



Assessing vitamin D contents in foods and supplements: challenges and needs¹⁻⁴

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ABSTRACT

Scientists need specific data on the amounts of vitamin D in foods and dietary supplements to facilitate the assessment of vitamin D dietary intake. This vitamin is available in foods both naturally and from fortification. The Nutrient Data Laboratory of the US Department of Agriculture (USDA) is collaborating with vitamin D experts to review and develop methods for analyzing the vitamin D content of foods and to use these methods to analyze the vitamin D content of certain foods and dietary supplements. In this article, we review existing sources of vitamin D data on foods and dietary supplements, describe the USDA's Dietary Supplements Ingredients Database, and discuss the development of the USDA's vitamin D database for foods. In addition, we define the challenges and needs related to providing updated data on the vitamin D content of foods and supplements. After we analyze the vitamin D content of these food samples, we will disseminate the current values in the National Nutrient Database for Standard Reference (Internet: <http://www.ars.usda.gov/nutrientdata>). *Am J Clin Nutr* 2008;88(suppl):551S-3S.

INTRODUCTION

Recently, assessing vitamin D intake has become increasingly important because of the growing recognition that humans might not form adequate supplies of vitamin D from exposure to sunlight alone. Because several factors (such as clothing, skin color, and latitude) can impair sunlight-induced cutaneous vitamin D synthesis, many people must rely on dietary sources to satisfy their vitamin D requirements (1). Vitamin D occurs naturally in a limited number of foods, including various fish species, such as salmon and herring (2). In the United States, manufacturers add vitamin D to certain foods, including fluid milk, calcium-fortified orange juice, margarine and other spreads, and breakfast cereals. In addition, manufacturers sometimes add this nutrient to dairy products other than milk, such as yogurt and American cheese slices, as well as macaroni products.

To support vitamin D intake research, researchers must collect current and accurate vitamin D₂ and vitamin D₃ data for foods and dietary supplements and investigate the variability in vitamin D content in different foods. Recently, US Department of Agriculture (USDA) scientists began expanding the USDA database on vitamin D in foods and dietary supplements by adding current values. Details on this project are available elsewhere in this supplement (3).

The objectives of this report were to review existing sources of vitamin D data on foods and dietary supplements, describe the

Dietary Supplements Ingredients Database, and discuss the development of the USDA's vitamin D database for foods. In addition, we define the challenges and needs related to providing updated data on the vitamin D content of foods and supplements.

THE USDA'S NATIONAL NUTRIENT DATABASE FOR STANDARD REFERENCE

The USDA's Nutrient Data Laboratory develops and maintains the National Nutrient Database for Standard Reference and related data products (4). The database is the authoritative source of food-composition data for the United States. Currently, the database contains values for up to 140 different components of >7500 formulated and processed foods and agricultural commodities. A subset of the database provides the foundation for the Food and Nutrient Database for Dietary Studies, which supports the continuous nationwide federal food consumption survey, What We Eat in America, which is the dietary intake interview component of the National Health and Nutrition Examination Survey (NHANES; 5). The USDA collaborates with the Office of Dietary Supplements, the Food Composition and Methods Development Laboratory, the National Institute of Standards and Technology, the Food and Drug Administration, and the Beverage Institute for Health and Wellness in developing its vitamin D composition databases.

VITAMIN D VALUES IN THE USDA NATIONAL NUTRIENT DATABASE FOR STANDARD REFERENCE

Release 20 of the USDA National Nutrient Database for Standard Reference (SR20) contains vitamin D values, expressed in IU/100 g, for ≈600 foods (4). Holden et al (6) describe the sources and distribution of these data. However, SR20 does not

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yet include values for foods that manufacturers have only recently fortified with vitamin D. Also, values for specific forms of vitamin D are not available in the database. Finally, the availability of data for only 600 foods limits the usefulness and applicability of the vitamin D dataset for dietary intake studies.

THE NATIONAL FOOD AND NUTRIENT ANALYSIS PROGRAM

In 1997, the Nutrient Data Laboratory developed the National Food and Nutrient Analysis Program under an interagency agreement between the US National Institutes of Health (NIH) and the USDA. The program's purpose is to generate new analytic data on up to 140 nutritional components in highly consumed foods and to disseminate updated data to the research community through the laboratory's Web site. The Nutrient Data Laboratory has used many of the standard protocols developed under this program to select and analyze foods for vitamin D content (7–9). The Nutrient Data Laboratory collaborates with the National Cancer Institute, the Office of Dietary Supplements, and other NIH institutes and centers to address shared research goals concerning food and dietary supplement composition.

Once scientists identified vitamin D as a critical nutrient for National Food and Nutrient Analysis Program analysis, the program needed to plan and initiate the major steps required to develop an expanded database of estimates for vitamin D content in foods. Holden et al (6) have described these steps.

The scientific community recognizes that in addition to requiring data on vitamin D values in foods, it needs values for dietary supplements. Reports from the NHANES What We Eat in America survey indicate that ≈50% of the US population takes dietary supplements; therefore, the amount of vitamin D in supplements could contribute significantly to total dietary intake. Scientists therefore need to determine total nutrient intake from dietary supplements as well as from foods. The Nutrient Data Laboratory and several collaborators are estimating vitamin D content in foods and dietary supplements in parallel projects.

