Analytical Vitamin Content of Over-the-Counter Prenatal Multivitamin/Mineral Products Measured for the Dietary Supplement Ingredient Database (DSID)

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DSID Initiative

The Nutrient Data Laboratory, Beltsville Human Nutrition Research Center, Agricultural Research Service (ARS) at USDA, in collaboration with the Office of Dietary Supplements, National Institutes of Health (ODS/NIH) and other federal agencies, has developed a Dietary Supplement Ingredient Database (DSID; http://dsid.usda.nih.gov) to evaluate levels of ingredients in dietary supplement products. The DSID is funded in large part by the Office of Dietary Supplements. It builds on the well-recognized strengths of the USDA/ARS in developing databases that support the assessment of intake of nutrients from foods. ODS provides leadership, jointly with its federal partners, in making this a reality. The consortium of federal agencies includes ODS and partners at USDA/ARS, the National Center for Health Statistics of the Centers for Disease Control and Prevention, The Food and Drug Administration, the National Cancer Institute, NIH and the National Institute of Standards and Technology of the Department of Commerce. The goals for this project are:

•To develop reliable estimates, including variability information for nutrients and other bioactive components in DS products
•To support improved dietary intake assessments in research by providing analytical estimates of the ingredient content of marketed DSs
•To release and maintain a publicly available on-line composition database for DSs

Priority dietary supplement product categories and ingredients are determined by a DSID Working Group with members from the collaborating agencies listed above. DSID provides researchers with analytical estimates of nutrient content for adult and children's multivitamin/mineral (MVM) dietary supplements. Data on analytical content of omega-3 polyunsaturated fatty acids in fish oil supplements and data on vitamin and mineral content in prenatal MVMs sold over-the-counter (OTC) are being prepared for release. A pilot study on green tea dietary supplements content is currently underway.

Sampling Plan and Product Distribution

OTC prenatal MVMs were defined for this study as products containing ≥3 vitamins, with or without minerals, sold for prenatal use and able to be purchased without a doctor's prescription. NDL developed a national sampling plan based on data from National Health and Nutrition Examination Survey (NHANES), Nutritional Business Journal (NBJ), company websites, websites that marketed to pregnancy customers, local and national store surveys. The sampling plan was based on estimates of market channel distribution and the conclusion that a large brand and product variety would best represent OTC prenatal MVM. Market share information for individual products/brands was not available. Multiple and single lots of 71 MVMs were purchased from direct marketers and from mass merchandisers and specialty retailers in 6 U.S. locations (AL, CA, CO, MI, MO, NY) identified as representative from the US census data. For the retail products, contracted shoppers were instructed to purchase a total of 40 products on store shelves from up to 15 different stores. Shoppers were instructed to purchase a minimum of 180 tablets (32 oz. for liquids) of the same lot for each product. The pie charts portray the market channel distributions achieved in the prenatal study and estimated from NBJ market data (see the diagram).

Laboratory Analysis and QC

After purchase, dietary supplement samples were repackaged and sent for laboratory analysis in defined batches. Quality control (QC) materials were added to each batch of MVM products in order to evaluate laboratory precision and accuracy on an ongoing basis. Each batch included:

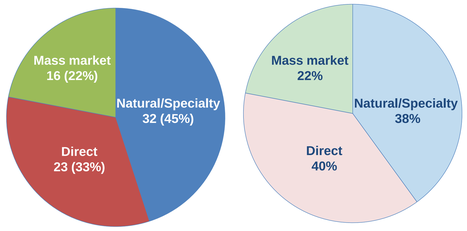
- National Institute of Standards and Technology Standard Reference Material (SRM) 3280, a MVM matrix with certified values for vitamins and minerals
- Two in-house control materials developed from a single lot of two different MVM products with a similar matrix to the study samples
- One product sample sent in duplicate

Qualified analytical contract and collaborative laboratories analyzed the sample sets using validated sample-handling protocols and appropriate methods, to obtain analytical information about ingredient levels. Analytical retests for ingredients in specific products were identified to check unusually high or low results, high variability among product lots or questionable data in batches where QC results showed a bias. For each sample analyzed, laboratory results were compared to labeled levels and a percent difference from label was calculated.

