HYPOVITAMINOSIS A IN THE AMERICAS

Report of a PAHO Technical Group Meeting

PAN AMERICAN HEALTH ORGANIZATION
Pan American Sanitary Bureau, Regional Office of the
WORLD HEALTH ORGANIZATION
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(Washington, D. C., 28-30 November 1968)

Scientific Publication No. 198

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Pan American Sanitary Bureau, Regional Office of the
WORLD HEALTH ORGANIZATION
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1970

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I. INTRODUCTION

Hypovitaminosis A attracted attention as a public health problem in Latin America and the Caribbean area at the first and second Pan American Health Organization technical advisory committee meetings on nutrition (1962 and 1968), and as a result of the world-wide survey of xerophthalmia made by the World Health Organization in 1962.

Although hypovitaminosis A is a well known problem in South and East Asia, where preventive measures have been attempted, it has received only minor attention in this respect in Latin America and in the Caribbean. As xerophthalmia is a very incapacitating disease, unless recognized and treated early, and protective measures can be readily applied without the need for specialized care, delay in their implementation should be avoided. Xerophthalmia is of special importance where distribution of skim milk has been made to population groups whose diets are deficient in both protein and vitamin A, as in some parts of Latin America and the West Indies. An international technical group convened in Princeton, New Jersey, in 1958 urged the fortification with vitamin A of skim milk for export to problem areas, but several years passed before this measure was adopted (1).

Results of many nutrition surveys show that a low dietary intake of vitamin A is widespread in sectors of the population in many parts of this Hemisphere. Clinical and biochemical studies also indicate that hypovitaminosis A exists in certain segments of the population. Cases of partial and total blindness resulting from severe vitamin A deficiency in association with protein-calorie malnutrition have been reported, often associated with high-case fatality rates. It may therefore be concluded that hypovitaminosis A represents a public health problem in this Hemisphere.

The manifestations of severe deficiency are relatively clear and in theory should be easy to quantitate. However, owing to deficient morbidity and mortality statistics, it is difficult to define accurately even these parameters of the problem. The majority of nutrition workers have not been adequately trained to diagnose eye disease and most physicians are not familiar with the treatment and prevention of xerophthalmia.

The milder forms of hypovitaminosis A present even greater problems in assigning priorities in the context of public health. Obviously, considerably larger numbers of the population are affected and yet our present lack of knowledge of the effects of the lesser degrees of this deficiency makes it difficult to assign priorities realistically. From experiments in animals, however, it can be assumed that prolonged low intake of vitamin A and its precursors may have serious effects on growth and development and on resistance to infectious diseases.

Despite the apparent interest in this subject in scientific literature and the considerable epidemiological data available for this Hemisphere, relatively little action has been taken to combat or control this disorder either in its severe or milder forms.

Local health services lack the necessary criteria for the diagnosis, treatment, and prevention of the disease and consequently interest in action programs has been minimal. Though the increased consumption of foods rich in vitamin A and beta-carotene is an ideal long-term solution to the problem, alternative methods for interim use are not currently available to health agencies.

As the agency responsible for international health services in Latin America and the Caribbean, it is important that the Pan American Health Organization take some action in this repect. A Technical Group was therefore convened to evaluate the vitamin A situation in this Region and to assist in defining lines of action for the future. Specifically, it was of interest that the Group:

1. Synthesize present knowledge of vitamin A deficiency not only in view of severe clinical manifestations but also in terms of the effects of chronic suboptimal intake.

2. Appraise the information available on vitamin A nutriture in this Hemisphere and interpret its significance in terms of public health.

3. Prepare specific guidelines, from information presently available on:

(a) Practical measures for the prevention of deficiency states under the varying socioeconomic conditions and resources of the Hemisphere.

(b) Criteria for diagnosis, methods of treatment, and rehabilitation of established disease in its severe forms.

4. Identify gaps in knowledge on the subject and recommend research activities that will provide the necessary information for effective action in public health practice.

The Technical Group met at the Headquarters of the Pan American Health Organization in Washington, D.C., from 28 to 30 November 1968. The following report represents the synthesis of their views on the question of hypovitaminosis A in the Americas.

II. DEFINITION OF HYPOVITAMINOSIS A AND CRITERIA FOR DIAGNOSIS

The following definition is proposed for hypovitaminosis A, as it may be applied to human populations in the context of public health practice:

> "The presence of depleted tissue stores and low serum levels of vitamin A which may result from a prolonged deficient dietary intake and lead to serious clinical lesions of the eye."

The criteria for diagnosis of hypovitaminosis A may be clinical, biochemical, and dietary.

