Role of dietary sodium/potassium ratio in the blood pressure rise with age: novel evidence from the Coronary Artery Risk Development in Young Adults study

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The role of excess sodium intake on the blood pressure (BP) increase with age was highlighted by the international study of electrolyte excretion and blood pressure (INTERSALT) study investigators more than 30 years ago, through the cross-sectional findings of a landmark ecological study exploring the relationship between several lifestyle factors and BP [1]. Their graphical representation of the linear regression of the rate of BP increase with age on the average habitual sodium intake (estimated from 24 h urinary sodium excretion) in 52 population samples from 32 countries has been mentioned and discussed in possibly thousands of publications and scientific meetings. Their results provided epidemiological support to the preexisting evidence of the importance of sodium intake for BP homeostasis deriving mainly from experimental animal and clinical studies. Yet, several objections were raised to the interpretation by the INTERSALT scientists of the observed statistical association as suggestive of a ‘causal’ relationship, generating a lively debate between supporters and detractors of the ‘salt hypothesis’ [2–6].

Among the studies in support of the INTERSALT findings, there was a very peculiar trial conducted a few years before. Two groups of newborn infants in Rotterdam had been randomly assigned to receive a formula diet with either regular or reduced salt content and had been followed for up to 6 months: at this time, the group with higher salt intake showed a significantly higher SBP by 2.1 mmHg compared with the lower sodium group [7]. Fifteen years later, the group fed more salt during their first 6 months of life was again found to have significantly higher SBP by 3.6 mmHg upon adjustment for possible confounders, in the absence of any other type of dietary intervention [8]. These data strongly suggested that the negative effects of high sodium intake on the arterial system start very early in life to become manifest through a gradual BP increase in the following years.

Later on, both the trial of hypertension prevention Phase I study [9] and the dietary approaches to stop hypertension sodium trial [10] gave randomized clinical trial evidence of a ‘causal’ relation of sodium intake to BP, dealing however with individuals with high-normal BP, in whom a lower sodium intake was able to induce a decrease in BP compared with a control group on a higher salt intake.

The article by Hisamatsu et al., in this issue of the Journal of Hypertension [11], provides novel evidence on the role of sodium intake on the BP increase with age and on the risk to develop clinically overt hypertension by initially ‘normotensive’ subjects. The study was part of the Coronary Artery Risk Development in Young Adults (CARDIA) investigation, a prospective observational survey that examined the trends and correlates of cardiovascular disease risk in young black and white men and women ages 18–30 years enrolled from 1985 to 1986 in four geographical areas in the United States [12].

Hisamatsu et al. analyzed the data from 1007 CARDIA participants (mean age, 30.2 years) who had their BP measured and provided at least two (most of them three) consecutive 24-h urine samples at baseline, and were re-examined at regular intervals in the subsequent 25 years. The authors concentrated not only on sodium but also on potassium intake by the study participants, classifying the study population in three groups by sex-specific medians of the average 24-h urinary electrolyte excretions: lower Na–lower K (about one-fifth of the population), higher Na–lower K (also about one-fifth), and all others. They found that SBP and DBP adjusted for age, BMI, alcohol intake and physical activity increased to a greater extent in the higher Na–lower K compared with the lower Na–higher K group, the difference achieving and maintaining statistical significance starting at 15 years and up to the final observation at 25 years from baseline.

Although the concomitant antihypertensive drug treatment was a possible source of confounding in this study,
the results about the novel incidence of hypertension were further supportive as, during the 25-year follow-up period, in the adjusted Cox proportional hazard model, the higher Na—lower K group had 45% higher risk of incident hypertension than the lower Na—higher K group.

Noteworthy, not only higher sodium intake but also lower potassium intake and a higher Na/K ratio were each independently associated with incident hypertension. Although the INTERSALT study had already shown that the ratio of sodium to potassium intake may be an even better predictor of the rise of BP with age than sodium intake ‘per se’ [1] and despite the strong clinical trial evidence of the BP-lowering effect of increased potassium intake [13], the beneficial role of potassium, not only on BP but also on the risk of cardiovascular events [14] is often disregarded in clinical practice. One of the explanations for this careless attitude by physicians toward potassium intake is that the strong debate that has taken place for decades around sodium (salt) intake and BP has obscured the equally important role of potassium. The CARDIA study was not designed to explore the biological mechanisms underlying the observed opposite BP effects of sodium and potassium on the cardiovascular system: it is tempting however to underline the contrasting effects of sodium and potassium on endothelial activity and arterial stiffness, which may play a major role in this respect [15,16]. It is more consistent with the nature of the CARDIA study to remark the fundamental difference occurring between sodium and potassium on nutritional grounds: whereas sodium is found in natural foods in almost negligible amounts, the largest part of dietary sodium is added to foods by individuals as well as by food manufacturers, potassium is abundant in foods and in particular in those of vegetable origin. Paradoxically, a net inversion in the intake of the two minerals has characterized the human diet of the last 5000 years, determined by a progressive increase in the use of salt for food preservation and seasoning and by a decrease in the consumption of vegetable foods in favor of growing consumption of animal foods.

The population average potassium intake in the study by Hisamatsu et al., although uncorrected for extra-urinary potassium losses, was no exception, being quite low and far from the adequate intake set by the World Health Organization and by the European Food Safety Authority (i.e. 3500 mg/day) [17]. An adequate potassium intake may be reached through the consumption of 5–6 daily portions of fruits and vegetables, but this goal has proved difficult to attain particularly in low-income population groups [18] and at the time of economic crisis [19] because of the relatively high costs of plant foods.

Despite the low average potassium intake of the study population, however, the subjects with a relatively higher intake (third and fourth quartile of the potassium intake distribution) in the Hisamatsu report were significantly protected from the risk of hypertension. It is also interesting to underline that black men and women had both a higher sodium intake and a lower potassium intake (thus the highest Na/K ratio) compared with their white peers, in keeping with the frequently observed aggregation of unfavorable dietary habits. Along the same line of reasoning, one can notice that the group of participants identified as having the most dangerous dietary habits, that is, the highest sodium and the lowest potassium intake, were also more overweight, more sedentary and more often smokers.

In keeping with the results of the CARDIA study, in a recent survey of the degree of knowledge and practical behavior about salt intake of an opportunist sample of the Italian adult population, we found that a lower degree of knowledge and a worse practical behavior about dietary salt were associated with lower potassium intake (unpublished data) and with a reduced degree of adhesion to a Mediterranean dietary model [20].

Altogether, this tells us that, while advocacy actions in favor of reduced salt intake remain important, there is a growing need to tackle unhealthy dietary habits and lifestyles by a unified approach given their tendency to aggregate and cluster in the same groups of individuals, at least in part as a consequence of insufficient levels of education and of healthcare, socioeconomic inequalities playing a major role in this regard.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

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