

Lactating Women Restricting Milk Are Low on Select Nutrients

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Objective: Currently there are no recommendations for vitamin/mineral supplementation for lactating women but supplementation may be important, particularly for those women who choose to restrict milk intake during lactation. The objective of this study was to assess nutrient adequacy for lactating women and compare their dietary intake, including supplements, between those who restrict milk and those who do not.

Methods: A cohort of 175 healthy exclusively breast-feeding women (19–45 yrs) recruited from prenatal classes were divided into milk restrictors (RS) defined as milk intake ≤ 250 ml/day and non-restrictors (NRS) (> 250 ml/day) and followed for six months postpartum. Participants provided repeated 24-hr dietary recalls, detailed use of vitamin/mineral supplements and reasons for restricting milk.

Statistical Analyses: Observed intakes were adjusted to remove day-to-day variability. Nutrient intakes were estimated for macronutrients and vitamins C, D, thiamin, riboflavin, niacin, and minerals, calcium and zinc, with and without vitamin/mineral supplements. Chi-square was used to compare the number of RS and NRS with intakes less than the Estimated Average Requirement (EAR).

Results: Milk restriction was practiced by 23% of the sample. Sixty per cent of RS reported protein intakes $< \text{EAR}$ compared to 38% of NRS ($\chi^2 = 6.22, p < 0.05$). Prior to supplementation, mean levels of calcium and vitamin D intakes for RS were below the adequate intake level (AI) and lower than NRS estimated intakes ($p < 0.05$). Following supplementation, mean levels of these nutrients reached AI for both groups. RS remained lower than NRS. RS had lower energy intakes than NRS ($p < 0.05$) but no difference in weight loss at 6 months was noted. A higher proportion of RS were below the EAR for thiamin, riboflavin and zinc.

Conclusions: Milk restriction compromised protein and nutrient intakes in lactating women who restricted milk to < 250 mL. Vitamin/mineral supplements helped exclusively breastfeeding milk restrictors improve their vitamin D and calcium intakes. Milk restriction is not recommended during lactation and where unavoidable, nutrients provided by milk should be compensated for by other foods or supplements.

INTRODUCTION

Exclusive breastfeeding for 6 months is universally recommended [1]. There are specific nutrient requirements for breastfeeding mothers [2–5] but overall, the benefit of routine vitamin/mineral supplementation has not been determined [6]. Early recommendations from the Standing Committee of the National Academy of Sciences Food and Nutrition Board (1980) and more recently the Canadian Pediatric Society

(1998) and Dietitians of Canada (1998) state that well nourished lactating women may not require supplementation [7], but this may not be true for all nutrients. Recently reports of low vitamin D intakes during pregnancy have raised interest in whether or not breastfeeding mothers are meeting current nutrient recommendations and have stimulated debate about the need for recommended vitamin/mineral supplementation during lactation [8–11]. Few studies have examined the nutrient adequacy of foods plus supplements in exclusively breastfeeding

Abbreviations: RS = restrictors, NRS = nonrestrictors, EAR = estimated average requirement, AI = adequate intake, UL = tolerable upper intake level, 25(OH)D = 25 hydroxyvitamin D

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women in North America but common use of vitamin/mineral supplements during lactation has been reported [12–15].

Milk restriction complicates the debate on the appropriateness of recommended supplements for all breastfeeding women because the consequences of this self-directed practice are unknown and may occur more often than health care providers estimate [16]. Breastfeeding women particularly, may self-impose milk restriction during lactation for reasons that include the perception that their food intake contributes to infant distress or colic [17–19], their own gastrointestinal distress [20], elevation of cholesterol [16], or an increase in the production of mucus [21]. They may also yield to social influences suggesting milk restriction will improve baby's behaviour [22]. It is known that dairy products are often included in elimination diets for women with a history of atopy although the results of this practice on the prevention of allergies in infants are inconclusive [23] and a recent systematic review recommended more research [24]. Women may also restrict milk to lose weight during the postpartum period as milk is perceived as a high fat food [16]; however some studies show a better level of weight loss with a high dairy product intake [25] although findings on this issue are controversial [26–28]. The objectives of this study were to report on nutrient adequacy in postpartum exclusively breastfeeding women and to compare nutritional adequacy among milk restrictors and nonrestrictors. A second objective was to measure the extent to which vitamin/mineral supplements may compensate for inadequate nutritional intakes where applicable. Reasons for restricting milk during lactation are reported.

