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Maternal and Infant Nutritional Supplementation Practices in Ireland: Implications for Clinicians and Policymakers

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Abstract
This prospective Irish observational study examined maternal and infant nutritional supplement use. From an initial sample of 539 mothers recruited from the Coombe Women and Infants University Hospital in Dublin (during 2004-2006), 450 eligible mothers were followed up at 6 weeks and 6 months postpartum. Only 200 women (44.4%) complied with peri-conceptional folic acid at the recommended time with strong social patterning associated with its uptake. Almost 10% of the sample (n=44) consumed a combined multivitamin and mineral supplement during pregnancy. A vitamin D-containing supplement was provided to only 5 (1.1%) and 15 (3.3%) infants at 6 weeks and 6 months, respectively. A national guideline that advises on adequate and safe use of both vitamin and multivitamin supplements during pregnancy with particular reference to vitamin A and D is warranted. Given the re-emergence of rickets in Ireland, and the reported morbidities associated with vitamin D insufficiency, promoting and monitoring compliance with 200IU [5µg] daily vitamin D supplements to all infants particularly those from higher risk groups from birth to 1 year, should be a public health priority.

Introduction

Consumption of nutritional supplements can play an important role in achieving recommended dietary intakes[1], particularly in high-risk populations[2]. Since peri-conceptional folic acid (FA) supplementation has been shown to decrease the incidence[1] and recurrence[3] of neural tube defects (NTDs), policy in Ireland recommends that women consume a daily 400µg FA supplement for a minimum of 12 weeks pre-conceptionally until the 12th week of pregnancy, in addition to a folate-rich diet[4]. More recently, considerable attention has been given to the adverse skeletal and non-skeletal clinical outcomes associated with vitamin D insufficiency[5], including increased risks of pre-eclampsia, calcium malabsorption and higher parathyroid hormone levels in pregnant women[6], as well as hypocalcaemic seizures, skeletal deformity, fractures, rickets, cardiomyopathy and growth failure in infants[7,8].

High rates of vitamin D insufficiency during pregnancy (5-50%) and infancy (10-56%)[6,8,9] and childhood nutritional rickets are increasingly being reported. Sub-optimal vitamin D status is attributed to an inadequate dietary intake[9,10] and poor dermal synthesis due to sunscreen use, dark skin pigmentation, extensive clothing cover, limited sunlight exposure especially from October to March at northerly latitudes >~35°[2,11]. Infants are at an additional risk if they are born to mothers with low vitamin D status[12]. Recognising these concerns, recent Irish policy in 2010 recommends a 200IU [5µg] vitamin D daily supplement for all infants from birth to 1 year[13].

However, high-dose supplementation at levels in excess of tolerable upper limits can be hazardous to health. Preformed vitamin A-containing supplements in daily doses ≥ 10,000 IU are teratogenic[14], and consumption of vitamin C and E supplements

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Table 1 Baseline characteristics of the total sample (n=450), and by nationality

Characteristic	Total sample (n=450) n (%)	Irish National Mothers* (n=401) n (%)	Non-Irish National Mothers† (n=49) n (%)
Maternal age (years) (mean ± SD)	29.2 ± 5.7	29.1 ± 5.8	30.18 ± 5.48
Maternal education level			
Primary/secondary	(39.3)	(39.9)	(34.7)
Vocational/training course	(27.6)	(28.7)	(18.4)
Third level degree/ postgraduate level	149 (33.1)	126 (31.4)	23 (46.9)
Marital status			
Married/cohabitating	(90.4)	(89.5)	48 (97.9)
Single	43 (9.6)	42 (10.5)	1 (2)
Smoking during pregnancy			
Yes	(20.9)	(23.2)‡	(2)‡
No	356 (79.1)	308 (76.8)	48 (97.9)
Planned current pregnancy			
Yes	282 (62.7)	250 (62.3)	32 (65.3)
No	168 (37.3)	151 (37.7)	17 (34.7)
Infant birth weight (kg) (mean ± SD)	3.55 ±0.52	3.55 ± 0.52	3.59 ± 0.54
Initiated breastfeeding postpartum			
Yes	228 (50.7)	189 (47.1)‡	39 (79.6)‡
No	222 (49.3)	212 (52.9)	10 (20.4)

SD, standard deviation. *All mothers were white Caucasian; †Racial groups include: white Caucasian (51%), Black African (37%), Asian (10%) and American Indian (2%); ‡ $P<0.001$: differences between Irish national and non-Irish national mothers.

