

# HYPOVITAMINOSIS A IN CHILE: A NUTRITION PROBLEM AFFECTING THE COMMUNITY<sup>1</sup>

A. Arteaga,<sup>2</sup> S. Valiente,<sup>2</sup> E. Rosales,<sup>2</sup> and C. Urteaga<sup>2</sup>

*An attempt is made to assess, in the light of the international recommendations on levels of vitamin A intake, the prevalence of hypovitaminosis A in Chile, where it is very common in the lower social and cultural groups and in children. Nutrition programs are recommended as a way of solving the problem.*

Studies made of the nutritional status of the Chilean population have paid little attention to the problems deriving from inadequate intake of vitamins. This is due to a number of factors: in the first place, the impact of vitamin deficiency on morbidity and mortality in the population is slight; secondly, since 1955 a program has been under way, and has already been found to be effective, for enriching bread with thiamine, riboflavin, and niacin; and thirdly, there is a wide national distribution of vitamin preparations.

Research into subclinical nutrition problems is difficult because of the notoriously non-specific nature of the clinical signs and the difficulty of biochemical testing in significant groups; furthermore, the data obtained need to be compared with the recommended patterns of intake, and the biological exactitude of these is debatable.

If we compare average food availability in Chile between 1956 and 1960 with the supply targets (Table 1), we find a vitamin A deficit of 33 per cent: availability is 2,787 I.U. and the target 4,300 I.U. per inhabitant/day (I).

Since vitamin A is the nutrient of which the deficiency is most marked, and since there is no program in Chile for making it up, a study of the problem was indicated with a view to determining its magnitude at various social and economic levels and its impact on morbidity

and mortality in the population, and also indirectly, to obtaining clinical and epidemiological information likely to corroborate the recommendations in regard to vitamin A intake. This could help in ascertaining the prevalence of vitamin A deficiency in Chile and in compiling data for the purpose of determining the extent of this nutritional problem throughout Latin America.

Since it is difficult to obtain data on hospital mortality and specific mortality attributable to hypovitaminosis A, recourse was had to clinical studies (2-5) and nutrition surveys.

An analysis was made of the findings of 13 nutrition surveys (6-19) carried out between 1955 and 1965 in Chile on the basis of

TABLE 1—Comparison between average food availability, 1956-1960, and supply target in Chile.<sup>a</sup>

	Net quantities per inhabitant/day		Percentage of target
	Availability	Target	
Calories	2,350	2,215	106
Proteins (g)	76	65	116
Glucides (g)	407	355	117
Lipids (g)	53	60	88
Calcium (g)	.521	.540	97
Iron (mg)	9.5	12.5	76
Vitamin A (I.U.)	2,787	4,300	65
Vitamin C (mg)	53	60	88
Vitamin B <sub>1</sub> (mg)	1.1	1.1	100
Vitamin B <sub>2</sub> (mg)	1.1	1.6	68
Niacin (mg)	11	15.3	72

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<sup>2</sup>Department of Nutrition, School of Public Health, University of Chile.

<sup>a</sup>Source: Department of Nutrition, School of Public Health, University of Chile.

Note: Meat availabilities do not include viscera; enrichment of bread with iron and vitamins is likewise not included.

standardized criteria and with the direct or indirect participation of the authors of this article. The studies in question may perhaps not represent a significant sample of the Chilean population, but they do cover different social and economic strata and different physiologic conditions.

An analysis was made of nutritional data covering 7,033 adults and also 950 pregnant women, 226 wet nurses and 217 preschool-age children, making a total of 8,426 persons apart from the cases referred to in the clinical studies in question.

### Methods Used in the Surveys

In most of the studies the diet was investigated using the technique of "food survey by quantified consumption trends" (20), involving direct questioning of each subject on a single occasion, where possible in the home; this technique is applied through the country by the Department of Nutrition of the University of Chile School of Public Health.

Signs of deficiency were observed directly by specialized personnel, and in all instances any ocular manifestation attributable to vitamin A deficiency was regarded as xerophthalmia: keratomalacia, corneal ulcers, conjunctival xerosis, corneal xerosis, and conjunctival pigmentation. The majority of the studies did not record symptoms so as to avoid the subjective opinions of the patient; hence no

satisfactory study was made of night blindness.

