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Title:

Nutritional supplements during breastfeeding

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Abstract

Women who are breastfeeding have increased requirements for energy and nutrients. Nutritional requirements for lactation have been the subject of several international reports and are included in general nutrient requirements documents, including those of the USA, Australia, European Union and WHO. Recommendations are made for all pregnant women to take folic acid prior to becoming pregnant and during the first trimester of the pregnancy and iodine supplementation is recommended in Australia and many other countries during pregnancy and lactation. The current WHO/ICCIDD/UNICEF recommendation for daily iodine intake (250 µg for lactating mothers) has been selected to ensure that iodine deficiency does not occur in the postpartum period and that the iodine content of the milk is sufficient for the infant's iodine requirement. While recommendations for nutritional supplements during pregnancy are specific, recommendations are usually less specific for lactation. The aim of this study was to review the use of supplements during lactation and to document the use of nutritional supplements in a cohort of mothers who are breastfeeding in Perth, Western Australia.

In the USA the limited data that is available suggest that supplement use during lactation is dependent on demographic, sociologic, and economic factors and that more women take supplements during pregnancy than during lactation. Data from the NHANES III study show that ethnicity and income predicted iron supplementation during lactation, with 77% of non-Hispanic white women reporting supplement use compared with 41% of non-Hispanic black or Mexican American women. Multivitamin-multimineral use was the most frequently reported dietary supplement (33%). In a cohort study of postpartum mothers in Australia the use of supplements fluctuated between 40% to 30%, with 35% still taking supplements a year after birth. During their pregnancy 78% of mothers took a folic acid supplement and 21% took an iron supplement. Mothers who took supplements were more likely to continue breastfeeding. More studies are needed to document supplement use by lactating mothers in different cultures and countries.

Keywords:

Breastfeeding, nutritional supplements, dietary supplements, review

Introduction

Breastfeeding is the recommended and natural way to feed all infants and during this period many mothers choose to take nutritional supplements. In the United States of America (USA), a dietary supplement is defined under the Dietary Supplement Health and Education Act of 1994 as a product that is intended to supplement the diet and contains any of the following dietary ingredients: a vitamin, a mineral, a herb or other botanical (excluding tobacco), an amino acid, a concentrate, metabolite, constituent, extract, or combination of any of the above. It must also be intended for ingestion in a pill, capsule, tablet, powder or liquid form. It must not be represented for use as a conventional food or as the sole item of a meal or diet and should be labelled as a “dietary supplement” (1). Similar definitions are in use in other countries, the main elements being that they are supplements taken in the belief by consumers that additional minerals, vitamins, herbs or other substance may enhance their health.

Nutritional requirements for lactation have been the subject of several international reports and are included in general nutrient requirement documents including those of the USA, Australia, European Union and the World Health Organisation (WHO) (2, 3). For example, additional energy is also needed in lactation to cover the production of breastmilk. The additional needs in lactation need to be estimated from average volume and composition of breastmilk. The average additional requirement in lactation may be taken as an extra 2.0–2.1 MJ/day, assuming full breastfeeding in the first six months and partial breastfeeding thereafter (4). There are similarly increased requirements of around one third additional for protein, long-chain polyunsaturated fatty acids (LCPUFA) and B group vitamins. For vitamins A, C and E, iron and zinc, requirements are increased. For vitamin D, calcium and phosphate, recommendations remain the same as for non-pregnant women, but more recent studies suggest that an increase in Vitamin D may be needed (5, 6). Details of requirements for selected nutrients for women during lactation are shown in Table 1, based on the Australian Nutrient Reference Values which are a revision of the most recent USA documents (3).

In addition to dietary supplements in many cultures there are specific foods that are encouraged during pregnancy or other foods that are subject to cultural taboos. These foods that are a part of a normal diet will not be discussed in this paper.

Information on the use of supplements during lactation was reviewed and a cohort study undertaken in Perth, Western Australia was subject to further analysis. The aim of this study was to review the use of supplements during lactation and to document the use of nutrition supplements in a cohort of mothers who are breastfeeding.

