Behavioral Aspects of Intervention Strategies
to Reduce Dietary Sodium

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This article addresses general and specific aspects of dietary sodium interventions from the perspective of behavioral change. Changing dietary behavior requires relearning a range of habitual behaviors involved in day-to-day eating situations in the context of a diverse and complex food supply and in consideration of numerous factors, other than health concerns, that influence habitual eating patterns. Potential obstacles to dietary sodium reduction relate to the wide distribution of sodium in foods, the strong cultural values for salt, and the difficulty of assessing success in sodium reduction. A review of sodium interventions reported in the literature suggests that state-of-the-art behavioral change strategies can be effective in achieving reductions in sodium intake to around 3,000 mg/day but that this level is achieved only with highly motivated individuals and when a high level of intervention (i.e., intensive and multifaceted) is provided. Thus, in regard to sodium reduction in the general population, either the goal will have to be modest or the food supply will have to change so that substantial decreases in sodium intake can be accomplished with less intensive and less costly interventions. (Hypertension 1991;17[ suppl I]:I-190–I-195)

Attempts to demonstrate the usefulness of dietary sodium reduction in hypertension prevention and control assume that sodium reduction is sufficiently feasible to be worth pursuing as a public health intervention strategy. However, dietary modifications such as sodium reduction are difficult. Caution is warranted in making judgments about the feasibility of long-term sodium reduction on a populationwide basis.

This article addresses general problems encountered in dietary change interventions and highlights issues of special relevance to sodium reduction. Differences in the effectiveness of various programs in achieving long-term changes in sodium intake of free-living individuals can probably be attributed to differences in the amount and type of intervention strategies used.

Dietary Behavior Change

Changing Habits

All dietary interventions must equip individuals to master the complex process of changing established behavior related to food selection and consumption in a variety of situations.1 Purchasing food within certain nutrient content restrictions requires the time, ability, and willingness to make careful choices from a large, diverse, and ever-changing array of food items available in supermarkets.2 A person must be able to read and interpret food labels and to differentiate among brands or forms of processed food items that may be similar in many respects but markedly different in others (e.g., in sodium or fat content). Changes in cooking practices require a new set of decisions about what to include in recipes and about procedures before (e.g., draining, rinsing, and marinating) and during food preparation, including what flavorings to add or avoid. Controlling qualitative aspects of food intake when eating away from home involves decisions about where or what to eat, as well as the social skills needed to find out how food was prepared or to request changes in how food will be prepared or served.

The burden of day-to-day eating decisions in our complex food environment is manageable precisely because many of these decisions are made without thinking. However, the habitual nature of eating poses a major obstacle to long-term dietary change, and strategies to build skills in habit change are now considered essential for state-of-the-art dietary interventions.1–3 Dietary change requires that habitual eating responses be set aside in favor of reasoned actions that ultimately become the basis for new habits. Habits are conditioned responses that are performed in response to certain cues (antecedents) and perpetuated by frequent, positive reinforcements (consequences) as perceived by the individual in question. Changes in habits require altering either
cues (i.e., reasons for eating), consequences (responses to eating), or both, in a direction favoring relinquishment of old patterns and adoption of new ones.

The process of dietary behavioral change is, therefore, more than a matter of simply knowing what needs to be done and having “will power.” Changing diet requires that numerous situational problems posed by familiar eating situations be identified and resolved and that the behavioral “scripts” for responding to these situations be rewritten. To succeed, the individual needs skill in diagnosing problems, considering alternatives, setting goals, and taking relevant actions as well as appropriate motivation and coping resources. For example, the social climate of eating includes family interactions that may have to be renegotiated in order for different foods to be made available in the home. Other factors related to eating motivations and to the potential for dietary behavioral change include knowledge, beliefs, and self-regulatory skills. Relevant material and logistical factors include the ability or resources to afford, acquire, and prepare different foods.

Short-term Versus Long-term Motivations

Health concerns are only one aspect of motivations for eating, and regardless of what health workers would like to believe, they are not usually the most important ones. Knowledge of human behavior strongly suggests that except in life-threatening situations such as extreme hunger or when adverse reactions are anticipated, health-related considerations will be subordinate to sensory, social, emotional, and pragmatic determinants of food consumption. Thus, even when consumers are fully informed about the potential health risks associated with a given dietary behavior, the key determinants of the ability to change the behavior may be the extent to which other, competing motivations for the behavior can be brought into alignment with the desired change. These factors include flavor, familiarity, cultural norms, emotional connotations of food, and pragmatic variables such as perceived cost, ease of acquisition and preparation, and the availability of alternatives. On a day-to-day basis, these other, short-term motivations are more likely than long-range health concerns to define the positive or negative reinforcements associated with an altered eating pattern.