Any one of these criteria by itself is not sufficient proof of vitamin A deficiency, but should arouse suspicion. Many factors, nutritional, physiological, and pathological, can influence vitamin A status and must be taken into account.

Clinical Criteria for Diagnosing Hypovitaminosis A

Abnormalities in the eye are the only reliable signs for diagnosing clinical vitamin A deficiency in man. There is insufficient proof that follicular hyperkeratosis depends exclusively on the depletion of the tissues stores of vitamin A. The following points are important to consider in clinical diagnosis of eye lesions resulting from avitaminosis A:

1. The ocular changes indicating vitamin A deficiency are nyctalopia and xerophthalmia.

2. Nyctalopia, or night blindness, is caused by loss of function of the rod cells of the retina and is manifested by impairment of vision at low light intensity, preceded by a decrease in dark adaptation.

Nightblindness, however, may also be due to non-nutritional causes such as congenital nightblindness, retinitis pigmentosa, and Oguchi's disease.

3. Xerophthalmia is a dyskeratosis of the transparent epithelia of conjunctiva and cornea exposed to the atmosphere and to light in the interpalpebral space. The conjunctiva shows "xerosis" — evidenced by poor maintenance of the covering film and the keratinization of the epithelium

— that is, an unwettability by tears, combined with opacity and stiffness of the conjunctiva, which forms thickened folds, especially when there are movements of the eye. The accumulation of an abnormal greasy foamy substance often causes formation of Bitot's spots. These are whitish, sometimes triangular plaques, adjacent especially to the temporal region of the limbus.

In some cases of advanced xerophthalmia, a similar material accumulates on the bulbar conjunctiva and may spread to adjacent parts of the cornea.

A fine smoky diffuse pigmentation may accompany long-standing xerosis conjunctivae although not all kinds of hyperpigmentation are specific. The specificity of xerosis conjunctivae is proved by the effectiveness of vitamin A administration within one or two weeks.

Corneal changes are characterized by a generalized dryness or unwettability combined with anesthesia and loss of luster and transparency, leading to an early haziness of the cornea. Small defects or erosions of the cornea may appear. Till this stage, the changes are reversible. In more advanced cases perforations of the cornea causing a glistening blackberry-like iris prolapse may appear; furthermore, large areas or even the whole cornea may soften to a greyish-yellowish gelatinous mass termed "keratomalacia." The former changes are not wholly reversible but leave a localized scar; the latter changes result in destruction of the cornea, leading to leukomas, corneal staphylomas, or phthisis bulbi. In either case the changes lead to partial or total blindness.

As a rule, these eye lesions tend to be most serious in the youngest age groups and occur earlier or later depending on the duration and efficiency of breast feeding. The peak-age frequency in countries where breast feeding is prolonged is in the third and fourth year of life. However, these lesions may also occur in younger ages in association with protein-calorie malnutrition.

4. In advanced xerophthalmia, severe degrees of protein-calorie malnutrition are usually present and many of the seriously affected die.

Corneal blindness in one or both eyes, acquired at an early age, is often proof of a former episode of xerophthalmia. Xerophthalmia should be considered as the most common cause of blindness acquired at an early age in developing countries.

5. Although xerophthalmia is usually a bilateral condition, asymmetry of the lesions is not proof against an etiology of vitamin A deficiency.

6. Bitot's spots may be ascribed to causes other than vitamin A depletion especially in older children and adults. In such cases no effect can be expected of vitamin A therapy and vitamin A serum levels may show no abnormality.

7. Care is required in the diagnosis of vitamin A specific epithelial changes. Not every slight degree of dryness, pigmentation, or thickening of the conjunctiva should be ascribed to vitamin A depletion. The term "pre-xerosis" in diagnosing eye changes should be avoided. Eye changes are often observed during respiratory and intestinal infectious disease, especially in the case of measles and diarrheal disorders.

8. The periodic appearance of xerophthalmia in a given environment may depend on infectious diseases or a seasonal variation in food consumption.

9. Though there is usually an association between nyctalopia and xerophthalmia, the presence of nyctalopia is difficult to diagnose in a small child.

10. Vitamin A deficiency in adults is more often precipitated by physiological and pathological stresses such as pregnancy or liver disorders than by diet alone.

Biochemical Criteria for the Evaluation of Hypovitaminosis A

1. At the present time, the estimation of the concentration of retinol in the blood plasma in field studies of population groups is the most convenient way of determining the prevalence of hypovitaminosis A resulting from insufficient intakes of vitamin A.