Methodology

A search was undertaken of the electronic databases PubMed, Web of Knowledge, CINAHL and the Cochrane Library for reviews published between January 2000 and May 2011. Studies were limited to the English language using the keywords 'lactation', 'breastfeeding', 'developed country', 'nutrition' and 'supplements'. Any study design was eligible for consideration. Studies using animal models were excluded. The combined search of the databases located 110 references. Abstracts of these articles were retrieved and evaluated to determine whether articles met the inclusion criteria. Most articles dealt with theoretical discussions of nutritional need or individual trials of supplementation. Reviews of community rates of supplementation during breastfeeding were uncommon and only three papers were located. While the main findings of these papers are reported in the results and discussion most of the paper will be devoted to a further analysis of questions on supplement usage in the Perth Infant Feeding Survey.

Perth is a city of 1.5 million people and the larger metropolitan area contains 70% of the state of Western Australia's population. The nearest large city is more than 1500 km distant. The subjects were 587 women recruited from two maternity hospitals in Perth located in suburban areas approximately 20 km from the city centre. The purpose of the study was explained to the mothers and those who gave consent were asked to complete a baseline questionnaire just prior to, or shortly after, discharge from hospital. The cohort was consecutive, unselected mothers who delivered babies during the study period. The study was approved by the Curtin University Human Ethics Research Committee and the Research Ethics Committees of both of the hospitals. Women were followed up by telephone interview at 4, 10, 16, 22, 32, 40 and 52 weeks postpartum. Data collected included breastfeeding, factors associated with the initiation and duration of breastfeeding and whether mothers were taking any nutritional supplement.

The breastfeeding definitions used in this study are consistent with standard WHO definitions and are recommended by the Australian Food and Nutrition Monitoring Unit (7). An 'exclusively breastfed' infant has received only breastmilk since birth, except for prescribed medications. A 'fully breastfed' infant is one that receives breastmilk as the main nutrient source, with or without water, water-based drinks, fruit juice or oral rehydration solutions but does not receive any other fluids (including artificial baby milk) or solids. 'Any breastfeeding' implies that the infant is receiving some breastmilk.

Statistical analysis was undertaken using the Statistical Package for Social Science (SPSS; IBM Corp, Somers, NY, USA) for Windows Version 17.0. Initially tables of descriptive statistics were developed. The breastfeeding rates were estimated using life-table method and compared by Wilcoxon (Gehan) test. The association between any breastfeeding duration and the use of nutritional supplements was analysed using multiple Cox proportional hazard regression and those variables previously found to be significant indicators of breastfeeding initiation and duration by the research team (8, 9) were included in the regression modelling procedure. The regression was carried out on those women who were still breastfeeding at the discharge time and the final model was obtained using backward elimination procedure. P values < 0.05 were considered as statistically significant.

Results

There have been only limited reviews of the use of nutritional supplements in lactation and they usually overlap with pregnancy or non-lactating, non-pregnant women including from the USA the National Health and Nutrition Examination Surveys (NHANES) and the Australia data from the 1995 National Nutrition Survey (10-12). In the USA the limited data that is available suggest that supplement use during lactation is dependent on demographic, sociologic, and economic factors. More women take supplements during pregnancy than during lactation (11). Data from the NHANES III study show that ethnicity and income predicted iron supplementation during lactation, with 77% of non-Hispanic white women reporting supplement use compared with 41% of non-Hispanic black or Mexican American women. Women in the higher socio-economic groups were more than twice ($P < 0.001$) as likely as poorer women to take iron supplements during this time period (11).

While there have been many studies of dietary supplementation during pregnancy there have been fewer studies of the prevalence and results of supplementation during lactation. Iron is

the most common nutrient that is deficient in women and supplementation is commonly recommended during pregnancy (13). The US Centers for Disease Control and Prevention (CDC) recommends starting oral, low-dose (30 mg/day) supplements of iron at the first prenatal visit and encouraging pregnant women to eat iron-rich foods and foods that enhance iron absorption (13). Recommendations are also made for all pregnant women to take folic acid prior to becoming pregnant and during the first trimester of the pregnancy. Similar recommendations for pregnancy are made in other countries, but recommendations for lactation are usually less specific. A Cochrane systematic review acknowledges the problem of lactational anaemia and advocates for more randomised controlled trials of treatment options (14).

