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Twentieth-century trends in essential fatty acid intakes and the predicted omega-3 index: evidence versus estimates

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Twentieth-century trends in essential fatty acid intakes and the predicted omega-3 index: evidence versus estimates[1–3]

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Although the health benefits of omega-3 (n–3) fatty acids are widely appreciated, those of the omega-6 (n–6) fatty acids have become somewhat controversial in recent years, with some viewing them as harmful at current intakes (1, 2) and others (3) [including the American Heart Association (4)] supporting the status quo. Understanding the relations between intakes of these essential fatty acids and disease prevalence over time could inform the debate. To that end, this issue of the Journal contains a report by Blasbalg et al (5) that attempts to reconstruct those intakes and, from this information, to estimate fatty acid tissue content (eg, the Omega-3 Index [red blood cell eicosapentaenoic plus docosahexaenoic acid (EPA+DHA) (6)]). Low concentrations of the latter have been linked to increased risk of total mortality (7), cellular aging (8), depression (9), and acute coronary syndromes (10).

In reconstructing historical intakes, Blasbalg et al (5) used US Department of Agriculture (USDA) commodity disappearance data and made multiple assumptions and estimations regarding, for example, the completeness of USDA food and nutrient databases, the extent of wastage, the considerable differences in the amount and types of foods shipped in from outside of the United States (which would be particularly true for seafood), the proportions consumed by people (as opposed to animals or used for industrial purposes), and so forth. The USDA/Center for Nutrition Policy and Promotion approach used by these authors assumes that the fatty acid content of various foods did not change over the second half of the 20th century. In fact, many meat products, fats and oils (which were subjected to varying degrees of hydrogenation), and processed foods containing everchanging blends of commodity oils entered the food supply during this time. Consequently, Blasbalg et al's reported intakes of both short-chain [α-linolenic acid (ALA) and linoleic acid (LA)] and long-chain, highly unsaturated fatty acids (HUFAs) of the n−6 and n−3 series cannot easily be independently verified and must remain as rough estimates only.

One way to gauge the accuracy of their estimates, however, is to compare them with published data from others obtained by different approaches. For example, Taylor et al (11) reported fatty acid intake data from the late 1980s in 234,426 individuals in the Nurses' Health Studies (NHS) and in the Health Professionals Follow-Up Study. In addition, Sun et al (12) reported dietary fatty acid composition in a small ($n = 306$) subset of women in the NHS. Both studies used the Willett food-

TABLE 1

Comparison of 1989 fatty acid intakes measured in Sun et al (12) and Taylor et al (11) by the Willett food-frequency questionnaire and those estimated by Blasbalg et al (5) from food disappearance data[1]

Fatty acid	Blasbalg et al (5)	Sun et al (12)	Taylor et al (11)
Linoleic (% of energy)	7.5	5.21	4.5
α-Linolenic (% of energy)	0.63	0.52	NA
Linoleic:α-linolenic ratio	11:1	10:1	NA
Eicosapentaenoic (% of energy)	0.01	0.04	0.09
Docosahexaenoic (% of energy)	0.02	0.08	
Arachidonic (% of energy)	0.055	0.07	NA

[1] NA, not available.

frequency questionnaire (FFQ) to estimate fatty acid intakes. They (like Blasbalg et al) based their analysis primarily on the USDA nutrient databases, which are not always complete or up-to-date but are the gold standard for diet surveys. (These databases use direct analysis for some foods, assume literature values for others, impute values for still others, and formulate generic recipes for many processed foods.) Importantly, Sun et al also measured the fatty acid composition of red blood cells from which the Omega-3 Index could be determined. The Sun et al study thus affords an opportunity to evaluate 2 of the 1989 estimations made by Blasbalg et al: fatty acid intakes and the Omega-3 Index [calculated by Blasbalg et al by using the Lands equation (1)].

