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Vitamin D supplementation in Swiss infants[1]

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Summary

Background: Various recent publications reported clinical manifestations of vitamin D deficiency in infants. Furthermore new research revealed additional properties of vitamin D for bone health and in the prevention of chronic diseases. However, prevalence data on actual supplementation rates are scarce. This study reports the prevalence of vitamin D supplementation in infants in Switzerland and presents risk factors for non-supplementation.

Methods: In 2003, mothers of 2861 randomly selected infants aged 0–9 months received a questionnaire on infant feeding, including a question on vitamin D supplementation. The prevalence of vitamin D supplementation was calculated and its dependency on various factors analysed by multiple logistic regression.

Results: 64% of the infants had received vitamin D. The regression analysis yielded various significant risk factors for non-supplementation: young maternal age, German language region, Swiss nationality, siblings and breastfeeding. Protective factors were intake of folic acid during pregnancy and professional information on infant feeding. The protective effect of professional information varied significantly by region.

Conclusions: Given that the supplementation of vitamin D is recommended for all infants, the supplementation prevalence in Swiss infants is unsatisfactorily low. Various risk factors were identified and a positive impact of professional counselling on the supplementation rate could be demonstrated. In view of the new evidence emerging on additional preventive properties of vitamin D and the resurgence of rickets, the importance of vitamin D for infant health and ways to improve its promotion must be discussed anew.

Key words: infant health; health promotion; rickets; vitamin D supplementation

Introduction

Vitamin D has been known for the prevention of rickets since the 1930's. Its supplementation has resulted in a major reduction of the clinical manifestations of vitamin D deficiency, such as rickets and growth failure, lethargy and irritability or hypocalcaemic tetany [1–3]. It is therefore internationally accepted to recommend vitamin D supplementation in infancy. The dose and duration, however, differs from country to country dependent on the risk profile of the concerned population [4–8]. The Swiss Paediatric Association recommends 400 µg of vitamin D daily from the infant's second week until the end of the first year [9, 10] (SGP). Lately, several publications discuss a resurgence of clinical manifestations, such as rickets and seizures, in risk populations, infants, who are less exposed to sunlight for environmental, cultural or medical reasons or who are fully breast-fed [11–21]. These findings imply either a lack of compliance with the recommendations or a need of higher supplementation dose. The later could be explained by the increasing prevalence of breastfeeding as well as a reduction of sunlight exposure and frequent use of sunscreen as preventive measures against skin cancer [5, 7, 15, 16, 22–24]. These genuinely positive results of health promotion activities may have had unwanted side effects. The prevailing importance of vitamin D supplementation in infancy is accentuated by new research on its preventive properties for bone health after infancy as well as for other diseases, such as diabetes type I, mental disorders or various cancers [6, 18, 25–38]. While vitamin D deficiency has been reported for risk populations and in various case studies [11, 17, 19, 39–44], only a few studies have investigated the prevalence of vitamin D supplementation in infants [8, 39, 45–47]. The present study investigates for the first time the prevalence of vitamin D supplementation in Switzerland and the possible risk factors for non-compliance to the guidelines.

1 Contributions: Julia Dratva participated in the development of the questionnaire, had primary responsibility for the planning and organisation of the data collection, data analysis and writing the manuscript. Sonja Merten wrote the project proposal, developed the study design and questionnaire, participated in the data analysis and contributed to the paper. Ursula Ackermann-Liebrich, as the director of the Institute of Social and Preventive Medicine, supervised all work and contributed to all steps mentioned above.

Ethics approval: The ethical commission of the university of Basel decided that no ethical approval was necessary, since the data collection was anonymous and no specimens were collected.

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Methods

Between April and July 2003 183 regional community-based mother-child health services, two hospitals and in the Italian speaking region health authorities were instructed to randomly select mothers, who had given birth within the previous nine months. 4114 mothers were sent a questionnaire on infant feeding, including a question on the vitamin D supplementation within the past 24 hours, as well as questions on socio-demographic characteristics and the health of the mother and her child. The return rate was 74% resulting in 3032 records. After exclusion of records with insufficient questionnaire data, missing information on the age of the child or on infant feeding, and records from children older than 11 months, 2868 records were left for analysis.

