EDITORIAL

Carbohydrates and Hypertension: The Quality Counts

Carmine Savoia

Population studies (both observational and randomized clinical trials) have progressively provided evidence of the effects of different type of diets and specific macro/micronutrients including carbohydrates on diverse surrogate end points such as the development of hypertension.[1] Lifestyle modification, including recommended dietary guidelines (focused on quantity and type of nutrients), can contribute to reduce blood pressure values and prevent the development of cardiovascular disease. Nevertheless, people worldwide have been often bombarded with confusing and conflicting recommendations on dietary regimen. These controversies are due, in part, to the fact that dietary recommendations have often been focused on single macronutrients in isolation without considering the impact of other concurrent micro/macronutrients. Moreover, in different studies, the associations between macronutrients and health outcomes were also considered linear across the range of consumption, focusing less on the complexity of food composition or the level of intake of other macronutrients and total energy consumption. Nevertheless, recent evidence suggests that many associations between macronutrient intake and all-cause mortality or cardiovascular diseases are nonlinear[2] and that macronutrient quantity and quality, as well as their interaction, may account for health promotion of the general population. The association between cardiometabolic diseases including hypertension and diets with high levels of carbohydrates (containing particularly refined or high glycemic index carbohydrates) has been documented.[2] Conversely, controversies exist on the role of low-carbohydrate diets. In this regard, both reduced and increased cardiovascular risk has been reported in individuals consuming low-carbohydrate diet particularly on long-term follow-up, although minimal risk has been found at about 50% carbohydrate consumption.[3] Furthermore, observational studies suggest that the type (ie, quality) of carbohydrates may have a greater effect than the total amount on the risk of chronic diseases including cardiovascular and metabolic diseases in the general population, although specific groups may respond differently to the carbohydrate quality and quantity.[4] On this matter, the nationwide observational prospective cohort study from Li et al[5] published in this issue investigated the relations of the amount and type of carbohydrates with new-onset hypertension in adult Chinese individuals. The results showed a U-shaped association between percentage of dietary carbohydrate intake and new-onset hypertension in adults (Figure). These data further support the notion that both high and low percentages of carbohydrate diets are associated with increased risk of hypertension, with minimal risk found at about 50% to 55% carbohydrate consumption. Interestingly, in this study, the increased risks were mainly found in those with lower intake of high-quality carbohydrate or high intake of low-quality carbohydrate (Figure). Moreover, an inverse association between the plant-based low-carbohydrate scores for low-quality carbohydrate and new-onset hypertension was also shown. Undoubtedly, these data contribute further to highlight the role of the quality of carbohydrate intake on the development of hypertension and cardiovascular risk, although no direct evidence of mechanisms has been provided. Randomized clinical trials have shown that higher intakes of dietary fibers, fruits, vegetables, some starches as well as cereals and whole-grain foods may reduce body weight and lower blood cholesterol and systolic blood pressure,[6,7] however, preclinical and in vivo mechanistic studies on the effect of quality and quantity