MATERIALS AND METHODS

Recruitment

Women expressing the intention to breastfeed were recruited from hospital based prenatal classes in Calgary, Canada. Signed consent and permission to access medical charts were obtained. The study protocol was approved by the Ethics Committee of McGill University in Montreal, Quebec and the Conjoint Health Research Ethics Board at the Faculty of Medicine, University of Calgary, Alberta.

Description of Subjects and Measurements

Healthy breastfeeding women ($n=246$, 19–45 yrs old), defined as having no chronic illness and who had experienced a healthy singleton pregnancy were contacted within two weeks of delivery to schedule home visits. Subjects were visited during the 2nd, 4th and 6th postpartum months, when 24-hour dietary recalls, supplement intake, reasons for milk restriction and breastfeeding assessments were obtained. Women were weighed to the nearest 0.1 kg, wearing light clothing using a Healthometer Professional Dial Floor Scale Model 134KG (Chicago, Illinois) that was calibrated on a firm surface prior to

each measurement. Weight loss was reported as the difference between maternal weight taken at the first home visit at 2 months postpartum and the last home visit at 6 months postpartum. Country of birth, height, pre-pregnant weight and educational level were recorded. Subjects who answered yes to the question 'Do you currently smoke?' were classified as smokers.

Exclusive breastfeeding was assessed by a validated infant feeding questionnaire and was defined as "breastfeeding with not more than one feeding of breastmilk substitute per week" [29]. During the 6-month data collection period, breastfeeding was assessed at three home visits and twice by telephone. Women who more frequently replaced breastmilk feeds with breastmilk substitutes or solid foods ($n=71$) were eliminated from the sample post hoc since it was not possible at recruitment to know who would breastfeed exclusively. The final sample consisted of 175 exclusively breastfeeding women.

Dietary Assessment

Validated repeat 24-hr dietary recalls [30] were conducted using standardized units of measure [31]. Each study subject used a package of reference materials including 1 cup (195 ml), 1 plate (50 cm), 1 bowl (340 ml) and a flexible 12 inch (35 cm) ruler, for the estimation of portion sizes. Dietary intake was recorded by trained research assistants who used the 24-hr recall method at home visits during the 2nd, 4th and 6th postpartum months. Each subject provided 3 weekdays and one weekend day of dietary intake. For all subjects the dietary recall at 3 months was taken by telephone, a procedure validated for data collection [32].

Supplement Use

Data on vitamin/mineral supplements were collected for each recall day. Supplement composition was determined using standard references for brand names, product labels and the Health Canada Drug Product Database (DPD) [33]. With inadequate recall information, the brand name or product type from an earlier recall was used or default values if the nutrient only was named. The default value for calcium supplements was 500 mg, the amount included in most common prenatal supplements. Mean supplement intake was added to the adjusted nutrient intake of each subject.

Dietary Analysis

Six percent of the sample provided 3-repeat dietary recalls and 94% provided 4 recalls. Energy and nutrients were evaluated based on coded food entry, double verification and nutrient analysis using CANDAT (Godin London Inc., London, ON) and the 1997 *Canadian Nutrient File* [34]. In addition 267 food items were added to the 1997 *Canadian Nutrient File* using nutrient information obtained from food manufacturers' data or the American data base [35]. Folic acid fortification of flour

began in Canada in January 1998 and folate was excluded from analysis because these fortification procedures were not reflected in the 1997 *Canadian Nutrient File*. Nutrients analyzed included energy, fat, protein, vitamin C, vitamin D, thiamin, niacin, riboflavin, calcium and zinc.