An adequate concentration of iodine in breastmilk is essential for optimal development of the infant, particularly of the nervous system. The WHO estimates that two billion people live in areas with some degree of deficiency in iodine (15). The current WHO, International Council for the Control of Iodine Deficiency Disorders (ICCIDD) and United Nations Children's Fund (UNICEF) recommendation for daily iodine intake (250 µg for lactating mothers) has been selected to ensure that iodine deficiency does not occur in the postpartum period and that the iodine content of the milk is sufficient for the infant's iodine requirement. (16). Recommendations are also made by the American Thyroid Association for Iodine supplementation in lactation (17). Supplements of 150 µg/d of iodine are recommended in Australia as safe and effective for pregnant and breastfeeding women (18).

Calcium requirements for women are commonly in excess of dietary intakes and in the general population in the USA and it is estimated that 43% of the population used calcium supplements (19). Separate estimates are not available for lactating mothers who are included with women in general, but 52% of women in the 30-50 year age groups took supplements (19). For vitamin D, the proportion of women in this age group taking supplements was 34%. There is increasing evidence of the need for vitamin D supplementation during lactation (5, 6). Vitamin A supplementation has been shown to be of great benefit during pregnancy in developing countries, but during the postpartum period a Cochrane review has not shown any benefit (20).

Studies of breastfeeding outcomes have shown improvement in cognitive development of infants who are breastfed, possibly due to LCPUFA (long chain polyunsaturated fatty acids)

in breastmilk (21, 22). Several trials of supplementation of breastfeeding mothers with LCPUFA have been undertaken to improve the intakes of these substances (23, 24). . Danish mothers (n =122) were randomized to fish oil (1.5 g/d (ω -3) LCPUFA) or olive oil supplementations during the first four months of lactation. When examined at seven years the infants in the fish oil group had significantly higher blood pressures, suggesting that caution is needed in such interventions (23). A review of experimental studies of docosahexaenoic acid (DHA) supplementation of mothers during lactation has found a need for better designed and larger studies before a definite conclusion on benefit to mother or infant can be made (25). However the studies that are available do suggest that DHA may be a conditionally essential nutrient for optimal infant or child outcome.

Vitamin A supplementation of lactating mothers and of infants at the time of routine vaccinations have both been suggested as measures to prevent deficiency among infants. A large (9424 mother-infant pairs) multicenter randomized, double-blind, placebo-controlled trial was conducted in Ghana, India and Peru to determine the effect of maternal vitamin A supplementation on breastmilk retinol content and of maternal and infant supplementation on infant vitamin A status. Maternal supplementation improved breastmilk retinol status at two months, but the authors concluded that additional strategies are needed to improve vitamin A status of six to nine month old infants (26). A meta-analysis of available studies found that there was no evidence of a mortality or morbidity benefit to infants following postpartum vitamin A supplementation (27).

There has been an increase in USA dietary supplement use over time since the 1970s, including during lactation (10). In NHANES III supplement use was reported by 49% of the US population (44% of males, 53% of females). Multivitamin-multimineral use was the most frequently reported dietary supplement (33%) (10). In the year ended 2000, Australians spent AU\$1671 million on dietary supplements, herbal medicines and natural products, which exceeded the expenditure on pharmaceutical drugs (28).

In the Perth Infant Feeding Study II (PIFSII) a total of 1068 women were eligible to participate, of whom 870 were contacted and 587 women completed the baseline questionnaire. A total of 551 (93.9%) women reported any breastfeeding, on discharge (8). In addition, 45.9% of all women reported any breastfeeding at six months (29). The majority participants were between 20-34 years old, had high school or above education, Australia or

New Zealand born and married. There were no significant differences in demographics between participants and non-participants, except that the non-participants were more likely to be in other kind of marital status than in married or defacto relationship. Detailed socio-demographic characteristics of participants in the PIFSII are shown in Table 2.

During their pregnancy 78% of mothers took a folic acid supplement and 21% took an iron supplement. After the birth of their infant many mothers continued to take nutritional supplements, and the use fluctuated between 40% to 30%, with 35% still taking supplements a year after birth (See Table 3). The major categories of supplements that were taken are also shown in Table 3. The most common supplements taken were iron, multivitamin preparations and calcium. In addition to these common types of supplements more than 40 other types of supplements were recorded, but most were taken by only a small number of mothers. For example, one mother took a garlic supplement throughout and another used a ginger supplement.

