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Development of a supplement composition database for the SURE Study

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Abstract

The Supplement Reporting (SURE) study is one of the first to systematically examine the accuracy of collection of dietary supplement use data for population-based studies of diet. In 2005–2007, the SURE study collected data from 444 participants in Hawaii and Los Angeles. Several methods of collecting data were compared, including an inventory of supplements, a recall, a daily diary, and a one-page supplement frequency questionnaire. Considerable effort was put into developing an extensive supplement composition database. To quantify intakes, we extended the existing supplement composition table (SCT) used at the Cancer Research Center of Hawaii. The original SCT contained default codes for multivitamin/multimineral products to be used when insufficient detail was available to assign an existing code. However, the default concept needed to be expanded for the SURE study to include additional multivitamin/multimineral default codes, as well as single nutrients and other components. Approximately 1800 new codes were created, including 211 new default codes. Roughly 130 nutrients and 870 other components were included in the SCT at the conclusion of the study. To accurately quantify intakes from supplements, it is crucial to maintain a comprehensive supplement composition database. Future improvements to our SCT include incorporation of analytic values from the US Department of Agriculture to replace composition data taken from supplement labels.

Keywords

Dietary supplements; Supplement database; Nutrient composition; Supplement composition; Multivitamins; Default values; SURE study; Food composition data; Food data management

1 Introduction

The use of dietary supplements appears to be a very common practice in the United States and as a result, is of increasing interest in studies of diet and health (Radimer, et al., 2004). More than half of the adults in the 1999–2000 NHANES survey reported taking at least one dietary supplement during the month prior to the interview (Radimer, et al., 2004). In addition, roughly 19% of adults in the Alternative Health/Complementary and Alternative

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Medicine supplement of the National Health Interview Survey (NHIS) reported consuming herbs/natural products within the past year (Barnes, et al., 2004). With the potential of dietary supplements to contribute a significant amount of nutrients and other components to the total diet, the collection of accurate use data is imperative. Although the accuracy of commonly used methods of assessing supplement use has previously been investigated (Ishihara, et al., 2001; Murphy, et al., 2002; Patterson, et al., 1998), the Supplement Reporting (SURE) study is one of the first to systematically examine the accuracy of collection of dietary supplement use data across a range of different methods. To accurately measure nutrient and other component intakes from these methods, an extensive supplement composition database was needed.

There have been few publications that actually document the development of a dietary supplement database. Dwyer et al. described a label-based dietary supplement database that was developed by the United States Department of Agriculture (USDA), the National Institutes of Health (NIH) Office of Dietary Supplements, and the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (CDC) (Dwyer, et al., 2003). Also within the United States, Dwyer et al. discussed the development of an analytically validated dietary supplement database, and Au et al. documented the conversion to a combined food and supplement database at the Cancer Research Center of Hawaii (Dwyer, et al., 2007; Au and Murphy, 2006). Internationally, Reinivuo et al. discussed updating the Finnish dietary supplement database and referred to the lack of guidelines on how to construct such a database (Reinivuo, et al., 2008). The purpose of this paper is to expand this information by documenting the development of a comprehensive dietary supplement database that has been used to support the SURE study.

2 Methods

2.1 The Hawaii-Los Angeles Multiethnic Cohort Study (MEC)

The Hawaii-Los Angeles Multiethnic Cohort (MEC) consists of 215,251 men and women aged 45–75 years (at cohort creation in 1993) residing in Hawaii and California (Los Angeles County) (Kolonel, et al., 2000). The major ethnicities represented include African-American, Latino, Japanese-American, Native Hawaiian, and Caucasian. Participants in the cohort filled out a food frequency questionnaire that included one page on use of different types of dietary supplements at baseline and in 2000–2007. The latest version is given in Fig. 1, where the use of three types of multivitamins and thirteen different single components were captured.

2.2 The Supplement Reporting (SURE) Study

In 2005–2007, the SURE study compared several methods of measuring dietary supplement use. Participants were randomly recruited from supplement users who were part of the MEC, and asked to complete five in-home visits, once every three months over the course of one year. During these visits, several methods of collecting supplement data were assessed, including a self-administered supplement frequency questionnaire (SFQ) and two open-ended methods: a recall of supplement use and a daily diary. A reference measure of supplement use was based on a quarterly inventory of supplement containers, which involved numbering all supplement containers in the participant's possession, counting the number of pills in each container, and noting when each had been finished. Out of 1,193 supplement users that were approached, 882 were eligible for the study and 444 agreed to participate in the study. The sample was stratified to include approximately equal numbers by sex and for six ethnic groups; Caucasians (19%), Japanese Americans (17%), and Native Hawaiians (15%) were recruited among cohort members residing on the island of Oahu in

Hawaii, and African Americans (18%) and Latinos both US born (18%) and non-US born (13%) were recruited among cohort members residing in Los Angeles County.