Milk restrictors (RS) were defined as those reporting ≤ 1 cup (≤ 250 ml) of milk/day and nonrestrictors (NRS) >1 cup (>250 ml) milk/day on an average. RS ($n=39$) provided reasons for milk restriction and listed the resources they had used.

Estimated average requirements (EAR) for protein using 1.05 g/kg/d [36] were calculated for each subject and compared to reported intake. Nutrient intakes were calculated and reported as means and standard deviations. Observed intake distributions were computed for vitamin C (mg) vitamin D (μg), thiamin (mg), riboflavin (mg), niacin (NE), calcium (mg) and zinc (mg) from repeat 24-hr dietary recalls, and normalized using appropriate log or square root transformations. As per the NRC method, observed intakes were adjusted to remove the day-to-day variability within each subject's intake to give a distribution of adjusted intake [37]. The NRC method adjusts individual deviations from the mean intake values by multiplying it by the ratio of the within variability to total variability. This is added back to the mean intake of the group and a distribution of adjusted intakes results.

For those nutrients with an established EAR, the proportion of subjects with nutrient intakes less than the EAR was recorded to estimate the proportion with inadequate intake [38]. Chi-square tests compared observed differences between the proportion of RS and NRS above and below the EAR. Mean supplement intake for each individual was added to the adjusted intake distribution for each nutrient and dietary adequacy after supplementation for riboflavin, niacin, thiamin, vitamin C and zinc was assessed. The nutrient distribution was not adjusted when supplements were added because we assumed that all supplements were taken on a daily basis as reported on the recalls. An assessment of inadequacy could not be determined for vitamin D and calcium as only adequate intake levels (AI) have been set [38]. Mean and median intakes $>AI$ were considered likely to have a low proportion of inadequate intakes [38].

Statistical Analyses

Descriptive statistics were used to summarize sample characteristics. Using t-tests, comparisons between RS and NRS were made for mean absolute intakes and mean intakes per 1000 kcal (nutrient density) to adjust for energy intake. Nutrient distributions were normalized using square-root transformations to observed intakes for vitamin C, riboflavin, calcium and zinc. Log transformations were used for thiamin and niacin. Assessment of normality was conducted using the Kolmogorov-Smirnov statistic, a measure of disparity between the empirical distribution function and an unknown distribution - essentially a test for goodness of fit. Statistical analyses were

performed using Statistical Application System (SAS version 8e, SAS Institute, Cary, NC). A p -value <0.05 was considered statistically significant.

RESULTS

Our exclusively breastfeeding mothers ($n = 175$) had a mean age of 31.3 ± 4.1 years. Their mean self-reported height and pre-pregnant weights were 165.6 ± 6.9 cm and 63.1 ± 9.9 kg respectively. Their mean BMI was 23 ± 3.4 . Most subjects ($>86\%$) had post secondary education; 57% at the university level; only 5% reported smoking. Canada was the country of origin for 87% of participants and 65% were first time mothers. The mean birth weight was 3445 ± 465 g. Mean maternal weight loss ($1.9 (\pm 2.9)$ kg) was calculated from maternal weight at 6 months postpartum minus measured weight taken at 2 months postpartum. Research assistants made home visits at 2, 4, and 6 months postpartum and used a portable *Healthometer* scale.

Reasons for Low Milk Intake during Lactation

Twenty three percent of breastfeeding women (95% CI; 16%–29%) restricted milk intake to ≤ 250 ml/day. Reasons for restriction in rank order were prevention of infant gas/colic and irritation of baby's GI tract ($n = 37/39$), perceived maternal lactose intolerance ($n = 19/39$), perceived maternal or infant allergy to milk ($n = 11/39$), improvement in baby's behaviour ($n = 7/39$), reduced mucus production ($n = 3/39$) and prevention of contamination of breast milk ($n = 2/39$). Dairy product restriction was endorsed mainly by physicians and nurses but also other health care providers including lactation consultants, homeopaths, prenatal instructors, as well as family and friends, internet sites, books and magazines. Although RS reported lower mean energy intake than NRS (2170 vs. 2324 kcal/d, respectively, $p < 0.05$), there was no significant difference in mean weight loss at six months postpartum: RS $1.66 (\pm 3.34)$ kg vs. NRS $1.91 (\pm 2.86)$ kg, respectively.

