



Carbohydrate quality is key for a healthy and sustainable diet

Gabriele Riccardi and Giuseppina Costabile

The quality of carbohydrate-rich foods rather than quantity has the strongest effect on major health outcomes. Systematic reviews and meta-analyses of prospective studies report lower mortality and reduced incidence of cardiovascular diseases, type 2 diabetes mellitus and colorectal cancer in people who habitually consume diets rich in fibre and whole grain.

Refers to Reynolds, A. et al. Carbohydrate quality and human health: a series of systematic reviews and meta-analyses. *Lancet* 393, 434–445 (2019).

The debate regarding the optimal amount of dietary carbohydrate has intrigued scientists and policy makers for decades, and does not seem to be close to an end¹. Unfortunately, very often, the dispute does not consider the different health effects of the various carbohydrate foods; this can lead to an inaccurate interpretation of the epidemiological evidence, thus inappropriately promoting the reduction of all carbohydrate-rich foods in the habitual diet, meddling beans and greens along with soft drinks and white bread². The present paper by Andrew Reynolds and colleagues contributes important elements that add clarity to this controversial issue, and supports, with strong epidemiological evidence, the concept that the quality of carbohydrate-rich foods rather than their quantity has the strongest effect on the development of major health outcomes³. In fact, their paper is based on systematic reviews and meta-analyses of prospective studies that report the relationship between the most widely studied indicators of carbohydrate quality (that is, dietary fibre, whole grain and dietary glycaemic index) and incidence of, and mortality from, a wide range of non-communicable diseases (NCDs). Moreover, they evaluated evidence from clinical trials to assess the effect of these indicators on relevant cardiometabolic risk factors.

Reynolds and colleagues report a 15–30% decrease in all-cause and cardiovascular-related mortality and in the incidence of coronary heart disease, stroke, type 2 diabetes mellitus and colorectal cancer between the highest and the lowest dietary fibre intake.

The greatest risk reductions in these NCDs were observed for individuals with a daily fibre consumption of 25–29 g, largely provided by cereal fibre. Accordingly, similar relationships with major health outcomes were demonstrated for the consumption of whole-grain foods — the habitual consumption of 40–50 g whole grain per day was associated with considerable risk reduction of ~20–30% for several NCDs, with significant dose–response relationships. Smaller or no risk reductions were found when the glycaemic index or glycaemic load of the habitual diet was considered; nevertheless, in agreement with previous meta-analyses, there was a statistically significant reduction in the incidence of type 2 diabetes mellitus (by 11%) in individuals who consumed a diet with a lower glycaemic index as compared with those who consumed a diet with a higher glycaemic index. The lack of significant associations between glycaemic index and other health outcomes does not necessarily imply the absence of relevant biological relationships and could be linked to methodological problems (too few events, high measurement variability, inadequate dietary assessment, modest variations within populations and interaction with other dietary constituents).

“The greatest risk reductions ... were observed for individuals with a daily fibre consumption of 25–29 g”

Unfortunately, the strong epidemiological evidence on the health relevance of carbohydrate quality is not fully supported by the results of randomized controlled trials (RCTs). In fact, so far, no trial has ever been performed on the effect of dietary fibre, whole grain or glycaemic index on clinical events. In addition, almost all the available RCTs on cardiometabolic risk factors show either very small or no effect on body weight, plasma cholesterol values, blood pressure and glycated haemoglobin^{3–6}. Moreover, as the completed trials were short term and mostly based on small sample sizes, they do not help clarify whether any effect would be maintained or even enhanced over time. Hence, the very strong associations between dietary carbohydrate quality and health outcomes in epidemiological studies are not fully justified by the results of intervention studies on disease risk factors. Other body functions (that is, composition of the gut microbiota, postprandial energy and metabolic fluxes) that are probably modulated by carbohydrate quality have not yet been fully evaluated⁴.

The lack of support from RCTs, however, does not negate the validity of the observational data, particularly in view of their consistency, strength and linkage by dose–response relationships with health markers, as well as the plausibility of the underlying mechanisms. In fact, concerns about causality cannot necessarily be removed by RCTs, as for outcomes such as cancer and cardiovascular diseases, it can take decades of follow-up and, based on previous studies, long-term adherence to assigned diets is usually poor⁷. Perhaps, looking back to previous studies on lifestyle interventions, such a trial might be attempted in a population at risk for type 2 diabetes mellitus, in view of the possibly shorter follow-up time needed.