Statistical Analysis

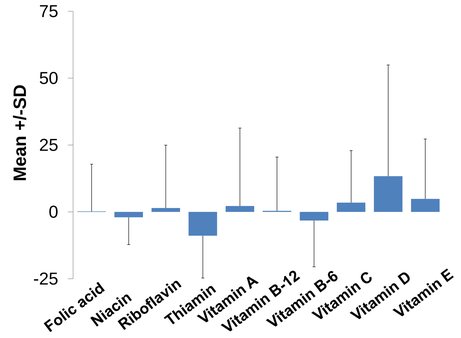
Ingredient data from laboratory analysis were prepared for statistical analysis by averaging duplicate observations. Observations were equally weighted. Regression analysis was used to assess whether and how the percent differences from label for ingredient analytical content depend on a labeled level. A regression equation was derived for each ingredient using the label value as the independent variable and the percent difference from the label as the dependent variable. Sources of variability and variance components were analyzed for all ingredients. The random portion of the models include the variability due to supplements within label levels, lots within supplements and analytical variability within lots. The resulting equations predict mean analytical levels in the product category (expressed as a predicted percent difference from the label). Accuracy and stability of the model's prediction were assessed. The mean predictions will be linked to labeled levels for each ingredient in the prenatal MVM product category and will not be brand or supplement-specific.

Product Distribution by Market Channel



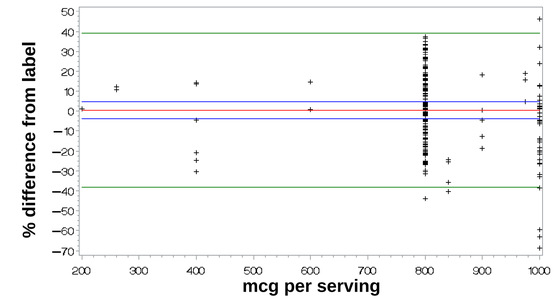
Prenatal MVMs analyzed — MVM sales, NBJ 2008

Analytical Vitamin Content: % Differences from Labels*



*Data averaged across all label levels before exclusions made in regression analyses. All supplements are equally weighted

No Difference from Label in Mean Folic Acid Content



No Difference from Label in Mean Vitamin A Content

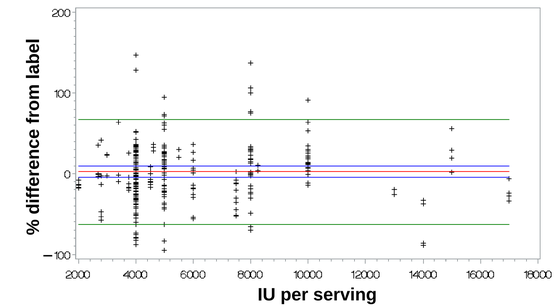
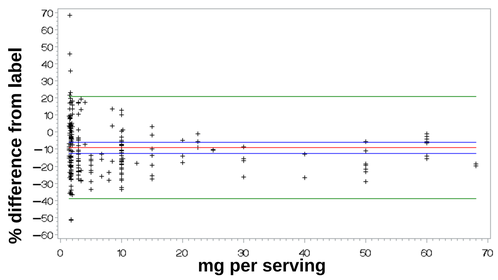


Table 1 Mean, Linear and Quadratic Regression Models: P-Values

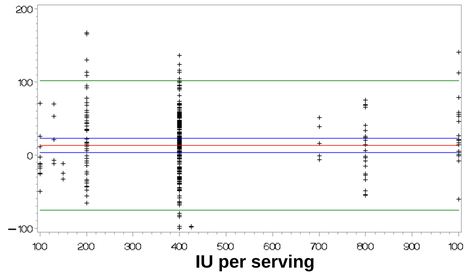
Ingredient	Mean	Linear (Slope)	Slope Direction	Quadratic
Folic Acid	0.815	0.204		0.17
Niacin	0.108	**<0.010**	"-"	0.286
Riboflavin	0.738	0.119		0.1
Thiamin	**<0.001**	0.143		0.127
Vitamin A	0.48	0.640		0.184
Vitamin B-6	0.334	**<0.020**	"-"	0.848
Vitamin B-12	0.883	0.066		0.811
Vitamin C	**<0.010**	0.582		0.519
Vitamin D	**<0.010**	0.702		0.48
Vitamin E	**<0.040**	0.340		0.559