First a descriptive analysis of the prevalence of vitamin D supplementation was conducted using the Chi2 test to assess differences in prevalence across various subgroups. P-values <0.05 were considered significant. And second, in an explorative approach, various factors, potentially influencing the supplementation of vitamin D, were studied using multivariate logistic regression. Variables, significant in uni-variate testing, as well as variables, known to be associated with vitamin D supplementation, were included in the analysis: season of data collection, age of mother, parity, full breastfeeding, region, education, information on infant feeding, mother's attitude towards primary prevention and sex and birth weight of the child. We further adjusted for potential confounding factors, reported in literature to influence infant feeding praxis, such as body mass index, smoking, allergy of the mother. The results are presented as odds ratios with 95% confidence intervals. The season of data collection was defined as spring/summer for the months May through September (n = 2684) and as fall (n = 235, data from October and November months). Educational status was defined as high, when mothers had reached a degree from a technical college or university, and otherwise as low. The mother's attentiveness regarding her own nutrition was assessed using a question from the Swiss Health Survey 1997 [48]. Breast feeding practices mentioned in this article were classified according to the WHO's definitions [49]. Mothers were questioned about their source of information on infant feeding. Information on infant feeding was used as a proxy for "information on vitamin D supplementation". Information provided by doctors and/or mother- and child-health workers was defined as "professional". If it was provided by relatives and/or friends as "non-professional" and if no information by such persons had been provided as "none". The variable "folic acid intake during pregnancy" was used as a proxy for the mother's attitude towards primary prevention. Potential effect modification by breast feeding was tested for by introducing interaction terms between breast feeding and the covariate of interest, known risk factors for breastfeeding: smoking, nationality, language region and infants' age. Furthermore potential interaction between region and nationality, education, parity and information on infant feeding were tested. Model comparisons were performed using the likelihood ratio test. To demonstrate the interaction seen between region and type of information (LR Test: p = 0,0241), we calculated regional prevalence of vitamin D supplementation adjusted for all other variables of the logistic regression model. The interaction-model was not included into the model presented in this paper (table 3).

A sensitivity analysis was conducted to distinguish the impact of different feeding types on vitamin D supplementation. The model was adjusted for season, maternal age, smoking and language region. The analysis was stratified for infant age groups, since breastfeeding prevalences vary significantly across age groups.

Statistical analysis was performed using STATA (STATA/S.E. 8.0).

Results

A comparison with Swiss national birth register showed that mothers in the study sample were slightly older and more often of Swiss nationality compared to the national birth register (data not shown [50]). The proportion of primiparous women was also higher in the study sample.

The overall prevalence of vitamin D supplementation was 64% (CI 0.615–0.650). Table 1 presents the prevalence of vitamin D supplementation across different sub-groups.

As to be expected, the prevalence rate was higher during the fall months than during the spring/summer months (72% *vs* 62%, p = 0.003). The supplementation rate also varied across different sub-groups (table 1).

Young mothers (<25 years) as well as mothers over 35 years gave vitamin D less often, a tendency also seen among multiparous mothers. In addition, prevalence rates differed by language regions and nationality. Swiss infants received vitamin D more often than infants from mothers coming from Balkan countries, but less often than infants, whose mothers came from EU member states or other countries. The prevalence of vitamin D supplementation was lower in the German-speaking region of Switzerland than in the French or Italian region. Further factors with a significant impact on vitamin D supplementation were the source of information mothers received, the intake of folic acid in pregnancy, the infants age and birth weight (univariate analysis).

Table 2 displays the influence of the source of information on the supplementation rate by language region, differentiating professional information into three categories: a) mother- and child-care workers b) information by doctors or c) both sources. Mothers, who had seeked advice from both doctors and mother- and child-care workers, showed the highest supplementation prevalence.

We further investigated the influence of different factors on the supplementation of vitamin D by multivariate logistic regression. The results are summarised in table 3.

The multivariate regression analysis yielded various factors negatively associated with vitamin D supplementation, such as maternal age below

Table 1

Prevalence of vitamin D supplementation across subgroups (n = 2868).

