

Computer Access to Research on Dietary Supplements: A Database of Federally Funded Dietary Supplement Research

Carol J. Haggans,¹ Karen S. Regan,* Lynda M. Brown,² Chunling Wang, Jim Krebs-Smith,* Paul M. Coates, and Christine A. Swanson

*Office of Dietary Supplements, National Institutes of Health, Bethesda, MD 20892-7517 and *Division of Nutrition Research Coordination, National Institutes of Health, Bethesda, MD 20892-5461*

ABSTRACT Dietary supplement use is prevalent in the United States, but support for supplement research has been relatively modest and only recently emphasized at the NIH. The Dietary Supplement Health and Education Act of 1994 led to the creation of the Office of Dietary Supplements (ODS) at the NIH to promote research on dietary supplements. In order to track federally funded dietary supplement research, the ODS developed a database known as Computer Access to Research on Dietary Supplements (CARDS). This article provides an overview of the development and potential uses of the CARDS database. In addition, we report that NIH-funded dietary supplement research steadily increased from fiscal year (FY) 1999 through 2002. The majority of NIH institutes or centers (ICs) funded research relevant to dietary supplements during this time, led by the National Cancer Institute and one of the newest NIH ICs, the National Center for Complementary and Alternative Medicine. CARDS data indicate that NIH-funded dietary supplement research from FY 1999 through 2002 involved primarily vitamins, minerals, botanicals and phytochemicals. Cancer and cardiovascular disease, two of the leading causes of morbidity and mortality in the United States, collectively accounted for almost 45% of the research related to dietary supplements. A variety of types of research studies were funded, with the majority consisting of human intervention studies. This information is useful to evaluate trends in federally funded dietary supplement research, identify research gaps, and help research scientists identify potential sources of NIH funding. *J. Nutr.* 135: 1796–1799, 2005.

KEY WORDS: • *dietary supplements* • *federally funded nutrition research* • *database resources*

Use of dietary supplements in the United States is widespread (1–3). The most recent National Health and Nutrition Examination Survey indicates that about half of the adult population regularly uses supplements, primarily vitamins and minerals (4). Essential nutrients, including vitamins and minerals, have been a major focus of nutrition research for decades. However, many other dietary supplements, such as botanicals, have received less attention. For several reasons, industry has little incentive to conduct research on dietary supplements (5,6), and until recently, federally funded research relevant to dietary supplements has been fragmented and relatively modest.

In 1994 the Dietary Supplement Health and Education Act authorized the establishment of the Office of Dietary Supplements (ODS)³ at the NIH to promote and coordinate scientific research on dietary supplements (7). ODS was also charged with the task of tracking all federally funded dietary

supplement research. In this article, we describe that effort and potential uses of the resulting public database known as Computer Access to Research on Dietary Supplements (CARDS) (8). In addition, we summarize research relevant to dietary supplements funded by NIH from fiscal year (FY) 1999 through 2002, the time period for which NIH data are currently available.

Development and description of CARDS

CARDS is populated with research projects supported by grants, cooperative agreements, contracts, and training awards that are included in another NIH-maintained database, the Human Nutrition Research and Information Management (HNRIM) system (9). HNRIM is a federal government-wide, online database created for the purpose of fiscal accounting, management, and control of a broad range of cross-agency nutrition research activities. In 1999 two new nutrition classification codes were added to HNRIM to identify for the first time research related to dietary supplements. These codes are “Dietary Supplements: Nutrient Ingredients” and “Dietary Supplements: Botanical and Other Non-nutrient Ingredients.” All HNRIM projects identified with these codes are downloaded to the CARDS database and classified in the following areas:

¹ To whom correspondence should be addressed.

E-mail: haggansc@od.nih.gov.

² Present address: Obesity Research Center, Department of Psychiatry, University of Cincinnati, Cincinnati, OH 45237.

³ Abbreviations used: CARDS, Computer Access to Research on Dietary Supplements; FY, fiscal year; HNRIM, Human Nutrition Research and Information Management; IC, institute or center; NCI, National Cancer Institute; ODS, Office of Dietary Supplements.