Vitamin/Mineral Supplement Intake

Vitamin/mineral supplementation during lactation was practiced by 78% ($n = 136$) with multivitamin/minerals as the most common supplement choice. There was no significant difference in the percentage of RS (73%) and NRS (79%) who took vitamin/mineral supplements but more RS used a single mineral supplement (i.e. iron) compared to NRS ($\chi^2 = 0.878$, $p < 0.05$).

Comparison of Nutrient Intakes Between Restrictors and Nonrestrictors

Table 1 compares the mean and percentiles of nutrient intake between RS and NRS for vitamin D and calcium, those

Table 1. Population Distribution by Milk Restriction Classification for Calcium and, Vitamin D Using Adjusted Nutrient Intakes in Lactating Women prior to Vitamin/Mineral Supplementation

Nutrient ¹	Milk Intake ²	Population Mean	Percentile of usual intake						
			5 th	10 th	25 th	50 th	75 th	90 th	95 th
Calcium (mg)	NRS	1379	805	868	1092	1326	1617	1868	2296
	RS	895	397	455	624	894	1133	1308	1498
Vitamin D (µg)	NRS	6.3	1.7	2.36	3.9	5.65	7.8	11.5	12.7
	RS	2.2	0.1	0.22	0.7	1.82	3.4	4.3	5.2

¹ For lactating women, the Adequate Intake (AI) is 1000 mg for calcium and 5 µg for vitamin D.

² NRS: nonrestrictors (milk consumption >250 ml/d), RS: restrictors (milk consumption ≤250 ml/d).

nutrients supplied in milk. The median intake of calcium without supplements for RS was 895 mg/d compared to 1326 mg/d for NRS. Calcium levels in the diets of restrictors (895 mg) was explained by 430 mg (48%) from dairy products including milk, cheese and yogurt, 109 mg (12%) from grain products, 105 mg (11%) from vegetables and fruit; mixed dishes and other foods explained the balance of the intake. Median intake of vitamin D from food only was 1.82 µg/d for RS and 5.65 µg/d for NRS. For NRS, the mean and median intakes for calcium and vitamin D from food only were above the AI, suggesting a low proportion of inadequate intakes.

In Table 2 the differences between mean intakes of RS and NRS by subcategories of food only and food plus supplements and the proportion of individuals below the EAR for protein, vitamin C, niacin, thiamin, riboflavin and zinc are shown. The mean intake for most nutrients was higher for NRS, a difference maintained after controlling for energy intake by comparing mean intakes per 1000 kcal (data not shown). A higher proportion of subjects reporting milk restriction had inadequate intakes of protein, riboflavin and zinc compared to NRS.

Contribution of Supplements

Given the differences in dietary intake between RS and NRS, supplementation of these two groups may have different consequences. For NRS supplementation decreased the proportion with inadequacy of vitamin C from 24% to 9% and zinc from 35% to 3%. With the exception of protein, other levels of nutrients tested were adequate (Table 2). Among restrictors, supplements elevated mean intakes above the AI for vitamin D and calcium, reduced the proportion reporting inadequacy for vitamin C from 17% to 8%, and zinc from 65% to 25%. Finally we examined the proportion of women above the UL for select nutrients. Eight per cent of NRS were above the UL for zinc compared with 2% of RS. Only 5% of both RS and NRS were above the UL for niacin. There were no appreciable differences between the percentages of RS and NRS above the UL for vitamin C, vitamin D, niacin, and calcium. Thiamin and riboflavin do not have a UL.