Issues of Dietary Behavioral Change Relevant to Sodium Reduction

Within the general framework that is common to all behavioral interventions, the nature of the challenges encountered and the strategies needed to address these challenges are shaped by factors specific to the food constituents involved, for example, which and how many foods are important dietary sources, the functional and social roles of these foods in the dietary pattern in question, and the ease or difficulty of keeping track of how much is consumed.

The food and eating decisions encountered in lowering dietary sodium are different in many respects from those encountered in increasing dietary fiber or reducing dietary fat, for example. Many of the foods that are major contributors to sodium, fat, and fiber in the US diet are different, and the number of different food items contributing to sodium intake is greater than for fat or fiber. The sensory effects of removing salt from food are qualitatively different from those that result from removing fat or adding fiber. Pietinen et al and Puska et al reported that, in a randomized study comparing success at reducing dietary fat and dietary sodium, sodium reduction was associated with a higher level of perceived difficulty than fat reduction. Some reasons why sodium reduction may pose more difficulty for the average consumer than some other aspects of dietary change are summarized below.

Flavor and Familiarity

Because no true substitute for the salty flavor is likely to be found, some deprivation of accustomed flavors is an inevitable concomitant of sodium reduction. Unlike cuisines that rely heavily on spices such as curry or chili for strong flavor, American cuisine relies primarily on salt to provide or enhance flavor. Even where salt is added to foods for reasons other than flavoring (e.g., for functional purposes), the salty flavor becomes an aspect of the characteristic taste of food at whatever level of salt is added. Experimental studies suggest that the perceived saltiness of a given concentration of salt increases with prolonged sodium restriction and that high concentrations of salt may become somewhat aversive after adaptation to a reduced sodium diet. Such adaptations favor the success of dietary sodium interventions because the sense of being deprived of the salty flavor may decrease with time. However, given the difficulty of avoiding inadvertent consumption of highly salted foods on a sustained basis, even by those who prefer to follow low sodium dietary practices, the environment promotes readaptation to a higher salt preference.

Strategies to counteract negative reactions to the loss of salty flavor include judicious use of small amounts of salt or generous use of other flavors. As discussed elsewhere in these proceedings, a small amount of salt added at the table may greatly improve the palatability of a food cooked without salt, with little overall increase in the amount of sodium consumed. Processed foods containing small amounts of salt may be more acceptable to consumers than foods that are entirely salt free. Herbs and spices, used in sufficient quantities and according to principles that have been well established in other cultures, can also result in very flavorful foods. However, the unfamiliarity of these flavors may limit the sociocultural or emotional value of these foods. In addition to being palatable, alternatives to high salt foods...
foods must be culturally, socially, and emotionally acceptable.

Cultural Values

The sociocultural and emotional values for salt or certain high salt foods may overwhelm even the most well-established health motivations for reducing sodium intake. Salted food may have religious uses (e.g., kosher meats) or be strongly tied to ethnic or regional identity (e.g., certain typical Asian, Caribbean, or Southern or Southern-black foods). Many highly salted foods have well-established social uses and connotations that may be linked to their salty flavor (e.g., potato chips, corn chips, snack crackers, salted peanuts and popcorn, pickles, and other party or buffet foods).

Much has been written about the historical importance of salt in trade, about wars fought over salt, about codification of cultural values for salt in words such as “salutary” and “salary,” or in expressions like “salt of the earth.” This strong cultural value may limit the extent to which sodium is viewed as a hazard worthy of rigid avoidance behaviors compared with potentially carcinogenic food additives or food constituents, such as cholesterol, that do not have any particular cultural connotation.

