Levels of the Antioxidant Nutrients, Vitamin C, Vitamin E, and Selenium in the Dietary Supplement Ingredient Database: NHANES Data Applications

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DSID Dietary Supplement Ingredient Database A U.S. Government Initiative

Abstract

Laboratory evidence indicates that antioxidants may slow or possibly prevent the development of certain cancers by protecting cells from damage caused by free radicals or other mechanisms. Many dietary supplements containing antioxidant constituents (e.g., vitamin C) are available to consumers. The Nutrient Data Laboratory (NDL), Beltsville Human Nutrition Research Center (BHNRC), part of the USDA Agricultural Research Service, working with the Office of Dietary Supplements, NIH, and other federal agencies, has developed a Dietary Supplement Ingredient Database (DSID) to estimate levels of ingredients in dietary supplement products. The first release of the DSID (DSID-1) provides data regarding predicted analytical levels for 18 nutrients in adult multivitamin/multiminerals (MVMs) which are linked with National Health and Nutrition Examination Survey (NHANES) dietary supplement data. DSID-1 data are available at http://dietarysupplementdatabase.usda.nih.gov.[1] For DSID-1, multiple lots of more than 100 representative products were collected from various retail and direct sales channels and chemically analyzed for their nutrient content. The analytical values were compared to labeled values and the percentage differences between the two values were calculated for each nutrient. These results were analyzed by regression techniques. The derived prediction equations showed linear relationships for the antioxidant nutrients vitamin C, vitamin E, and selenium over the respective ranges studied. Prediction equations were applied to labeled nutrient levels for adult MVM products reported in the NHANES 2003-06. The predicted mean %-difference-from-label ranged from 7.7% to 8.5% for vitamin C, -0.12% to 6.5% for vitamin E, and 22% to 26% for selenium. DSID-1 provides researchers with data for 18 nutrients, including these antioxidant nutrients, to allow for a more accurate estimation of these constituents in diets.

Key Words: Dietary Supplement, Dietary Supplement Ingredient Database, Vitamin C, Vitamin E, Selenium, NHANES, Antioxidant

Introduction

Epidemiological studies indicate that a diet high in fruits and vegetables, which are rich in antioxidants, is associated with delayed aging, prevention of cardiovascular diseases, and a lower risk of cancer[2]. In addition to antioxidants found in conventional foods, a large number of supplements containing antioxidant ingredients are available in the marketplace. In order to provide analytically based data regarding content of antioxidants and other ingredients in dietary supplements (DS), the Nutrient Data Laboratory (NDL), Beltsville Human Nutrition Research Center (BHNRC), Agricultural Research Service (ARS), USDA, has been working with the Office of Dietary Supplements (ODS) at the National Institutes of Health (NIH) and other federal agencies to develop a Dietary Supplement Ingredient Database (DSID) to evaluate dietary supplement products. The DSID is funded, in large part, by the ODS.

NDL recently analyzed samples of representative adult MVMs to determine levels of 18 nutrients. MVM products (n = 3 or more vitamins) were studied due to their high prevalence when compared to other supplements. For this presentation, predicted levels and variability measures for common levels of three antioxidant nutrients, vitamin C, vitamin E, and selenium in adult multivitamin/multimineral (MVMs) from DSID-1 are reported. In addition, applications of the DSID-1 data, including predicted values for adult MVMs reported in NHANES dietary supplement files[3], are demonstrated.

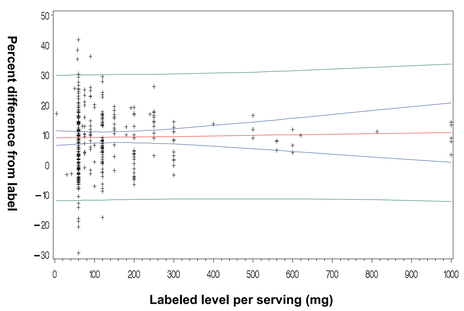
Methods and Materials

Over 100 representative adult MVM products were collected from 6 U. S. regions via various retail and direct sales channels to obtain multiple lots. Samples were chemically analyzed for their nutrient content using validated methods of analysis and certified reference materials. The analytical values were compared to labeled values, and the percent differences between the two values were calculated for each nutrient. These results were then analyzed by statistical regression techniques and a prediction equation was developed for each nutrient using SAS[4]. In addition, standard errors (SE) of mean and observation for each nutrient were calculated at each labeled level within the analyzed regression range. The results were applied to NHANES DS 2003-06 files. These data were released as the Dietary Supplement Ingredient Database, Release 1 (DSID-1) in April 2009 at http://dietarysupplementdatabase.usda.nih.gov. The DSID-1 files contain: 1) final regression analysis data for 18 nutrients in adult MVMs and 2) applications of these data for the nutrients and labeled levels of adult MVM products reported in NHANES 2003-06.

