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Dietary Assessment and the Reliability of Nutritional Epidemiology Research Reports

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It is a pleasure to comment on the valuable article by Dahm et al. (1) in this issue of the Journal and to provide my perspective on research needs and opportunities for progress in the challenging nutritional epidemiology research area. In doing so, I would like to first offer a tribute to the late Dr Sheila Rodwell (Bingham), senior author of the article by Dahm et al. For some decades, Dr Bingham provided cutting-edge research on nutritional biomarkers and dietary assessment methodologies and on related epidemiological

associations. Her diverse contributions have been vital to progress in the nutritional epidemiological research area, and her leadership will be much missed.

Dahm et al. (1) revisit the association between dietary fiber and risk of colorectal cancer in the context of an analysis of data from seven prospective UK cohort studies, with the novel feature that fiber consumption estimates are available from food diaries (also referred to as food records [FRs]). Whereas dietary

assessment in cohort studies of this and other nutritional epidemiology topics has almost universally been based on data obtained from food-frequency questionnaires (FFQs), a few cohorts have also collected dietary data by using FRs. The analysis of FRs for nutrient consumption and dietary pattern estimation is somewhat time-consuming and expensive so that some form of outcome-based sampling is needed for efficient association analyses. On the basis of data from 579 colorectal cancer case patients and 1996 matched control subjects, the authors report a statistically significant inverse association between intakes of either absolute fiber or fiber intake density (ie, the ratio of fiber to energy), as estimated from 4- to 7-day FRs, and the risk of colorectal cancer, particularly the risk of colon cancer. This inverse association was not apparent when fiber consumption, in the same case and control subjects, was estimated using an FFQ. This finding is consistent with earlier cohort study reports wherein risk of breast cancer was positively associated with fat consumption when assessment was based on FRs, whereas no association was apparent when assessment was based on FFQs (2,3).

Dahm et al. comment that, "Although food diaries are probably better dietary assessment tools than FFQs, they do not completely eliminate measurement error." In fact, the measurement properties of FRs, FFQs, and other dietary self-report procedures are largely unknown for most nutrients and dietary components, and uncertainty about such properties is the fundamental issue that separates the reliability of most reported nutritional epidemiological associations from that for many other well-established epidemiological risk factors and exposures. The fact that two conceptually different dietary assessment methods yielded results of differing interpretation does not, in itself, attest to the reliability of either. Rather, these findings point to the need to rigorously address the measurement error issue for progress in nutritional epidemiology.

To support their assertion that FRs are probably better than FFQs for dietary assessment, Dahm et al. refer to their studies of protein, sodium, and potassium intakes in which FR estimates of these nutrients correlated more strongly with corresponding urinary recovery biomarkers than did FFQ estimates. This is valuable information, but there is no established biomarker for fiber consumption, obviating the ability to directly compare measurement properties for the two assessment procedures and precluding a compelling way to adjust fiber consumption odds ratios for measurement error.

To address this limitation, Dahm et al. present "corrected" odds ratios for fiber consumption assuming a classical measurement error model, with little change in findings. Commendably, they also provide corrected sensitivity analyses that allow the measurement error to depend on the underlying (unobserved) fiber consumption while permitting the measurement errors for repeat application of the same assessment procedure to be correlated. These analyses also suggest little change in odds ratios for fiber consumption, using either FRs or FFQs. Although these measurement error provisions go beyond those typically presented in nutritional epidemiology reports, they still leave considerable uncertainty about the reliability and interpretation of the fiber and colorectal cancer association. This uncertainty is augmented by the

absence of support from the cited intervention trials of colorectal adenoma recurrence [eg, (4,5)].

Although measurement error modeling issues in nutritional epidemiology may seem esoteric to some readers, these issues appear to be fundamental to the reliability of dietary association reports. Specifically, available information indicates that individuals tend to report dietary data quite differently depending on such characteristics as age, body mass index, and ethnicity, at least for FFQ assessments of energy and protein (6). These types of systematic assessment biases can play havoc with association studies: In one of the few nutritional epidemiology study published to date that made provision for these types of systematic biases, FFQ-assessed energy consumption among postmenopausal women was unrelated to the incidence of total invasive cancer or site-specific cancer, whereas after energy consumption was corrected using a doubly labeled water biomarker, strong positive associations were evident for total cancer and for various cancer sites, including breast, colon, endometrium, and kidney (7). Also, FFQ-assessed protein density was not associated with total invasive cancer incidence before biomarker calibration but inversely associated after biomarker calibration (7), with protein assessed by a urinary nitrogen biomarker. The fact that Dahm et al. could not correct the fiber consumption odds ratios for these types of systematic biases casts a shadow over the interpretation of their reported inverse association.

Unfortunately, this shadow extends to virtually the entire body of the existing nutritional epidemiology literature and may well contribute to the fact that few associations between diet and cancer are regarded as established or probable (8). The explicit use of biomarkers to correct nutritional epidemiology associations for systematic and random measurement error in dietary assessment seems a logical next step in the nutritional epidemiology research agenda. Measurement error procedures that instead use one self-reported estimate to correct another are unlikely to be adequate because the availability of consumption estimates with measurement errors that are independent of those for the self-report estimates available for the study cohort is key to the correction procedure, and differing self-report assessment procedures can be expected to have some common sources of systematic bias. Instead, a major research effort is needed, using human feeding studies and other strategies, to develop suitable consumption biomarkers for additional nutrients and dietary components. The need for a vigorous and innovative research agenda to yield reliable information on diet and chronic disease risk seems imperative, given our ongoing epidemic of obesity and of obesity-related diseases.

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