Convenience, Availability, and Cost

The natural distribution of sodium in foods is superseded by the pattern of its addition to a wide variety of foods for functional purposes (e.g., as a preservative or leavening agent) and its addition as a flavoring agent. Processed versions of naturally low sodium foods such as grains and cereals or fruits and vegetables actually make major contributions to dietary sodium intake. In industrialized societies, in which consumers rely heavily on processed foods, the contribution of consumer-added salt (cooking salt and table salt) is only about 15%. Two behavioral change approaches can be used to work around the problem of sodium in processed foods, although unfortunately, neither is ideal. One strategy is to use fewer processed foods. However, processed foods are convenient, and the preparation of alternatives requires more effort, time, and skill. In addition, since the consumer has no control over the use of processed foods in restaurants, this approach also requires limiting the number of meals eaten out. The other strategy is to use low or reduced sodium versions of processed foods. Such products may be more available now than in the past, but their availability on supermarket shelves is still difficult to predict, and they may be unavailable in smaller food stores or low income neighborhoods. Further, even when sodium-modified products are priced to compete with regular versions, they are not likely to be the best bargain available.

Behavioral Feedback

There are usually no observable biological effects of increases or decreases in sodium intake, because homeostatic mechanisms lead to compensatory changes in sodium excretion in urine and other body fluids. The lack of visible effects of high sodium intake reinforces the idea that it is not harmful on a day-to-day basis. In addition, it is difficult for a person to know whether attempts to reduce sodium intake have been successful. Dietary sodium can be estimated from a food intake diary. However, not only does the food diary method require the patience and skill to accurately list everything eaten, but the use of diaries to monitor sodium intake is also limited by the difficulty of estimating the amounts of sodium added to a wide spectrum of processed and restaurant foods and by the probability that food records kept by “sodium-conscious” individuals underestimate the amounts of sodium actually consumed. Sodium intake can be estimated more objectively from sodium excretion determined by laboratory analysis of one or, preferably, several 24-hour urine collections or from short-cut urinalysis methods such as overnight urine collections or chloride titrator strips, which approximate 24-hour urinary sodium values. The greater difficulty and expense of using urine samples for behavioral feedback can be compared with the relative ease and economy of obtaining body weight as a measure of success at weight loss.

Amount of Sodium Reduction Associated With Different Levels of Intervention

Although potentially effective counseling and intervention techniques addressing various aspects of the dietary change process can be identified, these techniques are not easy to implement and are usually labor and time intensive. Further, even when dietary change interventions are initially successful, it is difficult to prevent relapses to former habit patterns without continuing or repeated interventions. Several studies indicate that interventions of limited intensity are inadequate for achieving meaningful reductions in dietary sodium intake even among hypertensive patients who may be highly motivated by the potential for reducing or avoiding medications. The low level intervention in these studies consisted of a limited number or frequency of patient education sessions. Community-wide programs that provide for minimal or no individual counseling are also associated with limited success. For example, Pietinen et al reported that in the North Karelia Salt Project, a community-based education program using mass media information, verbal and written information for individuals with hypertension, training programs for health workers, and efforts to increase the production of low sodium foods was not associated with decreased sodium excretion in the population over a 3-year period, with the exception of a 7% decrease in 24-hour sodium excretion (from an average of 170 to 158 mmol) among normotensive women. A small but statistically significant increase in sodium excretion among the men surveyed was noted.
At the other extreme, studies in which an intensive, multicomponent intervention was delivered for an extended period of time (generally to individuals preselected for a high adherence potential) report substantial success in lowering sodium intake levels.22,24,27-31 Lang et al27 reported reductions of sodium intake of about 50% at 3 months in a small study of men and women who received detailed instructions in their homes, supplemented by prompt telephone feedback on the sodium content of weekly 24-hour urine collections. The Hypertension Intervention Trial reported a 47% decrease in sodium intake maintained at 1 year,28 as a result of an intervention program that included an extended period of dietary instruction and behavioral counseling, involvement of family members, food-tasting experiences, and periodic feedback on 24-hour urinary sodium excretion (V. Lasser, oral communication, February 1990). Nugent et al29 report a 50% decrease in sodium excretion in patients receiving behavioral counseling that included feedback on 24-hour urinary sodium excretion, compared with a 30% drop among those receiving an intensive counseling program but without the behavioral components and urine feedback. Other intervention studies22,24,30,31 in which intensive and relatively comprehensive counseling was provided with support continued over an extended time period have reported sodium reductions in the range of 20–40% after periods of 1–5 years.

Based on the impressions from these studies and on the theoretical perspective previously described,1 the level of sodium reduction that might be expected to result from intervention programs that are more or less inclusive of various behavioral change strategies can be estimated (Table 1). Low, medium, and high interventions can be differentiated according to activities that are included (+), possibly included (±), or not included (−) in the intervention design. Considering the behavioral outcome as a function of the "dose" of intervention might help to clarify why some studies suggest that sodium reduction is not feasible and others demonstrate that it is highly feasible.

