

leading to a higher cardiac output, whereas blood flow to internal organs decreases with an increased body temperature. Sweat is secreted at a rate of 0.6 to 1.0 kg per hour at 80°C to 90°C temperature (176°F to 194°F, respectively), with an average total secretion of 0.5 kg, during a warm sauna bathing session.¹ Sweat is known to contain solutes that accumulate in patients with renal failure.⁵ Intensive sweating, induced by heat treatment with saunas (dry heat) or hot baths (wet heat), can increase loss of water, urea, sodium, potassium, chloride, lactate, and possibly other solutes.⁵ However, although possible, it is not known how effective diaphoresis therapy might be in removing uremic toxins and if sauna bathing helps to get rid of toxins, as the liver and kidneys usually remove more toxins than sweat glands. It is also unclear whether the minuscule amount of toxins in sweat actually indicates a health concern. In addition, the concentrations of metals or other toxins detected in sweat are quite low. Whether sauna bathing will be a useful strategy for the elimination of toxins, including organochlorinated pesticides, from the body is a topic for further investigation. Indeed, randomized controlled trials are needed to further explore the potential health effects of sauna bathing.

Sauna is a potential novel tool to promote public health in addition to many other previously known means, being an enjoyable way to take care of general health and well-being among many people; but its effectiveness and safety as an additional diaphoretic or diuretic therapy need to be carefully investigated. Sauna bathing may be a remedy to the call for additional lifestyle

interventions needed to enhance both general health and wellness, possibly in populations that have difficulty exercising, and at least as an adjunct to exercise training. Most people usually tolerate a typical warm dry sauna, which is a pleasurable activity with potential health benefits. Overall, we warmly recommend taking sauna bath as part of a healthy lifestyle for the prevention of chronic diseases.

Jari A. Laukkanen, MD, PhD
Tanjaniina Laukkanen, MSc, MA

Faculty of Sport and Health Sciences
University of Jyväskylä
Finland

Institute of Public Health and Clinical Nutrition
University of Eastern Finland
Kuopio

Central Finland Health Care District
Jyväskylä

Setor Kunutsor, MD, PhD

National Institute for Health Research
Bristol Biomedical Research Centre
University Hospitals Bristol NHS Foundation
Trust
University of Bristol
Translational Health Sciences
Bristol Medical School
Musculoskeletal Research Unit
Southmead Hospital
United Kingdom

Potential Competing Interests: The authors report no competing interests.

1. Laukkanen JA, Laukkanen T, Kunutsor SK. Cardiovascular and other health benefits of sauna bathing: a review of the evidence. *Mayo Clin Proc.* 2018; 93(8):1111-1121.
2. Laukkanen T, Khan H, Zaccardi F, Laukkanen JA. Association between sauna bathing and fatal cardiovascular and all-cause mortality events. *JAMA Intern Med.* 2015;175(4):542-548.
3. Kunutsor SK, Khan H, Zaccardi F, Laukkanen T, Willeit P, Laukkanen JA. Sauna bathing reduces the risk of stroke in Finnish men and women: a prospective cohort study. *Neurology.* 2018;90(22):e1937-e1944.
4. Kunutsor SK, Laukkanen T, Laukkanen JA. Longitudinal associations of sauna bathing with inflammation and oxidative stress: the KIH prospective cohort study. *Ann Med.* 2018;50(5):437-442.

5. Hanafusa N, Lodebo BT, Shah A, Kopple JD. Is there a role for diaphoresis therapy for advanced chronic kidney disease patients? *J Ren Nutr.* 2017;27(5):295-302.

<https://doi.org/10.1016/j.mayocp.2018.12.023>

Low-Sodium Intake: A Risk Factor for Stroke?



To the Editor: The recent findings by Kieneker et al¹ represent the first convincing evidence that a low sodium intake might be linked to an increased cerebrovascular risk. The highly cited papers by a Canadian group² already claimed to show a sort of J-shaped association between sodium intake and cardiovascular events, but there are limitations to these studies, as has been discussed previously.³

Kieneker et al¹ correctly studied the relationship between sodium intake and cerebrovascular events, evaluating multiple 24-hour urinary sodium excretions (UNaV) in a large (N>7000) cohort of Dutch patients. The authors observed an inverse association between sodium excretion and the risk of stroke, even after adjusting for confounders such as age, sex, diet, lifestyle, blood pressure, antihypertensive medications, plasma renin, aldosterone, and so on.

The association of low sodium intake and increased risk of stroke is intriguing, and the authors discuss the possibility that an increase of lipids, renin-angiotensin-aldosterone system (RAAS) activity, or sympathetic discharge may be involved. The contribution of these factors is uncertain at present.³

Kieneker et al correctly noted the limits of the study¹: The mean sodium intake in this population is relatively low, reverse causality cannot be ruled out, and residual confounders are to be taken into account.

