Population Advice on Salt Restriction: The Social Issues

John Swales

The scientific evidence that underlies public health advice depends upon critical integration of information from several sources. The most informative evidence relating to the effects of population reduction in salt intake comes from systematic reviews of clinical trials. Recent rigorous reviews of salt restriction trials in normal subjects show extremely small effects ranging from 1 to 2 mm Hg for systolic blood pressure and 0.1 to 1.0 mm Hg for diastolic pressure. These are the result of much greater reductions in sodium intake than can be achieved by population advice, and may be further amplified by publication bias and effects of changes in other dietary components. There is little trial evidence to enable possible benefits and adverse effects to be balanced.

Reviews biased by the inclusion of nonrandomized studies exaggerate the apparent blood pressure fall 5- to 50-fold and create spurious apparent progressive falls in blood pressure. Nevertheless, citation analysis shows that they are quoted much more frequently than rigorous reviews reaching more negative conclusions. This appears to be the result of an attempt to create an impression of scientific consensus. The salt debate has important implications for social policy.

Key words: Salt, blood pressure, sodium restriction, social policy.

There are two components to the progressive increase in life expectancy in Western societies over the twentieth century. One major contributor has been the revolutionary advance in medical science, which has led to fundamental improvements in the prevention and treatment of illness in individuals. The other factor has been better population health as a result of changes in social conditions, diet, and life-style. McKeown, among others, has pointed out that most of the decline in deaths due to infectious disease in the late nineteenth and twentieth centuries antedated specific drug treatments for bacterial disease. The decline in mortality due to stroke in this century began before antihypertensive drugs were extensively used, although acceleration in the rate of that decline in recent years is probably at least partially attributable to antihypertensive therapy. In some cases, the reverse phenomenon can occur. In Russia, there has been a spectacular shortening of life expectancy in the early 1990s with increased mortality due to cardiovascular disease and stroke. This appears to be due to social and life-style changes: it is unlikely that it is attributable to a decline in health services. The nature and mechanism of such environmental influences on health is much less well understood, and advocates of improvement in social conditions have had to rely on weak evidence about the health impact of such improvements. This should not imply, however, that invalid scientific evidence should be used to advocate public health measures. In recent years, the culture of medicine has attached a
high priority to critical appraisal of scientific evidence used in evaluating specific interventions for treating individuals. Much less attention has been directed at the nature of evidence required for population measures directed at improving health.

Interest in population advice that could lower blood pressure has attracted increasing attention in recent years for several reasons. The greatest burden of morbidity and mortality attributable to blood pressure lies in those with pressures close to the population mean, in whom antihypertensive medication would not normally be considered. As a consequence, a population strategy that produces a small downward shift in the population blood pressure curve could theoretically have a larger impact on morbidity and mortality than treatment of conventionally defined “hypertensive patients” with drugs. If effective, such a strategy would have the advantage of reducing an individual’s lifetime blood pressure rather than only initiating treatment when blood pressure crossed an arbitrary threshold. It would be consistent with the widely held popular belief that dietary prevention of disease is preferable to drug treatment, particularly when there is a possibility that the diet being advocated represents a return to some form of “natural” diet enjoyed by free-living ancestors. Health care providers are also likely to be enthusiastic about population measures that could reduce the costs of drug treatment.

There are, however, some important obstacles that have to be overcome before any population strategy based on dietary change can be advocated.

1. The evidence has to be persuasive. It is logistically exceedingly difficult to design “gold-standard” randomized, controlled trials used to evaluate individual interventions to assess the efficacy of population measures. Evidence has to be extrapolated from epidemiological associations, pathophysiology, and trials carried out under different conditions on more selected individuals. There are, nevertheless, some common sense principles. An intervention that is not efficacious under controlled conditions in adequately powered studies is unlikely to be effective when used in larger, less selected populations under less intense supervision.

2. Although the importance of small population changes in blood pressure is a valid statistical conclusion from epidemiological evidence, extremely small possible beneficial changes in individual risk have to be balanced against possibly equally small harmful changes induced by the maneuver. There may be little in the way of epidemiological evidence to help in this context. To claim that trial evidence shows that such risks are small and can therefore be discounted is logically inconsistent and implies double standards.

3. Even where efficacy is proven, achieving effectiveness through population measures may be extremely difficult unless considerable local enthusiasm and commitment is achieved. This is clear from other fields of dietary advice. Convincing evidence from intervention trials has demonstrated that weight reduction produces a reduction in blood pressure. In England, the “Health of the Nation” strategy set up health targets in 1992. One of these was “to reduce the percentage of men and women who are obese by at least 25% for men and at least 33% for women by 2005.” Despite considerable public investment, by the time the program was discontinued in 1998, the trend in obesity had been in the opposite direction. Although a substantial reduction in salt intake has been achieved in a rural community in Portugal with an extremely high salt intake as a result of an intensive public campaign and active supervision, community-based interventions have produced only very small effects on sodium intake and no effect on population blood pressure in five other studies. This has led to the view that substantial reductions in salt intake can only be achieved by reducing the salt content of manufactured foods. This effectively removes the decision from the level of individual choice to that of government policy.