The mothers who took supplements during lactation had significantly higher 'any breastfeeding rates' up to six and 12 months than the group of never taking any supplements after birth (See Table 4). This is also true for fully breastfeeding rates up to six and 12 months. No significant differences in exclusive breastfeeding rate up to six months were found between the two groups. In Figure 1 & 2 the results of the multiple Cox proportional hazard regression show that mothers who took vitamins plus minerals after giving birth were less likely to stop any breastfeeding up to six months compared to those never took any supplements, after controlling for likely confounders. No statistically significant associations were found between the types of supplement taken versus other breastfeeding durations.

Discussion

A high proportion of Australian mothers (greater than one third) took nutritional supplements during lactation. Although no similar studies were located in from other countries, it is likely that similar results are applicable to other developed countries. While there is an association between taking supplements and breastfeeding rates, there is no evidence that this is a causal relationship. There have been no previous published reports of a relationship between taking nutritional supplements and breastfeeding duration. Further studies will be required to verify this relationship and to document any possible causal pathways.

Recently the National Health and Medical Research Council (NHMRC) and the American Thyroid Association have recommended that mothers should take an iodine supplement of 150 µg/d while pregnant or breastfeeding (17). At the time of this study no mothers reported taking iodine supplements, but small amounts of iodine are commonly included in multivitamin/mineral supplements, but not in the recommended amount.

Recommendations concerning nutritional supplement use during lactation are not consistent. However, the Institute of Medicine, in its report addressing nutrition during lactation, recommended that lactating women be encouraged to obtain their nutrients from a well balanced, varied diet rather than from vitamin and mineral supplements (30). For women whose eating patterns lead to a very low intake of one or more nutrients, individualized dietary counselling is preferred and dietary supplementation may be necessary. For example, vegans might be advised to take vitamin B₁₂ supplements daily, and those who avoid all dairy products might be advised to take calcium and vitamin D supplements (11).

Limitations of the study

The PIFSII participants all came from government hospitals is a limitation of this study. However, there was no significant difference in maternal age and level of education between participant and non-participants, suggesting that the sample was representative of the population from which it was drawn. The sample does not include rural mothers. There were a large variety of supplements taken by the mothers and further studies are needed to provide more details of the types of supplements and the reasons for their choices.

Conclusions

A high proportion of mothers take nutritional supplements while breastfeeding, but fewer than while pregnant. The large variety of supplements being used while breastfeeding suggests the need for firm recommendations and education on nutritional requirements during pregnancy and lactation.

Acknowledgements

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Table 1: Requirements for selected nutrients during lactation (3).

	EAR	RDI	AI
Thiamin	All ages 1.2 mg CV 10%	All ages 1.4 mg	—
Folate	All ages 450 µg CV 10%	All ages 500 µg	—
Vitamin A as retinol equivalents	14-18 yrs 780 µg 19-50 yrs 800 µg CV 20%	14-18 yrs 1100 µg 19-50 yrs 1100 µg	—
Vitamin C	14-18 yrs 58 mg 19-50 yrs 60 mg CV 20%	14-18 yrs 80 mg 19-50 yrs 85 mg	—
Vitamin D	—	—	All ages 5 µg
*Zinc	14-18 yrs 9 mg 19-50 yrs 10 mg	14-18 yrs 11 mg 19-50 yrs 12 mg	—
**Iron	14-18 yrs 7 mg 19-50 yrs 6.5 mg CV 30%	14-18 yrs 10 mg 19-50 yrs 9 mg	—
Calcium	14-18 yrs 1050 mg 19-50 yrs 840 mg CV 20%	14-18 yrs 1300 mg Women 1000 mg	
Iodine	All ages 190 µg CV 20%	All ages 270 µg	

CV= coefficient of variation

* Absorption of zinc is lower from vegetarian diets so intakes will need to be up to 50% higher.

** Absorption of iron is lower from vegetarian diets so intakes will need to be up to 80% higher.

Table 2: Socio-demographic characteristics of mothers invited to participate in the Perth Infant Feeding Study Mark II.

