EDITORIAL

Attributing Death to Diet
Precision Counts

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A substantial body of evidence has implicated several aspects of diet with the occurrence of cardiometabolic disease (CMD)—heart disease, stroke, and type 2 diabetes. Dietary factors studied have included individual nutrients (macronutrients, micronutrients, minerals, vitamins, electrolytes, and phytochemicals), foods, and overall dietary patterns. It is generally accepted that a suboptimal diet is causally related to CMD, but scientists debate which factors are responsible and the relative importance of each factor given the challenges of isolating and estimating the potential effects of individual nutrients and foods, especially in observational studies. Another topic that is receiving considerably more attention is estimating the fraction of preventable deaths due to suboptimal diet and other factors. Policy makers, in particular, are eager to understand the total burden of CMD that may be attributable to suboptimal diet, given that modification of diet is a cornerstone of prevention policy.[1]

Related article page 912

In this issue of *JAMA*, Micha and colleagues[2] used comparative risk assessment models, leveraging multiple data sources including nationally representative data on population demographics, dietary habits, and mortality, to approximate the number and fraction of CMD deaths in the United States related to suboptimal diet. The authors estimated that 318 656 (45.4%) of CMD deaths in the United States in 2012 were associated with 10 dietary factors that they deemed to have "probable or convincing evidence" for causality with heart disease, stroke, diabetes, or systolic blood pressure. The highest proportion of CMD deaths was estimated to be related to excess sodium intake (9.5% of CMD deaths); the other 9 factors were low intake of nuts and seeds (8.5%), high intake of processed meats (8.2%), low seafood omega-3 fats (7.8%), low vegetables (7.6%), low fruits (7.5%), high sugar-sweetened beverages (7.4%), low whole grains (5.9%), low polyunsaturated fats (2.3%), and high unprocessed red meats (0.4%).

A notable finding was that the fraction of CMD deaths associated with diet differed across important subgroups. A greater fraction of mortality from diet was observed among men compared with women, among blacks and Hispanics compared with whites, and among adults with low education compared with those with high education. The authors also report that the fraction of deaths related to these dietary factors changed from 2002 to 2012 (deaths declined for high sugar-sweetened beverages, low polyunsaturated fats, and low whole grains), and these trends differed by demographic strata (eg, the proportion of deaths related to high sodium disproportionately increased over time for blacks). Such results reinforce the importance of improving diet quality as a means to achieve health equity.

The findings reported by Micha and colleagues have the potential to guide policy makers in planning public health nutrition interventions that not only could help prevent CMD deaths but also could reduce health disparities. However, several aspects of the study methods and findings require careful evaluation.

First, calculations of population-attributable fraction rely on a critical assumption—namely, that exposure-outcome relationships are causal. For diet, strong evidence from large-scale, long-term randomized trials with hard clinical outcomes is rarely available and will likely never be for each of the factors studied. Relying on evidence from observational studies alone—for which the authors have done for fruits, vegetables, nuts/seeds, whole grains, red meats, processed meats, sugar-sweetened beverages, and polyunsaturated fatty acids—carries the potential limitation of confounding bias. Even though the estimated measures of association were based on data from multiple prospective cohort studies that used multivariable adjustment for "other risk factors," the effect of confounding could be substantial. Potential sources of confounding include other highly correlated dietary factors; nondietary factors, particularly socioeconomic factors and physical activity, which are notoriously difficult to measure; and the overall dietary pattern. For instance, it is possible that processed meat consumption merely reflects a Westernized dietary pattern.

A second matter is whether the 10 selected factors are the right set or whether some other dietary factors should be included and others removed. For example, should saturated fat have been included among the dietary factors? Randomized trials conducted decades ago demonstrated that replacement of saturated fat with polyunsaturated vegetable oil reduced cardiovascular disease events by 18% to 41%.[3-8] Arguments could also be made for the inclusion of *trans* fat reduction, sugar reduction, and increased potassium intake. In contrast, many CMD prevention experts might argue that the effects of nuts and seeds (second highest) are overestimated. Decisions about which and how many factors to include are critical. Summation of single risk factors is valid only under limited conditions, and the population-attributable fraction inevitably increases with the number of dietary factors included; for instance, adding an 11th factor would increase the attributable fraction beyond that of the 10th factor.[9,10]

A third and related issue is the extent to which the dietary factors are interrelated and modified by each other. In

the DASH-Sodium Trial, the effects of the DASH dietary pattern and low sodium had significant, subadditive effects on blood pressure.[11] Although superadditivity (when the effect of the whole is greater than the sum of individual factors) is also a possibility, there is limited empirical evidence in support of this phenomenon. Micha et al attempted to address interdependency by modeling the potential joint influence of dietary factors. Their final estimation of 318 656 CMD deaths associated with the 10 dietary factors is 70% of the 457 930 CMD deaths that would be estimated to result if all deaths from each individual factor were summed without weights. But does 30% subadditivity fully account for the overlap of the dietary factors included? What components of processed meats might contribute to its 8.1% attributable fraction, if not for sodium (80% of which comes from processed foods[12]) or components of red meat, which were already accounted for in the model? An alternative approach, albeit challenging, would be to estimate in the original cohorts the risk associated with each dietary factor in multivariable models while simultaneously adjusting for the other factors and including interaction terms when necessary to allow for the possibility of effect modification (subadditivity or superadditivity).

Accordingly, the precision of the estimates reported by Micha et al should be interpreted cautiously given that the excess fraction of CMD deaths related to suboptimal diet relies on the strong assumption of causality, the number of factors included and accurate estimation of their effect size, and the extent to which each of the factors interact with each other on risk of CMD. Moreover, the 95% confidence intervals around the estimates should be also be interpreted cautiously because these values represent boundaries from their analytic model.

Despite these limitations and concerns, the study by Micha et al is quite relevant to public health nutrition policy, a critically important issue both in the United States and around the world. As the authors suggest, policies that affect diet quality, not just quantity, are needed. Policy decisions should also consider accessibility to and costs of components of a healthier diet, sustainability in the United States and on a global scale, and the potential environmental effects of their recommendations (eg, the implications of increased consumption of seafood omega-3 fatty acids for the preservation of fish stocks[13,14]).

In conclusion, the findings reported by Micha et al appear correct—a substantial proportion of CMD deaths are associated with suboptimal diet, and improving diet quality could help prevent a large fraction of CMD deaths and reduce health disparities. There is some precedence, such as from trials of the Mediterranean diet plus supplemental foods, that modification of diet can reduce cardiovascular disease risk by 30%[15] to 70%.[16] Yet estimation of downstream benefits is complex and imprecise. Whether the authors overestimated or underestimated the potential effects of improved diet, the likely benefits are substantial and justify policies designed to improve diet quality.

ARTICLE INFORMATION

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