2.3 The Cancer Research Center of Hawaii's Supplement Composition Table

The Supplement Composition Table (SCT) of the Cancer Research Center of Hawaii (CRCH) is used to manage dietary supplement data in support of research projects. Each record corresponds to a specific supplement product, identified by a unique number. Brand and/or manufacturer information is used to define a unique multi-component supplement (i.e. anything containing more than one component). Dosage amounts are used to define unique single supplements (e.g. Vitamin C 500 mg). After updating the SCT for the SURE study, it currently houses more than 6,700 supplements, including 726 single nutrients, 545 multivitamins, 307 multimineral, 1,026 other component supplements, and 1,222 default codes. Of the 6,700 supplements in the CRCH SCT, 1425 have been discontinued. Up to 1,000 supplement components are currently carried on the SCT, including goji fruit, watermelon fruit extract, green tea powder, and pumpkin seed oil, as well as several different entries for ginseng. Data on supplement components are primarily taken from supplement labels, but can also be obtained from the Internet, product catalogs, the Physicians' Desk Reference (Thomson PDR, 2007), or by contacting supplement manufacturers/distributors. Updates to the SCT are done periodically to ensure formulations coincide with what is available in the current market.

2.4 Creating the Supplement Composition Table for the SURE Study

To quantify intakes of reported supplements for the SURE study, we extended the existing CRCH SCT to include additional multivitamin/multimineral, single nutrient, and other component supplements (including existing products with formulation changes) that were reported by the SURE participants. Almost all of the supplements reported in the SURE study were added to the database. Some had previously been entered for other studies, and a few for which we were unable to locate the supplement facts information were omitted. The original SCT contained default codes for multivitamin/multimineral products reported for the MEC, which could be used for the SURE study when insufficient detail was available to assign an existing code. However, the default concept needed to be expanded for the SURE study to include additional multivitamin/multimineral default codes, as well as single nutrients and other components. The same methodology used to create and assign nutrients to the multivitamin/multimineral default codes created for the MEC was utilized by the SURE study (Blitz, et al., 2005). Briefly, the default codes were linked to appropriate supplements based on similarities in name. Nutrient values were then calculated using a weighted average of the most commonly reported supplements that were similarly named. For example, the "Longs® Default B Complex" code was linked to the following products: Longs® Balanced B Complex Vitamin Supplement with C & E, Longs® Balanced B-100 B Complex Vitamins, Longs® B-50 B Complex Vitamin Supplement, Longs® Balanced B-150 High Potency B Complex Vitamins, and Longs® Balanced B-50 Time Release B Complex.

2.5 Default Amounts for the SFQ

In addition to the default codes that were created for the open-ended methods, default amounts were created for the SFQ. Default profile amounts for the three categories of multi-type supplements listed at the beginning of the SFQ had previously been calculated from an earlier survey of multivitamin use by MEC participants (Park, et al., 2006), but new default amounts for the single-type supplements were needed. These amounts were assigned according to the most frequently used single-type supplements reported by area (Hawaii and Los Angeles) in the SURE study. If greater than 75% of participants took a specified amount, that value was used as the default. If less than 75% of participants reported taking

any specified amount, a weighted average was used to determine the default. Only true singles (i.e. those without other components) were used to determine the amount for each single supplement. The SFQ asks about dosage ranges for vitamin C and vitamin E, but default amounts were still needed for those participants that did not indicate a range. The specific amounts assigned for the dosage ranges for these two vitamins were based on the most commonly reported amounts within the categories by area. Unlike the other singles listed on the SFQ, the single calcium and vitamin D line items include combination products; therefore single-type and combined supplements containing these nutrients were used in the assignment of their default amounts.

3 Results

SURE participants reported approximately 1,800 different supplements on the two open-ended methods and the reference inventory method during the 2-year data collection period, accounting for roughly one-fourth of the CRCH SCT database. Of that, 714 were multivitamin and mineral combinations, 287 single nutrient supplements, and 798 other component supplements. Included in these counts are a total of 262 default codes of which 211 were created specifically for the SURE study. The other 51 codes, which were originally created for the MEC, were used for the SURE study whenever applicable. Some examples of the most commonly assigned defaults listed by category are shown in Table 1.

