

# Reduction in dietary sodium improves blood pressure and reduces cardiovascular events and mortality

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Long-term consumption of high consumption of sodium in the diet is a risk factor for hypertension with increased cardiovascular disease and chronic kidney disease and mortality (1). Modest reductions in dietary salt intake reduce blood pressure in many persons with hypertension (2-4). High dietary sodium intake may cause hypertension by renal dysfunction with abnormal increased renal retention of sodium (5) or by vasodysfunction that involves renal vasodysfunction (6). Dietary sodium intake is recommended by the AHA to be <1,500 mg daily (3).

A national US survey included 12,267 persons (7). At 14.8-year follow-up, increased dietary sodium intake increased all-cause mortality by 20% per 1,000 mg/day of increased dietary sodium, whereas increased dietary potassium decreased all-cause mortality by 20% per 1,000 mg/day of increased dietary potassium (7). For sodium-potassium ratio, compared with the lowest quartile, the highest quartile increased all-cause death by 46%, increased cardiovascular disease death by 46%, and increased coronary heart disease death by 215% (7).

Numerous studies have demonstrated a dose-dependent lowering of blood pressure after decreasing dietary sodium, with the most blood pressure lowering in persons with the highest blood pressures and the best interventions (8). A meta-analysis of 56 randomized controlled studies demonstrated that decreasing sodium excretion by 100 mmol per day lowered blood pressure by 3.7/0.9 mmHg (9).

Most persons in the United States ingest 5 grams of sodium daily (8). Guidelines state that daily sodium intake be between 1,500 to 2,300 mg (1) with 1,500 mg daily of dietary sodium recommended for blacks, the elderly, and for

persons who have hypertension, diabetes, or chronic kidney disease (8). Most excess dietary sodium is added during food processing (10). In a randomized controlled trial, 412 adults consumed a diet with high, intermediate, and low levels of sodium for 30 consecutive days each (11). Lowering dietary sodium from a high level to an intermediate level decreased systolic blood pressure 2.1 mmHg. Lowering dietary sodium from an intermediate level to a low level lowered systolic blood pressure by an additional 4.6 mmHg (11). Compared to a control diet with high sodium intake, a DASH diet with a low sodium intake lowered systolic blood pressure 7.1 mmHg in adults without hypertension and 11.5 mmHg in hypertensive adults (11).

Increased sodium leads to severe structural and functional cardiovascular and kidney abnormalities experimentally and clinically in hypertensive adults (12). Restriction of sodium intake in the diet reverses vascular endothelial dysfunction in middle aged/older adults with moderately increased systolic blood pressure (13,14). Sodium sensitivity increases cardiovascular events in hypertensive adults (15).

In 66 countries in 2010, 1.65 million cardiovascular deaths were attributed to dietary sodium intake above a reference level of 2,000 mg per day (16). A meta-analysis of 13 clinical trials of 177,025 persons demonstrated that higher consumption of dietary sodium caused a 23% increase in stroke and a 14% increase in cardiovascular disease (17).

Many clinical trials have shown that a lower consumption of sodium decreases cardiovascular events and death (7,18-22). Decreasing sodium consumption in Finland by one-third decreased blood pressure and decreased both stroke and ischemic heart disease death by 75% to

80% (18). In a retirement home, 1,981 elderly men were randomized to a potassium-enriched salt diet or to regular salt intake (19). At 31-month follow-up, the elderly men on a potassium-enriched salt diet had a 41% decrease in cardiovascular disease death (19). The potassium-enriched salt group lived 0.3 to 0.9 years longer and spent 426 US dollars per year less on inpatient care for cardiovascular disease (19).

In the Trial of Hypertension Prevention (TOHP), 744 prehypertensive adults during 1987 to 1990 (TOHP I) and 2,382 prehypertensive adults during 1990 to 1995 (TOHP II) were randomized to reduced dietary sodium or to usual sodium intake (25% to 35% more sodium ingestion) (20). Follow-up for cardiovascular events was made 10 to 15 years after the clinical study. This clinical trial found that reduced consumption of sodium lowered cardiovascular events by 25% (20). Over 20-year follow-up in this study, all-cause mortality was increased 12% per increase in sodium of 1,000 mg per 24 hours, with a 25% lowering of all-cause death if daily sodium intake was less than 2,300 mg (21).

An English survey included 9,183 persons in 2003, 8,762 persons in 2006, 8,974 persons in 2008, and 4,753 persons in 2011 (22). This study found that from 2003 to 2011, daily sodium intake measured by 24-hour urinary sodium was reduced by 1.9 grams, blood pressure in adults not receiving antihypertensive drugs was decreased 2.7/1.1 mmHg, stroke death was reduced 42%, and death from coronary heart disease was reduced 40% (22).

Lowering consumption of sodium by decreasing sodium content in processed food and by not adding salt to food would lead to reducing hypertension, cardiovascular events, and death. A national salt reduction program is a simple and cost-effective way to improve public health (23).