Serum carotene and vitamin A levels were determined by the technique recommended by the Office of International Research of the U.S. National Institutes of Health (OIR-NIH) (18). In the case of vitamin A, less than 10 gammas per cent was regarded as "deficiency level" and between 10 and 19 gammas per cent as "low level." In the case of carotene, under 20 gammas per cent was regarded as "deficiency level," and between 20 and 39 gammas per cent as "low level."

It was decided to arrange the findings in accordance with the various physiological conditions analyzed, and to round them off at the end with a number of over-all conclusions. The data on intake, physical examination, and biochemical requirements are given for each group studied.

### Survey of Adults

Table 2 shows the average daily intake of vitamin A per person according to the findings of 12 surveys of the adult Chilean population. The consumption range, which includes the biologic activity of vitamin A and carotenoid pigments, varies from 1,324 I.U. a day among Pehuenche Indians to 8,000 I.U. a day among the rural workers of Ovalle in the North-Central Zone (Norte Chico). The average recorded in this study of 7,033 adults was 4,449 I.U. a day, which is decidedly lower than the figure obtained by OIR-NIH, where a sampling of the

TABLE 2—Average daily intake of vitamin A in 12 food surveys of the adult population in Chile.

Year	Socioeconomic group	Region	No. surveyed	Average daily intake of vitamin A (I.U.)
1965	Pehuenche Indians (11)	Lonquimay	542	1,324
1964	Rural workers (7)	Chillán	255	2,200
1955	Marginal population (6)	Santiago	760	2,300
1966	Population cross-section (10)	Curicó	275	2,498
1964	Factory workers (9)	Santiago	480	3,700
1964	Rural workers (7)	Santiago	1,018	4,200
1965	Rural workers (8)	Purranque	651	4,875
1964	Rural workers (7)	Ancud	281	4,900
1966	Executives (13)	Santiago	223	6,019
1963	White-collar workers (12)	Santiago	599	6,400
1960	National sample (18)	Chile	1,640	6,980
1964	Rural workers (7)	Ovalle	309	8,000
Total		Chile	7,033	4,449

TABLE 3—Comparative levels of vitamin A intake in adult population groups in Chile.

Levels (I.U.)	Pehuenche Indians (11)		Factory workers (9)		Rural workers (7)		Executives (13)		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
0-1,000	31	43.0	17	3.6	16	4.3	—	—	64	5.7
1,001-2,000	24	33.4	43	9.0	36	9.6	—	—	103	10.7
2,001-3,000	14	19.5	102	21.2	43	11.3	6	11.8	165	17.0
3,001-4,000	1	1.3	112	23.3	72	19.0	9	17.6	194	19.9
4,001-5,000	2	2.8	101	21.0	71	18.8	15	29.4	189	19.4
5,001-+	—	—	105	21.9	140	37.0	21	41.2	266	27.3
Total	72	100	480	100	378	100	51	100	981	100

adult population in the country, covering only 1,640 cases, gave an average of 6,980 I.U. (18).

Table 3 shows the individual intake levels of vitamin A according to several surveys of adults carried out by the Department of Nutrition of the School of Public Health. It will be noted that the intake is above 2,000 I.U. in 83.6 per cent of the cases, though only 27.3 per cent exceed 5,000 I.U.

Thus in Chile, where hypovitaminosis A is not usually regarded as a serious nutrition problem, to judge by these findings at least 16 per cent of the population have an intake of under 2,000 I.U. a day, and among the Pehuenche Indians studied by Arteaga *et al.* (11) the figure is as high as 76.4 per cent of cases. Valiente *et al.* (13) point out that in the executive category in Santiago only 41 per cent have an intake of more than 5,000 I.U. a day, the "daily dietary allowance" recommended for adults by the National Research Council of the U.S. National Academy of Sciences (NRC-NAS).