- Ingredient (e.g., folic acid, calcium, St. John's wort) or type of product (e.g., ergogenic aid, probiotic).
- Health outcome or biological effect (e.g., osteoporosis,⁴ immune modulation).
- Type of study (e.g., in vitro, clinical trial).
- Relevance of the research to dietary supplements (e.g., directly or indirectly related). For example, a clinical trial comparing bone density in women given a daily calcium supplement versus a placebo would be classified as *directly* related to dietary supplements. A study examining the activation of steroid hormone receptors by supplemental vitamin D in cell culture would be classified as *indirectly* related to dietary supplements because the direct physiological or health effects of vitamin D supplementation are not being studied.

In October 2001 CARDS was released with information about dietary supplement research funded by NIH in FY 1999. Research funded by NIH through FY 2002 has since been added, along with links to citations of scientific publications resulting from the research awards. Dietary supplement research funded by NIH in subsequent fiscal years and that funded by other federal agencies, such as the USDA, the FDA, and the Department of Defense, will be added in future database updates. CARDS is a database of federally funded research and does not contain information about research funded by nonfederal sources such as pharmaceutical companies, dietary supplement manufacturers, or nonprofit foundations.

CARDS can be used to sort and tabulate information for a variety of purposes. For example, the ODS may wish to identify possible overlaps or gaps in the scientific research on a particular ingredient used in dietary supplements. A scientist may want to know which NIH institute or center (IC) funds research on ingredients (e.g., vitamins, minerals, and botanicals) used in supplements or may want to locate scientific publications associated with the research included in CARDS. The media or consumers may be interested in learning whether the federal government is supporting research on popular dietary supplement ingredients such as (n-3) fatty acids. Instructions for searching CARDS are provided on the CARDS website.

The CARDS database has some limitations. Each NIH IC and federal agency required to identify nutrition research for inclusion in HNRIM is also asked to identify dietary supplement research and use one or both of the HNRIM dietary supplement codes. There is variability in compliance with reporting procedures, and inevitably some nutrition and/or dietary supplement projects are not identified for inclusion in HNRIM and thus CARDS. On the other hand, summary reports generated from CARDS in any given year may overstate the total number of research projects or expenditures. Many research projects are assigned to more than one area because they involve a number of supplement ingredients or more than one health outcome. In addition, some projects are funded by more than one NIH IC or federal agency. Thus, summing the number of projects or expenditures by area (e.g., supplement ingredients) will yield a value that exceeds the total number of projects or expenditures. For example, a project investigating the effects of both zinc and echinacea on the common cold would be counted once for the minerals category and once for the botanicals category. For these rea-

sons, CARDS is most valuable for evaluating trends in federally funded dietary supplement research and for providing information about individual projects. To avoid overstating financial information, data presented in this article are based on the number of projects only. Financial data other than broad NIH figures are not included.

NIH-funded dietary supplement research

The NIH annually invests >\$28 billion in medical research (10). Since FY 1999, obligations in support of nutrition research and training have comprised ~4% of all NIH IC obligations (11,12). The National Cancer Institute (NCI), the National Institute of Diabetes and Digestive and Kidney Diseases, and the National Heart, Lung, and Blood Institute led NIH ICs in nutrition research expenditures from FY 1999 through FY 2002, collectively accounting for almost two-thirds of the total NIH nutrition-related spending (11,12). In FY 2002, NIH obligations for nutrition research and training totaled ~\$917 million. Of this, \$108 million supported research on dietary supplement nutrient ingredients, and \$73 million supported research on dietary supplement botanical and other non-nutrient ingredients (11).

From FY 1999 through 2002 the number of NIH-funded dietary supplement-related research projects increased steadily from 374 to 569 projects/y, for a total of 1749 projects during the 4-y reporting period. Preliminary data indicate that this number will continue to increase for FY 2003. During each year, more than half of the research projects involved nutrient ingredients such as vitamins and minerals, with the remainder involving botanical and other non-nutrient ingredients such as herbs and phytochemicals.

