Humans and animals like the taste of salt. It is 1 of 5 taste sensations present on the human tongue. We developed this sense because sodium and chloride are critical to our circulatory blood volume. Numerous redundant regulatory systems also evolved to protect and preserve blood volume through sodium conservation.

So is too much of a good thing bad for us? During evolution, effective sodium conservation was favorable to survival when the environment was arid and food intake capricious. A surfeit of salt intake rarely occurred, until the modern era. Less evolutionary pressure existed to develop mechanisms to excrete excess salt. Thus, it became possible for too much salt intake to become detrimental.

Clinical investigators such as Lewis Dahl hypothesized and then became convinced through experimentation that excess salt intake is injurious to the cardiovascular system. But, although experimental animals can be bred to develop salt intake–related changes in blood pressure, humans are a much more complex entity. Scores of studies in humans have examined the blood pressure response to salt loading and deprivation. Almost all are short term (<30 days). From these studies, the terms salt sensitivity and salt resistance arose to describe the blood pressure response to changing dietary salt. But these terms often are arbitrarily defined and applied, and no clinical tool exists that can predict a given person’s blood pressure response to changes in salt intake.

National guidelines for the prevention and treatment of hypertension consistently advocate salt restriction for the general population1 on the basis of the known benefits that accrue for a given blood pressure reduction, assuming that one occurs with salt restriction. A series of meta-analyses have generally, although not always, supported this conclusion,2-4 albeit the average blood pressure change is likely small with marked interindividual variation. Many would accept that ≈50% of hypertensive patients have a significant fall in blood pressure (eg, 5 to 10 mm Hg) when salt intake is markedly reduced (eg, <30 mmol/d sodium). Older, hypertensive, and black individuals tend to have the greatest effects. An association also exists between higher salt intake and risk of cardiovascular disease.5 These findings suggest that hypertensive patients should be encouraged to restrict salt intake. However, much more debate exists about whether people with normal blood pressure derive benefits from salt restriction.

The article by Elliott et al13 in this issue of Circulation describes a novel experiment conducted in chimpanzees that could never be accomplished in humans. Using 2 geographically separated cohorts of chimps (Gabon, France, and Bastrop, Tex), the investigators altered the animals’ sodium intake for up to 2 years while maintaining intake of all other nutrients the same. It should be noted that the chimpanzees were not just healthy, young animals. Indeed, many were older, many had increased body weight, and some had hypertension (defined by a blood pressure >140/90 mm Hg). Thus, the study population was similar to the heterogeneous human population to which we may wish to extrapolate their findings. Two parallel experiments were performed. One had modified sodium intake within a cohort, with the animals serving as their own controls. In another experiment, parallel groups were assigned either to maintain a higher sodium intake or to reduce sodium intake by half. It is very important to note that the remainder of the animals’ diet remained the same; it indeed was replete with fruits and vegetables and, although not mentioned, was likely reduced in total and saturated fat. This sounds a lot like the Dietary Approaches to Stop Hypertension (DASH) diet.14

While the animals were on the reduced sodium diets, blood pressure was lower. Not unexpectedly, significant interactions were present with weight and baseline blood pressure. Those animals that were heavier or had higher baseline blood pressure had greater responses to sodium restriction. In the Bastrop cohort, adjustment for age, sex, and baseline weight reduced the size of the blood pressure effect, and the differences between groups crossed above the threshold for statistical significance. Nonetheless, the mean values for blood pressure reduction still suggested that a clinically meaningful effect was evident. Overall, the experiments are novel in their duration and attempt to control all but a single variable, but they suffer from many of the same contamination issues that we see in long-term human studies.

These data extend the findings from the DASH-Sodium study,15 which evaluated the role of short-term (4 weeks) sodium restriction on blood pressure in individuals with prehypertension.
and stage 1 hypertension. In that study, levels of sodium intake in 2 dietary patterns were compared. The DASH diet, a dietary pattern that is rich in fruits, vegetables, and low-fat dairy products and is reduced in total and saturated fat, was compared with a control diet typical of average US consumption. Sodium restriction in both dietary patterns lowered blood pressure. Those eating the DASH diet had significantly lower blood pressures at all levels of sodium intake, and the effects were significant across major subgroups: nonhypertensives, hypertensives, blacks, nonblacks, men, and women. The response to sodium restriction was nonlinear; a greater blood pressure reduction took place at the lowest level of sodium intake compared with moderate sodium restriction.

Thus, the DASH-Sodium study showed that sodium restriction to levels at or below current recommendations (100 mmol/d, 6 g/d salt) lowers blood pressure, more so when the DASH diet is used. The results of Elliott et al13 show that sustained adherence to this salt-restricted dietary pattern in chimpanzees resulted in persistently lower blood pressure. Such adherence is almost impossible to control in humans over extended periods of time, as was evident in the salt restriction arm of the Trials of Hypertension Prevention.17 But the long-term health benefits (or risks) that might accrue from the DASH diet with reduced salt intake are as-yet unproven through clinical trials. Certainly, the study by Elliott et al provides no information on this. However, we do know that the risk of coronary heart disease and ischemic stroke is reduced in individuals consuming higher daily intake of fruits and vegetables (>5 to 6 servings per day)18,19 and that a dietary pattern similar to the DASH diet is associated with lower risk of coronary heart disease over a 12-year period.20 In the midst of the public policy debate about salt restriction, one is reminded of the poem “Blind Men and the Elephant” by John Godfrey Saxe, in which 6 blind men approach an elephant to learn more about it. After noting the side, trunk, and tusk of the elephant, the first 3 men conclude that the elephant is a like a wall, a spear, or a snake. The last 3 men feel its knee, ear, and tail and note that the elephant is like a tree, a fan, or a rope. Thus, depending on one’s perspective, different evaluators of the same information may arrive at very different conclusions.

I stand in favor of advocating salt restriction in the setting of the DASH dietary pattern. Elliott et al13 have provided new information, albeit in chimpanzees, showing that long-term salt restriction in the setting of a diet rich in fruits and vegetables produces sustained reductions in blood pressure. These data are relevant to humans but should be approached with caution and respect for the sample size, the lesser effects when adjusted for key factors, and the inability to add knowledge on the health and/or cardiovascular benefits of salt restriction beyond blood pressure lowering. Major next steps include understanding why increased salt intake has such appeal to humans, figuring out how to overcome this attraction and sustain adherence to a salt-restricted DASH dietary pattern, and confirming that eating such a dietary pattern provides unquestioned health benefits.

Disclosures
Dr Conlin is the principal investigator on a National Institutes of Health–funded grant (R01 HL77234) that studies the effects of the DASH diet on individuals with isolated systolic hypertension.

References

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Eat Your Fruits and Vegetables But Hold the Salt
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