Results

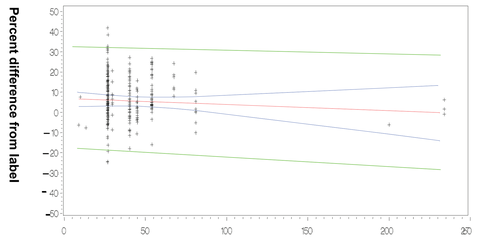
The results for predicted mean percent-differences-from-label varied by nutrient and nutrient level. The derived prediction equations showed linear relationships for the antioxidant nutrients vitamin C, vitamin E, and selenium over the respective ranges studied. The predicted percent differences from label for these nutrients were determined by statistical regression analysis and are shown in Figures 1-3 (red lines) and Table 1, column 7. The predicted amounts per serving were then calculated for each nutrient and are listed in Table 1, column 3. The SE for the predicted mean (SEM) is the error associated with the predicted mean for a large population of supplements labeled at the same level. The SEM percent differences from label for these nutrients are graphed in blue in Figures 1-3. The SEM values are calculated based on the SEM percent differences and listed in Table 1, column 5, Predicted Amount per Serving, SEM. The SE for a predicted observation estimates the error associated with the predicted mean for a single observation, which in this case is any individual adult MVM product. The SE percent differences from label for predicted observations for these nutrients are graphed in green in Figures 1-3. The SE (Individual) values are calculated based on the SE percent differences and listed in Table 1, column 6, Predicted Amount per Serving SE (Individual).

Figure 1. Predicted Vitamin C Percent Difference From Label in Adult MVMs (327 observations for 96 adult MVM products)



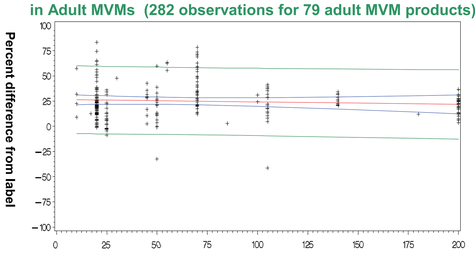
The DSID-1 defined regression range for making predictions for vitamin C included labeled levels from 4 to 1000 mg. The predicted means ranged from 7.7% to 8.5% above labeled levels.

Figure 2. Predicted Vitamin E Percent Difference From Label in Adult MVMs (316 observations for 88 adult MVM products)



The DSID-1 defined regression range for making predictions for vitamin E included labeled levels from 9.9 to 230 IU. The predicted means ranged from (-0.12%) to +6.5% of labeled levels.

Figure 3. Predicted Selenium Percent Difference From Label in Adult MVMs (282 observations for 79 adult MVM products)



The DSID-1 defined regression range for making predictions for selenium included labeled levels from 10 to 200 mcg. The predicted means ranged from 22% to 26% above labeled levels.

Table 1: Predicted Values For Selected Labeled Levels of Vitamin C, Vitamin E and Selenium in Adult MVMs