The most commonly reported products from the two open-ended methods and the reference inventory method are listed in Table 2. Products are defined by the product name, and for single nutrients, also by the dose (amount). After summing the number of unique supplement products reported by each participant, we determined that a total of 4,156 products were reported during the SURE study. A single vitamin E 400 IU (no particular brand) was the most commonly reported supplement followed by Centrum® Silver®, a proprietary multivitamin with minerals that is marketed to adults over 50 years of age. In addition, we categorized all supplements reported for the SURE study into 66 different supplement types based on product name and ingredient content. When categorized into one of these types, the most commonly reported from the two open-ended methods and the reference inventory method was a One-a-day with minerals type, which was reported 611 times (Table 3).

Default values for single supplements on the SFQ are shown in Table 4 (separately for HI and LA). The values were the same in both locations for several of the nutrients, but differed for others such as calcium and vitamin D. For example, we found that most participants in Hawaii took a calcium supplement that contained vitamin D, whereas those in Los Angeles took a single calcium supplement. The difference in the vitamin D amount can be attributed to a high level reported by one of the participants in Los Angeles. If this participant were excluded from the analysis, the Vitamin D amount would have been 400 IU.

4 Discussion

The supplement information collected from the SURE Study allowed us to expand the CRCH SCT database beyond the multi-type or single nutrient supplements that were previously captured. We were able to obtain information about herbal and other non-nutrient supplements that individuals are taking, which will provide for a more comprehensive SCT database. The expanded SCT will also permit a better estimate of the intakes of the many nutrient and non-nutrient ingredients in dietary supplements, and facilitate study of their associations with health-related outcomes. However, developing and maintaining a supplement database is a time-consuming task. We estimate that the CRCH dietitians spent at least 10 hours per week for six months adding new data to our existing supplement

database to reflect products reported by SURE participants. The process of adding default values utilized an additional 10–12 hours per week for several additional months. This reinforces the need for a national SCT, especially one with more analytic data.

Incomplete information provided by participants is a common problem in surveys. Although only 7% of the codes used for the SURE study interviewer-administered recalls required default codes, a much larger percentage of reported supplements is likely to be incomplete when using self-administered methods. For example, Blitz et al. noted that 24% of supplement items on the MEC follow-up questionnaire were assigned default codes as a result of incomplete questionnaire responses (Blitz, et al., 2005).

Insufficient or missing brand, product, and dosage information can impact the accuracy of the data that is collected. For example, in this relatively small study of 444 individuals, 714 different multivitamin and mineral combinations were reported. If these exposures are incorrectly estimated, associations with health outcomes may be attenuated, and thus more difficult to detect. If no default values are assumed, then missing data could seriously decrease the power to detect associations. As would be expected, assigning a default nutrient profile provides a better estimate of nutrient intake than assuming no supplement was consumed (Blitz, et al., 2005). Furthermore, Park et al. found that well-defined multiple-default values can rank nutrient intakes more correctly within the study population (Park, et al., 2006). In their study, the use of specific default codes allowed for greater accuracy when estimating nutrient intake from supplements, compared to the use of only a general multivitamin or multivitamin with minerals default.

However, it can be a challenge to identify a large number of default nutrient profiles in a timely manner. Because the default codes were to be linked to products actually reported by SURE study participants, work on the linkages could only begin after the data entry for the entire study was complete. This extended the length of time to develop the full supplement composition table beyond that originally estimated.

It is unclear whether other researchers have faced similar challenges in developing supplement composition tables. Dwyer et al. have discussed the challenges involved in finding suitable product information for supplements for which labels were unavailable or which contained insufficient information (Dwyer, et al., 2003). We found that sometimes the labels only contained ingredient names and no amounts. Additionally, a few products were from foreign countries and were difficult to track down in the United States. As more analytic data for supplement components becomes available, it is our hope that the dependency on supplement labels for information will decrease.

5 Conclusion

Dietary supplement use is of increasing interest in studies of diet and health. To accurately quantify intakes from supplements, it is crucial to both collect detailed information from participants and maintain a comprehensive supplement composition database. Future improvements to the CRCH SCT will include incorporation of analytic values from the US Department of Agriculture as they become available to replace composition data taken from supplement labels.

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[illegible]

Fig. 1.

