 mm Hg (table 3).

The reduction in mortality from stroke and MI implies 1–2% reductions in the total mortality rates. This means an increase in life expectancy by 1.8 months and 1.4 months in 40 year old men and women.

#### HEALTH CONSEQUENCES OF 25 YEARS OF BLOOD PRESSURE REDUCTIONS

During the 25 year period, the estimated reductions in fatal events were 7000 for MI and 4500 for stroke (table 4). The estimated number of life years saved was 87 000 over the 25 years and 6000 more people would be alive at the end of the period. The average number of potential life years saved for these survivors is 10 life years after the 25 years programme period, resulting in totally 150 000 life years saved (table 4) or 52 000 when discounted at 5% rate.

### Number of People Receiving Antihypertensive Treatment

In the Tromsø Study 5.9 per cent were receiving antihypertensive treatment (table 5). The percentage receiving treatment increased with increasing blood pressure. From logistic regression models, adjusted for age, sex and body mass index, it was estimated that the number using antihypertensive drugs would be reduced by 4.9% if systolic blood pressure were reduced by 2 mm Hg.

#### Economic Consequences

The estimated net savings of the programme over 25 years were $270 millions, or $120 millions when discounted at 5% (table 6). The net economic consequences over the whole period until all persons are deceased, are cost savings in the order of $240 millions ($120 millions when discounted).
Sensitivity Analysis

Changing one parameter at a time, there were net cost savings unless the blood pressure reduction was only 1 mm Hg, if welfare losses were high, or if productivity gains were disregarded (elasticity factor=0). The results were more sensitive to the size of blood pressure reduction at higher levels of welfare losses (table 7).

### Discussion

The results of this analysis indicate that population reductions in the intake of salt will increase life expectancy and at the same time save costs to individuals and society. However, this conclusion is susceptible to changes in the assumptions upon which it was based.

The effectiveness of population programmes in reducing blood pressure is not fully established. If decisions are to be made now rather than in the future, we consider a 2 mm Hg reduction to be a probable, but possibly conservative, estimate of the programme effectiveness. We can expect a 1 mm Hg reduction to be about half as effective.

The association between blood pressure and MI and stroke is well established. If decisions are to be made now rather than in the future, we consider a 2 mm Hg reduction to be a probable, but possibly conservative, estimate of the programme effectiveness. We can expect a 1 mm Hg reduction to be about half as effective.

The use of taxes and subsidies will induce people to eat less salt than they normally would prefer, and this “quality of life” loss is accounted for by the economic welfare loss. The estimated loss of $14 million per year is however uncertain because detailed data on the consumption of salty food are lacking and because we do not know exactly how much the consumption of salty food is reduced by the market intervention. We based our calculations on the incidence of MI and stroke on mortality data. In our model, the annual number of strokes is currently about 20 000. This is in line with incidence data from Nord-Trøndelag and Sweden. Therefore, our estimation seems to yield valid results. One way sensitivity analyses even showed net cost savings when we chose the lowest alternatives for the ratios between non-fatal and fatal events.

There is evidence that reduced intake of salt will decrease the risk of gastric cancer, but this is not incorporated in the model. The use of taxes and subsidies will induce people to eat less salt than they normally would prefer, and this “quality of life” loss is accounted for by the economic welfare loss. The estimated loss of $14 million per year is however uncertain because detailed data on the consumption of salty food are lacking and because we do not know exactly how much the consumption of salty food is reduced by the market intervention. We may have had a parallel development with regard to declines in saturated fat, which also was said to have impact on quality of life, but the trend in most Western countries is decreased intake of fatty food.
The results of the study indicate that the cost savings from avoided treatment of MI and stroke are $286 millions while the health care costs in additional life years are $222 millions (table 6). This seems contra-intuitive in that longer lives would mean more years to consume health care. However, we only included hospital costs in additional life years. If costs of other types of health care such as primary care and nursing home are included, the total undiscounted health care costs may be higher when people live longer. However, because health care costs of additional life years occur in the future, the present value of health care costs may still be lower with a salt reduction programme.

There has been a dramatic change in the activity concerning the treatment of stroke patients. They are more likely to be taken into hospital and referred to active rehabilitation before and this trend is likely to continue. This may have led to an increase in hospital costs and costs of rehabilitation, but to a decrease in the nursing home costs for stroke patients.

Because the welfare losses from taxation or subsidising might be considerable and because such instruments may be politically difficult, an incremental intervention programme may be advisable. A first step could include information campaigns, declaration of salt content and development of new food products. The cost of these measures is modest, and even if the health effects were modest, this step is likely to be cost saving. A second step would then involve taxation or subsidising with higher costs (that is, welfare losses) but also greater health benefits.

To our knowledge, economic evaluation of reduced intake of salt has not been published. However, population interventions to reduce the intake of fatty foods have been undertaken. A Norwegian study concludes that such interventions are cost saving, while an American one concludes that the cost per life year saved is very small. Reductions in the intake of salt and of fatty food have much in common. Both types of programmes have small costs per person of the population, both have small effects on the mortality rates and both have considerable effects with respect to life years saved at the aggregate level. Therefore, one would expect that the cost effectiveness of the two types of programmes would be quite similar as indicated by our study.

Economic and epidemiological analyses of a public health problem like salt and blood pressure will inevitably be uncertain. The aim of such an analysis is not to present the “truth”. Rather, the aim is to present costs and consequences of a potentially important programme as fair and complete as possible. In conclusion, the aggregate health benefits from population interventions to reduce the intake of salt may be substantial. The cost of the interventions will be modest compared with the cost savings from lower morbidity and mortality. However, if welfare losses from taxation or subsidising, are very large, the interventions will not be cost saving.

**KEY POINTS**

- Salt reductions are likely to reduce blood pressure and the risk of stroke and myocardial infarction.
- Model simulations show great aggregate health benefits from population interventions to reduce the intake of salt.
- The costs of population interventions will probably be off set by cost savings from fewer stroke and heart attacks.

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Conflicts of interest: none.


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