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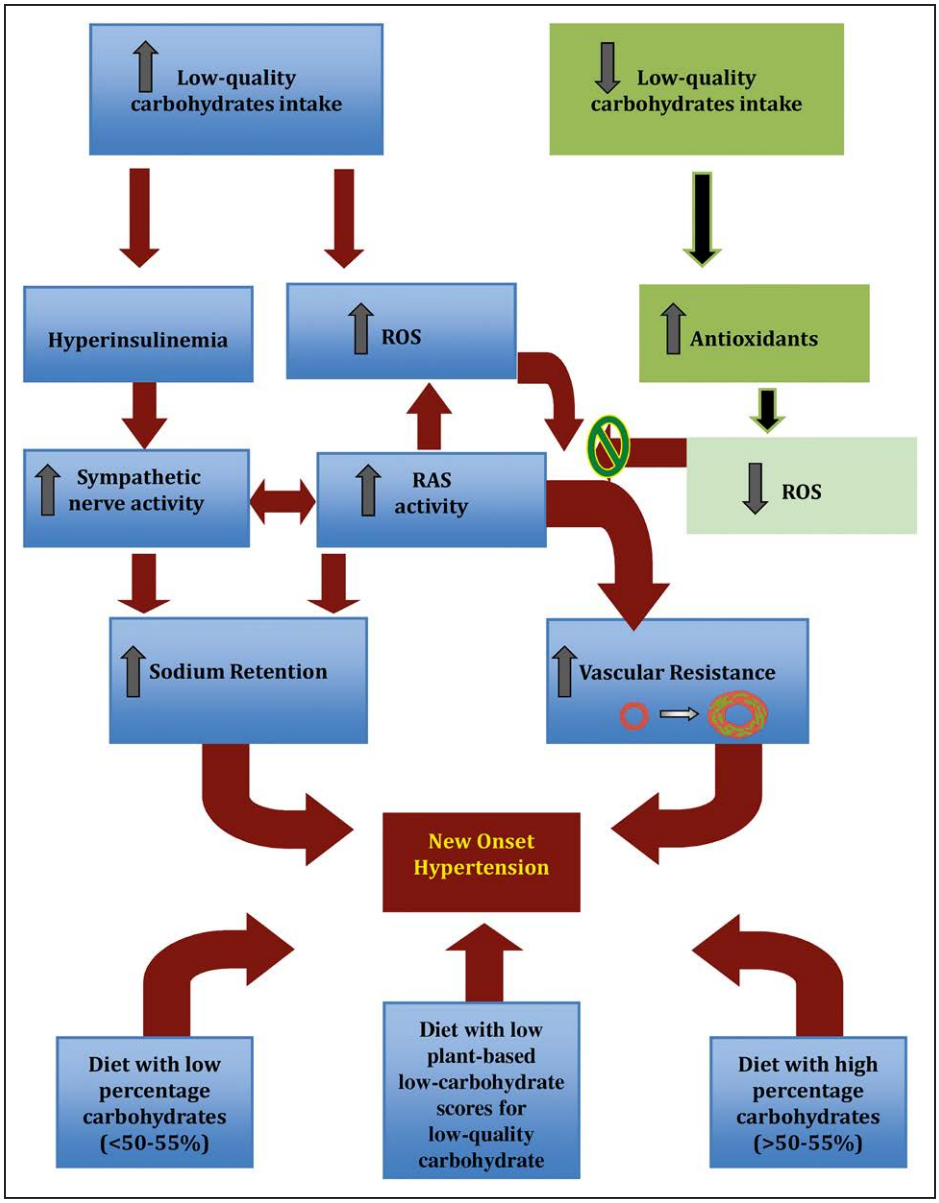

Figure. Role of quantity and quality of carbohydrates on new-onset hypertension.
RAS indicates renin-angiotensin system; and ROS, reactive oxygen species.

of carbohydrates on cardiovascular function are limited. Carbohydrate-containing foods may influence cardiometabolic risk and the development of chronic diseases in various ways according to the type of carbohydrate, and different mechanisms have been hypothesized (Figure). Viscous fibers (nonstarch polysaccharide carbohydrate derived from plant) and insoluble fibers (from wheat bran) have shown limited metabolic actions by reducing postprandial glycemia and cholesterol absorption. Moreover, foods containing high-quality carbohydrates (ie, nonstarchy vegetables, whole fruits, legumes, and whole-kernel grains) are effective for the prevention of chronic diseases development including hypertension as they contain also other micronutrients such as antioxidants and antinflammatory molecules which may exert a protective role in the cardiovascular system. Indeed, whole plant foods contain numerous compounds, including vitamins, minerals, antioxidant, and anti-inflammatory phytochemicals, which may interact with each other and exert beneficial actions in the cardiovascular system, possibly by modulating neurohormonal systems and vascular remodeling (Figure). In particular, high potassium, antioxidants, and fiber contents in some fruits, vegetables, and grains may contribute to reduce blood pressure levels and to prevent/improve hypertension-related organ damage (ie, coronary heart disease, ischemic stroke).[8,9] Hence, the carbohydrate quality seems to have a more important impact on population health as compared to the carbohydrate amount,[10] although further long-term clinical trials and prospective observational research

as well as in vitro and in vivo mechanistic studies are required. Indeed, these studies might possibly contribute to further extend the knowledge and clarify the influence of dietary carbohydrates on hypertension risk and the circadian pattern of blood pressure as well as to elucidate the underlying mechanisms including the potential interaction with the intestinal microbiome.

