

Contribution of breastfeeding to vitamin A nutrition of infants: a simulation model

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Objective To provide information on the potential contribution to vitamin A nutrition in infants of strategies for improving maternal vitamin A status and increasing the consumption of breast milk.

Methods The contribution of breastfeeding to the vitamin A nutrition of children in eight age groups between 0 and 24 months was simulated under four sets of conditions involving two levels of breast milk consumption with or without maternal vitamin A supplementation.

Findings During the first 6 months, optimal breastfeeding on its own (compared with withholding colostrum and then partially breastfeeding after the first week) was as effective as postpartum maternal supplementation alone, retinol intakes being increased by 59 µg per day and 68 µg per day, respectively. Combined in synergy, these strategies increase retinol intake by 144 µg per day, or 36% of the recommended intake. After 6 months, partial breastfeeding continued to provide a significant proportion of the recommended intakes: 42% from 6–12 months and 61% during the second year.

Conclusion Maternal supplementation with a high dose of vitamin A at the time of delivery and the promotion of optimal breastfeeding practices are highly effective strategies for improving vitamin A nutrition in infants and should be strengthened as key components of comprehensive child survival programmes.

Keywords Vitamin A; Vitamin A deficiency/prevention and control; Dietary supplements; Breast feeding/statistics; Milk, Human/chemistry; Nutritive value; Nutrition; Nutrition assessment; Mothers; Infant; Developing countries; (*source: MeSH, NLM*).

Mots clés Vitamine A; Rétinol, Carence/prévention et contrôle; Compléments alimentaires; Allaitement au sein/statistique; Lait femme/composition chimique; Valeur nutritive; Nutrition; Evaluation nutritionnelle; Mère; Nourrisson; Pays en développement; (*source: MeSH, INSERM*).

Palabras clave Vitamina A; Deficiencia de vitamina A/prevenición y control; Suplementos dietéticos; Lactancia materna/estadística; Leche humana/química; Valor nutritivo; Nutrición; Evaluación nutricional; Madres; Lactante; Países en desarrollo; (*fuentes: DeCS, BIREME*).

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Voir page 85 le résumé en français. En la página 86 figura un resumen en español.

Introduction

It is estimated that subclinical vitamin A deficiency affects 75–140 million preschool-age children in developing countries (1). Such deficiency increases susceptibility to infection and the probability of death. A meta-analysis of randomized control trials indicated that improvement in the vitamin A status of children aged 6–59 months reduced mortality by 23% in populations at risk of vitamin A deficiency (2). Most of this mortality occurred before the age of 2 years. Data from eight field trials showed that the mortality reductions in children aged 6–24 months comprised over 70% of the number of lives saved through improving the vitamin A status of children aged 6–59 months (2).

Breastfeeding can be highly beneficial in this connection because of the high levels of retinol and other factors normally found in breast milk (3). The promotion and protection of breastfeeding is therefore an important strategy in the

prevention of vitamin A deficiency in infancy. If maternal vitamin A status is poor, however, even breastfed infants are likely to become subclinically deficient by about 6 months of age (4, 5). Maternal supplementation with a high dose of vitamin A shortly after delivery increases its concentration in breast milk (6). Quantification of the roles of these strategies can be expected to help child health advocates promote both optimal breastfeeding practices and improved maternal vitamin A nutrition in populations at risk of vitamin A deficiency.

In this paper we report calculations of the contribution of breastfeeding to infant vitamin A requirements under different conditions. Model inputs included the concentration of vitamin A in breast milk, the quantity of breast milk consumed, and the vitamin A requirements of infants. Estimates derived from the literature were used in order to simulate and compare different conditions, thus providing a measure of the benefits potentially obtainable from improvement in both maternal vitamin A status and breastfeeding practices.

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Methods

Vitamin A level in breast milk

The level of vitamin A in breast milk varies with maternal vitamin A status and the stage of lactation. In well-nourished mothers, colostrum contains 151 µg/100 ml, transitional milk contains 88 µg/100 ml and mature milk contains 75 µg/100 ml of vitamin A (7). The US National Research Council (8) gives the range of vitamin A levels in the milk of well-nourished women in the USA and Europe as 40–70 µg/100 ml. The concentration of vitamin A in the mature milk of unsupplemented mothers in developing countries was found to be about half that in the milk of such mothers in developed countries (5). Lower intakes of animal foods in developing countries probably explain much of this difference. However, other contributory factors may include lower intakes of dietary fat (needed for optimal absorption and utilization of vitamin A and precursor carotenoids), higher intakes of dietary fibre (which may reduce the bioavailability of carotenoids), infections (which can increase metabolic demand), and iron or zinc deficiencies.