2. Plasma vitamin A concentration should be considered in accordance with some guides for their interpretation. Guidelines proposed by the Office of International Research (OIR) of the National Institutes of Health (U.S.A.) should be followed until more precise criteria become available.

The following prevalence should be considered evidence for the existence of a public health problem related to hypovitaminosis A in population groups:

(a) A prevalence of less than 20 micrograms of retinol per 100 milliliters of plasma in 15 per cent or more of the population.

(b) A prevalence of less than 10 micrograms of retinol per 100 milliliters of plasma in 5 per cent or more of the population.*

* At these levels of serum retinol, low levels of carotenoids are to be expected. Consistently higher levels of carotenoids accompanying low levels of retinol should be further investigated.

In view of the marked differences in serum levels between sex and age groups noted in some surveys, subcategories should be tabulated separately.

3. In the interpretation of the findings it is emphasized that the sector of the population with plasma vitamin A concentrations of less than 10 micrograms per 100 milliliters represents a high risk group, unprepared to face nutritionally adverse conditions such as temporary shortage of foods rich in vitamin A due to seasonal variations, infections, protein-calorie malnutrition, or selective dietary supplementation with protein alone.

Criteria for the Evaluation of Vitamin A Intake

1. In evaluating dietary intake of vitamin A, the allowance proposed in the 1965 report of the FAO/WHO Expxert Group on vitamin requirements should be followed (2). Intake of total protein, animal protein, calories, and fat should be considered together with vitamin A requirements. Protein deficiency impairs intestinal absorption, transport, and metabolism of retinol, and depresses conversion of carotene to the vitamin. Very low fat in the diet may decrease the availability of carotene.

2. Dietary intake of vitamin A should be reported in micrograms of actual retinol, beta-carotene, and/or other vitamin A active carotenoids, since the suggested correction for the efficiency of utilization of beta-carotene and other active carotenoids is tentative. Total retinol equivalence should be calculated as the sum of:

mcg retinol
mcg β-carotene x 1/6
mcg pro-vitamin A carotenoids other than beta-carotene x 1/12

When the estimated distribution of vitamin A activity between beta-carotene and other carotenoids in a mixture is not well established, the micrograms of the mixture should be multiplied by 1/9, as an estimate of its retinol equivalence.

3. Dietary surveys should show the seasonal variations in vitamin A intake. The seasonal context of data obtained at a single point in the year should be stated.

III. REVIEW OF THE PRESENT KNOWLEDGE

The Lesions

Vitamin A,* either as the preformed vitamin (vitamin A_1 alcohol or retinol), or as pro-vitamin carotenoids, especially beta-carotene, is essential for normal growth and development and for the maintenance of health in all mammals including man. In animals a wide variety of lesions are attributable to hypovitaminosis A, especially affecting the reproductive, skeletal, nervous, and epithelial systems (3). In man only the changes in cornea, conjunctiva, and retina of the eye have characteristic and readily detectable clinical manifestations (4). Thus night blindness, which is easily reversible with treatment, is the result of a prolonged moderate deficiency of vitamin A, whereas partial or total blindness from corneal scarring and disorganization of the eye, which is irreversible, is a consequence of severe and prolonged deficiency. The gravity of this condition is increased by the frequent involvement of other epithelial structures leading to susceptibility to infections and a high case fatality rate (5).

The Process of Depletion (3)

In health, vitamin A is stored in the body, chiefly in the liver, in large amounts and released slowly into the circulation for transportation to the tissues. If the dietary intake of vitamin A is greatly reduced, the liver stores are gradually drawn on. Only when these stores are exhausted does the level in the plasma begin to fall. Up to this stage the tissues are unimpaired in function and structure. If depletion continues and circulating vitamin A is exhausted, the rod cells of the retina soon thereafter show evidence of dysfunction manifested by impaired dark adaption. Then the conjunctiva and cornea keratinize (xerophthalmia) and ultimately the cornea liquifies (keratomalacia). The preclinical period of hypovitaminosis A is usually prolonged but the subsequent stage of overt disease is short and proceeds with disastrous rapidity. This is especially so in the young child, the most susceptible age group, probably because of a combination of factors: low storage of vitamin A *in utero;* high requirements for rapid growth; poor dietary intake of vitamin A after wean-

* In this report the terms "vitamin A" and "retinol" are used interchangeably.

ing; other dietary deficiencies, especially protein; and adverse influence of accompanying infections and infestations. The clinical signs indicate, as it were, only the visible tip of an iceberg, with a much larger hypovitaminosis A state below the surface, associated with deficient intake leading to low stores and scarce circulating levels (6).

