National Cancer Institute

Usual Dietary Intakes: The NCI Method

Risk Factor Monitoring and Methods Branch
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In collaboration with staff at the US Department of Agriculture's Center for Nutrition Policy and Promotion, the National Cancer Institute (NCI) has developed a method to estimate usual dietary intakes of foods and nutrients. This method can be used for a variety of applications, including estimating:

- the distribution of usual food or nutrient intake for a population or subpopulation;

- individual food or nutrient intake for use in a disease model; and

- the effects of individual covariates on food or nutrient consumption.

The premise of the NCI method is that usual intake is equal to the probability of consumption on a given day times the average amount consumed on a "consumption day." The exact methods used for dietary components that are consumed nearly every day by nearly everyone differ slightly from those used for dietary components that are not. In general, the former category refers to nutrients and the latter category refers to foods.

For foods, a two-part model with correlated person-specific effects is used to model these components. The first part of the model estimates the probability of consuming a food using logistic regression with a person-specific random effect. The second part of the model specifies the consumption-day amount using linear regression on a transformed scale, also with a person-specific effect.

Parts I and II are then linked by allowing the two person-specific effects to be correlated and by including common covariates in both parts of the model. Intake data from 24-hour recalls provide the values for the dependent variable, while average daily intake estimated from a food frequency questionnaire (FFQ) may be incorporated as one of the covariates. The resulting estimated model parameters can then be used to estimate the final products, depending on the application of interest.

For nutrients, the process is the same, except that the probability part of the model is not needed because the probability is assumed to be 1.

Has the NCI Method Been Validated?

Evidence for the validity of the method, as it relates to estimating the distribution of usual intakes of foods, has been published through a series of papers in *the Journal of the American Dietetic Association*. Analyses establishing the method's validity for estimating the distribution of usual intakes of nutrients and for estimating usual intakes for use in a regression analysis, e.g. to examine relationships between diet and health, are being finalized. Publications are in process.

What Part Does the Frequency Instrument Play in the NCI Method? Under What Circumstances Is It Helpful?

The NCI method involves using two or more 24-hour recalls as well as covariates, which may include data from an FFQ such as the NHANES 2003-2006 Food Frequency Questionnaire (formerly called the Food Propensity Questionnaire). A frequency instrument can substantially improve the power to detect relationships between dietary intakes and other variables. The magnitude of improvement depends on the specific food or nutrient in question and the population under study. For some dietary constituents and some populations, improvement may be modest.

When applying the method to estimate usual intake distributions, satisfactory results can generally be obtained without the FFQ as a covariate. However, there are conditions under which the FFQ may help -- particularly for estimating the tails of the distributions.

How Does the NCI Method Compare to Other Methods?

Other methods have been proposed to estimate either the distribution of usual intakes or individual-level usual nutrient intake for use in epidemiologic analyses. These previous methods have some limitations, and they have used different assumptions depending on whether they were designed for surveillance or epidemiologic applications. To date, no other unified methods that estimate usual food intake from 24-hour recall data have been available that are:

- appropriate for use in both surveillance and epidemiologic analyses; and

- designed to address previous limitations.

Two methods have been used to estimate the distribution of usual intake of foods with a few days of 24-hour recalls. The simplest of these, using the within-person mean, usually leads to biased estimates of the prevalence of either inadequate or excess food intake. This is because this method does not:

- account for reported days without consumption of a food group or for consumption-day amounts that are positively skewed;

- distinguish within-person from between-person variation;

- allow for the correlation between the probability of consuming a food and the consumption-day amount; or

- relate covariate information to usual intake.

The other method for estimating the distribution of foods, which was developed at Iowa State University and uses modeling, meets most of the challenges noted in the previous paragraph. However, it does not allow for correlation between probability and amount, and it cannot incorporate covariate information regarding usual intake.

The NCI method was designed to meet all of these challenges. As established by Tooze et al., the NCI method is an improvement over the ISU method in two ways: it is applicable in situations in which the ISU method is not, and it allows efficient estimation of usual food intake distributions for subpopulations.

NHANES analyses relating food intake to health outcomes in regression analyses have generally used reported intakes in place of estimated usual intakes. This approach, although simple to execute, is known to lead to biased estimation of risks. The NCI method is expected to improve on this approach.

Further Information

Importance of Estimating Usual Intakes

Freedman LS, Midthune D, Carroll RJ, Krebs-Smith S, Subar AF, Troiano RP, Dodd K, Schatzkin A, Bingham SA, Ferrari P, Kipnis V. Adjustments to improve the estimation of usual dietary intake distributions in the population. *J Nutr* 2004 Jul;134(7):1836-43. Erratum in: *J Nutr* 2005 Jun;135(6):1524.

Basiotis PJ, Welsh SO, Cronin FJ, Kelsay JL, and Mertz W. Number of days of food intake records required to estimate individual and group nutrient intakes with defined confidence. *J Nutr* 1987; 117:1638-1641.

Review of Other Methods

Dodd KW, Guenther PM, Freedman LS, Subar AF, Kipnis V, Midthune D, Tooze JA, Krebs-Smith SM. Statistical methods for estimating usual intake of nutrients and foods: a review of the theory. *J Am Diet Assoc* 2006 Oct;106(10):1640-50. Review.

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Subar AF, Dodd KW, Guenther PM, Kipnis V, Midthune D, McDowell M, Tooze JA, Freedman LS, Krebs-Smith SM. The food propensity questionnaire: concept, development, and validation for use as a covariate in a model to estimate usual food intake. *J Am Diet Assoc* 2006 Oct;106(10):1556-63.

Tooze JA, Midthune D, Dodd KW, Freedman LS, Krebs-Smith SM, Subar AF, Guenther PM, Carroll RJ, Kipnis V. A new statistical method for estimating the usual intake of episodically consumed foods with application to their distribution. *J Am Diet Assoc* 2006 Oct;106(10):1575-87.

Go to http://riskfactor.cancer.gov/diet/usualintakes/ for further details about the NCI method, SAS macros for running the method, tables of food intakes for the US population, and a copy of the 2003-2006 NHANES FFQ.