Table 2 Factors associated with maternal nutritional supplementation practices during pregnancy

Variable	Folic acid uptake at the recommended time (n=200) n (%)	Supplements other than folic acid and iron during pregnancy* (n=48) n (%)
Maternal age (years)		
< 24	(6)†	5 (10.4)
24-34	134 (67)	34 (70.8)
> 34	54 (27)	9 (18.8)
Maternal education level		
Primary/secondary	(26)†	7 (14.6)†
Vocational/training course	63 (31.5)	(20.8)
Third level degree/ postgraduate level	85 (42.5)	31 (64.6)
Marital status		
Married/cohabitating	198 (99)†	47 (97.9)
Single	2 (1)	1 (2.1)
Smoking during pregnancy		
Yes	(9)†	4 (8.3)‡
No	182 (91)	44 (91.7)
Planned current pregnancy		
Yes	186 (93)†	32 (66.7)
No	14 (7)	16 (33.3)

*Supplements include: combined multivitamin and mineral (n=44), omega-3 fish oil (n=7) and vitamin D (n=5). †$P<0.001$; ‡$P<0.05$: significant differences between the groups within the columns.

during pregnancy have been associated with lower birth weight[15]. However, there is no Irish policy on the recommended use or dose of these or other vitamins in pregnancy and data on prevalence of their use is scant. Furthermore, in light of the recent vitamin D supplementation policy for all infants, it is important to understand current supplementation patterns. This study was designed to examine the prevalence of maternal and infant nutritional supplementation practices; a second objective was to determine the factors associated with maternal nutritional supplement use during pregnancy.

Methods

The methods and sample representativeness of this prospective observational study are already reported in detail[16]. In summary, 491/539 (91%) women from antenatal clinics in the Coombe Women and Infants University Hospital (CWIUH) during June 2004-October 2006 agreed to participate. 450 mothers (401 Irish national [Irish-born] and 49 non-Irish national [non-Irish-born]) meeting study criteria and delivering a healthy full term singleton infant were followed up at 6 weeks and 6 months postpartum. The antenatal patient-administered survey addressed pregnancy supplement use (type, brand and dose) and initiation time, socio-demographic factors and pregnancy smoking habit. The maternal, obstetric and infant characteristics and the timing of FA supplementation were extracted from the mother's and/or infant's medical notes, and any self-reporting ambiguity clarified. The 6 week and 6 month postpartum interviewer-administered surveys elicited information on maternal and infant supplement use (type, brand and dose).

The Statistical Package for the Social Sciences (SPSS®, version 17) was used to analyse the data. Comparison between groups was performed using the Student's t-test for continuous variables, and the Chi-square test or Fishers exact test for categorical variables. Descriptive results are expressed as percentages (%), means and standard deviations (SD), and median with interquartile ranges (IQR), as appropriate. Binary logistic regression analysis was used to determine the factors associated with maternal nutritional supplement use during pregnancy. Ethical approval was granted by the Ethical Committees of the CWIUH and Dublin Institute of Technology.

Results

Data for the 450 mother-infant pairs (n=401 Irish national; 49 non-Irish national) were complete. The mean age of mothers at antenatal recruitment (median 36 weeks gestation, IQR: 32-39 weeks) was 29.2 years (SD 5.7) (Table 1). Significantly fewer non-Irish national compared with Irish national mothers smoked during