Twenty NIH ICs contributed funding to dietary supplement-related projects from FY 1999 through FY 2002 (Table 1). The National Center for Complementary and Alternative Medicine and NCI led ICs in the number of funded projects, each accounting for ~20% of all NIH dietary supplement projects. Though ODS does not have direct grant-writing authority due to its status as an office within the Office of the Director at NIH, ODS cofunded 96 projects during the 4-y reporting period. In addition, ODS has cosponsored workshops

TABLE 1

Number of dietary supplement research projects funded by each NIH IC, FY 1999–2002¹

NIH IC	Projects	
	<i>n</i>	%
National Center for Complementary and Alternative Medicine	359	21
National Cancer Institute	347	20
National Institute of Diabetes and Digestive and Kidney Diseases	135	8
National Eye Institute	134	8
National Heart, Lung, and Blood Institute	133	8
National Institute of Child Health and Human Development	126	7
National Institute on Aging	89	5
National Center for Research Resources	86	5
Other ²	340	19

¹ Approximately 3% of the research projects were funded by more than one IC. For these projects, each IC's contribution is counted as 1 project.

² Includes 12 ICs, each funding <4% of the research projects.

⁴ Dietary supplement regulations stipulate that a supplement may not be marketed to diagnose, treat, cure, or prevent any disease (5). Research included in CARDS is not restricted by this definition because much federally funded dietary supplement research is disease-related.

TABLE 2

Dietary supplement ingredients investigated in NIH-funded dietary supplement research, FY 1999–2002¹

Ingredient	Projects	
	<i>n</i>	%
Vitamins and minerals	821	47
Botanicals ²	389	22
Phytochemicals, ³ excluding essential nutrients	336	19
Unspecified ⁴	178	10
Proteins and amino acids	144	8
Fatty acids and lipids	136	8
Hormones or their precursors	61	3
Dietary fiber and carbohydrates	18	1
Other ⁵	95	5

¹ Percentages are calculated using the total number of projects in CARDS from FY 1999 through 2002. Total exceeds 100% because projects may be assigned to more than one category.

² Includes herbs and other plants and plant parts, such as garlic.

³ Includes compounds isolated from plants, such as carotenoids and flavonoids.

⁴ Project abstract does not specify the dietary supplement ingredient(s) being investigated.

⁵ Includes other dietary supplements such as coenzyme Q10, glucosamine, shark cartilage, and probiotics.

and conferences to help define research directions in dietary supplements.

The FY 1999 through 2002 CARDS projects were tabulated to identify the various dietary supplement ingredients being investigated (Table 2). About 47% of all projects included *vitamins and minerals*. *Botanicals*, including herbs and other plants such as soy, were identified in ~22% of the

TABLE 3

Health outcome or biological effects investigated in NIH-funded dietary supplement research, FY 1999–2002¹

Outcome or effect	Projects	
	<i>n</i>	%
Cancer	482	28
Cardiovascular system	288	16
Immune function	162	9
Cognitive performance, nervous system, and psychological health	153	9
Women's reproductive health	151	9
Musculoskeletal system	150	9
Vision	147	8
Aging	140	8
Digestive and gastrointestinal systems and urinary system	131	7
Unspecified ²	63	4
Diabetes	61	3
Respiratory system	55	3
Nutrient requirements and metabolism	55	3
Other ³	313	18

¹ Percentages are calculated using the total number of projects in CARDS from FY 1999 through 2002. Total exceeds 100% because projects may be assigned to more than one category.

² Project abstract does not specify the health outcome or biological effect being investigated.

³ Includes 14 other areas of research, such as cellular, enzymatic, or molecular mechanisms; oral health and disease; dietary supplement/drug interactions; hematology; obesity; and eating disorders.

TABLE 4

Types of dietary supplement research studies funded by NIH, FY 1999–2002¹

Study type	Projects	
	<i>n</i>	%
Human intervention study	817	47
Animal study	395	23
In vitro study	326	19
Unspecified ²	252	14
Human observational study	153	9
Chemical analysis of foods or supplements	88	5
Scientific conference or education	40	2

¹ Percentages are calculated using the total number of projects in CARDS from FY 1999 through 2002. Total exceeds 100% because projects may be assigned to more than one category.