Table 4 gives a comparative picture of average daily intake levels of vitamin A and shows the frequency of deficiency signs in three population groups (9, 11, 18). Noteworthy is the absence of serious ocular lesions in the Pehuenche Indian group, with an average intake of 1,324 units a day and, as already indicated, 76.4 per cent ingesting under 2,000 I.U. of this nutrient. It should also be pointed out that perifollicular hyperkeratosis is the most frequent sign, even in the first sample analyzed, where the intake was 6,980 I.U.—more than sufficient according to the NRC-NAS recommendations. No ocular lesions of any kind were observed here.

In Table 5 we find a correlation between average daily intake of vitamin A, carotenemia and serum vitamin A level, and the frequency of manifestations of vitamin A deficiency. In the group consisting of 1,640 adults (18) the average daily intake is 6,980 I.U.; average carotenemia is 85 gammas per cent, and the average serum vitamin A level is 24 gammas per

TABLE 4—Average daily intake of vitamin A and deficiency signs among adult groups in Chile.

Intake and signs	Chilean population sample (18)	Factory workers (9)	Pehuenche Indians (11)
Average intake (I.U.)	6,980	3,908	1,324
NRC recommended allowance (I.U.)	5,000	5,000	5,000
Keratomalacia (%)	0	0	0
Corneal ulcer (%)	0	0	0
Corneal xerosis (%)	0	0	0.6
Conjunctival xerosis (%)	0	8.0	48.2
Skin xerosis (%)	0	8.0	11.9
Perifollicular hyperkeratosis (%)	15.3	19.0	54.4
Number of cases	1,640	100	452

TABLE 5—Average daily intake, serum carotene levels, and vitamin A deficiency signs in two adult population groups in Chile.

Intake and manifestations	1,640 adults	452 Pehuenche Indians
Average daily intake (I.U.)	6,980	1,324
Average carotenemia ( $\gamma/\%$ )	85.0	39.0
Average serum vitamin A level ( $\gamma/\%$ )	24.0	19.0
Ocular xerosis (%) <sup>a</sup>	0	48.8
Skin xerosis (%)	0	11.9
Perifollicular hyperkeratosis (%)	15.3	54.4
Deficiency level of vitamin A (%)	3.5	8.2
Low level of vitamin A (%)	40.0	63.0

<sup>a</sup>Conjunctival and corneal xerosis, conjunctival pigmentation.

cent. Both figures are within reasonable limits. In spite of this, there is 15.3 per cent of perifollicular hyperkeratosis, which might well be connected with the 40 per cent of subjects with a "low level" of vitamin A and the 3.5 per cent with a "deficiency level."

In the Pehuenche Indian group in Table 5, the average daily intake is 1,324 I.U., average carotenemia is 39.0 gammas per cent, and average serum vitamin A level 19 gammas per cent. These levels would seem to be low, especially if we observe that 63.0 per cent are "low level" and 8.2 per cent "deficiency level" cases. Coincident with this is the appearance of a pathological eye condition—corneal xerosis,

0.6 per cent, and conjunctival xerosis, 48.2 per cent—while there is skin xerosis in 11.9 per cent of the subjects.

#### Surveys of Pregnant Women and Wet Nurses

Only the studies of Valiente (14), Barja (15) and Aüil (16) were analyzed. These give a clear picture of the problem of vitamin A intake in this physiologically important group.

Table 6 shows the average daily vitamin A intake in groups of pregnant women and wet nurses as 3,689-5,000 I.U. in the case of the pregnant women (an average of 4,793 units for 950 cases) and 2,200-3,560 for the wet nurses (an average of 2,958 I.U. for 226 cases).

In Table 7 we see the daily vitamin A intake in a group of 800 pregnant women studied by Valiente and Muñoz (14), the average daily figure being 5,000 I.U. It will be noted that only 30 per cent ingest the NRC-NAS recommended allowance, while 16 per cent of those who do not reach this level have an intake of under 2,000 I.U. a day. Analysis of the diet throughout pregnancy of 400 of these women indicated that vitamin A intake at the recommended level of 6,000 units a day increased from 40 per cent in the first three months to 56 per cent in the second three months, reaching 62 per cent in the third three-monthly period—a satisfactory trend of consumption of this vitamin (21).