Underlined values indicate regression models selected to predict mean percent difference in ingredient content from label levels in DSID-3

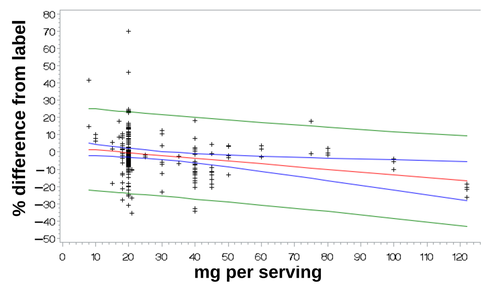
Mean Model Predicts Thiamin Content



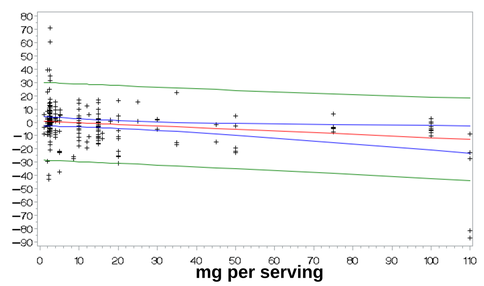
Mean Model Predicts Vitamin D Content



Linear Model Predicts Niacin Content



Linear Model Predicts Vitamin B-6 Content



Red lines indicate linear predictions for means, green lines indicate CL95 for individual observations, blue lines indicate CL 95 for means.

Table 2 Predicted vs. Label Ingredient Content

Nutrient	Units of Measure	Most Common Label Levels	Predicted Results	Lower Mean CL95	Upper Mean CL95	Number of Observations	Number of Lots	Number of Suppl. Products
Folic Acid	mcg	800	804	770	838	160	111	52
Niacin	mg	20	19.9	19.4	20.5	118	76	34
Riboflavin	mg	1.7	1.72	1.62	1.81	63	43	18
Thiamin	mg	1.8	**1.64**	1.58	1.69	43	30	12
Thiamin	mg	3	**2.73**	2.63	2.82	23	16	8
Thiamin	mg	10	**9.08**	8.76	9.41	33	18	8
Vitamin A	IU	4000	4096	3823	4369	100	60	26
Vitamin B-6	mg	2.6	2.62	2.53	2.70	52	37	15
Vitamin B-12	mcg	8	8.03	7.63	8.43	60	43	18
Vitamin C	mg	100	**105**	102	109	51	34	16
Vitamin C	mg	120	**126**	122	131	74	53	23
Vitamin D	IU	400	**452**	413	491	208	101	47
Vitamin E	IU	30	**31.7**	30.1	33.3	75	62	27

Values in bold are significantly different from the label level. Label levels are per serving.

Results and Conclusions

For OTC prenatal MVMs, the mean analytical content of ingredients analyzed may differ from the labels. Mean or linear regression models could be used to adjust ingredient content vs. label levels (see Table 1 and 2, and the regression plots). When analyzed across all label levels, the mean analytical content of folic acid, niacin, riboflavin, vitamins A, B-6 and B-12 are not significantly different from the label levels ($p>0.05$ for the mean model). Overages were found for vitamins C, D and E ($p<0.05$, Tables 1, 2). The mean analytical content of thiamin is below label. Niacin and vitamin B-6, although not significantly different from the label at the common label level (Table 2), are significantly different from label at greater label levels (niacin is below label with 45 to122 mg range; vitamin B-6 below label within 35 to 100 mg range, see the plots). The major source of variability in the % differences from label (~67% of the total variance) was observed at supplement product level suggesting its association with the supplement manufacturers. These data will be released in DSID-3 and can provide researchers with more accurate estimates of nutrient intake from OTC prenatal MVM than the labeled levels. **Funding: ARS/USDA & ODS/NIH.**