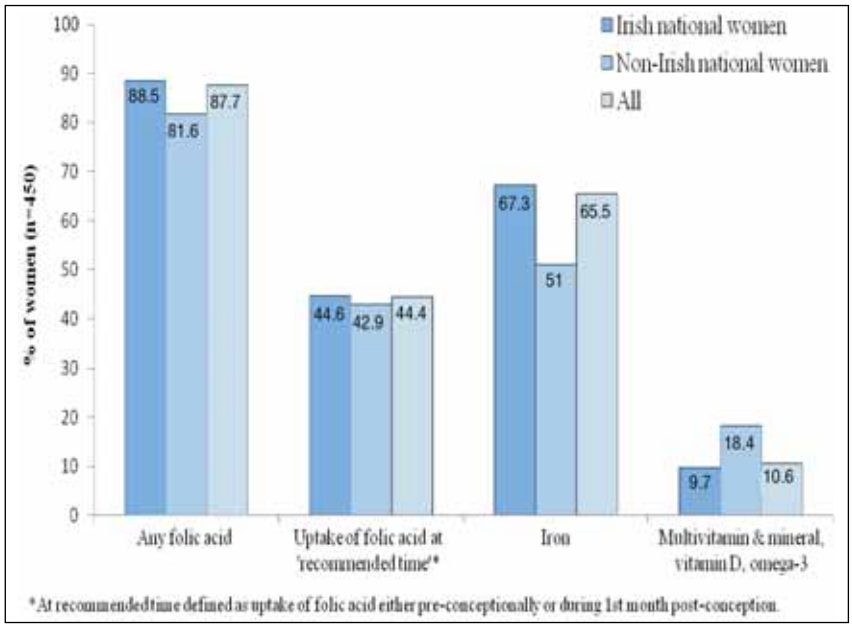

Figure 1 Maternal nutritional supplementation practices during pregnancy (n=450)

pregnancy (2% vs 23.2%, P=0.000) and their breastfeeding initiation rates were higher (79.6% vs 47.1%, P=0.000).

Maternal vitamin and mineral supplementation practices during pregnancy

Although 395/450 women (87.7%) reported to taking a specific peri-conceptional FA supplement, only 200 women (44.4%) commenced FA at the recommended time i.e. either pre-conceptionally (n=181, 40.2%), or during the first month post-conception (n=19, 4.2%). In all, 160/450 women (35.5%) commenced supplemental FA during the second month of pregnancy, 35/450 (7.7%) during the third month of pregnancy, while 55/450 women (12.2%) did not take any FA. Uptake of FA at the recommended time did not differ between the Irish and non-Irish national populations (44.6% vs 42.9%, P=0.933). Iron supplements were consumed by 295/450 women (65.5%) during pregnancy (Figure 1), with a high usage observed during the first (n=132; 44.7%) and second (n=136; 46.1%) trimesters of pregnancy. A significantly greater proportion of Irish, compared with non-Irish nationals reported taking an iron supplement at any pregnancy stage (67.3% vs 51%, P=0.035). In total, 48/450 women (10.6%) reported taking nutritional supplements other than FA or iron, including a combined multivitamin and mineral (n=44), omega-3 fish oil (n=7) and vitamin D (n=5).

In the univariate analysis (Table 2), education to third level degree/postgraduate compared with primary/secondary level was significantly associated with both use of FA at the recommended time (42.5% vs 26%, P=0.000), and other nutritional supplements during pregnancy including, multivitamin and mineral, omega-3 fish oil and vitamin D (64.6% vs 14.6%, P=0.000). Factors positively associated with combined multivitamin and mineral and/or vitamin D and/or omega-3 fish oil supplement use during pregnancy, after adjustment, included breastfeeding initiation, maternal nutritional supplement use at 6 weeks postpartum and education to third level degree/postgraduate (Table 3).

Table 3 Factors associated with maternal consumption of a combined multivitamin and mineral and/or vitamin D and/or omega-3 fish oil supplement during pregnancy (n=48): binary logistic regression model

Independent variables	Estimates	SE	df	*P*	OR (95%CI)
Breastfeeding initiation postpartum					
No*	1.428	0.448	1	0.001	4.17 (1.73-10)
Yes					
Maternal nutritional supplement use at 6 weeks postpartum†					
No*	1.307	0.357	1	0.000	3.69 (1.83-7.44)
Yes					
Maternal education level					
Primary/secondary level*					
Third level degree/ postgraduate level	1.209	0.496	1	0.015	3.34 (1.26-8.8)
Vocational/training course	0.462	0.533	1	0.386	1.58 (0.55-4.51)

SE, standard error; df, degrees of freedom; OR, odds ratio; CI, confidence interval.
Model controls for maternal age and smoking status during pregnancy.
*Reference category; †Supplements include: combined multivitamin and mineral (n=74), evening primrose oil (n=6), omega-3 fish oil (n=5), calcium (n=2), vitamin B-Complex (n=2), probiotic (n=1) and folic acid (n=1).

Maternal supplementation practices postpartum

At 6 weeks postpartum (median 6.5 weeks, IQR 6.1-7 weeks) 206/450 mothers (45.7%) consumed a nutritional supplement. These included iron (n=153, 74%) and a combined multivitamin and mineral supplement (n=74, 35.9%). Other supplements consumed included, evening primrose oil (n=6), omega-3 fish oil (n=5), calcium (n=2), vitamin B-Complex (n=2), probiotic (n=1) and FA (n=1).