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## Footnote

*Conflicts of Interest:* The author has no conflicts of interest to declare.

## References

1. Aronow WS, Fleg JL, Pepine CJ, et al. ACCF/AHA 2011 expert consensus document on hypertension in the elderly: a report of the American College of Cardiology Foundation Task Force on Clinical Expert Consensus Documents. Developed in collaboration with the American Academy of Neurology, American Geriatrics Society, American Society for Preventive Cardiology, American Society of Hypertension, American Society of Nephrology, Association of Black Cardiologists, and European Society of Hypertension. *J Am Coll Cardiol* 2011;57:2037-14.
2. Appel LJ, Frohlich ED, Hall JE, et al. The importance of population-wide sodium reduction as a means to prevent cardiovascular disease and stroke: a call to action from the American Heart Association. *Circulation* 2011;123:1138-43.
3. Whelton PK, Appel LJ, Sacco RL, et al. Sodium, blood pressure, and cardiovascular disease: further evidence supporting the American Heart Association sodium reduction recommendations. *Circulation* 2012;126:2880-9.
4. He FJ, MacGregor GA. Effect of modest salt reduction on blood pressure: a meta-analysis of randomized trials. Implications for public health. *J Hum Hypertens* 2002;16:761-70.
5. Hall JE. Renal dysfunction, rather than nonrenal vascular dysfunction, mediates salt-induced hypertension. *Circulation* 2016;133:894-906.
6. Morris RC Jr, Schmidlin O, Sebastian A, et al. How does high salt intake cause hypertension? Vasodysfunction that involves renal vasodysfunction, not abnormally increased renal retention of sodium, accounts for the initiation of salt-induced hypertension. *Circulation* 2016;133:881-93.
7. Yang Q, Liu T, Kuklina EV, et al. Sodium and potassium intake and mortality among US adults. Prospective data from the Third National Health and Nutrition Examination Survey. *Arch Intern Med* 2011;171:1183-91.
8. Whelton PK. Urinary sodium and cardiovascular disease risk. Informing guidelines for sodium consumption. *JAMA* 2011;306:2262-4.
9. Midgley JP, Matthew AG, Greenwood CM, et al. Effect of reduced dietary sodium on blood pressure: a meta-analysis of randomized controlled trials. *JAMA* 1996;275:1590-7.
10. Mattes RD, Donnelly D. Relative contributions of dietary sodium sources. *J Am Coll Nutr* 1991;10:383-93.
11. Sacks FM, Svetkey LP, Vollmer WM, et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. *N Engl J Med* 2001;344:3-10.
12. Frohlich ED, Susic D. Sodium and its multiorgan targets. *Circulation* 2011;124:1882-5.
13. Jablonski KL, Racine ML, Geolfos CJ, et al. Dietary sodium restriction reverses vascular endothelial

- dysfunction in middle-aged/older adults with moderately elevated systolic blood pressure. *J Am Coll Cardiol* 2013;61:335-43.
14. Celermajer DS, Neal B. Excessive sodium intake and cardiovascular disease. A-salting our vessels. *J Am Coll Cardiol* 2013;61:344-5.
  15. Morimoto A, Uzu T, Fujii T, et al. Sodium sensitivity and cardiovascular events in patients with essential hypertension. *Lancet* 1997;350:1734-7.
  16. Mozaffarian D, Fahimi S, Singh GM, et al. Global sodium consumption and death from cardiovascular causes. *N Engl J Med* 2014;371:624-34.
  17. Strazzullo P, D'Elia L, Kandalaria NB, et al. Salt intake, stroke, and cardiovascular disease: meta-analysis of prospective studies. *BMJ* 2009;339:b4567.
  18. Karppanen H, Mervaala E. Sodium intake and hypertension. *Prog Cardiovasc Dis* 2006;49:59-75.
  19. Chang HY, Hu YW, Yue CS, et al. Effect of potassium-enriched salt on cardiovascular mortality and medical expenses of elderly men. *Am J Clin Nutr* 2006;83:1289-96.
  20. Cook NR, Cutler JA, Obarzanek E, et al. Long term effects of dietary sodium reduction on cardiovascular disease outcomes: observational follow-up of the trials of hypertension prevention (TOHP). *BMJ* 2007;334:885-8.
  21. Cook NR, Appel LJ, Whelton PK. Sodium intake and all-cause mortality over 20 years in the trials of hypertension prevention. *J Am Coll Cardiol* 2016;68:1609-17.
  22. He FJ, Pombo-Rodrigues S, Macgregor GA. Salt reduction in England from 2003 to 2011: its relationship to blood pressure, stroke and ischaemic heart disease mortality. *BMJ Open* 2014;4:e004549.
  23. Webster JL, Dunford EK, Hawkes C, et al. Salt reduction initiatives around the world. *J Hypertens* 2011;29:1043-50.

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