Occurrence (7, 8)

a. *Dietary Information:* Dietary intake data from many developing countries indicate that substantial proportions of the population consume considerably less vitamin A than is needed. The major portion of the vitamin A activity of the diets in these countries comes from vegetable sources, limited by the reduced efficiency of conversion of beta-carotene to vitamin A and lower pro-vitamin potency of carotenoids other than beta-carotene. In the youngest age group, breast milk of an adequately nourished mother and cow's milk tend to be protective, but weaning dietaries are often deficient.

b. *Biochemical Data:* In the field, biochemical tests for hypovitaminosis A are at present limited to the measurement of plasma levels. Normal values are considered to range between 20 and 50 micrograms per 100 milliliters. The occurrence of low (10-19 micrograms) and deficient (under 10 micrograms)* levels in surveys correlate quite well on a population basis with dietary data.

c. *Clinical Findings:* In the past reliance has chiefly been placed on the diagnosis of cases of xerophthalmia to map the occurrence of hypovitaminosis A. While it is true that a highly endemic area of xerophthalmia undoubtedly indicates a serious hypovitaminosis A problem it should be recognized that the population "at risk," as indicated by dietary and biochemical data, is much larger. Thus hypovitaminosis A may be more extensive and is not necessarily indicated by the prevalence of xerophthalmia alone.

The young child with xerophthalmia usually suffers from concurrent severe protein-calorie malnutrition. The proportion of cases of severe protein-calorie malnutrition with xerophthalmia in the population "at risk" varies from less than 1 per cent to over 75 per cent, depending on the locality. The proportion encountered in El Salvador in the population "at risk" is 15 per cent. In countries where xerophthalmia is a prob-

* *ICNND Manual for Nutrition Surveys.* Interdepartmental Committee on Nutrition for National Defense. Washington, D.C., 1963.

lem, attack rates in preschool children have been reported as high as 1 per cent. The prevalence appears to be related to the vitamin A activity of the protein-deficient diets. Protein deficiency probably impairs transport and storage of vitamin A and conversion of beta-carotene to the vitamin.

The regular occurrence of xerophthalmia cases in an area is indicative of a very serious preschool public health nutrition problem. The high case fatality rate of at least 25 per cent contributes to under-estimation of its magnitude. The severity of the eye lesions and the fatality are inversely related to age, and are greater in males than in females.

The Outlook

In general nutritional diseases are more intractable than those of infectious origin. Several features of hypovitaminosis A and xerophthalmia, however, provide cause for optimism in the approach for prevention. Numerous vitamin A sources of vegetable origin in endemic areas are readily available even to the poor segment of the community. Unlike protein, vitamin A does not have to be consumed daily because of storage and intermittent dosing has protective possibilities. Furthermore, the highly susceptible age range is a narrow one. Xerophthalmia in a child is the product of neglect at many levels. Only a slight improvement in care could make a world of difference for the victim and his community.

IV. AVAILABLE DATA IN THE AMERICAS

The following is a summary of the clinical, biochemical, and dietary data concerning vitamin A nutriture in Latin America and the Caribbean available in 1968.

Clinical Data

The criteria most often recorded by clinicians on survey teams as associated with hypovitaminosis A are the following:

Eye Lesions, especially conjunctival xerosis and pigmentation, corneal xerosis, Bitot's spots, keratomalacia, corneal opacities, scars, and blindness.

Skin Lesions often cited are follicular hyperkeratosis, xerosis, crackled skin, mosaic dermatosis, and perifolliculosis. However, recent studies have suggested that more frequently both xerosis of the skin and follicular hyperkeratosis (type I) are due not to lack of vitamin A but to other environmental and dietary factors including a low fat diet deficient in essential unsaturated fatty acids such as linoleic acid (Hensen, *et al.*, 1962). The surveys of the U.S. Interdepartmental Committee on Nutrition for National Defense (ICNND) show that the only positive finding occurring with an over-all frequency greater than that of suggested standards was follicular hyperkeratosis, observed in one or more body areas, from 30 per cent of the population surveyed in Paraguay to less than 1 per cent in Uruguay (9, 10). The skin lesion generally had its highest incidence in dry areas of countries and at high altitudes, and seemed to be more closely related to climatic conditions rather than to degree of hypovitaminosis A.

Among infants and young children, the more common eye signs are xerophthalmia and keratomalacia, both evidences of severe avitaminosis A. Severe xerophthalmia, however, is not likely to be found in the course of surveys as it usually occurs in severely malnourished preschool children who are more apt to have died or to be in the hospitals inaccessible to the home.