CURRENT CHALLENGES

The challenges in developing a complete vitamin D database for foods include the difficulty of measuring amounts of specific forms of vitamin D in foods, the need to estimate variability in vitamin D levels, and the requirement for calculation procedures to estimate vitamin D values in foods not analyzed. Estimating vitamin D content in unanalyzed foods requires collecting data on the vitamin D composition of the foods used as ingredients in these unanalyzed foods, as well as on the approximate weights of the ingredients and instructions for preparing the food.

The USDA developed separate sampling plans to address the various venues where people obtain dietary supplements, such as over the Internet. Quantitative data concerning market volume and locations where people purchase their dietary supplements are not readily available, but scientists must take these details into consideration when planning to sample dietary supplements. Therefore, USDA staff must obtain data on dietary supplements from various sources (such as market surveys), often at significant expense, and ascertaining the validity of these surveys is difficult.

We need to determine the vitamin D composition of dietary supplements that contain vitamin D. This might be especially

challenging as a result of the possible encapsulation of the vitamin to protect it from oxidation by certain minerals in the formulation mix.

Finally, monitoring the reformulation of specific products, such as margarine, which might be newly formulated to contain vitamin D, is difficult. To monitor reformulations, the Nutrient Data Laboratory must identify changes in the content of fortified products and develop a plan to update the corresponding data entries in the USDA's database. Updates are necessary to provide current estimates to the research community through the laboratory's website.

RESEARCH NEEDS

To support the development of a database containing the vitamin D values of products available on the market, laboratories must be qualified to analyze different forms of vitamin D in foods and dietary supplements. Analyzing different forms of vitamin D requires validated analytic methods and analytic reference materials for vitamin D. Guaranteed support for methods development and quality control program analytic work must be available to generate accurate and precise data, because existing methods lack specificity, sensitivity, and precision. Scientists therefore need to update or modify existing methods to increase their specificity, sensitivity, and precision. Developing a comprehensive program for generating original analytic data that are representative of the national food supply is costly (comparable with the costs of a research grant for human studies) because the chemistry is complex, food sampling and preparation is expensive, and compiling and estimating values is time-consuming and detailed work that requires state-of-the-art computer systems to maintain and disseminate the data and related documentation. After laboratories generate an adequate number of observations on the vitamin D content of foods and supplements, they must analyze the data by using appropriate statistical procedures to determine the significance of their findings before the USDA releases the data to the scientific community.

FUTURE PLANS

After the USDA analyzes the vitamin D amounts in all the food samples and reviews the results of these analyses, it will incorporate acceptable values for vitamin D₂ and D₃ content in foods into its National Nutrient Databank System. Scientists will be able to use these values to assess vitamin D intake. The USDA will also review the vitamin D values in the database that are not replaced by new values for currency and accuracy.

The USDA will populate the data on vitamin D in SR22 first with analytic values from USDA contractor analyses, the scientific literature, and data from the food industry. The agency will augment these data with values from the food industry (based on fortification levels) or the Nutrient Data Laboratory (from percent daily value food label declarations). The USDA will consult food industry representatives about the form of vitamin D they add to fortified foods.

When the USDA expands its vitamin D data to include all foods in the National Nutrient Database for Standard Reference subset developed for the USDA Food and Nutrient Database for Dietary Studies (FNDDS), the Nutrient Data Laboratory will calculate vitamin D values for foods not in the database by using



standard imputation procedures (10). These procedures will include calculating values based on the vitamin D content of similar foods and using appropriate concentration adjustments (depending, for example, on whether the food is in the form of a solid or a fat), basing calculations on a recipe or estimated formulation, or assigning an assumed value of zero (such as for most vegetables). Expansion of vitamin D data and subsequent transfer of this subset to the USDA's Food Surveys Research Group for use in developing the FNDDS will occur with SR22 (release data 2009).

Similarly, the USDA will modify its procedures for selecting and sampling dietary supplements to analyze their vitamin D levels. Qualified expert laboratories will generate the data on dietary supplements, analyze them statistically, and compile them so that the USDA can disseminate the final estimates through the Dietary Supplement Ingredient Database.

After the NHANES What We Eat in America survey collects data on vitamin D intake for the first time, the USDA will begin the formal process of developing a key foods list to provide more complete information for future updates. The key foods list includes ≈ 600 commonly consumed foods in the United States that contribute $\approx 75\%$ of the intake of ≈ 20 nutrients of public health significance (7). This approach is based on results from a combination of composition data and the USDA's food consumption data for the population estimates of intake. The USDA will monitor formulation changes in foods and dietary supplements that could affect vitamin D content as well as possible updates in federal nutrition policies regarding vitamin D. Based on this information, the USDA will use the same combination of composition and food consumption data to develop ranked lists of vitamin D contributors for future analysis. The USDA might identify additional foods for analysis based on their ranking in the key foods list for vitamin D and market share data.

The expansion and quality improvement of vitamin D values in the USDA National Nutrient Database for Standard Reference will provide accurate and current data to epidemiologists and other investigators so that they can better assess the adequacy of

dietary vitamin D intake in the US population. The results of these analytic studies will probably help resolve some of the outstanding questions about the apparent variability in vitamin D values in foods and dietary supplements.

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