² Project abstract does not specify the study design.

projects, and *phytochemicals*, including plant-derived compounds such as carotenoids and flavonoids, were identified in ~19% of the projects. It should be noted that projects may be assigned to more than one category, so the percentages listed in the tables may total >100%.

A variety of health outcomes and biological effects were investigated in NIH-funded dietary supplement research (Table 3). About 28% of all projects were related to *cancer*, primarily prostate and breast cancer. About 16% of all projects were related to the *cardiovascular system*, primarily coronary heart or artery disease and atherosclerosis. The total number of projects (2351) in Table 3 far exceeds the 1749 projects funded during the 4-y reporting period, indicating that many of the research projects studied multiple health outcomes.

Finally, the FY 1999 through 2002 CARDS projects were tabulated to identify the various types of studies that were funded (Table 4). Almost half were *human intervention studies*, primarily clinical trials. *Animal studies* accounted for ~23%, and *in vitro studies* accounted for ~19% of all projects. About 5% of NIH-funded dietary supplement studies supported the chemical analysis of foods or supplements.

Ongoing development of CARDS

The development of CARDS is continuing. Data from FY 2003 and subsequent years as well as data from other federal agencies will be added as that information becomes available. In addition, feedback from users will help to formulate plans for enhancing the database. Notices of updates will be posted to the ODS website (13), which also provides a link to the CARDS database. As CARDS is updated and enhanced, its importance to research investigators, federal agencies, and other stakeholders in the dietary supplement community will continue to grow.

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LITERATURE CITED

1. Ervin, R. B., Wright, J. D. & Kennedy-Stephenson, J. (1999) Use of Dietary Supplements in the United States, 1988–94. National Center for Health Statistics. Vital and Health Statistics, Series 11, no. 244: 1–14.
2. Millen, A. E., Dodd, K. W. & Subar, A. F. (2004) Use of vitamin, mineral, nonvitamin, and nonmineral supplements in the United States: The 1987, 1992, and 2000 National Health Interview Survey results. *J. Am. Diet. Assoc.* 104: 942–950.
3. Schaffer, D. M., Gordon, N. P., Jensen, C. D. & Avins, A. L. (2003) Nonvitamin, nonmineral supplement use over a 12-month period by adult members of a large health maintenance organization. *J. Am. Diet. Assoc.* 103: 1500–1505.
4. Radimer, K., Bindewald, B., Hughes, J., Ervin, B., Swanson, C. & Picciano, M. F. (2004) Dietary supplement use by US adults: Data from the National Health and Nutrition Examination Survey, 1999–2000. *Am. J. Epidemiol.* 160: 339–349.
5. Overview of Dietary Supplements [Online]. Center for Food Safety and Applied Nutrition, U.S. Food and Drug Administration. <http://www.cfsan.fda.gov/~dms/ds-oview.html> [accessed June 24, 2004].
6. Katan, M. B. & de Roos, N. M. (2003) Public health. Toward evidence-based health claims for foods. *Science* 299: 206–207.
7. Dietary Supplement Health and Education Act of 1994 (1994) Public Law 103–417, 103rd Congress, 2nd session.
8. Computer Access to Research on Dietary Supplements (CARDS) Database [Online]. National Institutes of Health. <http://cards.nih.gov> [accessed April 18, 2005].
9. Human Nutrition Research Information Management (HNRIM) [Online]. National Institutes of Health. <http://hnrnim.nih.gov> [accessed April 18, 2005].
10. National Institutes of Health [Online]. National Institutes of Health. <http://www.nih.gov/about/NIHOverview.html> [accessed July 16, 2004].
11. Financial Report of NIH Biomedical Research and Training in Nutrition, FY 2002 [Online]. Human Nutrition Research and Information Management System database. http://hnrnim.nih.gov/Report/Nih02_rpt.pdf [accessed July 16, 2004].
12. Financial Report of NIH Biomedical Research and Training in Nutrition, FY 1999–2001 [Online]. Human Nutrition Research and Information Management System database. http://hnrnim.nih.gov/Report/Nih99_01rpt.pdf [accessed July 16, 2004].
13. Office of Dietary Supplements [Online]. National Institutes of Health. <http://dietary-supplements.info.nih.gov/> [accessed April 18, 2005].