Differences in regional averages do not reveal the range of retinol concentrations in breast milk observed among poorly nourished mothers. Although the weighted average reported for developing countries by Newman (5) is 333 µg/l (5), some populations have lower average levels and many women have retinol levels lower than this. For example, 79% of 72 unsupplemented mothers in rural Bangladesh had retinol levels < 300 µg/l in their mature (3-month) breast milk (9). In Indonesia, one study reported that 33% of unsupplemented mothers participating in a clinical trial had retinol < 300 µg/l at three months (10), while another found that the control group had mean retinol concentrations in their breast milk of only 175 µg/l (11).

Vitamin A levels in breast milk tend to decline over time in both developed and developing countries (5), for both supplemented and unsupplemented mothers (12). Table 1 shows weighted average vitamin A levels in breast milk by time after delivery (5). Colostrum is particularly high in retinol, even in unsupplemented mothers in developing countries, but during the first month the vitamin A level declines rapidly to less than

half its original value. The common practice of withholding or expressing and discarding colostrum is, therefore, particularly inappropriate. To capture the effect of this practice and the benefits of early initiation of breastfeeding, we placed infants aged up to 1 week in a separate age group in the spreadsheet.

The default value used for the vitamin A level in the breast milk of poorly nourished mothers in the absence of any intervention to improve vitamin A status was 300 µg/l, while for well-nourished women it was 700 µg/l. The levels used for the first week and for the next two weeks were those indicated for retinol in Table 1.

Vitamin A requirements of infants

The recommended daily allowance of 375 retinol equivalents (RE) per day in the USA is based on an absence of signs of vitamin A deficiency in infants consuming 300 RE per day, plus 75 RE per day representing two standard deviations, thus ensuring that the requirements of 97.5% of the population are met (8). The FAO/WHO recommendation is that infants consume 350 RE per day (13). The US Institute of Medicine (IOM) (14) proposes an adequate intake (AI) of vitamin A for infants that is based on the observed intakes of healthy infants exclusively breastfed by healthy well-nourished mothers, but makes the following assumptions. For infants aged 0–6 months the AI is based on the observation that infants consume an average of 0.78 l per day of breast milk containing 485 µg/l of retinol (0.78 x 485), i.e. 385 µg/day, rounded up to 400 µg/day. For older infants the basis is an observed intake of 0.60 l/day of breast milk containing 291 µg of retinol (0.60 x 485) and of 244 µg of retinol from complementary foods, totalling 535 µg, rounded down to 500 µg/day. Uncertainty about the role and conversion efficiency of carotenoids in breast milk led the IOM not to consider these matters in making their estimates and to express the AI only in terms of retinol. At these levels the net transfer of retinol would be 180 x 400 = 72 000 µg (251 µmoles, 240 000 IU) during the first 6 months and 180 x 500 = 90 000 µg (314 µmoles, 300 000 IU) for the second half of infancy.

A recent review of requirements for infants under 6 months of age proposed that current estimates of vitamin A

Table 1. Retinol, carotene, retinol equivalents and retinol activity equivalents in term milk of unsupplemented mothers in developed and developing countries, by time after delivery (see ref. 5)

Time after delivery	Developed countries				Developing countries			
	Retinol (µg/l)	Carotene (RE/l) ^a	RE/l	RAE/l ^b	Retinol (µg/l)	Carotene (RE/l)	RE/l	RAE/l
1–6 days	1524	130	1654	1589	1193	50	1243	1218
7–21 days	1023	25	1048	1035.5	866	NA ^c	NA	NA
1–2 months	683	33	716	699.5	495	46	541	518
3–4 months	640	54	694	667	480	41	521	500.5
5–6 months	745	35	780	762.5	459	43	502	480.5
7–12 months	NA	NA	NA	NA	347	35	382	364.5
13–24 months	NA	NA	NA	NA	278	31	309	293.5
>24 months	NA	NA	NA	NA	130	NA	NA	NA

^a Converted in ref. 5 at a rate of 6 µg carotene per retinol equivalent (RE).