DISCUSSION

Dietary restriction of milk compromised protein intakes and without supplements, vitamin D, calcium and zinc as well. One cup of milk is nutrient dense, supplying approximately 8 g of protein, 0.98 mg of zinc and 308 mg calcium and is fortified with 2.56 µg of vitamin D. Although supplements raised nutrient intake above recommended levels for NRS and some RS, protein was low- something that could be alleviated by the addition of one cup of milk a day or an alternate protein dense food choice. Under reporting of both energy and protein may have occurred; over one third of the sample reported protein intakes below the EAR which contrasts with earlier reports of higher intakes in exclusively breast-feeding healthy women [39]. However our study indicates higher intakes of vitamin D, calcium, riboflavin and zinc in non-restrictors and corroborates an earlier study where milk consumers were found to have a better quality diet overall [40].

Zinc has been identified as a nutrient that was below the RDA (12 mg/d) for lactating women in dietary assessments conducted prior to the DRI publications when mean levels were used as a comparison value to the RDA [13,41]. Our results indicate that 25% of women who restricted milk had zinc intakes (with supplements) below the EAR. Zinc is thought to be important in fetal development and infant birthweight but studies have not consistently shown this [42,43].

The restriction of fortified milk denies women an important food source of vitamin D [44]. Low vitamin D can occur as a result of lack of sun exposure [45], polar latitudes [46], dark skin pigmentation [47], clothing cover [48] in addition to low intakes of fortified foods [49]. The consequences of low maternal vitamin D can result in nutritional rickets which continues to be reported in breastfed children in Canada, and the United States [38,50–52]. In Canada, Lebrun et al [53] found low serum 25-hydroxyvitamin D in 76% of mothers and 43% of breastfed infants in 80 mother-child pairs. This was attributed to the combined effect of low exposure to sunlight, a lack of fortified dairy products and a lack of vitamin/mineral supplements containing vitamin D. It is known that vegetarians who eliminate dairy products have low intakes of calcium, vitamin D and vitamin B₁₂ [54,55]. The low vitamin intake and the northerly latitude of

Table 2. Comparison in Daily Nutrient Intakes between Restrictors (RS) and Nonrestrictors (NRS) in Exclusively Lactating Women Stratified Using “Food Only” or “Food + Supplements”

Nutrient	Food only		Food + Supplements	
	Nonrestrictors ¹ n = 136	Restrictors ² n = 39	Nonrestrictors n = 136	Restrictors n = 39
Energy (kcal)				
Mean $\pm$ SD ³	2324 $\pm$ 413 ^a	2170 $\pm$ 385 ^b	N/C ⁴	N/C
% <EAR ⁵	50	63	ND ⁶	ND
Fat (g)				
Mean $\pm$ SD	79.8 $\pm$ 20.0	76.9 $\pm$ 18.8	N/C	N/C
% <EAR	ND	ND	ND	ND
Protein (g)				
Mean $\pm$ SD	101 $\pm$ 22 ^a	86 $\pm$ 20 ^b	N/C	N/C
% <EAR	38 ^A	60 ^B	ND	ND
Carbohydrate (g)				
Mean $\pm$ SD	306 $\pm$ 57	290 $\pm$ 57	N/C	N/C
% <EAR	ND	ND	ND	ND
Vitamin C (mg)				
Mean $\pm$ SD	160 $\pm$ 80	159 $\pm$ 75	260 $\pm$ 158	241 $\pm$ 159
% <EAR	24	17	9	8
Vitamin D (μ g)				
Mean $\pm$ SD	6.3 $\pm$ 4 ^a	2.2 $\pm$ 2.0 ^b	10.7 $\pm$ 4.9 ^a	6.1 $\pm$ 4.7 ^b
Thiamin (mg)				
Mean $\pm$ SD	2.0 $\pm$ 0.5 ^a	1.7 $\pm$ 0.4 ^b	4.9 $\pm$ 6.6	5.8 $\pm$ 9.0
% <EAR	0	15	0 ^A	10 ^B
Niacin (NE)				
Mean $\pm$ SD	40.0 $\pm$ 7.7 ^a	35.4 $\pm$ 6.4 ^b	54.9 $\pm$ 13.8 ^a	46.4 $\pm$ 13.4 ^b
% <EAR	0	0	0	0
Riboflavin (mg)				
Mean $\pm$ SD	2.5 $\pm$ 0.7 ^a	1.9 $\pm$ 0.6 ^b	5.7 $\pm$ 6.6	6.0 $\pm$ 8.9
% <EAR	2 ^A	15 ^B	0 ^A	10 ^B
Calcium (mg)				
Mean $\pm$ SD	1379 $\pm$ 471 ^a	895 $\pm$ 330 ^b	1564 $\pm$ 487 ^a	1287 $\pm$ 470 ^b
Zinc (mg)				
Mean $\pm$ SD	13.2 $\pm$ 2.9 ^a	11.2 $\pm$ 2.9 ^b	25.9 $\pm$ 10.3 ^a	19.8 $\pm$ 10.4 ^b
% <EAR	35 ^A	65 ^B	3 ^A	25 ^B