	Distribution in study population (n = 2868) %	Vitamin D supplementation across subgroups				Univariate testing
		no (n = 1053)		yes (n =1815)		
		n	%	n	%	
Maternal age						
<25	6	70	44	89	56	
25–34	65	648	35	1230	66	
>35	28	330	40	486	60	
Missing	1	5	33	10	67	p = 0.002
Nationality						
Swiss origin	80	861	38	1433	62	
Balkan origin	4	53	46	63	54	
EU origin	12	110	32	237	68	
Other	3	26	26	74	74	
Missing	0	3	27	8	73	p = 0.004
Region						
German speaking	67	768	40	1158	60	
French speaking	22	199	32	432	68	
Italian speaking	10	80	28	202	72	
Missing	1	6	21	23	79	p = 0.000
Educational level						
Low	71	742	37	1280	63	
High	27	285	37	489	63	
Missing	3	26	36	46	64	p = 0.992
Parity						
One child	53	479	32	1030	68	
Two or more	47	571	42	782	58	
Missing	0	3	50	3	50	p = 0.000
Partial breastfeeding						
No	67	688	36	1247	64	
Yes	33	365	39	568	61	p = 0.063
Full breastfeeding						
No	74	780	37	1346	63	
Yes	26	273	37	469	63	p = 0.960
Exclusive breastfeeding						
No	79	821	36	1454	64	
Yes	21	232	39	361	61	p = 0.172
Source of information on infant feeding						
None	8	95	42	130	58	
Non-professional	35	418	41	595	59	
Professional	57	540	33	1090	67	p = 0.000
Folic acid intake						
No	28	347	43	466	57	
Do not know	5	47	36	83	64	
Yes	66	652	34	1248	66	
Missing	1	7	28	18	72	p = 0.000
Infants' age group						
0–1 months	6	57	34	110	66	
2–3 months	21	194	33	403	68	
4–5 months	26	248	33	507	67	
6, 7 and 8 months	38	433	40	651	60	
9 months and older	9	121	46	144	54	p = 0.000
Infants' sex						
Male	50	534	38	887	62	
Female	50	519	36	926	64	
Missing	0	0	0	2	100	p = 0.365

Table 1 cont.

	Distribution in study population (n = 2868) %	Vitamin D supplementation across subgroups				Univariate testing
		no (n = 1053)		yes (n =1815)		
		n	%	n	%	
Infant's birth weight						
<2500 g	5	35	24	109	76	
2500–4500 g	93	993	37	1667	63	
>4500 g	2	25	39	39	61	p = 0.006
Health problems after birth (infant)						
No	76	813	37	1368	63	
Yes	23	236	35	437	65	
Missing	0	4	29	10	71	p = 0.447
Season of data collection						
Fall	8	63	28	166	72	
Spring/summer	92	990	38	1649	62	p = 0.003

Table 2

Unadjusted prevalences of vitamin D supplementation by source of information.

	Infants substituted with vitamin D							
	Total study population (n = 2686)		German speaking region		French speaking region		Italian speaking region	
	n	%	n	%	n	%	n	%
Source of information on infant feeding								
All infants with data on source of information and region	1770	63	1145	60	427	69	198	72
No information	105	56	78	59	21	62	6	29
Non-professional sources	95	49	45	42	32	62	18	55
Professional information	1570	65	1022	61	374	70	174	78
a) only mother and child care workers	639	57	539	55	64	63	36	84
b) only doctors	327	67	66	59	182	68	79	71
c) doctors and mother/ child care workers	604	74	417	71	128	77	59	88

Table 3

Factors influencing vitamin D supplementation – results of multivariate regression.[1]

	OR	[95% Conf. Interval]	
Maternal age			
25–34 years	1.00		
<25 years	0.53	0.360	0.779
>35 years	0.88	0.730	1.060
Nationality			
Swiss origin	1.00		
Balcan origin	0.98	0.616	1.545
Europe origin	1.43	1.086	1.883
Other	1.75	1.057	2.909
Swiss regions			
German	1.00		
French	1.52	1.219	1.892
Italian	1.88	1.384	2.547
Educational status			
Low	1.00		
High	0.85	0.704	1.034

[1] logistic regression model additionaly adjusted for: bmi, smoking, allergy (mother), mothers nutritional attentiveness, health problems and sex (infant)

Table 3 cont.

	OR	[95% Conf. Interval]	
Parity			
Primaparous	1.00		
Multiparous	0.63	0.530	0.751
Full breastfeeding			
No	1.00		
Yes	0.73	0.572	0.939
Source of information			
Professional	1.00		
None	0.59	0.384	0.918
Non-professional	0.71	0.510	0.985
Folic acid intake			
No	1.00		
Yes	1.20	1.091	1.319
infant's age			
0–1 months	1.00		
2–3 months	0.98	0.661	1.462
4–5 months	0.83	0.553	1.239
6, 7 and 8 months	0.55	0.363	0.834
9 months and older	0.37	0.228	0.600
Birth weight			
2500–4500 g	1.00		
<2500 g	1.38	0.913	2.092
>4500 g	1.19	0.664	2.140
Season of data collection			
Fall	1.00		
Spring/summer	0.62	0.430	0.880

[1] logistic regression model additionaly adjusted for: bmi, smoking, allergy (mother), mothers nutritional attentiveness, health problems and sex (infant)

Table 4

Sensitivity analysis[1] – impact of breast-feeding types on vitamin D supple-mentation – stratified by age groups.