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The study from Li et al[5] presents also other few limitations that need to be highlighted and taken into account for future prospective studies. In particular, although most of the related variables (including age, sex, education, body mass index, self-reported diabetes, and cardiovascular diseases) have been included in the regression models, the stratified analysis showed that age did not significantly modify the association between dietary carbohydrate intake and new-onset hypertension, which is possibly due to the fact that only a single group of age (ie, young-adult population) was studied. Moreover, the putative roles of ethnicity and familiarity (ie, genetic predisposition) as well as the effect of carbohydrates on different metabolic variables (including insulin resistance and hyperglycemia which can contribute to hypertension development) were not properly addressed. Hence the effect of age, ethnicity, familiarity, and diet-induced metabolic alterations on hypertension development should be carefully investigated in future prospective studies which should include different ethnic and age groups to evaluate the potential impact of age and racial/ethnic differences on the influence of dietary carbohydrates in hypertension. Finally, additional aspects that need further consideration in clinical and effectiveness studies are related to the assessment of economic and environmental impacts of diet on different population, including the behavioral and environmental factors, such as food availability and affordability, that may affect the compliance to dietary treatment and therefore may have an impact on cardiovascular prevention.

ARTICLE INFORMATION

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REFERENCES

1. Greenlund KJ, Daviglus ML, Croft JB. Differences in healthy lifestyle characteristics between adults with prehypertension and normal blood pressure. *J Hypertens.* 2009;27:955–962. doi: 10.1097/HJH.0b013e32832926fb
2. Seidelmann SB, Claggett B, Cheng S, Henglin M, Shah A, Steffen LM, Folsom AR, Rimm EB, Willett WC, Solomon SD. Dietary carbohydrate intake and mortality: a prospective cohort study and meta-analysis. *Lancet Public Health.* 2018;3:e419–e428. doi: 10.1016/S2468-2667(18)30135-X
3. Diamond DM, O'Neill BJ, Volek JS. Low carbohydrate diet: are concerns with saturated fat, lipids, and cardiovascular disease risk justified? *Curr Opin Endocrinol Diabetes Obes.* 2020;27:291–300. doi: 10.1097/MED.0000000000000568
4. Hardy DS, Garvin JT, Xu H. Carbohydrate quality, glycemic index, glycemic load and cardiometabolic risks in the US, Europe and Asia: a dose-response meta-analysis. *Nutr Metab Cardiovasc Dis.* 2020;30:853–871. doi: 10.1016/j.numecd.2019.12.050
5. Li Q, Liu C, Zhang S, Li R, Zhang Y, He P, Zhang Z, Liu M, Zhou C, Ye Z, et al. Dietary carbohydrate intake and new-onset hypertension: a nationwide color study in China. *Hypertension.* 2021;78:422–430. doi: 10.1161/HYPERTENSIONAHA.120.16751
6. Chan Q, Stamler J, Griep LM, Daviglus ML, Horn LV, Elliott P. An update on nutrients and blood pressure. *J Atheroscler Thromb.* 2016;23:276–289. doi: 10.5551/jat.30000
7. Ascherio A, Hennekens C, Willett WC, Sacks F, Rosner B, Manson J, Witteman J, Stampfer MJ. Prospective study of nutritional factors, blood pressure, and hypertension among US women. *Hypertension.* 1996;27:1065–1072. doi: 10.1161/01.hyp.27.5.1065
8. Whelton SP, Hyre AD, Pedersen B, Yi Y, Whelton PK, He J. Effect of dietary fiber intake on blood pressure: a meta-analysis of randomized, controlled clinical trials. *J Hypertens.* 2005;23:475–481. doi: 10.1097/01.hjh.0000160199.51158.cf
9. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Cutler JA, Windhauser MM, et al. A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. *N Engl J Med.* 1997;336:1117–1124. doi: 10.1056/NEJM199704173361601
10. Reynolds A, Mann J, Cummings J, Winter N, Mete E, Te Morenga L. Carbohydrate quality and human health: a series of systematic reviews and meta-analyses. *Lancet.* 2019;393:434–445. doi: 10.1016/S0140-6736(18)31809-9