Ingredient	Label Amount Per Serving	Predicted Amount per Serving	Unit	Predicted Amount per Serving SEM	Predicted Amount Per Serving SE (Individual)	Predicted % Difference from Label
VITAMIN C	60	64.6	mg	0.62	6.3	7.7
VITAMIN C	75	80.8	mg	0.74	7.9	7.7
VITAMIN C	90	97	mg	0.86	9.5	7.7
VITAMIN C	100	107.8	mg	0.94	11	7.8
VITAMIN C	150	162	mg	1.4	16	7.8
VITAMIN C	200	216	mg	2.0	21	7.8
VITAMIN C	250	270	mg	2.8	26	7.9
VITAMIN C	300	324	mg	3.8	32	7.9
VITAMIN C	500	540	mg	11	54	8.1
VITAMIN C	1000	100	mg	51	120	8.5
VITAMIN E	13	13.8	IU	0.23	1.7	6.5
VITAMIN E	24	25.5	IU	0.35	3.1	6.1
VITAMIN E	30	31.8	IU	0.40	3.9	5.9
VITAMIN E	50	52.7	IU	0.62	6.5	5.3
VITAMIN E	100	104	IU	2.3	13	3.8
VITAMIN E	200	202	IU	8.6	28	0.79
VITAMIN E	230	230	IU	7.6	34	-0.12
SELENIUM	20	25.2	mcg	0.44	3.4	26
SELENIUM	25	31.5	mcg	0.53	4.2	26
SELENIUM	55	69	mcg	0.98	9.2	25
SELENIUM	70	87	mcg	1.3	12	25
SELENIUM	100	124	mcg	2.1	17	24
SELENIUM	105	130	mcg	2.3	18	24
SELENIUM	140	172	mcg	4.2	24	23
SELENIUM	200	243	mcg	9.3	35	22

Steps to Link DSID-1 Results with NHANES Supplement Ingredient Levels

Examples of the tables are shown below with the matching fields highlighted.

DSID Table 2: Predicted Amount

Ingredient	Label Amount Per Serving	Predicted Amount per Serving	Unit	Predicted Amount per Serving SEM	Predicted Amount Per Serving SE Individual	Predicted % Difference from Label	NHANES 2003-04 DSID Linking Code	NHANES 2005-06 DSID Linking Code
VITAMIN C	100	107.8	mg	0.94	11	7.8	104010301000	104010501000

DSID Table 4 : NHANES 2005-06 Application

NHANES 2005-06 DSID Linking Code	Ingredient	NHANES Ingredient ID	Label Amount Per Serving	Unit	NHANES Supplement ID
104010501000	VITAMIN C	10000979	100	mg	10000118021

NHANES DSQ File 3

DSDSUPID	DSDSUPP	DSDSRCE	DSDTYPE
10000118021	ABC MULTIVITAMIN AND MULTIMINERAL	Internet Listing	Standard formulation

1. Locate Table 2, Predicted Amount, on the bottom tab of this file from the DSID-1 website: http://dietarysupplementdatabase.usda.nih.gov/dsid_database/complete_dsid_1_data_file.xls. Table 2 contains 2005-06 NHANES DSID Linking Code (highlighted in green).
2. Locate Table 4 in the same DSID-1 file, NHANES 2005-06 Application, which contains the same 2005-06 NHANES DSID Linking Code (highlighted in green) as in Table 2. Link this field directly to Table 2 NHANES DSID Linking Code (both fields highlighted in green). Table 4 also contains the NHANES Supplement ID field (highlighted in yellow).
3. Locate File 3, Supplement Information, from NHANES 2005-06: http://www.cdc.gov/nchs/nhanes/nhanes2005-2006/quex05_06.htm. This file contains the DSDSUPID field, which is the NHANES Supplement ID. Link this field directly to the NHANES Supplement ID in Table 4 of DSID (both fields highlighted in yellow).

The DSID-1 nutrient level estimates in Table 2 are now linked to the NHANES data.

Conclusions

1. Predicted mean percent-difference-from-label ranged from 7.7% to 8.5% for vitamin C, -0.12% to 6.5% for vitamin E, and 22% to 26% for selenium.
2. DSID-1 as a research tool provides analytically-based estimates of nutrient values in adult MVMs, based upon regression analysis of nutrient levels in representative adult MVM products reported in the U.S.
3. The prediction equations for these and other nutrients, applied to labeled nutrient levels for adult MVM products reported in NHANES 2003-06, are available at http://dietarysupplementdatabase.usda.nih.gov.

Future Plans

The following studies are underway to analyze representative products based on statistically representative sampling plans and to provide publicly accessible data for researchers' use in assessing total intake:

1. Children's MVMs
2. Omega-3 fatty acid products
3. Prenatal MVMs: over-the-counter products

References

1. http://www.dietarysupplementdatabase.usda.nih.gov
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4. SAS (version 9.1, SAS Institute, Cary, North Carolina)