¹ Nonrestrictors: >250 ml/milk/day, N = 135.² Restrictors: $\leq$ 250 ml/milk/day, N = 40.³ Lower case superscripts indicate significant ($p < 0.05$) differences between restrictors and nonrestrictors for ‘Food Only’ and for ‘Food+ Supplements’ using a Student t-test.⁴ N/C: no change.⁵ Upper case superscripts indicate significant ($p < 0.05$) differences in the proportions of restrictors and nonrestrictors <EAR for each nutrient using a CHI square test.⁶ ND: not determined.

Calgary may suggest that many residents have low serum 25(OH)D, particularly in the winter months. Vitamin D insufficiency may be related to reduced utilization of dietary calcium [56] and prolonged low dietary calcium can exacerbate bone demineralization [38,40,54,57,58]. Our data indicate that mothers who restrict milk may require a vitamin/mineral supplement as a result of the lowered nutrient adequacy of their diet.

There is very little evidence supporting the success of maternal milk restriction in decreasing infant crying, increasing infant calmness, and preventing colic [18,19]. The etiology of colic remains unknown yet there is a perception that milk is responsible for infant gastrointestinal distress and/or colic-type symptoms. Lactose intolerance was the second most frequently reported reason for women to restrict milk but was largely

self-diagnosed and predicated upon commonly held myths surrounding milk consumption [59].

This sample of women exclusively breastfed for six months and had energy intakes comparable to other well nourished lactating groups [13,39,60] but few women achieved their pregravid weight by the end of the six month measurement period. Diets high in calcium and dairy products have been associated with decreases in body weight in samples of obese and overweight people but only small clinical trials have tested these effects on adiposity and have not shown consistent results [26,61,62]. In our study, we would have expected greater weight loss in NRS because they included dairy products in their diet and had significantly higher calcium intake than RS. This was not the case and may be explained by the common use

of vitamin/mineral supplements that raised calcium intake to 1287 ± 470 mg in RS, a level comparable to NRS. We encountered very few women with calcium intakes below 500 mg/d, the level Zemel suggests is required before additional calcium can affect energy balance [25,63]. In the one randomized, double blind trial, calcium supplementation of 1g/d and placebo were given to both lactating and non-lactating women with habitual low calcium intakes of 800 mg/d. There was no difference in weight loss at six months postpartum that could be attributed to calcium supplementation [28].

CONCLUSION

In our study population of well-educated women who were exclusively breast feeding their infants, some reported low intakes of protein, vitamin C and zinc. However, women who restrict milk intake and who do not take vitamin/mineral supplements would appear to be at elevated risk for low intakes of calcium, zinc and vitamin D. This supplementation should be suggested specifically for those who limit milk intake, in addition to the recommendation that they supplement with folic acid [64]. Health care providers [65] should discuss the reasons women have for restricting milk and try to dispel commonly held myths or find other ways of increasing intake of calcium, vitamin D and zinc.

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