In our opinion, there are other relevant considerations:

1. The study population is at very low risk of stroke (number of observed events = 183 during a follow-up of more than 12 years), with a prevalence of 0.21% per year, in front of the actual stroke prevalence of 0.8% to 8.2% per year (from 4x to 40x) in the general population across Europe.^{4,5}
2. The group in the lowest quintile of UNaV has an average value of 83 mmol per 24 hours (really low; actually well below the current indications). In this group, the possible reverse causality should be investigated.
3. The patients with the lowest UNaV show also the lowest potassium excretion, reflecting a low potassium intake. High potassium intake has protective cardiovascular effects. This is not taken into account in the discussion.
4. In Figures A and B of their study,¹ Kieneker et al report graphically the inverse (J-shaped?) relationship between UNaV and risk of stroke, after adjusting (A) for age and sex, and (B) additionally adjusting for height, weight, race, smoking status, and so on, but not for blood pressure and/or antihypertensive medication consumption, although these last adjustments may have clarified their findings.

In our opinion, the paper by Kieneker et al¹ is the first to have addressed correctly a possible inverse relation between sodium intake and risk of stroke; their conclusions are nevertheless clouded by a number of confounders.

Natale Musso, MD
Andrea Dotto, MD

Department of Internal Medicine
IRCCS Policlinico San Martino Genova
Italy

Potential Competing Interests: The authors report no competing interests.

1. Kieneker LM, Eisenga MF, Gansevoort RT, et al. Association of low urinary sodium excretion with increased risk of stroke. *Mayo Clin Proc.* 2018; 93(12):1803-1809.
2. O'Donnell M, Mente A, Rangarajan S, et al; PURE Investigators. Urinary sodium and potassium excretion, mortality, and cardiovascular events (Published correction appears in *N Engl J Med.* 2014;371(13):1267.). *N Engl J Med.* 2014;371(7):612-623.
3. Campbell NRC. Dissidents and dietary sodium: concerns about the commentary by O'Donnell et al. *Int J Epidemiol.* 2017;46(1):362-366.
4. The burden of stroke in Europe. King's College of London, SAFE Secretariat. Stroke Association House, <http://strokeeurope.eu/index/the-burden-of-stroke-in-europe/>. Accessed September 29, 2018.
5. Béjot Y, Bailly H, Durier J, Giroud M. Epidemiology of stroke in Europe and trends for the 21st century. *Presse Med.* 2016;45(12):e391-e398.

<https://doi.org/10.1016/j.mayocp.2018.12.027>

In reply—Low-Sodium Intake: A Risk Factor for Stroke?



To the Editor: We are grateful to Drs Musso and Dotto¹ for the appraisal of our article on low urinary sodium excretion (UNaV) as an indicator of low sodium intake and increased risk of stroke.² We agree that the mentioned earlier study by O'Donnell and colleagues,³ although representative of various populations by including more than 100,000 participants from 17 countries, has some limitations. In particular, the assessment of sodium intake via a single spot urine sample is a major limitation. Actual measurement of 24-hour UNaV in multiple urine collections (to account for day-to-day variability), as we did in the Prevention of Renal and Vascular End-Stage Disease (PREVEND) study, has been shown to be a more accurate method for the assessment of usual sodium intake.^{4,5}

In their letter, Drs Musso and Dotto note potential concerns regarding our study. First, they noted

that the number of strokes among the participants of PREVEND study is low when compared with other European populations. For this, it is important to realize that, in our study, we excluded all participants with cardiovascular events (including strokes) at baseline. Therefore, in our analyses we are investigating incidence rates of stroke rather than rates of prevalence. But, still, the stroke incidence rate of 0.21% per year in the PREVEND study may seem relatively low compared with the incidence rates of other European populations, which reportedly range from 0.08% to 2.54%, with highest rates in Eastern and Northern Europe (Croatia, Estonia, Lithuania, Sweden).⁶ These differences among countries can partly be explained by the presence of risk factors of stroke such as the number of smokers, elevated blood pressure, elevated cholesterol levels, and treatment of stroke. However, some of this variation is likely also due to the different criteria—such as inclusion of transient ischemic attacks—and methods used to collect the data.⁷ Important to note is that the incidence of stroke in the PREVEND study (0.21% per year) is very similar to the overall stroke incidence reported for the Netherlands (0.23% per year).⁸

Second, the participants of the PREVEND study had relatively low sodium intake when compared with other study populations.⁹ When looking at the lowest quintile of UNaV, we observed that the median intake of this quintile was 83 mmol per 24 hours. Assuming that approximately 90% of ingested sodium is excreted in the urine,⁴ subjects in this lowest quintile of UNaV consumed approximately 5.4 grams of salt per day (equivalent to 92 mmol of sodium per day). This is slightly below the current