^b RAE = retinol activity equivalents.

^c NA = no data available.

requirements for infants might be slightly too high (15). It was concluded that, during the first 6 months of life, infants probably required about 300 µg of vitamin A per day in order to accumulate adequate liver stores and about 125 µg per day to prevent the development of clinical symptoms of deficiency. Thus infants' true physiological requirement for vitamin A is not clear nor is the standard of health that should be used to determine it. Prevention of clinical deficiency is probably too low a standard in this respect. Since subclinical deficiency is a risk factor for mortality (2) it would seem more prudent to avoid such deficiency by ensuring that stores are adequate. It therefore seems reasonable to recommend an average daily intake of 300 RE plus 75 RE per day (two standard deviations) to cover variations in requirements. However, for the purposes of assessing the adequacy of intakes by infants we use the IOM's adequate intakes of 400 µg/day for infants aged 0 to <6 months and 500 µg/day for infants aged 6 to <12 months (14). These amounts are considered to meet the needs of virtually all infants. In populations where infections are common, however, they may be inadequate.

Intake of breast milk

Infants' intake of breast milk varies with breastfeeding practices. In many societies the colostrum is expressed and discarded or withheld until the secretion of mature milk begins, which can be 6–10 days after delivery. This deprives infants of breast milk when it is particularly rich in vitamin A. Moreover, the early initiation of breastfeeding increases the success and overall duration of exclusive breastfeeding (16), which is important for the optimal transfer of vitamin A from mother to infant. When colostrum is discarded it is often replaced by prelacteal feeds made from cereal, animal milk, herbal

concoctions, or other liquids. These are lower in vitamin A and other nutrients and may expose infants to pathogens and allergens capable of causing infections and trauma that further compromise their vitamin A status by increasing their requirements or reducing absorption.

Once mature milk is being released, non-exclusive breastfeeding, i.e. the addition of any other food or fluid, even water, to the diet, has similar effects. The promotion of early initiation and exclusive breastfeeding for six months should therefore be seen as a key intervention for improving the vitamin A status of infants.

WHO has compiled the results of studies on intakes of breast milk in poor and industrialized countries by partially and exclusively breastfed infants (17). The default values used in the spreadsheet are shown in Table 2.

Effect of maternal supplementation with vitamin A

Studies by Hrubertz et al. (18) and Sobel et al. (19) in the 1940s demonstrated that maternal supplementation with high doses of vitamin A increased its concentration in human milk. WHO has recommended that, in communities where vitamin A deficiency is common, mothers be supplemented shortly after delivery in order to improve their vitamin A status and increase the level of the vitamin in their breast milk (20). Supplementation trials in Bangladesh (9, 21), Indonesia (10), and India (12) indicate the expected increase in vitamin A levels in breast milk. In Fig. 1 the concentration of retinol in breast milk for each day from birth to 6 months in control and supplemented mothers is the pooled mean reported for all studies, weighted by the inverse of the variance reported for each period. Assuming the consumption of breast milk to be 0.5 l per day in the first week, 0.62 l per day until 3 months, and finally 0.66 l per day from 3 to

Table 2. Intakes of breast milk in developing and developed countries by exclusively and partially breastfed infants (see ref. 17)