Characteristic	Participating (n=587)		Non-participating ^c (n=233)		P value where significant ^d
	n	% ^b	n	% ^b	
Age, yrs					
< 20	32	5.5	19	8.3	
20-24	124	21.1	55	24.1	
25-29	169	28.8	68	29.8	
30-34	176	30.0	56	24.6	
35+	86	14.7	30	13.2	
Total	587	100.1	228	100.0	
Education level					
Did not complete high school	222	37.8	102	45.3	
Completed high school or equivalent ^a	296	50.4	105	46.7	
Bachelors degree or higher	69	11.8	18	8.0	
Total	587	100.0	225	100.0	
Country of birth					
Australia/ NZ	428	73.2	data not collected	-	
UK/Ireland	53	9.1			
Other	104	17.8			
Total	585	100.1			
Marital status					
Married/Defacto	542	92.3	185	82.2	0.000
Other	45	7.7	40	17.8	
Total	587	100.0	225	100.0	
Number of previous children					
None	219	37.4	89	38.9	
One or more	367	62.6	140	61.1	
Total	586	100.0	229	100.0	

^a includes those with a trade or technical certificate/diploma.

^b percentage totals may not add up to exactly 100 due to the effect of rounding.

^c includes those who declined participation when first approached (but provided basic information) as well as those who initially agreed to participate than failed to.

^d significant differences were calculated using the Chi square test statistic at $p \leq 0.05$.

Table 3: Major supplement groups taken by mothers in the weeks following delivery [number (percentage)].

	Week 4	Week 10	Week 16	Week 22	Week 32	Week 40	Week 52
N (%)							
Took supplement	209 (39.9)	158 (31.4)	148 (30.6)	147 (30.6)	137 (29.7)	150 (32.5)	161 (35.5)
95% CI	35.9 ~ 43.7	27.6 ~ 35.2	26.9 ~ 34.3	26.0~ 33.4	26.0~ 33.4	28.7 ~ 36.3	31.6~ 39.4
Vitamins	25 (4.8)	19 (3.8)	25 (5.2)	27 (5.6)	29 (6.3)	29 (6.3)	38 (8.4)
Minerals	59 (11.4)	32 (6.4)	25 (5.2)	28 (5.9)	15 (3.3)	23 (5.0)	17 (3.8)
Vitamins + minerals	103 (19.7)	86 (17.1)	79 (16.4)	72 (15.1)	66 (14.3)	59 (12.8)	73 (16.2)
Combinations of Herbal/functional foods/other	22 (4.2)	20 (4.0)	19 (3.9)	18 (3.8)	26 (5.6)	39 (8.4)	32 (7.1)

Table 4: Association of supplement taking with the risk of discontinuing any breastfeeding* before 6 months after adjustment for potential confounders in the Perth Infant Feeding Study Mark II.

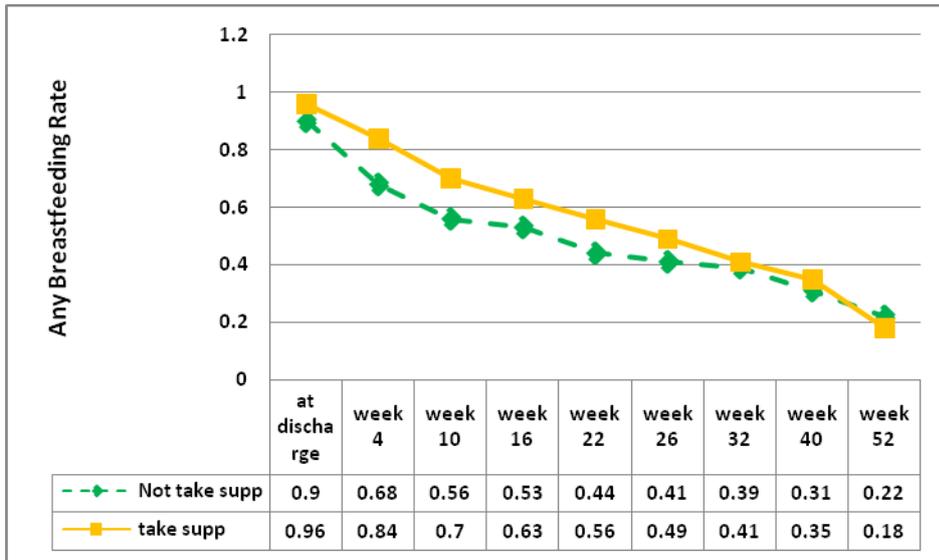
Event	Crude HR (95% CI)		Adjusted HR* (95% CI)	
Not taking any supplement	1			
Yes took some				
Vitamins	0.977	(0.605, 1.576)	0.559	(0.277, 1.129)
Minerals	1.204	(0.746, 1.943)	1.361	(0.663, 2.793)
Vitamins + Minerals	0.613	(0.427, 0.880)	0.479	(0.288, 0.797)
Combination	0.890	(0.585, 1.355)	0.593	(0.326, 1.078)
-2 log likelihood (deviance)	2409.136 df = 4		1217.297 df =21	