Table 8 reveals that the pregnant women studied by Valiente *et al.* (14), and again the

TABLE 6—Average vitamin A intake in pregnant women and wet nurses in Chile.

Year	Socioeconomic group	Region	No. surveyed	Average daily vitamin A intake (I.U.)
1966	Pregnant rural workers (16)	Rancagua	150	3,689
1963	Pregnant factory workers (14)	Santiago	800	5,000
1964	Wet nurse factory workers (15)	Santiago	100	2,200
1966	Wet nurse rural workers (16)	Rancagua	126	3,560

TABLE 7—Daily vitamin A intake in 800 pregnant women in Chile (14).

Daily vitamin A intake (I.U.)	No.	%	No.	%
— 2,000	128	16.0	560	70.0
2,001— 4,000	238	29.7		
4,001— 6,000	194	24.3		
6,001— 8,000	151	18.8		
8,001—10,000	67	8.5	240	30.0
10,001— +	22	2.7		
Total	800	100	800	100

wet nurses surveyed by Aüil *et al.* (16)—with a vitamin A intake of only 59 per cent and 48 per cent respectively of the NRC-NAS recommended allowance—showed no signs of either xerophthalmia or skin xerosis. Only 22.2 per cent of the pregnant women and 33.2 per cent of the wet nurses had manifestations of perifollicular hyperkeratosis. Aüil *et al.* report that a nursing period of seven or more months brought about a deterioration of the nutritional status of the wet nurses and an increase in the frequency of signs and symptoms not related to vitamin A, such as cheilosis and glossitis.

These facts suggest the possibility that the NRC-NAS vitamin A recommended allowances for these physiological conditions may be unduly high, particularly in view of the fact

TABLE 8—Daily vitamin A intake and frequency of deficiency manifestations in 27 cases during pregnancy and after seven months of lactation.

	Pregnant women	Wet nurses
Daily vitamin A intake (I.U.)	3,560	3,860
% of NRC recommended allowance	59	48
Keratomalacia (%)	0	0
Corneal ulcer (%)	0	0
Conjunctival xerosis (%)	0	0
Corneal xerosis (%)	0	0
Skin xerosis (%)	0	0
Perifollicular hyperkeratosis (%)	22.2	33.2
Cheilosis (%)	7.4	44.4
Glossitis (%)	11.1	29.6

that both studies included groups of women consuming under 2,000 I.U. per day.

The few studies of serum vitamin A levels in pregnant women (22) were made over 15 years ago, using methods which cannot be compared with the present-day techniques, so that these will not be discussed in detail.

### Surveys of Children

There is little information available concerning intake, deficiency manifestations, and serum carotene and vitamin A levels in the Chilean child population.

Some clinical studies of multiple-deficiency disease (kwashiorkor) mention serious eye conditions. In 1949, Meneghello *et al.* (2) found conjunctival xerosis in 55 per cent and keratomalacia in 6.9 per cent of a group of 144 children. Similar findings are mentioned by Scroggie (3 and 5) in 1941-1942 and by Baeza *et al.* (4) in 1945. All these writers observe that it is impossible to isolate hypovitaminosis exclusively or independently because it very rarely appears in the multi-deficiency syndrome. Unfortunately none of the authors in question refers to vitamin A intake levels.

In 1963, García *et al.* (23), analyzing the characteristics of the multi-deficiency syndrome in children, report an average of 14.9 gammas per cent for carotenemia and 11.9 gammas per cent for vitamin A, as compared with 37.4 gammas per cent for carotenemia and 14.2 gammas per cent for vitamin A in apparently healthy children of the same age group. This study makes no reference to eye signs, dry skin and dyschromia being the only signs mentioned which are related to serum vitamin A deficiency.

In another project an investigation was made of a representative sample of preschool-age children in Curicó, Central Chile, where 138 children of both sexes between two and seven years of age were studied (10).

Table 9 indicates that where the average daily intake is 1,899 I.U. the corresponding average carotene level is 37.8 gammas per cent.

**TABLE 9**—Correlation of average daily vitamin A intake, serum carotene levels, and vitamin A deficiency manifestations in 138 preschool-age children, Curicó, Chile, 1966.