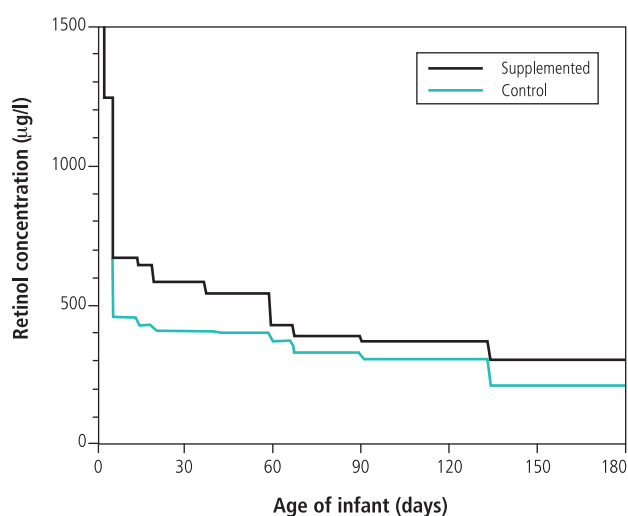
	Age group (months)				
	0 to <3	3 to <6	6 to <9	9 to <12	12 to <24
Developing countries					
<i>Partially breastfed</i>					
No. of studies	8	9	14	13	9
No. of subjects	381	437	533	342	377
Breast milk intake ^a (l/day ± SD ^b)	0.598 ± 0.163	0.643 ± 0.150	0.640 ± 0.148	0.597 ± 0.167	0.532 ± 0.181
<i>Exclusively breastfed</i>					
No. of studies	3	5	2	NA ^c	NA
No. of subjects	172	259	70	NA	NA
Breast milk intake (l/day ± SD)	0.693 ± 0.127	0.760 ± 0.124	0.753 ± 0.137	NA	NA
Developed countries					
<i>Partially breastfed</i>					
No. of studies	4	5	6	4	1
No. of subjects	175	416	351	108	40
Breast milk intake (l/day ± SD)	0.621 ± 0.164	0.666 ± 0.176	0.574 ± 0.177	0.423 ± 0.248	0.435 ± 0.243
<i>Exclusively breastfed</i>					
No. of studies	5	7	5	1	NA
No. of subjects	333	399	139	26	NA
Breast milk intake (l/day ± SD)	0.689 ± 0.130	0.763 ± 0.124	0.779 ± 0.113	0.873 ± 0.038	NA

^a Volumes calculated from g per day data in ref. 17, assuming a specific gravity of 1.031.

^b SD = standard deviation.

^c NA = data not available.

Fig. 1. Pooled weighted mean breast milk retinol concentrations in supplemented and control mothers in four studies



6 months (Table 2), the weighted mean net transfer of retinol to infants attributable to supplementation is 13 226 µg between birth and 6 months of age (Table 3). According to this analysis, 20% of the supplement in these trials was transferred to the infants, contributing 18% of the AI for the first 6 months and representing an increase of 35% over the estimated vitamin A intake of infants in placebo groups.

Roy et al. (21) reported that the vitamin A levels in breast milk reached four times the baseline level 24 hours after supplementation. This peak might have been expected on the basis of the results of the studies conducted in the 1940s, cited above, but was not detected in the other studies because breast

milk was not sampled shortly after supplementation. Depending on the magnitude and duration of this peak, the contribution of breast milk to vitamin A intake during this period is likely to be underestimated in Table 3. For the simulation we estimated the net transfer of retinol from a supplement of 200 000–300 000 IU during the first 6 months to be 13 226 µg (73 µg per day), on the assumption that partial breastfeeding is practised. Given the average retinol concentrations in breast milk (Table 1) and the average intakes of breast milk (Table 2) in developing countries, this implies an increase in the average retinol level in breast milk of 29% (13 226 µg / 45 659 µg).

Scenarios and simulation methods

We estimated the contribution of breastfeeding to the vitamin A nutrition of infants by means of a spreadsheet that calculates the product of breast-milk volume and retinol concentration for different age groups. Any scenario or situation can be described in terms of the volume and retinol concentration of breast milk consumed by infants of different ages. If the maternal vitamin A status is poor, if colostrum is not consumed, or if exclusive breastfeeding is not practised, the vitamin A intakes of infants are compromised. Under these circumstances the potential contribution of interventions aimed at improving maternal vitamin A status (and therefore the levels of vitamin A in breast milk) and promoting the early initiation of exclusive breastfeeding can be assessed on the basis of assumptions about the effects on the volume and retinol levels of breast milk.