4. The reduction in drug costs to health care providers carries an additional price for the individual. The cost of dietary change may well exceed the cost of pharmacological treatment. The social impact of dietary advice on the cost of food to the individual and to society cannot be ignored.

5. Where the evidence is uncertain or controversial, the consequences of a later change in policy may be serious. Advocacy of increased consumption of milk and dairy foods after the War was followed by recognition of adverse effects upon cardiovascular risk. In Western populations, which often have a skeptical approach to government health advice, changes in direction can make later interventions even more difficult as credibility is reduced to vanishing point.

Any decision to recommend reduction in salt intake should reflect analysis of all the scientific evidence available, giving appropriate weighting to the most directly relevant. Such a decision also, however, requires a judgment of value in assessing putative benefits, risks, and costs. The final conclusion is not the sole prerogative of public health specialists, epidemiologists, or clinicians: extremely important social issues are involved. However, if a public discussion is necessary, those responsible for providing expert scientific opinion bear a responsibility to ensure that evidence is presented objectively. I wish to examine how far this has been achieved in practice.
SYSTEMATIC REVIEWS OF SALT RESTRICTION AND BLOOD PRESSURE

Traditionally, evidence in favor of medical interventions comes from several sources: clinical observation, pathophysiological reasoning, epidemiological association, and systematic review of interventional trials. Of these, there is now widespread acceptance that the strongest evidence comes from “at least one systematic review of multiple well-designed randomized controlled trials.” The first source of evidence, clinical experience, is unhelpful in this particular context, as the blood pressure changes under debate are small. Physiological arguments can be used on either side of the debate. Although sodium retention undoubtedly causes blood pressure elevation, there is no evidence for this in essential hypertension, where plasma volume, for instance, is contracted in relation to the degree of blood pressure elevation. Epidemiological association studies have yielded conflicting results. Although these mostly have failed to show higher blood pressures in subjects with higher salt intakes, it has been argued that this may reflect the difficulty in obtaining representative measures of usual salt intake. By contrast, recent evidence from systematic reviews of salt restriction in normotensive subjects is remarkably consistent.

Six systematic reviews have been published since 1991 (Table 1: 16 to 21). One of these, however, was an updated version of a review first published in 1991. With the exception of one review published in 1991, all used randomization as a criterion for entry. These four reviews all report falls in pooled systolic blood pressure of between 1 and 2 mm Hg and falls in diastolic blood pressure between 0.1 and 1.1 mm Hg. The falls in systolic blood pressure were statistically significant in each case. The falls in diastolic blood pressure were not significant in three of the four reviews.

What is the relevance of these reports to public health advice? It seems probable that the reported very small effect sizes are overestimates of the blood pressure lowering that would be expected as a result of a population strategy. The reduction in sodium intake of 76 to 160 mmol/day is well above what could be achieved as a result of population advice. Long-term trials using more intensive dietary supervision have achieved a reduction of approximately 40 mmol/day at the most. It is also possible that confounding by other dietary changes was observed, where a double blind protocol was not used. A diet high in fruit and vegetables, for instance, produces substantial blood pressure lowering independently of any change in sodium intake. Consistent with this hypothesis, regression analysis of the relationship between reduction in sodium intake and change in blood pressure in one systematic review showed falls in blood pressure even when sodium intake was unchanged.

It is also likely that a tendency to publish positive rather than negative findings resulted in publication bias. Without access to unpublished studies, the extent of this phenomenon, which is almost universally seen, is difficult to assess. However, on the assumption that large studies are more likely to be published than smaller trials, it is possible to relate the effect size to the study size, using a “funnel” plot. When this was done, smaller trials reported significantly greater effects than larger trials. One review failed to find a significant relationship between effect size and change in blood pressure, whereas dietary advice on

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<th>Reduction in BP (mm Hg)</th>
<th>Reduction in Na (mmol/day)</th>
<th>Number of Trials</th>
<th>Randomized Only?</th>
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<tbody>
<tr>
<td>Law et al.</td>
<td>10/5</td>
<td>100</td>
<td>23</td>
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<tr>
<td>Cutler et al.</td>
<td>1.7/0.97</td>
<td>76</td>
<td>6</td>
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<td>Swales</td>
<td>1.48/0.94</td>
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<td>9</td>
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<td>Midgley et al.</td>
<td>1.0/0.1</td>
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<td>28</td>
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<tr>
<td>Cutler et al.</td>
<td>1.9/1.1</td>
<td>76</td>
<td>12</td>
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<tr>
<td>Graudal et al.</td>
<td>1.2/0.26</td>
<td>160</td>
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weight reduction and alcohol restriction continued to have a significant blood pressure lowering effect.\textsuperscript{25} When weight is reduced by diet, the effect is not only much greater than the effect size reported in these reviews, but achieved simultaneously with the reduction in weight.\textsuperscript{26} Although the longest trial included in these reviews was 3 years and most were of \textlt 2 months duration, the relationship between duration and effect was a negative one, ie, longer duration was associated with smaller effects.\textsuperscript{19,20} This may reflect the difficulty in sustaining salt restriction over long periods.