Infant supplementation practices

At 6 weeks postpartum, 6 infants (1.3%) received at least one nutritional supplement daily. These included a vitamin A, B, C and D-containing supplement (n=4), vitamin D only (n=1), vitamin C (n=1) and fluoride (n=1). At 6 months postpartum (median 24.7 weeks IQR 24.4-25 weeks), 17 infants (3.8%) consumed at least one nutritional supplement daily, including a vitamin A, B, C and D-containing supplement (n=12), vitamin D only (n=3), iron (n=1), omega-3 fish oil (n=1) and fluoride (n=1). Two infants were given camomile drops, while homeopathic drops (sulphur) were given to one infant for the treatment of eczema (data not shown).

Discussion

A high prevalence of nutritional supplementation was observed among both Irish, and non-Irish national pregnant women in this study. Although 87.7% of the sample reported to taking a specific FA supplement during pregnancy, only 44.4% of

women commenced FA at the recommended time peri-conceptionally. In contrast to the higher peri-conceptional use of FA among Irish nationals reported in a previous Dublin-based study[17], no nationality uptake difference was observed in our study (44.6% vs 42.9%, respectively: P=0.933). In agreement with the literature[17,18], strong social patterning: marriage (99%), third level degree/postgraduate (42.5%), non-smoking (91%) and report of planned pregnancy (93%) were all associated with FA uptake at the recommended time. Since neural tube closure occurs between 22 and 28 days post conception[19], the timing of FA was suboptimal in over half of our sample of women (55.5%). A slightly higher pre-conceptional FA rate of 45% is reported in a previous Irish study[18] than what we found (40.2%). Nonetheless, to date, no Irish study has reported peri-conceptional FA rates greater than 50% indicating that risk minimisation is not being achieved. This warrants public health attention given that Irish NTD rates are still among the highest in Europe (1-1.5 per 1000 total births nationally[20]). More effective public health efforts and FA promotional campaigns are necessary to convince all women of child-bearing age in Ireland of the critical time-frame for NTD prevention.

Over 10% of the women in this study consumed a combined multivitamin and mineral and/or omega-3 fish oil and/or vitamin D supplement during pregnancy, with strong social patterning associated with their use. Given the reported teratogenicity associated with excessive supplemental vitamin A consumption during pregnancy[14], recommendations in the UK advise the avoidance of vitamin A-containing supplements, including multivitamins and fish liver oils, in addition to foods high in vitamin A such as liver and pâté, during pregnancy[21]. However, such recommendations for pregnant women in Ireland are lacking. To prevent any potential teratogenic risks associated with excessive vitamin A consumption, the establishment of a national recommendation that provides guidelines on appropriate and safe use of such supplements during pregnancy is warranted. Since low maternal vitamin D status during pregnancy increases the risks of vitamin D insufficiency and rickets in infants[22], the implementation of a national recommendation on vitamin D pregnancy supplementation also needs to be addressed.

The incidence of rickets has risen in infants and toddlers in Ireland and other developed countries over the past decade[7,23,24]. As Ireland is located at 51° to 55° North, little or no vitamin D can be produced from sunlight during the winter months. Although exclusively breastfed infants and those with dark skin pigmentation have been identified as particular high-risk groups for vitamin D deficiency, all infants are at potential risk since their vitamin D stores at birth are dependent on their mother's vitamin D status[8], which is frequently insufficient according to recent evidence. According to Muldowney[25] (n=264 women; >95% white-skinned: 2004-2006), 19% and 70% of pregnant women living in Cork had serum 25(OH)D levels < 25 nmol/L and < 50 nmol/L, respectively, highlighting the high prevalence of vitamin D insufficiency in pregnant women in Ireland. Findings from the present study, conducted pre-HSE vitamin D recommendation (2004-2006), indicate that only 5 infants at 6 weeks (1.1%) and 15 infants at 6 months (3.3%) were provided with a daily vitamin D-containing supplement. To ensure an adequate infancy vitamin D status the HSE recently recommended the provision of 200IU [5µg] vitamin D per day to all infants from birth to 1 year[13]. Given the potential for serious short and long term morbidities associated with vitamin D insufficiency, health professionals in Ireland should ensure that all parents, particularly those from at-risk populations, are aware of the HSE vitamin D recommendation.

In conclusion, a national health promotion campaign to advise women on safe and effective nutrient supplementation during pregnancy is required. Achieving compliance with infancy vitamin D supplementation from birth to 1 year should be a public health priority.

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