		Odds Ratio	[95% Conf. Interval]	
Partially breastfed				
All (unstratified) n = 933		0.93	0.783	1.107
Strata	0–1 months	1.24	0.409	3.749
	2–3 months	1.84	1.022	3.309
	4–5 months	1.06	0.765	1.474
	6, 7 and 8 months	0.65	0.501	0.838
Fully breastfed				
All (unstratified) n = 742		0.74	0.585	0.929
Strata	0–1 months	0.61	0.269	1.385
	2–3 months	0.82	0.560	1.187
	4–5 months	0.66	0.462	0.930
	6, 7 and 8 months	0.80	0.353	1.818
Exclusively breastfed				
All (unstratified) n = 593		0.65	0.517	0.823
Strata	0–1 months	0.55	0.267	1.126
	2–3 months	0.65	0.455	0.937
	4–5 months	0.60	0.413	0.879
	6, 7 and 8 months	0.96	0.378	2.419

[1] mulitvariate logistic regression adjusted for season, maternal age, smoking and region

25 years, Swiss nationality, German language region, the presence of siblings and full breastfeeding. In addition, the analysis revealed protective factors. Mothers, who had taken folic acid in pregnancy and had received professional information on infant feeding substituted vitamin D significantly more often. Certain variables, such as Balkan origin, were no longer negatively associated with vitamin D supplementation after the adjustment.

The median duration of exclusive and full breastfeeding in this study were 9 and 17 weeks respectively, while the total breast feeding duration was 31 weeks [50].

Mothers who partially breastfed, which means they complemented breast milk with formula milk, tended to give their infants vitamin D more often than mothers who breastfed fully or exclusively (table 4). While partial breastfeeding showed a positive association with vitamin D supplementation across all age groups, even though non-significant, full and exclusive breastfeeding were negatively associated. Both feeding types were significant in the 2–3 months olds and for exclusive breastfeeding also in the 5–6 months olds.

The observed interaction between language regions and source of information is illustrated in figure 1 showing adjusted prevalences. Compared to the professionally informed, the prevalence of vitamin D supplementaion was consistenly lower in mothers, who were not informed or non-professionally informed. In the German speaking regions the "uninformed mothers" substituted their infants with vitamin D nearly as often as professionally informed mothers had done.

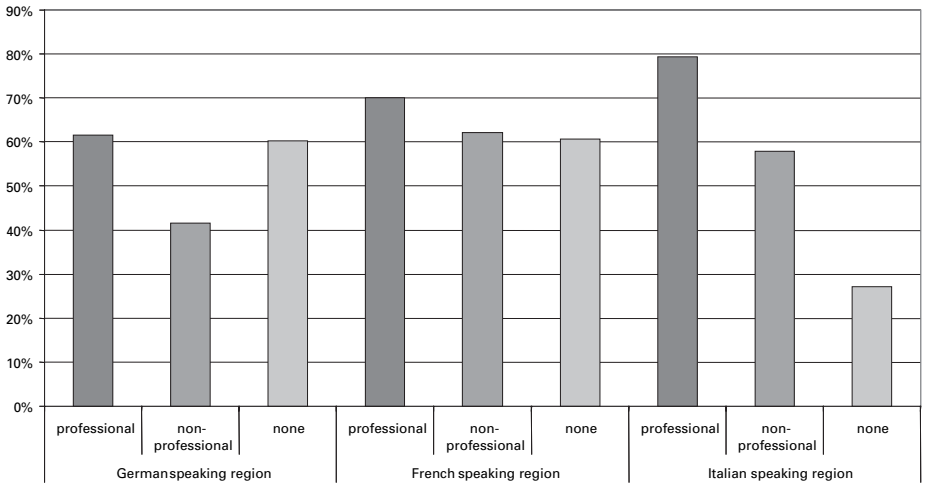

Figure 1

Adjusted* prevalence of vitamin D supplementation by source of information – stratified for language region.

* Adjusted for maternal age, nationality, education, parity, full breast feeding, smoking, maternal nutritional consciousness, infants' age, sex, birth weight and health problems after birth and season of data collection