The relations between Blasbalg et al's estimated intakes and reported intakes in both Sun et al (12) and Taylor et al (11) are shown in **Table 1**. For AA, ALA, and the LA:AA ratios, there was relatively good agreement. However, LA intake was overestimated in the former by ≈45%, and intakes of EPA and
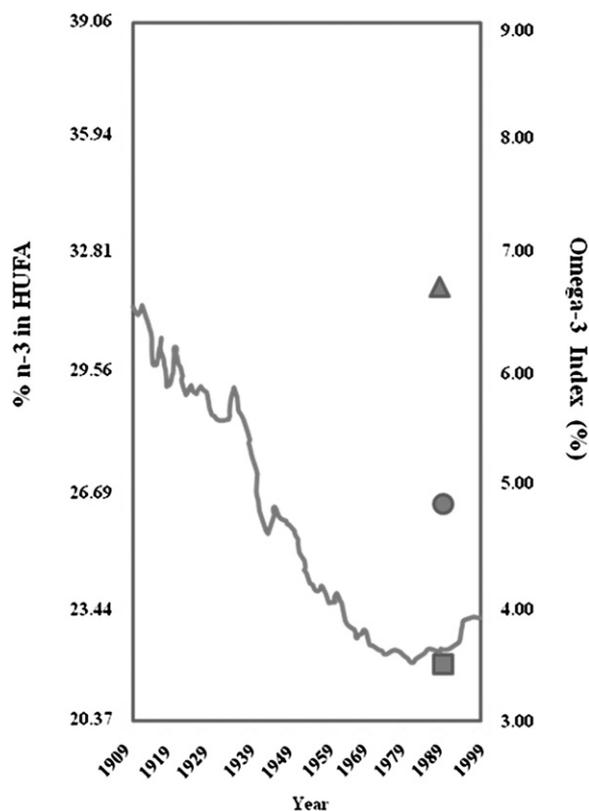
FIGURE 1. Data from the Nurses' Health Study [collected in 1989 and reported by Sun et al (12)] were used to test the estimations of Blasbalg et al (5). ▲, the predicted Omega-3 Index from the Lands equation based on known fatty acid intake in Sun et al (12); ●, the reported Omega-3 Index in Sun et al (12); ■, the Blasbalg et al (5) predicted Omega-3 Index based on their 1989 estimated fatty acid intakes. HUFA, highly unsaturated fatty acids.

DHA were underestimated by 3–4-fold. When the intake estimates of Blasbalg et al (5) for LA and EPA+DHA are compared with the reported intakes by Taylor et al (11), the estimates were markedly higher and lower, respectively, than those reported. Because all of these authors used the same USDA databases, differences in estimated intakes between them cannot be attributed to the use of different databases.

There are also problems with the predicted Omega-3 Index [Figure 8 in Blasbalg et al (5)] derived from presumed fatty acid intakes. This calculation is made by entering fatty acid intakes into the Lands equation (provided in spreadsheet form as "mgSIMPLE-1.xls" and downloaded from http://efaeducation.nih.gov/sig/food.html). This equation returns a value for $n-6$ HUFAs as a percentage of total HUFAs. The $n-3$ HUFAs as a percentage of total HUFAs are calculated simply as 1 – the $n-6$ value. Blasbalg et al describe the $n–3$ HUFA metric as being related to the Omega-3 Index in a "linear and robust" manner via a regression equation published by Lands (13). The estimated Omega-3 Index was ≈3.5% in 1989 according to Blasbalg et al (5). This was 28% lower than the 4.9% actually observed in Sun et al (12).

To test how well fatty acid intakes translate into the Omega-3 Index, data from Sun et al (12) were entered (as a percentage of energy) into mgSIMPLE-1. The predicted value (6.15%) was 40% higher than that observed (4.86%), which itself was ≈39% higher than that predicted by Blasbalg et al from food disappearance data (≈3.5%) (**Figure 1**). Therefore, Blasbalg et al did not match the observed Omega-3 Index in this cohort because both their assumed fatty acid intakes and the equation used to estimate the Omega-3 Index are flawed.

We know the limitations of routinely used databases and diet surveys; here, we have a different approach that may have the potential to give us better information about foods consumed sporadically or of unknown fatty acid content, but the limits of this data set for predicting fatty acid consumption are unclear. Although this is an interesting exercise in collating food disappearance data, the inescapable uncertainties inherent in both the data and in the extrapolations to tissue compositions used by Blasbalg et al infuse more confusion than information into the field. It would be unfortunate indeed if these estimations were viewed as facts and used in future publications to draw conclusions regarding diet and disease relations across the 20th century.

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