Children's Vitamins

GOALS

The goals of this project were to:

- Evaluate the overall quality and safety of children's vitamins.
- Test children's vitamins for nutrients and heavy metals.
- Compare the levels CR found with tolerable upper intake levels (UL) and USP tolerances.

TEST APPROACH AND METHODS

Twenty-one children's vitamins were evaluated. Three samples of each product, representing one to three lots, plus two duplicates, were tested for heavy metals; vitamins A, B1, B2, B3, B5, B6, B9, C, D2, D3, and E; and the minerals iodine and zinc. Testing was performed at an accredited laboratory.

Ten tablets/capsules/gummies were used to determine the average weight for each lot of each model. A composite was prepared from at least 20 tablets/capsules/gummies for all analyses.

The children's vitamins were prepared and analyzed in accordance with the following methods:

- Vitamin A as retinyl acetate, retinyl palmitate, and beta-carotene (AOAC 2012.10) by HPLC-DAD
- Vitamin C (AOAC 2012.22) by HPLC-VWD
- Vitamins D2, D3 (AOAC 2016.05 mod.), and B9 as folic acid and 5-methyltetrahydrofolate (AOAC 2022.002); B1, B2, B3, and B6 as pyridoxine (AOAC 2015.14 mod.); and B5 (AOAC 2012.16 mod.) by LC-MS/MS
- Vitamin E as alpha-tocopherol and alpha-tocopherol acetate) (AOAC 2012.10) by HPLC-FLD and Vitamin E as alpha-tocopherol succinate (USP 551) by HPLC-DAD
- Iodine (FDA [EAM 4.13]) by ICP-MS
- Zinc (AOAC 2011.14) by ICP-OES
- Arsenic, cadmium, lead, and mercury (AOAC 2015.0) by ICP-MS

We reviewed all the test results and quality control data provided by the contract lab for accuracy and clarity.

DATA ANALYSIS

To estimate the average concentration of a heavy metal contaminant (arsenic, cadmium, lead, or mercury) in a supplement, we applied a method used by many risk assessors,[1] including the Environmental Protection Agency.[2] If a contaminant was detected or measurable in any of the samples of the product, the samples that had test results below the method detection limit, or MDL, were assumed to have a concentration of half the MDL for that contaminant. If the contaminant was not detected in any of the tested product samples, we assumed a concentration of zero for all the samples of that product for the contaminant. This approach to risk assessment appropriately considered important uncertainties about potential levels of undetected risk in samples with test results below the MDL. For vitamins and minerals, the amounts found during testing were compared with amounts listed on the product labels.

RISK ASSESSMENT

We estimated a child's daily intake (based on the manufacturer recommended daily servings), at 1 to 3 years old (average weight of 13 kg, or 26.7 pounds), 4 to 8 years old (average weight of 22 kg, or 48.5 pounds) and 9 to 13 years old (average weight of 40 kg, or 88.2 pounds),[3] of the tested arsenic; cadmium; lead; mercury; vitamins A, B1, B2, B3, B5, B6, B9, C, D2, D3, and E; and iodine and zinc for each product. Where appropriate and applicable, we compared the intake estimates with the exposure limits in the table below. In addition, tested vitamins and minerals were compared with USP tolerance ranges, where applicable. Note that vitamin A tested values (r. palmitate, r. acetate, beta-carotene) were converted to RAE units and compared with the RAE amounts listed on the label. Total vitamin A values in RAE units were calculated as follows: 0.55 x retinyl palmitate + 0.87 x retinyl acetate + 0.5 x beta-carotene.[4] Vitamin E values from testing were compared with the values in the formulation (a-tocopherol, a-tocopherol acetate, or a-tocopherol succinate) listed on the label. Vitamin B9 values from testing were compared with those in the formulation (folic acid, mTHF, or DFE [folate]). Total vitamin B9 values in DFE (folate) units were calculated as follows: 1.7 x folic acid + 1.7 x mTHF.[5]

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[1] Xue, J.; Zartarian, V.; Wang, S.; et al., "Probabilistic Modeling of Dietary Arsenic Exposure and Dose and Evaluation with 2003-2004 NHANES Data," *Environmental Health Perspectives* 118, no. 3 (2010): 345-50. [2] "Regional Guidance on Handling Chemical Concentration Data Near the Detection Limit in Risk Assessments," *Environmental Protection Agency,* www.epa.gov/risk/regional-guidance-handling-chemical-concentration-data-near-detection-limit-risk-assessments. [3] www.ncbi.nlm.nih.gov/books/NBK45193. [4] AOAC 2012.10. [5] www.fda.gov/media/129863/download.