Discussion

Only few studies have been conducted on the prevalence of vitamin D supplementation in infants. A Dutch study reported a supplementation prevalence of 91% at the age of one year [8] and a Finnish study published a prevalence of vitamin supplements of 50% at the age of 2 years [47]. The EURODIAB study, investigating the preventive properties of vitamin D in the development of diabetes type I in children, presented a supplementation prevalence varying from 47–97% for 7 different European countries [45]. The variation of recommendations in Europe [4, 6, 8–10] and differences in study settings do not permit a comparison of the results. However, one may state, that compliance with national guidelines varies in Europe and that some countries present an undersupplementation of vitamin D. In Switzerland, given that the Swiss national recommendation on vitamin D supplementation is universal for all infants, the general prevalence of vitamin D supplementation in infants is low, irrespective of the season. Only 62% of the infants had received vitamin D in spring/summer months and 72% in fall months. A possible explanation for the seasonal difference may be the common knowledge of the endogenous production of vitamin D via direct sunlight. Some mothers might restrict vitamin D supplementation to winter months. This mechanism, being commonly known, might also explain, why a higher educational level was not associated with a higher prevalence of vitamin D supplementation. Interestingly, we found a higher prevalence in French and Italian regions than in the German-speaking region of Switzerland. The regional differences can only partly be explained by the observed interaction seen between the source of information and the language region. We also found that nationality influences the supplementation of vitamin D. Swiss infants received significantly less often vitamin D than infants, whose mothers came from EU member states. Also important were other socio-demographic factors, such as young maternal age (<25 years) and parity. Having a sibling reduced the probability of receiving vitamin D by 38%. Exclusively or fully breastfed infants have been reported to be at higher risk for vitamin

D deficiency [5, 13, 16, 20, 21, 51–55]. This observation is often explained by the small amount of vitamin D in breast milk, especially in vitamin D deficient, lactating mothers. Our study shows, that exclusive or full breastfeeding itself poses a risk for vitamin D non-supplementation, while partial breastfeeding does not, on the contrary. The recent breastfeeding promotion may have led to the belief that the exclusive breastfed infant is in need of no further supplements. The association of breastfeeding with vitamin D supplementation and discontinuation of vitamin D in older infants would best be analysed by a longitudinal study design. The supplementation prevalence showed a significant association with the infant's age, although vitamin D is recommended from the 2nd week until the end of the first year. This association did not change after adjustment for potential confounders. Infants aged 6 months and older had a significant higher risk of non-supplementation than younger infants. Possibly, the professional as well as the parental attention on preventive measures, such as vitamin D supplementation, slackens once an infant thrives and gets older. This speculation correlates with the fact, that infants with low birth weight and health problems are better substituted than healthy infants. Furthermore, mothers might stop vitamin D supplementation when infants are weaned and formula milk, fortified with vitamin D, replaces breast milk. Apart from the risk factors, the multiple logistic regression yielded factors positively influencing the supplementation of vitamin D, such as the mother's positive attitude versus preventive measures (use of folic acid in pregnancy) and professional information on infant feeding. Information on infant feeding in general, although not specific for vitamin D, showed a positive influence on the supplementation rate. Certainly, the non-specificity of the question limits the interpretation of the results. The highest prevalence rates could be seen in infants, whose mothers had received professional information. After further differentiating the professional source, we observed that the prevalence increased with the level of source authority and the number of professional sources a mother consulted.

The surprisingly high prevalence in the "non-informed" mothers can be explained by other sources of information, such as print media or internet, which were not covered by the questionnaire. These sources, however, are open to all mothers. We can only hypothesize, that women, who solely rely on information by non-professionals, will seldom consult other media for professional information.

The study was primarily designed to study infant feeding in a representative study sample in Switzerland. The generalisability of the study is limited mainly by the higher prevalence of primiparous mothers and the under-representation of non-Swiss mothers. In addition, we probably reached mothers, capable of reading and understanding at least one of the national languages in which the questionnaires were available. These groups, however, supplemented their children more often, than did multiparous or Swiss mothers, resulting in an overestimation of the supplementation prevalence. On the other hand, the vitamin D supplementation rate is known to be higher in winter-months and the study only collected spring-fall data (May – November), thereby possibly underestimating the vitamin D supplementation.

Clinical manifestations of vitamin D deficiency are rare diagnoses in Swiss children and therefore vitamin D deficiency in infancy and childhood has not been a priority health topic in Switzerland. However, some European countries, mainly with a large percentage of dark-skinned migrant infants, have reported vitamin D deficiency in infants and an increase in rickets [11, 15, 17, 21, 41, 53, 55–58]. But vitamin D deficiency is not an infant health topic alone. Several studies have identified sub-clinical vitamin D deficiency in children and adolescents, predominantly in winter months [4, 17, 19, 28, 32, 44, 46, 56, 59–63].

Investigating the prevalence of vitamin D supplementation in infants was a first step to assess a potential vitamin D deficiency in Switzerland. Further investigations on actual vitamin D levels in Swiss infants and children are needed. In view of the new evidence of preventive properties of vitamin D, a discussion on the importance of vitamin D supplementation for public health needs to be initiated.