Intervention trials are insensitive to possible adverse effects of salt restriction because of inadequate power. At best, surrogate markers of risk have to be used. Significant elevation of renin, aldosterone, and LDL cholesterol occur, without a compensatory rise in HDL cholesterol.\textsuperscript{21} It is uncertain how far these metabolic changes, each of which has a theoretical adverse effect on risk profile, would occur with lesser degrees of salt restriction achieved by population advice. These concerns can only be set at rest by large scale, controlled studies. In the meantime, it would seem irrational to dismiss them on the grounds that they pose a theoretical risk, while accepting the beneficial effects of putative long-term blood pressure reductions on equally theoretical grounds.

The authors of three of the four systematic reviews concluded that the evidence does not support population advice to reduce dietary salt\textsuperscript{18,19,21}; the authors of the other review concluded that it has “great potential.”\textsuperscript{20}

**NONRANDOMIZED STUDIES**

The earliest of the systematic reviews discussed here is in many ways the most informative.\textsuperscript{18} Law et al analyzed 78 trials of salt restriction in hypertensive and normotensive subjects dating back to 1947. Only 10 of these were randomized in design. The authors state that “to exclude bias” only crossover trials were included in the nonrandomized group, ie, trials in which a groups of subjects were “crossed over” from one to another dietary regimen in nonrandomized sequence. Stability of baseline blood pressures was not an inclusion criterion, so that placebo falls in blood pressure could not be excluded. The authors conclude that a reduction of 100 mmol in daily sodium intake would produce a fall in blood pressure of 10/5 mm Hg and reduction in population salt intake would prevent 70,000 deaths/year in Britain. This reduction is therefore 5-6-fold higher for systolic blood pressure and 5-50-fold higher for diastolic pressure reduction than that reported by the other reviews. Furthermore, in striking contrast to the other views, the authors concluded that there is a progressive fall in blood pressure that only reaches a maximum after 4 wk. Separate analysis of the randomized trials in normotensive subjects included in the review by Law et al shows effects of similar order to those recorded in the later systematic reviews and no evidence for progression with time.\textsuperscript{27} The discrepancy between this meta-analysis and the others is therefore attributable to the predominance of nonrandomized studies. It is perhaps surprising, therefore, in view of the universal refusal of drug licensing authorities to accept such evidence of efficacy, bodies such as JNC V cited this work, with the implication that it has authoritative status: “In trials involving people aged 50–59 years and lasting 5 weeks or longer, a 50 mmol/d reduction in sodium intake was associated with an average of a 7 mm Hg reduction in systolic blood pressure in hypertensive persons and a 5 mm Hg reduction in normotensive people.”\textsuperscript{28} It seems probable that a meta-analysis has been cited without consideration of its component clinical trials.

**IMPLICATIONS FOR SOCIAL POLICY**

The debate over the benefits and value of population advice to reduce salt intake has been a long-standing one. The uncertainty of the evidence reviewed here suggests that it will continue until better studies are available. At present, the status of the evidence is far removed from that which informs advice, for example, on smoking, alcohol, or obesity. In view of the mixed results of governmental action in these areas, it would seem ill advised to risk loss of credibility by advocating dietary change where the evidence is so weak. Others may feel that the putative, very small effects on systolic blood pressure balance the equally putative metabolic risks of salt restriction. This is a legitimate field for scientific debate.

Unfortunately, the perceived need to conduct a public campaign has its own well defined imperatives. A simple message has to be repeated, with no suggestion of expert disagreement. This accounts for the surprising claim that there is a scientific consensus in favor of population reduction in dietary salt.\textsuperscript{11,29} At first sight, this would seem unsustainable in the light of the majority of recent systematic reviews which, in the view of their authors, provide no support for population advice to reduce salt intake. The strategy that has led to the controversy that Taubes has recorded has two components. One is the repeated noncritical citation of positive evidence, and the second is the attribution of improper motives to the perceived scientific opposition. Taubes has described selective citation of positive studies as one part of a strategy to create an appearance of consensus where, manifestly, there is no consensus.\textsuperscript{29} This applies equally to citation of systematic reviews. Citation analysis shows that, despite its demonstrable bias from inclusion of nonran-
domized studies, and despite the existence of more rigorous and up-to-date reviews, the meta-analysis by Law et al continues to be cited more frequently than any other (Table 2). The most likely explanation is that, despite its manifest flaws, its conclusions are more congenial than those reached by the more recent unsupportive meta-analyses. An additional component of this strategy is less creditable. Where expert scientific opinion is seen to be divided, attempts are made to destroy the credibility of scientific skeptics by implying connections with commercial interests. Legal constraints prevent statement of the obvious implication behind such claims, ie, that funding of individuals or their research has induced them to take a specific scientific position that they would not otherwise have taken.

The debate over salt intake may serve a useful purpose if it helps to clarify the processes that lead to appropriate social and public health policies for diet and health.

REFERENCES


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