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Health-Based Exposure Limits Selected for Risk Assessments for Select Heavy Metals, Vitamins, and Minerals				
Chemical	**EPA RfD mcg/kg bw/d**	**OEHHA MADL (NSRL) mcg/day**	**NIH UL (mg/day)**	**USP Tolerance Range % of Label Value**
Arsenic	0.06[6]	10[7]	NA	NA
Cadmium	NA	4.1[8]	NA	NA
Lead	NA	0.5[9]	NA	NA
Mercury	0.1[10]	NA	NA	NA
Vitamin A	NA	NA	0.6 (ages 1-3); 0.9 (ages 4-8); 1.7 (ages 9-13)[11]	90-165 (tablets/capsules) 90-170 (chewable gels)[12]
Vitamin B1	NA	NA	ND[10]	90-150 (chewable gels)[13]
Vitamin B2	NA	NA	ND[10]	90-150 (chewable gels)[13] (tablets/capsules: ND)
Vitamin B3	NA	NA	10 (ages 1-3); 15 (ages 4-8); 20 (ages 9-13)[10]	90-150 (tablets/capsules and chewable gels)[11]
Vitamin B5	NA	NA	ND[10]	90-150 (tablets/capsules)[11] (chewable gels: ND)
Vitamin B6	NA	NA	30 (ages 1-3); 40 (ages 4-8); 60 (ages 9-13)[10]	90-150 (tablets/capsules and chewable gels)[11]
Vitamin B9 (as folate)	NA	NA	0.3 (ages 1-3); 0.4 (ages 4-8); 0.6 (ages 9-13)[10]	90-150 (tablets/capsules) 90-245 (chewable gels)[11]
Vitamin C	NA	NA	400 (ages 1-3); 650 (ages 4-8); 1,200 (ages 9-13)[10]	90-150 (tablets/capsules) 90-250 (chewable gels)[11]
Vitamin D	NA	NA	0.063 (ages 1-3); 0.075 (ages 4-8); 0.100 (ages 9-13)[10]	90-165 (tablets/capsules) 90-170 (chewable gels)[11]
Vitamin E	NA	NA	200 (ages 1-3); 300 (ages 4-8); 600 (ages 9-13)[10]	90-165 (tablets/capsules) 90-170 (chewable gels)[11]
Iodine	NA	NA	0.2 (ages 1-3); 0.3 (ages 4-8); 0.6 (ages 9-13)[13]	90-125 (tablets/capsules) 90-160 (chewable gels)[11]
Zinc	NA	NA	7 (ages 1-3); 12 (ages 4-8); 23 (ages 9-13)[14]	90-125 (tablets/capsules) 90-130 (chewable gels)[11]

EPA=Environmental Protection Agency
NIH=National Institutes of Health
OEHHA=California's Office of Environmental Health Hazard Assessment
UL=tolerable upper intake level
USP=United States Pharmacopeia
ND=Not determined; NA=Not available or not applicable

[6] iris.epa.gov/static/pdfs/0278_summary.pdf. [7] oehha.ca.gov/proposition-65/chemicals/arsenic-inorganic-arsenic-compounds. [8] oehha.ca.gov/media/downloads/crnr/cadmium20madl.pdf. [9] oehha.ca.gov/proposition-65/chemicals/lead. [10] www.ncbi.nlm.nih.gov/books/NBK225764. [11] www.ncbi.nlm.nih.gov/books/NBK56068/table/summarytables.t7/?report=objectonly. [12] cersi.umd.edu/sites/cersi.umd.edu/files/Session_1-1_NataliaDavydovaCandy-Like_Oct30_2023.pdf. [13] www.uspnf.com/errata/oil-and-water-soluble-vitamins-minerals-chewable-gels-2021-05-01. [14] www.ncbi.nlm.nih.gov/books/NBK545442/table/appJ_tab9/?report=objectonly.