Average daily vitamin A intake	1,899
Average carotenemia ( $\gamma/\%$ )	37.8
% with carotene "deficiency level"	1.3
% with carotene "low level"	58.0
Keratomalacia (%)	0
Corneal ulcer (%)	0
Corneal xerosis (%)	0
Conjunctival xerosis (%)	0.7
Skin xerosis (%)	7.9
Perifollicular hyperkeratosis (%)	49.2

Deficiency levels were found in 1.3 per cent of cases and low carotene levels in 58 per cent. Only 0.7 per cent were found to have slight ocular lesions, 7.9 per cent had skin xerosis, and 49.2 per cent perifollicular hyperkeratosis.

The average nutritional intake of the rest of the nutrients was satisfactory except in respect of protein quality, which is of low biologic value. This can be expressed theoretically by a protein count of 65.4 per cent with methionine and cystine as limiting amino acids.

In 1956, Werner (19) detected the presence of ocular xerosis, especially conjunctival, associated with hemeralopia, in 10 per cent of 50 schoolchildren he examined. The average daily vitamin A intake of these children was 1,500 I.U. as compared with the recommended intake of 4,500 I.U. for these age groups.

## Sources of Vitamin A and Carotenoids

Table 10 shows the percentage of vitamin A in the four food groups in five studies covering 3,080 persons in Chile. Between 61.9 and 81.9 per cent of the vitamin A is supplied by the third group in the Chilean classification of foodstuffs (green vegetables and fruits in general). The first group (milk and cheese) comprises only 11.7 to 13.1 per cent. The second group (meat and eggs) supplies between 3.7 and 20.3 per cent, and the fourth group (cereals, bread, legumes, fats including butter, and sugar) between 0.4 and 6.1 per cent. This last group is the poorest source of vitamin A in the Chilean diet.

It is worth mentioning that among the population groups of low social and economic status, eggs and butter contribute practically nothing to the vitamin A intake.

## Discussion

The studies carried out show that the vitamin A intake level in Chile varies with the geographic, socioeconomic, and physiologic groups concerned. As regards the last-named, there is a shortage of data on the most vulnerable groups, especially children. The basic sources of vitamin A in Chile are fruits and green vegetables. Eggs and butter play an increasingly large part the higher the social and economic level of the population groups.

**TABLE 10**—Percentage vitamin A contribution of four food groups according to five surveys covering 3,080 persons in Chile.

Food groups	Groups studied				
	760 marginal population cases (6)	480 factory workers (9)	1,018 rural workers (7)	599 white-collar workers (12)	223 executives (13)
I (milk and cheese)	11.2	12.4	13.1	12.3	11.7
II (meat and eggs)	7.2	11.8	4.9	3.7	20.3
III (green vegetables and fruit)	81.2	70.9	81.9	81.4	61.9
IV (cereals, legumes, sugar and fats)	0.4	4.9	0.1	2.6	6.1
Total	100	100	100	100	100

Generally speaking, it may be said that where the average daily intake was less than 2,000 I.U. there were low average levels of serum carotene and vitamin A as well as signs attributable to deficiency, although it is impossible here to pin down specifically the signs described. It should be stressed that in the epidemiologic studies carried out no keratomalacia was found, not even among the Pehuenche Indians, where 43 per cent of adults had a daily vitamin A intake of under 1,000 I.U.

If we accept the NRC-NAS recommended daily allowances, we have to admit that a very large sector of the Chilean population, as represented by the groups surveyed, have an inadequate intake of vitamin A. Obviously the groups where the intake is lowest show the most frequent signs of deficiency; but in the present study it is not possible to attribute these signs with certainty to a lack of vitamin A. Worth mentioning is the absence of ocular manifestations in pregnant women and wet nurses, in spite of a notably deficient vitamin A intake as compared with the recommended levels; but deficiency manifestations are more frequent in wet nurses than in pregnant women.

The problem would appear to be particularly serious in the child population, since occasional clinical studies of kwashiorkor mention keratomalacia. Nevertheless, in group studies eye lesions are very infrequent, although not so infrequent as in adult populations.