Users of the spreadsheet who are interested in the contribution that breastfeeding makes towards meeting the requirements of infants for vitamin A in a given situation should use information specific to the population in question. Below we compare four hypothetical scenarios in order to

Table 3. Results of published maternal supplementation trials

Country (Ref.)	Supplement amount and timing	Vitamin A level in breast milk in placebo group (µg/l)		Duration of measured effect (months)	Net transfer of retinol ^a (µg) (0–6 months)	Proportion of acceptable intake met by supplement transferred (0–6 months)	Proportion of supplement transferred (0–6 months)	Supplement transferred as proportion of retinol intake of infants in placebo group
		1 month	3 months					
Indonesia (10)	300 000 IU; 7–21 days postpartum	550	521	8	25 431	0.353	0.283	0.415
Bangladesh (21)	200 000 IU; 24 hours postpartum	355	321	6	18 957	0.263	0.316	0.524
India (12)	200 000 IU; within 72 hours postpartum	590	420	1.5	5914	0.082	0.099	0.1754
Bangladesh (9)	200 000 IU; 7–21 days postpartum	NA ^b	238	3	7715	0.107	0.129	0.265
Weighted average ^c					13 226	0.184	0.196 ^d	0.353

^a Calculated as the product of the number of days represented by a measurement, the mean difference in retinol level (µg/l) between supplemented and placebo groups, and assumed daily intake of breast milk (0.66 l/day). The number of days represented by a measurement is calculated as half the time since the previous measurement plus half the time until the next.

^b NA = not available.

^c The average increase in breast milk retinol for each day from birth to 6 months was calculated as the mean of the increase reported for all studies, weighted by the inverse of the variance reported for each time period. Net transfer assumes breast milk intake of 0.5 l per day in the first week, 0.62 l per day to 3 months, and 0.66 l per day for 3–6 months.

^d Calculated as a proportion of the mean dose for the four studies (225 000 IU = 67500 µg).

illustrate the separate and combined potential contributions of interventions to improve maternal vitamin A status and promote early initiation and exclusive breastfeeding.

1. Poor maternal vitamin A status, low rates of early initiation and exclusive breastfeeding

The assumptions for this scenario are based on the vitamin A levels in breast milk during the first month in developing countries (Table 1) and on 333 µg/l from the age of 1 month (7). The consumption of breast milk is as given in Table 2 for partially breastfed infants in developing countries, no breast milk being consumed in the first week.

2. Poor maternal vitamin A status, optimal infant feeding practices

The levels of vitamin A in breast milk are as in the previous scenario but the infants are assumed to be exclusively breastfed from delivery until the age of 6 months. The consumption of breast milk in the first week is assumed to average 0.5 l/day but otherwise is as in Table 2 for exclusively breastfed infants in developing countries.

3. Improved maternal vitamin A status, low rates of early initiation and exclusive breastfeeding

In this scenario a maternal dose of 200 000 IU results in an increase of 29% in the level of retinol in breast milk over 6 months. Although the trial data indicate that this increase is unevenly distributed over time, there being an initial peak in the vitamin A level in breast milk followed by a gradual decline, the patterns are extremely varied and the pharmacokinetics have not been adequately studied. We therefore assume that there is a consistent 29% increase during the first six months. To the extent that the increase in the concentration of vitamin A in breast milk occurs earlier, this assumption leads to an underestimation of the contribution of breastfeeding at an early stage and to an overestimation later. With regard to the net transfer of retinol, however, the assumption has no effect. The consumption of breast milk in this scenario is low, as described for scenario 1.

4. Improved maternal vitamin A status, optimal infant feeding practices

As in the previous scenario the level of vitamin A in breast milk is assumed to increase by 29% over the first half of infancy. Breastfeeding practices are optimal, as described for scenario 2.

Rather than inventing an additional scenario based on the assumptions used by the IOM (14) in setting the current AI, we simply take the latter as a standard for comparison.

The values for the volume of breast milk and the retinol levels for the different infant age groups in this simulation are given in Table 4.

Results and discussion

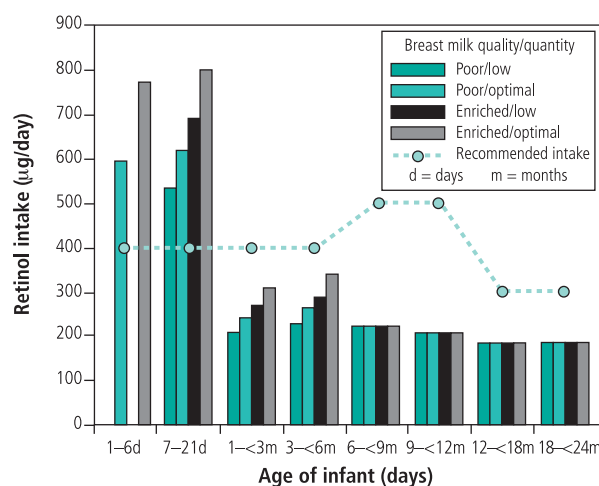
The results of the simulation, expressed as total intake of retinol by infants at different ages, are shown in Fig. 2. The percentages of the recommended intakes met during aggregated age intervals are shown in Fig. 3.