Conclusion

The analysis showed a low prevalence of vitamin D supplementation in Switzerland and thereby a serious non-compliance to national recommendations. So far, vitamin D deficiency in infants is not a priority health problem in Switzerland. However, given the importance of vitamin D for the infant's bone health and possibly other chronic diseases, the results are worrisome. The study revealed certain risk factors, such as age, multi-parity or breastfeeding, which can easily be addressed in counselling settings. The regional and national differences need to be further investigated. Professional information on infant feeding and mother's attitude towards primary prevention were positively correlated with vitamin D supplementation. This leads us to the conclusion, that the supplementation rate of vitamin D can be influenced by promotion and repeated professional information on the need and benefit of vitamin D. The prevailing importance of vitamin D for

infants' health and better ways to promote the supplementation of vitamin D must be discussed in the public health community.

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References

1 DeLuca HF. Overview of general physiologic features and functions of vitamin D. Am J Clin Nutr 2004;80:1689S–96S.
2 Holick MF. Vitamin D: the underappreciated D- lightful hormone that is important for skeletal growth and cellualar health. Endocrinology and Diabetes 2002;9:87–98.
3 Rajakumar K. Vitamin D, cod-liver oil, sunlight, and rickets: a historical perspective. Pediatrics 2003;112:e132–5.
4 Davies PS, Bates CJ, Cole TJ, Prentice A, Clarke PC. Vitamin D: seasonal and regional differences in preschool children in Great Britain. Eur J Clin Nutr 1999;53:195–8.
5 Gartner LM, Greer FR. Prevention of rickets and vitamin D deficiency: new guidelines for vitamin D intake. Pediatrics 2003; 111:908–10.
6 Hypponen E, Laara E, Reunanen A, Jarvelin MR, Virtanen SM. Intake of vitamin D and risk of type 1 diabetes: a birth-cohort study. Lancet 2001;358:1500–3.
7 Ward LM. Vitamin D deficiency in the 21st century: a persistent problem among Canadian infants and mothers. Cmaj 2005; 172:769–70.
8 van der Linden-Kuiper AT, Bunge-van Lent FC, Boere-Boonekamp MM. Recommendations of vitamin D supplements for toddlers frequently disregarded. Ned Tijdschr Geneeskd 1999; 143:2146–50.
9 Schweizerische Gesellschaft für Pädiatrie E. Empfehlungen für die Säuglingsernährung 1998. Schweizerische Ärztezeitung 1998;79: Sonderdruck 1–11. Available from http://www.swiss-paediatrics.org/.
10 Spalinger J SG, Baerlocher K. Ernährung gesunder Neugeborener in den ersten Lebenstagen. Paediatrica 2003;14:24–5.
11 Tomashek KM, Nesby S, Scanlon KS, Cogswell ME, Powell KE, Parashar UD, et al. Nutritional rickets in Georgia. Pediatrics 2001;107:E45.
12 Hatun S, Ozkan B, Orbak Z, Doneray H, Cizmecioglu F, Toprak D, et al. Vitamin D deficiency in early infancy. J Nutr 2005;135:279–82.
13 Dawodu A, Agarwal M, Hossain M, Kochiyil J, Zayed R. Hypovitaminosis D and vitamin D deficiency in exclusively breast-feeding infants and their mothers in summer: a justification for vitamin D supplementation of breast-feeding infants. J Pediatr 2003;142:169–73.
14 Bassir M, Laborie S, Lapillonne A, Claris O, Chappuis MC, Salle BL. Vitamin D deficiency in Iranian mothers and their neonates: a pilot study. Acta Paediatr 2001;90:577–9.
15 Spence JT, Serwint JR. Secondary prevention of vitamin D-deficiency rickets. Pediatrics 2004;113:e70–2.
16 Mølgaard C, Christian | Michaelsen, KF, Kim Fleischer. Vitamin D and bone health in early life. Proceedings of the Nutrition Society 2003;62:823–8.
17 Pedersen P, Michaelsen KF, Molgaard C. Children with nutritional rickets referred to hospitals in Copenhagen during a 10-year period. Acta Paediatr 2003;92:87–90.