In the one Chilean study representative of preschool-age children, we find a low daily vitamin A intake and a deficient carotene level with skin lesions, dry skin, and dyschromia as the most frequent symptoms.

In the light of the foregoing, hypovitaminosis A would appear to be a frequently occurring condition in Chile, especially among low social and economic groups and children. In general it may be said that except for isolated clinical cases the deficiency is not severe, and its impact on health is difficult to assess; but apart from exceptional cases of kwashiorkor it does not produce a specific

pathology requiring clinical consultation. It seems probable that this deficiency is of great importance for the general health of the population, but it is difficult to separate it from a multitude of other factors conditioning the way in which the individual reacts to the environment.

It is well known that in early infancy vitamin A deficiency assumes a different form, since it is not dependent on the intake of vitamin A but rather on the adequacy of the protein carrying it, which is closely linked with protein intake. Hence the problem of infants should be tackled differently.

This is a common problem having a definite impact on the health of the community, and it calls for more accurate definition; greater attention should no doubt also be paid to it by the entities responsible for public health. To solve the problem in Chile, various plans of action might be postulated. First, more fruits and green vegetables might be made available by encouraging production and pointing out the good it does to eat them. Secondly, in view of the magnitude of the problem an enrichment program would be the quickest and most comprehensive solution, though there is the difficulty of choosing what is the most suitable vehicle. Butter, cheese, milk, and hydrogenated vegetable fats are not generally consumed in Chile, and hence would not be a sound choice, so that consideration should be given to the possibility of using oil, which is popular with Chileans. Food programs for schoolchildren should place special emphasis on foodstuffs rich in carotenoids. Finally, there is the possibility of pharmacological administration of large doses once or twice a year. The authorities concerned should obviously examine the choice of the most suitable types of program from the technical angle.

It is hoped that this study of hypovitaminosis A in Chile will help toward a better knowledge throughout Latin America of this nutrition problem, the control in its various forms and ultimate solution of which call for research by national and international bodies

until it is eradicated in its entirety, as envisaged in the recent study by Oomen *et al.* (24).

### Summary

Of all nutrients vitamin A is the one most deficient in the Chilean diet and there are no programs under way for remedying the situation. The article reports the findings of a study of data on ingestion, deficiency manifestations, and serum levels observed in surveys of 7,033 adults, 950 pregnant women, 226 wet nurses, and 217 preschool-age children in Chile, broken down by socioeconomic levels and physiologic conditions.

The 7,033 adults had an average daily intake of vitamin A ranging from 1,324 to 8,000 I.U., and although only 27.3 per cent exceeded 5,000 I.U. no serious ocular lesions were observed. In 452 Pehuenche Indians with an average daily intake of 1,324 I.U., the serum vitamin A level was 19 gammas per cent and 48.8 per cent of them were found to be suffering from xerophthalmia.

In the 950 pregnant women the average daily intake was 4,793 I.U., only 30 per cent receiving more than 6,000 units. No xeroph-

themia was observed but 22 per cent suffered from perifollicular hyperkeratosis.

In the 226 wet nurses, the average intake was lower (2,958 I.U.) but there was no xerophthalmia and only 33.2 per cent suffered from hyperkeratosis.

Vitamin A deficiency has been little studied in children, although isolated cases of xerophthalmia have been described and serum levels of 14.9 gammas per cent of carotene, 11.9 gammas per cent of vitamin A have been found in children with kwashiorkor. In a study of 138 preschool-age children with an average daily intake of 1,899 I.U., levels of 37.8 gammas per cent of carotenemia, 0.7 per cent of xerophthalmia, and 49.2 per cent of perifollicular hyperkeratosis were found.

The authors conclude that vitamin A deficiency is common in Chile, and although its influence on the population is not very clear, they believe that further research should be undertaken. The solution recommended is a program embodying the promotion of production and consumption of fruits and green vegetables, the enrichment of certain substances, the more extensive use of oil and other foodstuffs rich in carotenoids in school feeding programs, and possibly the administration of large doses of vitamin A to the general public.

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