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Vitamin D concentrations in fortified foods and dietary supplements intended for infants: Implications for vitamin D intake

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ABSTRACT

Due to potential overages to cover losses during shelf life, the actual vitamin D concentration of fortified foods and dietary supplements may deviate from the label. In this pilot study the vitamin D concentrations of fortified foods (n = 29; follow-on formula, baby porridge, curd cheese dessert) and dietary supplements (n = 15), both specifically intended for infants, were analytically determined. Compared to the declared values, the vitamin D content ranged from 50% to 153% for fortified foods and from 8% to 177% for supplements. In general, both instant follow-on formula and oil-based supplements had a measured vitamin D content similar to or higher than the labelled value. Ready-to-eat baby porridge was the only category in which all measured vitamin D concentrations were below the declared value (74–81%). The use of label information for fortified foods and dietary supplements may result in invalid estimations of vitamin D intake distributions of infants; both under- and overestimation may occur.

1. Introduction

Vitamin D is a fat-soluble vitamin that plays an important role in bone health. In infants, serious vitamin D deficiency leads to rickets (Health Council of the Netherlands, 2012; Institute of Medicine, 2011; The Nordic Council of Ministers, 2014). On the other hand, excessive vitamin D intake is associated with the risk of hypercalcaemia or hypercalciuria and kidney problems. Therefore, several institutes have set tolerable upper intake levels (UL) of vitamin D for several age-groups, including infants (European Food Safety Authority (EFSA), 2012; Institute of Medicine, 2011).

Vitamin D can be synthesized in the human skin upon exposure to ultra violet light. Besides this, food and dietary supplements can be a source. Since it is generally advised to protect young children against direct sunlight exposure to prevent skin cancer, they rely mainly on foods and dietary supplements for their vitamin D. It is difficult to obtain an adequate intake by relying solely on the consumption of vitamin D naturally present in foods (Health Council of the Netherlands, 2012). Similar to other countries (Health Canada, 2012; The Nordic Council of Ministers, 2014), the Dutch Health Council recommends vitamin D supplementation for young children (Health Council of the Netherlands, 2012). Since 2012 the advice has been to give a daily dose of 10 μg (i.e. 400 IU) supplemental vitamin D to children until the age of 4 years, irrespective of their diet and the actual exposure to sunlight (Health Council of the Netherlands, 2012).

In a previous scenario study it was estimated that 4–11% of the infants aged 7–11 months would exceed the UL (25 μg/day as set by EFSA (European Food Safety Authority (EFSA), 2012)) assuming that all these children would take daily 10 μg supplemental vitamin D as recommended by the Health Council of the Netherlands (Health Council of the Netherlands, 2012). The vitamin D concentration of fortified foods and dietary supplements of that scenario study were mainly obtained using label information (Yetley, 2008). In addition, food composition databases commonly include vitamin D content data for fortified foods and dietary supplements that are derived from labelled values (e.g. Anonymous, 2013; Public Health England, 2015). It is, however, not always possible for food or supplements to contain the exact micronutrient level specified on the label, due to natural and processing variations, as well as changes during storage. But on the other hand substantial deviation from what is labelled could mislead the consumer and should be prevented. The European Commission have provided guidance for setting tolerances for nutrients declared on the label. Tolerances are defined as the acceptable differences between the nutrient values declared on the label and those analysed. For vitamin D, these are −35% to +50% for foods and -20% to +50% for dietary supplements (Anonymous., 2012a). In addition, the added

Abbreviations: EFSA, European Food Safety Authority; UL, tolerable upper intake level.

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amount should not deviate from the applicable (national) legislation limits (Anonymous, 2006a). In the Netherlands these are, for example, set for follow-on formula (Anonymous, 2006b), baby porridges with grains (Anonymous, 1997), and dietary supplements (Anonymous, 2012b). Little is known about the exact vitamin D content in fortified foods and dietary supplements at the moment of consumption. Some studies indicate that manufacturers of such products may add higher amounts of micronutrients, in general, to compensate for losses during processing and shelf life (so-called overages) (Holick, Shao, Liu, & Chen, 1992; Veatch, Brockman, Spate, Robertson, & Morris, 2005; Yetley, 2007); although, also lower concentrations than labelled are reported (Garg et al., 2013). The disparity between the labelled amount and the actual composition of a product can be considerable; depending on the nutrient and product measured, concentrations lie in the range of 50–200% of the declared value (Dutch Food Safety Authority, 2009; Yetley, 2007). Consequently, estimations of the habitual intake distribution and evaluations of the prevalence of inadequate intakes or risk of excessive intakes that rely mainly on labelled nutrition content information may be invalid. Therefore, this pilot study aims to investigate the vitamin D concentrations of fortified foods and dietary supplements designed for infants aged 6–12 months and to examine any deviation from the labelled values. In addition, the potential variations of the vitamin D concentrations between different production batches of the same brand and the potential implications for estimation of the vitamin D intake distribution are discussed.