18 Holick MF. Sunlight and vitamin D for bone health and prevention of autoimmune diseases, cancers, and cardiovascular disease. Am J Clin Nutr 2004;80:1678S–88S.
19 Hatun S, Islam O, Cizmecioglu F, Kara B, Babaoglu K, Berk F, et al. Subclinical vitamin D deficiency is increased in adolescent girls who wear concealing clothing. J Nutr 2005;135:218–22.
20 Raiten DJ, Picciano MF. Vitamin D and health in the 21st century: bone and beyond. Executive summary. Am J Clin Nutr 2004;80:1673S–7S.
21 Wharton B, Bishop N. Rickets. Lancet 2003;362:1389–400.
22 Glerup H, Mikkelsen K, Poulsen L, Hass E, Overbeck S, Thomsen J, et al. Commonly recommended daily intake of vitamin D is not sufficient if sunlight exposure is limited. J Intern Med 2000;247:260–8.
23 Greer FR. Issues in establishing vitamin D recommendations for infants and children. Am J Clin Nutr 2004;80:1759S–62S.
24 Hollis BW, Wagner CL. Assessment of dietary vitamin D requirements during pregnancy and lactation. Am J Clin Nutr 2004;79:717–26.
25 Branca F, Valtuena S. Calcium, physical activity and bone health – building bones for a stronger future. Public Health Nutr 2001;4:117–23.
26 Baerlocher K SE. Prävention der Osteoporose im Kindesalter. Schweizer Zeitschrift für Ernährungsmedizin 2005;3:21–30.
27 Zamora SA, Rizzoli R, Belli DC, Slosman DO, Bonjour JP. Vitamin D supplementation during infancy is associated with higher bone mineral mass in prepubertal girls. J Clin Endocrinol Metab 1999;84:4541–4.
28 Valimaki VV, Alfthan H, Lehmuskallio E, Loyttyniemi E, Sahi T, Stenman UH, et al. Vitamin D status as a determinant of peak bone mass in young Finnish men. J Clin Endocrinol Metab 2004;89:76–80.
29 Weiler H, Fitzpatrick-Wong S, Veitch R, Kovacs H, Schellenberg J, McCloy U, et al. Vitamin D deficiency and whole-body and femur bone mass relative to weight in healthy newborns. Cmaj 2005;172:757–61.
30 Soltesz G. Diabetes in the young: a paediatric and epidemiological perspective. Diabetologia 2003;46:447–54.
31 Pawley N, Bishop NJ. Prenatal and infant predictors of bone health: the influence of vitamin D. Am J Clin Nutr 2004;80: 1748S–51S.
32 Lehtonen-Veromaa MK, Mottonen TT, Nuotio IO, Irjala KM, Leino AE, Viikari JS. Vitamin D and attainment of peak bone mass among peripubertal Finnish girls: a 3-y prospective study. Am J Clin Nutr 2002;76:1446–53.
33 Harris SS. Vitamin D in type 1 diabetes prevention. J Nutr 2005;135:323–5.
34 McGrath J, Saari K, Hakko H, Jokelainen J, Jones P, Jarvelin MR, et al. Vitamin D supplementation during the first year of life and risk of schizophrenia: a Finnish birth cohort study. Schizophr Res 2004;67:237–45.
35 McGrath J, Eyles D, Mowry B, Yolken R, Buka S. Low maternal vitamin D as a risk factor for schizophrenia: a pilot study using banked sera. Schizophr Res 2003;63:73–8.
36 Gorham ED, Garland CF, Garland FC, Grant WB, Mohr SB, Lipkin M, et al. Vitamin D and prevention of colorectal cancer. J Steroid Biochem Mol Biol 2005.
37 Grant WB, Garland CF. A critical review of studies on vitamin D in relation to colorectal cancer. Nutr Cancer 2004;48:115–23.
38 Garland CF, Garland FC, Gorham ED. Calcium and vitamin D. Their potential roles in colon and breast cancer prevention. Ann N Y Acad Sci 1999;889:107–19.
39 El-Hajj Fuleihan G, Nabulsi M, Choucair M, Salamoun M, Hajj Shahine C, Kizirian A, et al. Hypovitaminosis D in healthy schoolchildren. Pediatrics 2001;107:E53.
40 Narchi H. Case-control study of diet and sun exposure in adolescents with symptomatic rickets. Ann Trop Paediatr 2000; 20:217–21.
41 Narchi H, El Jamil M, Kulaylat N. Symptomatic rickets in adolescence. Arch Dis Child 2001;84:501–3.
42 Weisberg P, Scanlon KS, Li R, Cogswell ME. Nutritional rickets among children in the United States: review of cases reported between 1986 and 2003. Am J Clin Nutr 2004;80:1697S–705S.