In the two low breastfeeding scenarios, where infants are not breastfed until the secretion of mature milk begins, the advantages of early initiation are clear, providing 600–800 µg/day, well in excess of the AI and presumably affording an

Table 4. Assumed breast milk volumes and retinol levels, by infant age, for different scenarios

Time after delivery	Breast milk vitamin A (µg/l)		Breast milk intake (l/d)	
	Poor	Improved	Low	Optimal
1–6 days	1193	1539	0.00	0.50
7–21 days	866	1117	0.62	0.71
1–2 months	333	430	0.62	0.71
3–4 months	333	430	0.66	0.78
5–6 months	333	430	0.66	0.78
7–12 months	333	333	0.64	0.78
13–24 months	333	333	0.55	0.60

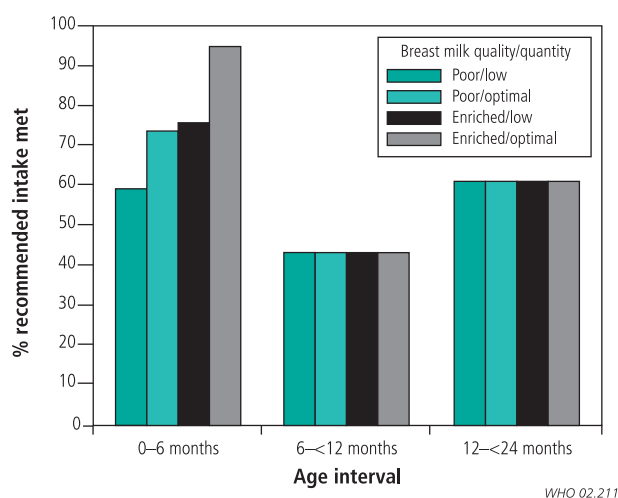
Fig. 2. Daily retinol intake from breast milk by children aged 0–24 months at different breast milk retinol levels (poor or enriched) and breast milk consumption (low or optimal) compared with recommended intakes (14), by age interval



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opportunity to build stores. In the following two weeks, when the breast milk continues to have a high retinol content, regardless of maternal vitamin A status, exclusive breastfeeding increases the transfer of retinol to infants by about 100 µg/day compared with partial breastfeeding. For the rest of the first six months the advantages of exclusive breastfeeding are proportionally as great but, because the levels of vitamin A in breast milk are lower, the absolute difference is smaller. The net effect of optimal breastfeeding alone (poor/optimal scenario) on the intake of retinol during the first half of infancy is approximately the same as the net effect of supplementation alone (enriched/low scenario) compared with the poor/low scenario (Fig. 3), the mean daily retinol intakes being raised by 59 µg and 68 µg, respectively. In combination the increase is 144 µg per day, or 36% of the recommended intake. This should be considered a conservative estimate of the advantages of exclusive breastfeeding in respect of infant vitamin A status at this time because it does not include the benefits afforded by protection against infectious disease. The latter can independently increase vitamin A requirements and losses and reduce intake and absorption.

Fig. 3. Percentage of recommended retinol intakes met under different conditions, by aggregated age interval



We have assumed that the levels of retinol in breast milk are a function of maternal vitamin A status and supplementation but not of breastfeeding practices. If these practices improve, however, and the total volume of breast milk production increases, there may be a compensatory effect as maternal vitamin A stores are drawn on. However, since there is no pharmacokinetic evidence of such an effect we have assumed that the levels of retinol in breast milk are independent of breastfeeding practices.