Table 1

The 5 most commonly assigned default codes within 3 categories of supplements used in the SURE study.

Default name by category ^a	Frequency ^b
One-a-day type with minerals	
Kirkland Signature™ default Multivitamin	17
Default one a day	10
Default multivitamin & multimineral	6
Default daily vitamin	6
Kirkland Ssignature™ default multivitamin with mineral	5
Single calcium	
Default calcium	7
Kirkland Signature™ default calcium	5
Default coral calcium	2
Default Tums®	2
Origin® default calcium	2
Fish oil	
Kirkland Signature™ default fish oil	13
Default fish oil	9
Nature made® default fish oil 1200 mg	6
Default fish omega 3	4
Default cod liver oil	3

^aOut of 262 total default codes. Default names indicate if the default is used for a brand/manufacuturer (e.g. Kirkland Signature™ default) or for a type of supplement (e.g. default one a day) (see Blitz et al., 2006).

^bNumber of participants assigned this default (out of 444 total inventory participants).

Table 2

Top 13 most commonly reported supplement products on the recalls, diaries, and inventories.

Supplement product	Frequency ^a	%
Vitamin E 400 IU	124	6.9
Centrum® Silver®	97	5.4
Vitamin C 500 mg	96	5.3
Fish oil 1000 mg	88	4.9
Kirkland Signature™ daily multivitamin & minerals	54	2.9
Vitamin B-12 500 mcg	42	2.3
Kirkland Signature™ Calcium 500 mg with D	36	1.9
Kirkland Signature™ Mature Adults Daily Multivitamin & Minerals	36	1.9
Vitamin C 1000 mg	33	1.8
Calcium 500 mg	33	1.8
Centrum®	33	1.8
Folic acid 400 mcg	30	1.7
Nature made® super B-complex with Vitamin C (with Folic Acid)	28	1.6

^a Out of 1804 unique supplement products reported.

Table 3

Top 16 most commonly reported supplement types on the recalls, diaries, and inventories.

Supplement type	Frequency ^a	%
One-a-day with mineral type	611	14.7
Bone type (calcium plus other components)	472	11.3
Joint supplements (glucosamine, chondroitin)	370	8.9
Fish oil	293	7
Vitamin C	271	6.5
Stress or B-vitamin type	200	4.8
Other multi-type	188	4.5
Vitamin E	182	4.4
Calcium	109	2.6
Vitamin B-12	101	2.4
Garlic	92	2.2
Fruit or vegetable extract or concentrate	73	1.8
Enzymes	56	1.3
Folic acid	51	1.2
Coenzyme Q-10	50	1.2
Flaxseed	45	1

^aOut of 4156 supplements reported by 444 participants.

Table 4

Default values for single supplements on the SFQ by site.

Nutrient	Reported frequency	Reported amount	Default amount (HI)	Default amount (L/A)
Vitamin A	>0	NA ^a	8000 IU	8000 IU
Beta-carotene	>0	NA	25,000 IU	10,000 IU
Vitamin C	>0	Blank	250 mg	250 mg
	>0	250 mg or less	250 mg	250 mg
	>0	300–500 mg	400 mg	400 mg
	>0	600–1000 mg	800 mg	800 mg
	>0	1000 mg or more	1000 mg	1000 mg
Vitamin E	>0	Blank	200 IU	200 IU
	>0	200 IU or less	200 IU	200 IU
	>0	250–400 IU	400 IU	400 IU
	>0	450–1000 IU	1000 IU	1000 IU
	>0	1000 IU or more	1000 IU	1000 IU
Folic Acid, Folate	>0	NA	800 mcg	800 mcg
Vitamin B-12	>0	NA	700 mcg	850 mcg
Vitamin D	Vitamin D > 0	NA	400 IU	2700 IU
	Both calcium and vitamin D > 0	NA	200 IU vitamin D 500 mg calcium	200 IU vitamin D 500 mg calcium
Calcium	Calcium > 0	NA	200 IU vitamin D 500 mg calcium	500 mg calcium
	Both calcium and vitamin D > 0	NA	200 IU vitamin D 500 mg calcium	200 IU vitamin D 500 mg calcium
Selenium	>0	NA	200 mcg	160 mcg
Iron	>0	NA	65 mg	45 mg
Zinc	>0	NA	55 mg	35 mg
Fish oil or omega-3 fatty acids	>0	NA	1000 mg	1050 mg
Garlic	>0	NA	500 mg	530 mg

^aNA = Not applicable.