2. Materials and methods

2.1. Product selection

Mid 2014, an inventory was made of vitamin D fortified foods and dietary supplements on the Dutch market especially designed for young children (6–12 months). First, the INNOVA database (www.innovadatabase.com) was searched for foods fortified with vitamin D. In addition, manufacturers' websites were searched and shops were visited to gain insight into the actual supply of vitamin D fortified foods and vitamin D supplements. Vitamin D fortified foods designed for young children were found in the following product groups: infant formula, follow-on formula, baby porridge based on cereals, infant milk, soy milk, yoghurt drink, instant chocolate milk, curd cheese dessert and lemonades. Products not specifically meant for children, such as margarines, were excluded for product analysis and vitamin D supplements in chewable forms were considered as inadequate for infants and therefore the study focused on liquid forms which were found in two types: oil-based and water-based.

In September 2015, 44 products were purchased for this pilot study from local supermarkets and drugstores in the Netherlands: 18 samples of follow-on formula, 10 samples of porridge, 1 curd cheese dessert, and 15 vitamin D supplements (Table 1). This selection included the majority of the available brands and types in each category. Brands in different price categories were included. According to the manufacturer's website, curd cheese dessert is designed for children from one year onwards, but food consumption data showed that curd cheese dessert is also frequently consumed by infants (De Boer, Hulshof, & Ter Doest, 2006). All products were bought within the best-before date. To study a potential difference in vitamin D content between different production batches, pairs of products of the same brand but each with a different best-before date (n = 5 follow-on formulas; n = 5 dietary supplements) were bought. Thus, 10 different brands of dietary supplements and 13 different brands of follow-on formulas were bought.

2.2. Labelled vitamin D concentration

The labelled vitamin D concentration (in μg) was obtained by the manufacturer's label declaration for comparison with the analysed vitamin D concentration. Label information indicated that 13 out of 29 fortified foods and all 15 dietary supplements contained vitamin D_3. For the remaining 16 fortified foods the information on the label did not specify the vitamin D form. On all labels, one value for vitamin D content was given, with no uncertainty range provided by the manufacturer. Generally, on the labels of follow-on formulas and baby porridges, the vitamin D content was declared per 100 g prepared product. These vitamin D contents were re-calculated to 100 g unprepared product, based on the instructions for preparation on the label. For dietary supplements, the vitamin D concentration was displayed on the label per number of drops per daily dose (i.e. not per mL or g).

2.3. Chemical analysis

The chemical analysis of vitamin D_3 was performed according to European Standards as specified by NEN-EN 12821: Foodstuffs: Determination of vitamin D by high performance liquid chromatography (HPLC) – Measurement of cholecalciferol (D_3) or ergocalciferol (D_2). All analytical work was carried out by TNO Triskelion B.V. (Zeist, the Netherlands), accredited for internal reference method TRIS/VIT/051 to measure vitamin D concentration in all foods. After purchase, the samples were homogenized and aliquoted, thereafter liquid samples were stored at −20 °C until analysis while powdered samples were stored at room temperature. All samples were analysed in duplicate in unprepared form (without added milk or water) within 3–5 weeks after purchase. To check for saturation during sample reprocessing, the samples of each duplicate had a different weight: 3 and 6 g for solid samples, 10 and 16 g for liquid samples, and 0.25 and 0.5 g for dietary

Table 1
Overview of the 44 fortified foods and dietary supplements containing vitamin D of which the vitamin D concentration was chemically analysed.

Food group	Specification	Number of products	Number of days until best-before date	Labelled age-category
Follow-on formula	Instant milk-based (powdered)	16[a]	68–668	6–10 months or 6–12 months
	Ready-to-eat, milk-based with cereals/yoghurt or fruit (liquid)	2	145–265	>6 months
Porridge	Instant with cereals (adding milk or water)	7	283–735	>6 months or >8 months
	Ready-to-eat, milk-based with cereals	3	148–282	>6 months
Dessert	Curd cheese with fruit	1	7	>1 year[b]
Supplement	Water-based, only containing vitamin D	12[a]	85–955	0–4 years
	Oil-based, only containing vitamin D	3	355–895	0–4 years

[a] Including 5 similar products (brand and type) with a different best-before date (interval of 3–12 months).
[b] This product was consumed by infants aged > 7 months onwards (De Boer et al., 2006).