

*Joint Irish Section and American Society for Nutrition Meeting, 15–17 June 2011, 70th anniversary: ‘Vitamins in early development and healthy ageing: impact on infectious and chronic disease’*

## Response of serum 25-hydroxyvitamin D concentrations to vitamin D supplementation during lactation

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Pregnancy, lactation and early childhood are life stages when the risk of low vitamin D status is high and the knowledge basis for determining nutritional requirements for vitamin D is weak. The current dietary reference intervals (DRI) for vitamin D in pregnant and lactating women are the same as those in non-pregnant adult females below 70 years (600 IU/15 µg/d)<sup>(1)</sup>. The aim of the current study was to investigate vitamin D requirements during lactation. We conducted a double-blind randomised placebo-controlled trial across three intervention groups using 20 µg/d of vitamin D<sub>3</sub> (to achieve a total vitamin D intake of ~25 µg/d), with or without 500 mg Ca, or placebo, over 12 weeks of lactation. The study protocol was implemented across a calendar year to account for seasonal effects.

Concentrations of serum 25-hydroxyvitamin D (s25(OH)D) were measured at baseline (BL) and endpoint (EP) in mothers and in umbilical cord blood using ELISA. Vitamin D metabolites (D<sub>3</sub>, D<sub>2</sub> and 25(OH)D) were quantified in expressed breast milk at four time points during the intervention study using HPLC. Dietary intakes of vitamin D and Ca, anthropometric data, socio-demographic and lifestyle data were collected, as well as antenatal supplement use and habitual sunshine exposure. The s25(OH)D data are described here.

25(OH)D (nmol/L)	Total (n 100)	Placebo (n 27)	Vitamin D (n 36)	D and Ca (n 37)	P
Baseline*	43.4 (31.5–60.1)	45.2 (29.2–64.9)	45.4 (38.1–54.2)	39.5 (30.1–62.6)	0.835
Endpoint†	71.8 (58.6–88.7)	48.3 (36.7–65.6)	78.4 (67.9–94.1)	75.9 (67.7–98.0)	<0.001

Median; interquartile range in parentheses; \*One-way ANOVA followed by Tukey's test.

†ANCOVA adjusting for BL s25(OH)D, dietary intake of vitamin D and season of EP blood sampling.

At BL, 21 and 63% had a s25(OH)D level below the thresholds for vitamin D deficiency and sufficiency of 30 and 50 nmol/l, respectively. Season of blood sampling was the main determinant of BL s25(OH)D (adj.  $R^2 = 0.338$ ;  $\beta = 0.571$ ;  $P < 0.001$ ), as expected. Other determinants were parity and total vitamin D intake ( $\beta = 0.157$  and 0.150, respectively;  $P < 0.05$ ). Mean (sd) cord s25(OH)D levels were 33.8 (14.8) nmol/l (*n* 92) and were 78% of maternal levels on average ( $R^2 = 0.7$ ;  $P < 0.001$ ). Season of birth (adj.  $R^2 = 0.274$ ;  $\beta = 0.137$ ) and antenatal vitamin D supplement use (adj.  $R^2 = 0.004$ ;  $\beta = 0.140$ ) were independent predictors of cord s25(OH)D levels (both  $P < 0.05$ ).

A final sample of 100 women completed the intervention protocol, of which ninety were more than 80% compliant. The intervention considerably increased s25(OH)D levels in the treatment groups by ~30 nmol/l (see Table) with no difference in the EP concentrations between women who received vitamin D only and those who received vitamin D+Ca. Given that the average habitual vitamin D intake in the group was 4.3 µg/d, supplementation with 20 µg/d vitamin D<sub>3</sub> to achieve a total intake of ~25 µg/d, maintained s25(OH)D levels >30 nmol/l in all lactating women and brought 96% above the desirable threshold of 50 nmol/l.

In conclusion, the current DRI of 15 µg/d is inadequate to achieve a target s25(OH)D of 50 nmol/l in 97.5% of lactating women at a latitude of 51°N.

Funded by the Irish Department of Agriculture, Fisheries and Food through the Food Institutional Research Measure.

1. IOM (Institute of Medicine) (2011) *Dietary Reference Intakes for Calcium and Vitamin D*. Washington, DC: The National Academies Press.