43 Najada AS, Habashneh MS, Khader M. The frequency of nutritional rickets among hospitalized infants and its relation to respiratory diseases. J Trop Pediatr 2004;50:364–8.
44 Sullivan SS, Rosen CJ, Halteman WA, Chen TC, Holick MF. Adolescent girls in Maine are at risk for vitamin D insufficiency. J Am Diet Assoc 2005;105:971–4.
45 Vitamin D supplement in early childhood and risk for Type I (insulin-dependent) diabetes mellitus. The EURODIAB Substudy 2 Study Group. Diabetologia 1999;42:51–4.
46 Guillemant J, Taupin P, Le HT, Taright N, Allemandou A, Peres G, et al. Vitamin D status during puberty in French healthy male adolescents. Osteoporos Int 1999;10:222–5.
47 Marjamaki L, Rasanen M, Uusitalo L, Ahonen S, Veijola R, Knip M, et al. Use of vitamin D and other dietary supplements by Finnish children at the age of 2 and 3 years. Int J Vitam Nutr Res 2004;74:27–34.
48 Abelin T, Bachmann N, Bisig B, Schweiz. BfS. Gesundheit und Gesundheitsverhalten in der Schweiz 1997. 2000.
49 WHO Publication nal. Indicators for assessing breast feeding practices. available from http://www.who.int/en/ 1991; WHO Document WHO/CDD/SER,91.
50 Dratva J, Merten S, Ackermann-Liebrich U. "The Timing of Complementary Feeding of Infants in Switzerland – Compliance with the Swiss and the WHO guidelines". Acta Paediatrica 2006; in press.
51 Andiran N, Yordam N, Ozon A. Risk factors for vitamin D deficiency in breast-fed newborns and their mothers. Nutrition 2002;18:47–50.
52 Hollis BW, Wagner CL. Vitamin D requirements during lactation: high-dose maternal supplementation as therapy to prevent hypovitaminosis D for both the mother and the nursing infant. Am J Clin Nutr 2004;80:1752S–8S.
53 Kreiter SR, Schwartz RP, Kirkman HN Jr, Charlton PA, Calikoglu AS, Davenport ML. Nutritional rickets in African American breast-fed infants. J Pediatr 2000;137:153–7.
54 Pettifor JM. Nutritional rickets: deficiency of vitamin D, calcium, or both? Am J Clin Nutr 2004;80:1725S–9S.
55 Thomson K, Morley R, Grover SR, Zacharin MR. Postnatal evaluation of vitamin D and bone health in women who were vitamin D-deficient in pregnancy, and in their infants. Med J Aust 2004;181:486–8.
56 Looker AC, Dawson-Hughes B, Calvo MS, Gunter EW, Sahyoun NR. Serum 25-hydroxyvitamin D status of adolescents and adults in two seasonal subpopulations from NHANES III. Bone 2002;30:771–7.
57 Mughal Z. Rickets in childhood. Semin Musculoskelet Radiol 2002;6:183–90.
58 Ladhani S, Srinivasan L, Buchanan C, Allgrove J. Presentation of vitamin D deficiency. Arch Dis Child 2004;89:781–4.
59 Lehtonen-Veromaa M, Mottonen T, Irjala K, Karkkainen M, Lamberg-Allardt C, Hakola P, et al. Vitamin D intake is low and hypovitaminosis D common in healthy 9- to 15-year-old Finnish girls. Eur J Clin Nutr 1999;53:746–51.
60 Specker BL, Ho ML, Oestreich A, Yin TA, Shui QM, Chen XC, et al. Prospective study of vitamin D supplementation and rickets in China. J Pediatr 1992;120:733–9.
61 Feliciano ES, Ho ML, Specker BL, Falciglia G, Shui QM, Yin TA, et al. Seasonal and geographical variations in the growth rate of infants in China receiving increasing dosages of vitamin D supplements. J Trop Pediatr 1994;40:162–5.
62 Glerup H, Rytter L, Mortensen L, Nathan E. Vitamin D deficiency among immigrant children in Denmark. Eur J Pediatr 2004;163:272–3.
63 Nozza JM, Rodda CP. Vitamin D deficiency in mothers of infants with rickets. Med J Aust 2001;175:253–5.

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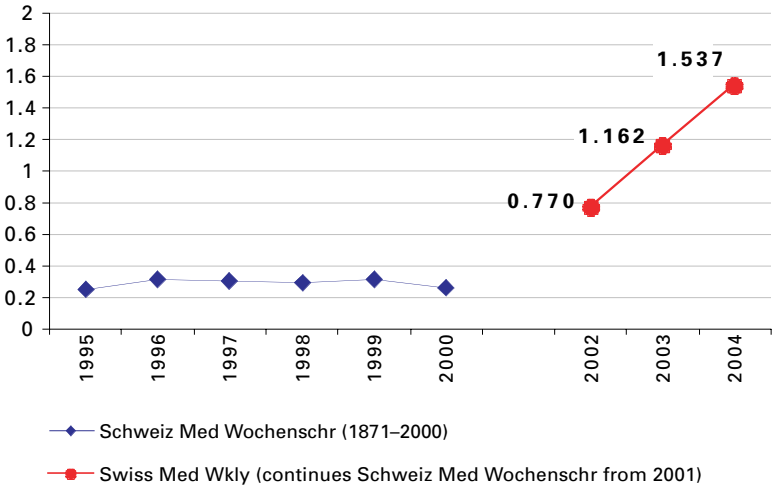

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