Adjusted HR: The variables controlled for the model were maternal age, infant sex, infant birth-weight, infant admitted in a special care nursery, maternal marital status, demand feeding, parity, attendance at antenatal classes, maternal IOWA score, mothers' occupations, age of infant when mother returned to work, maternal years of education, maternal country of birth, maternal grandmother's feeding preference, father's feeding preference, age by which dummy was introduced, time at which infant feeding method decided, how many times mother having breastfeeding problems in one year, if this pregnancy is planned or not, first feed, smoking status during pregnancy, delivery method, and the type of supplement taken in one year.

Non-significant variables in the final model were infant sex, infant birth-weight, infant admitted in a special care nursery, attendance at antenatal classes, mothers' occupations, maternal years of education, age by which dummy was introduced, time at which infant feeding method decided, and if this pregnancy is planned or not, delivery method.

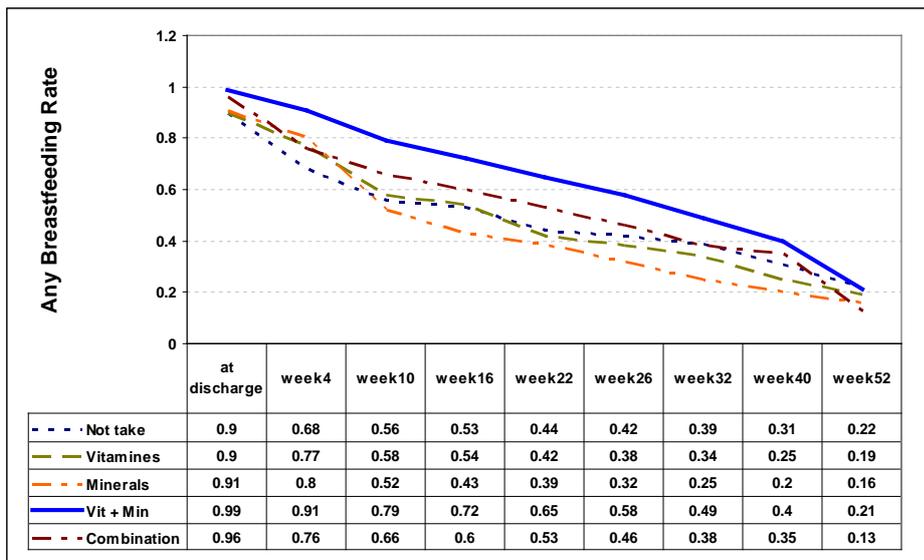
The regression was carried out on those women who were still breastfeeding at the discharge time and the final model was obtained using backward elimination procedure.

Figure 1. Any breastfeeding duration up to 12 months by the status of taking supplements.



- Overall comparison between groups was done by Wilcoxon (Gehan) test. P = 0.034
- At week 4, the any breastfeeding rate for the group of taking supplements was found statistically significant higher than that for the group of never taking any supplements.

Figure 2. Any breastfeeding duration up to 12 months by the types of supplements taken.



- Overall comparison between groups was done by Wilcoxon (Gehan) test. $p = 0.001$
- At discharge, week 4, 10, 16, and 22, the any breastfeeding rates for the group of taking vitamins plus minerals were found statistically significant higher than that for the group of never taking any supplements.

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