According to the classification scheme in Table 1, the lowest level of intervention potentially associated with at least minimum success would include community education strategies (e.g., information in the mass media), either as a specific aspect of the intervention design or as an opportunistic aspect (i.e., one that takes advantage of ongoing health promotion campaigns), along with supplementary individually oriented informational strategies such as oral presentations or printed information and would also include attempts to increase the availability of low sodium foods. This would be similar to the community-based program described in the North Karelia Salt Project12 and, at best, might yield a 10% reduction in average daily sodium intake. Results of programs using most or all of the strategies listed in Table 1 suggest that in a general population this highest level of intervention might yield sodium intake reductions of 20–40%. Intermediate between these extremes would be interventions providing for face-to-face contacts with individuals and family members and including appropriate informational and motivational content along with one or more of the other strategies listed. This level of intervention can be expected to have moderate but not optimal success. For example, in the North Karelia Salt Project,12 a 2-year substudy involving 200 persons with mild hypertension evaluated the effect of more extensive individual and group counseling in addition to the community-based program and demonstrated a sodium reduction of 16% in men and 20% in women.

Based on an initial sodium intake level of about 4,000 mg (175 meq) per day these low, medium, and high levels of intervention would reduce sodium intake, respectively, to about 3,600 mg (158 meq), 3,200 mg (140 meq), and 2,400 mg (105 meq) per day. However, Table 1 is an oversimplification in that there is overlap among these components and in that other variables, such as the intensity and skill of the intervention, also affect success. In addition, the success of dietary sodium interventions may vary according to whether sodium alone is the focus or

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**Table 1. Strategies Included in Different Levels of Sodium Interventions**

<table>
<thead>
<tr>
<th>Intervention strategies</th>
<th>Level of intervention</th>
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<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Knowledge about sodium reduction</td>
<td>+</td>
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<tr>
<td>Mass media information in community</td>
<td>±</td>
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<tr>
<td>Individuals given instruction face to face</td>
<td>+</td>
</tr>
<tr>
<td>Family members given instruction face to face</td>
<td>-</td>
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<tr>
<td>Facilitating acquisition of low sodium foods</td>
<td>+</td>
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<tr>
<td>Individuals helped to identify sources of low sodium foods</td>
<td>+</td>
</tr>
<tr>
<td>Retailers encouraged to make low sodium foods available</td>
<td>+</td>
</tr>
<tr>
<td>Individuals given low sodium foods</td>
<td>-</td>
</tr>
<tr>
<td>Behavioral counseling and social support</td>
<td>-</td>
</tr>
<tr>
<td>Opportunities to taste low sodium foods</td>
<td>-</td>
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<tr>
<td>Feedback on urinary sodium excretion</td>
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+, Strategy included; ±, strategy possibly included; −, strategy not included.
whether sodium reduction is integrated with other areas of nutrition or health counseling. Theoretically, including sodium reduction as part of a broader health improvement effort provides an opportunity to link motivations for sodium reduction to other, perhaps more intrinsically rewarding, changes such as weight reduction.22

In conclusion, the relevance of this discussion of behavioral aspects of sodium interventions relates to the feasibility of dietary sodium interventions in high salt, industrialized societies where people rely on processed or restaurant foods for logistical reasons, whether or not they prefer them, where the food supply is extremely large and diverse, where the existence of current generations can be tied to historical roles of salted foods in survival, and, furthermore, where it is difficult for individuals to really determine how much sodium they are consuming on a day-to-day basis. Advocates of dietary sodium reduction who attempt to minimize the associated problems may be doing a disservice to their cause. Rather, what would seem to be needed is a complete understanding of the factors involved in dietary sodium reduction and of what level of sodium reduction is probable when only a limited program is mounted. Facing the reality then that, based on the examples above, reduction of sodium intake to an average of less than 3,000 mg (130 meq) per day will require cost- and labor-intensive individualized counseling programs and will only be suitable for individuals likely to actively engage in such counseling, the alternatives for public health interventions are sharpened: either the targeted level of sodium reduction or of what level of sodium reduction will have to be at a level that can be achieved with less costly campaigns or the task of sodium reduction will have to be made easier for the average individual. The first alternative suggests a need for research to better specify the dose–response relation of population blood pressure change to specific levels of population sodium reduction. The second suggests a need for drastic changes in the food supply. Some combination of these two alternatives may be ideal.

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