In our simulation the assumptions about vitamin A levels in breast milk and breastfeeding practices are identical for the different scenarios after six months, when, consequently, no differences are noted. However, two important points should be made in this connection. First, partial breastfeeding at the mean levels reported for developing countries continues to

provide a significant proportion of the recommended intakes: 42% from 6–12 months and 61% during the second year. Second, intakes remain far below the recommended levels and it is therefore necessary to supplement breast milk with foods rich in vitamin A. If such foods are not regularly available, affordable and fed, it is recommended that children be supplemented every 6 months after the age of 6 months.

The provision of maternal high-dose postpartum vitamin A has become standard practice in many countries, although coverage rates above 50% are uncommon. Moreover, even though the success of this strategy depends on breastfeeding, this link in the delivery chain is often taken for granted. Maternal supplementation with a high dose of vitamin A at the time of delivery and the promotion of optimal breastfeeding practices are highly effective in improving vitamin A nutrition in infants. Both strategies should be strengthened by giving them increased attention and resources in order to achieve maximum potential reductions in child mortality through improvements in vitamin A status. ■

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Conflicts of interest: none declared.

Résumé

Modélisation de la contribution de l'allaitement maternel à l'apport de vitamine A chez le nourrisson

Objectif Fournir des informations sur la contribution potentielle à l'apport en vitamine A chez le nourrisson de stratégies visant à améliorer le bilan vitaminique A chez la mère et à augmenter la consommation de lait maternel.

Méthodes La contribution de l'allaitement maternel à l'apport de vitamine A chez des enfants de huit groupes d'âge entre 0 et 24 mois a fait l'objet d'une simulation avec quatre séries de conditions – deux niveaux de consommation de lait maternel, avec ou sans supplémentation en vitamine A chez la mère.

Résultats Jusqu'à l'âge de six mois, l'allaitement au sein optimal (par opposition à l'allaitement au sein sans le colostrum puis partiel après la première semaine) était aussi efficace à lui seul que la simple supplémentation post-partum chez la mère, l'apport

en rétinol étant augmenté de 59 µg par jour dans le premier cas et de 68 µg par jour dans le second. Appliquées en synergie, ces stratégies augmentaient l'apport en rétinol de 144 µg par jour, soit 36 % de l'apport recommandé. Au-delà de six mois, l'allaitement partiel continuait à fournir une proportion notable de l'apport recommandé, soit 42 % de 6 à 12 mois et 61 % la deuxième année.

Conclusion La supplémentation par une forte dose de vitamine A chez la mère au moment de l'accouchement et la promotion de modalités optimales d'allaitement au sein constituent des stratégies efficaces d'amélioration de l'apport en vitamine A chez le nourrisson et devront être renforcées en tant qu'éléments clés de tout programme global pour la survie de l'enfant.

Resumen

Contribución de la lactancia materna al aporte de vitamina A en los lactantes: un modelo de simulación

Objetivo Proporcionar información sobre la contribución potencial al aporte de vitamina A en los lactantes de las estrategias tendientes a mejorar los niveles de vitamina A de la madre y aumentar el consumo de leche materna.

Métodos Se procedió a simular la contribución de la lactancia materna al aporte de vitamina A en niños de ocho grupos de edad entre 0 y 24 meses, considerando cuatro conjuntos de condiciones que incluían dos niveles de consumo de leche materna, con o sin administración de suplementos de vitamina A a la madre.

Resultados Durante los 6 primeros meses, la lactancia materna óptima por sí misma (en comparación con la retención del calostro y la alimentación parcial al pecho tras la primera semana) fue tan eficaz como la suplementación materna posparto como medida única, con aumentos de la ingesta diaria

de retinol cifrados en 59 µg y 68 µg, respectivamente. Combinadas sinérgicamente, estas dos estrategias aumentaron la ingesta de retinol en 144 µg diarios, o el 36% de la ingesta recomendada. Después de los 6 meses, la lactancia materna parcial siguió aportando una proporción significativa de la ingesta recomendada: 42% en el intervalo de 6-12 meses, y 61% durante el segundo año.

Conclusión La administración de suplementos de altas dosis de vitamina A a la madre en el momento del parto y la promoción de unas prácticas de lactancia materna óptimas constituyen estrategias altamente eficaces para mejorar la aportación de vitamina A a los lactantes y merecen ser reforzadas como componentes clave de los programas integrales de supervivencia infantil.

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