

## Dietary carbohydrate intake and mortality: reflections and reactions

### Authors' reply

We appreciate the interest in our work. We found that in long-term observational studies, low carbohydrate dietary intake (<40% of total energy from carbohydrates) was associated with higher mortality when animal-based fat and protein were substituted for carbohydrate.<sup>1</sup> However, when plant-based sources of fat and protein such as whole grains, legumes, and nuts are incorporated into low carbohydrate diets, they were associated with lower mortality. We fully acknowledge the limitations of observational studies, while recognising the difficulties associated with long-term randomised trials in the area. For example, the large Women's Health Initiative trial was largely uninformative because of poor adherence to the assigned diets as indicated by lack of difference in biomarkers sensitive to dietary fat.<sup>2</sup>

We agree that our findings should be considered within the context of previous work, including both observational data<sup>3,4</sup> and randomised trials,<sup>5</sup> and these strongly support better blood lipid patterns and lower risks of cardiometabolic disease and premature death with consumption of plant-based foods compared with animal-based foods. It is also essential to recognise that our study assessed long-term dietary patterns and outcomes in a predominantly healthy community population; we did not study prescribed diets to treat obesity or specific diseases. We also did not evaluate very-low carbohydrate diets (5–10% of energy) because so few participants in a general population consume such diets: the available evidence on these diets is limited to short-term studies, many of them without a control group.

We provided additional details on regression and quintile results in

our Article's appendix.<sup>1</sup> As we noted, the food frequency questionnaire used in the Atherosclerosis Risk in Communities study was designed to capture eating patterns over the course of a year, and a similar questionnaire has been formally validated<sup>6</sup> by comparison with weighed and measured food intake. Although that questionnaire underestimated total energy intake, adjustment of specific nutrients for it provides values with good validity and that have predicted biomarkers of diet and disease risks in hundreds of published studies.

Recall of diet inevitably includes some error; however, bias with respect to the outcome was avoided by the prospective design. We observed no association between carbohydrate intake and change in bodyweight at 3-year and 6-year intervals, as noted in table 1 of our Article,<sup>1</sup> which is similar to the overall results of randomised trials. We adjusted for waist-to-hip ratio with no meaningful difference in the overall association, as did many of the studies included in our Article's meta-analysis. We did not exclude participants with heart disease, diabetes, and stroke from the primary analysis, but this exclusion was performed in the sensitivity analysis provided in the appendix. Finally, we acknowledge the problems of residual confounding, as with any observational data.

In conclusion, we reiterate that it is not enough to focus on carbohydrates alone, but to consider the types of food replacing them. This area is important for further research.

We declare no competing interests.

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