For the time being, until there is an evidence base consisting of adequately timed and powered RCTs, recommendations and policy decisions need to be based on the best global available evidence. In this respect, the results of the study by Reynolds and colleagues concord with current literature, which fully supports their conclusions that the intake of total dietary fibre by the adult population should increase from the present usual consumption of <20 g per day for most individuals, to at least 25–29 g per day. Replacing, albeit partially, refined grains with whole grains would

Table 1 | Major sources of carbohydrate and fibre in the universal healthy reference diet

Type of carbohydrate-rich food	Daily intake (g)	Carbohydrate (g)	Fibre (g)	Energy (kcal)
Whole grains (for example, rice, wheat and corn)	232	174	18	811
Potatoes	50	9	1	39
Vegetables	300	17	7	75
Fruit	200	29	5	126
Pulses	50	24	13	172
Nuts	50	10	4	291
Total	–	263	48	1514

These are the global scientific targets of consumption necessary for human health of carbohydrate-rich foods (including their approximate energy, carbohydrate and fibre content) for an energy intake of 2500 kcal per day, as proposed by an expert panel. To prevent environmental degradation due to food production, these values should not be exceeded¹⁰. Following this dietary pattern would enable individuals to reach the intakes of fibre and whole grain identified in the paper by Reynolds et al. as relevant to decrease the risk of NCDs and, possibly, lower the dietary glycaemic index³. These quantities would be achieved even if whole grain represents half of the cereal intake.

help reach this target; this would be appropriate also in view of the strong and reproducible association between whole grain and reduced risk of major NCDs. A further contribution to this goal could come from fruit and vegetables³. Consumption of these foods at the population level is low — more than one-third of the population in most Western countries do not habitually consume whole-grain foods and <10% achieve the recommended intake of 48 g per day⁸.

Against this background, suitable changes in dietary behaviours should be implemented to achieve a substantial reduction in NCDs. Inappropriate dietary habits account for as much as 22.4% of all deaths and 49.2% of cardiovascular deaths in Europe; among them, >50% are attributable to a diet low in dietary fibre, whole grain, vegetables, legumes

and fruit⁹. A shift in dietary behaviours, with emphasis on carbohydrate quality, would translate into food choices that can maximally benefit not only people's health but also the health of our planet¹⁰ (TABLE 1). In fact, food production is among the largest drivers of land and water use, carbon dioxide emissions and other environmental risks, including reduced biodiversity. The targets for a universal healthy reference diet, which was proposed by an authoritative panel in 2019 (REF.¹⁰) to reduce the ecological impact of the food system, clearly indicate that a sustainable diet cannot reasonably be low in carbohydrate, and that healthy carbohydrate foods would be the cornerstone of such a diet (TABLE 1). The endorsement of carbohydrate quality by health professionals and policy makers will contribute to the transformation of the global

food system towards the provision of healthful and sustainable foods for all the present and future inhabitants of the earth¹⁰.

Gabriele Riccardi* and Giuseppina Costabile

Diabetes, Nutrition and Metabolism research group,
Department of Clinical Medicine and Surgery,
Federico II University, Naples, Italy.

*e-mail: riccardi@unina.it

<https://doi.org/10.1038/s41574-019-0190-x>

- Ludwig, D. S. et al. Dietary fat: from foe to friend? *Science* **362**, 764–770 (2018).
- Dehghan, M. et al. Associations of fats and carbohydrate intake with cardiovascular disease and mortality in 18 countries from five continents (PURE): a prospective cohort study. *Lancet* **390**, 2050–2062 (2017).
- Reynolds, A. et al. Carbohydrate quality and human health: a series of systematic reviews and meta-analyses. *Lancet* **393**, 434–445 (2019).
- Della Pepa, G. et al. Whole grain intake and risk of type 2 diabetes: evidence from epidemiological and intervention studies. *Nutrients* **10**, 1288 (2018).
- Kelly, S. A. et al. Whole grain cereals for the primary or secondary prevention of cardiovascular disease. *Cochrane Database Syst. Rev.* **8**, CD005051 (2017).
- Clar, C. et al. Low glycaemic index diets for the prevention of cardiovascular disease. *Cochrane Database Syst. Rev.* **7**, CD004467 (2017).
- Hu, F. B. & Willett, W. C. Current and future landscape of nutritional epidemiologic research. *JAMA* **320**, 2073–2074 (2018).
- Ferruzzi, M. G. et al. Developing a standard definition of whole-grain foods for dietary recommendations: summary report of a multidisciplinary expert roundtable discussion. *Adv. Nutr.* **5**, 164–176 (2014).
- Meier, T. et al. Cardiovascular mortality attributable to dietary risk factors in 51 countries in the WHO European Region from 1990 to 2016: a systematic analysis of the Global Burden of Disease Study. *Eur. J. Epidemiol.* **34**, 37–55 (2019).
- Willett, W. et al. Food in the anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *Lancet* **393**, 447–492 (2019).

Acknowledgements

The expert linguistic revision of R. Scala is gratefully acknowledged.

Competing interests

G.R. is member of the Scientific Advisory Board of the Barilla Center for Food and Nutrition Foundation and of the Health & Wellbeing Advisory Board of Barilla Company.