Xerophthalmia was reported in 0.3 per cent of the children under five years in the survey group in Northeast Brazil, and Bitot's spots in 0.2 per cent (11). In Colombia Bitot's spots were found only in persons over five years of age and the incidence in the total group was 0.1 per cent (12). In Haiti, Bitot's spots were reported in 5 per cent (13).

Conjunctival dryness was found in 45.2 per cent of children under five years in Northeast Brazil and varied from 23.9 per cent to 63.2 per cent in localities surveyed in the area.

In a survey carried out by Escapini in Latin America and the Caribbean, in which 2,532 children were examined in 11 countries, 14.7 per cent revealed evidences of malnutrition, while 1.4 per cent had eye lesions manifested as ulcers of keratomalacia (14). Xerophthalmia in the malnourished group alone was 9.7 per cent, as compared to 1.4 per cent in the total group. The incidence of xerophthalmia was greatest from July to December and corresponded directly to seasonal gastro-intestinal infections of childhood.

Furthermore, in 500 cases of malnutrition examined in a children's hospital in San Salvador, 13.2 per cent had advanced eye changes with degree of malnutrition is shown in Table 1. It was observed that 14.5 per cent of the children with third-degree malnutrition showed xerophthalmia in varying degrees.

Table 1 — *Eye Lesions and Mortality in 500 Cases of Advanced Malnutrition, Children's Hospital, San Salvador*

Stage of malnutrition	Number	With eye lesions (%)	Mortality (%)
Stages 1 and 2	108	8.3	11.1
Stage 3 (Kwashiorkor)	275	12.4	18.2
Stage 3 (marasmus)	117	19.7	29.9
(All forms of stage 3)	(392)	(14.5)	(21.7)
All stages	500	13.2	19.4

Xerophthalmia is generally found in those parts of Caribbean, Central, and South American areas where living standards for the majority of people is low. The preschool child, or more specifically those from six months to four years of age, represent the most vulnerable sector in the deprived group, and these are especially difficult to reach and protect.

Biochemical Data

Because of the readiness with which the vitamin is taken up by the liver, levels of vitamin A in the serum do not reflect status except in extremes of hypo and hypervitaminosis A. In the absorptive phase they are much influenced by intake. Serum carotenoid levels are under the influence of dietary intake in the recent past and resemble this qualitatively and quantitatively.

Biochemical data are difficult to correlate with recent intake and clinical manifestations. However, they may be used to indicate the probability of inadequate intake on the following basis:

1. A population is considered to have a vitamin A nutrition problem when 15 per cent or more of the persons surveyed have serum values less than 20 mcg per 100 ml, and/or 5 per cent or more present serum values less than 10 mcg per 100 ml.

2. Persons with less than 10 micrograms per cent vitamin A are likely to have significantly depleted liver stores and can be considered as poten-

tial clinical cases. The data presented in Table 2 include serum vitamin A values from ICNND surveys in Latin America and the West Indies. From 5 to 45 per cent in the over-all populations surveyed had serum vitamin A levels under 20 micrograms per cent. Vulnerable groups, including children and pregnant women, had even higher portions of low or deficient values.

Table 2 — *Serum Vitamin A Levels in Latin America and the West Indies (ICNND Data, 1959-1967)*

Country or area	Over-all Population: No. of subjects	Serum levels 10-19mg% (% distribution)	Serum levels <10mg% (% distribution)	Persons under 15 years: No. of subjects	Serum levels 10-19mg% (% distribution)	Serum levels <10mg% (% distribution)
Central America	5,879	12.8	1.5	2,548	22.4	2.8
Panama	763	6.8	0.3	521	10	0.4
Nicaragua	983	9.6	0.5	388	9	0.3
Guatemala	1,219	9.8	1.7	—	—	—
Costa Rica	1,095	13.0	1.6	482	26	4.0
Honduras	923	18.0	3.5	820	29	5.0
El Salvador	896	20.0	1.3	337	36	2.0
S. America/ W. Indies	2,910	19.0	4.4	1,271	27.4	9.6
Venezuela	329	4.9	0.0	123	8.0	0.0
Paraguay	886	6.5	0.1	435	11.5	0.2
Uruguay	111	12.0	0.0	81	23.0	0.0
Colombia	156	16.0	1.2	—	—	—
West Indies	530	27.7	7.7	234	52.4	33.0
Brazil	342	29.0	14.0	133	32.0	17.0
Chile	143	30.0	2.8	68	18.5	3.1
Bolivia	413	37.0	8.1	197	47.0	10.0
All countries	8,789	14.9	2.5	3,819	24.1	5.0

Dietary Data

Knowledge of nutrient intake in Latin America is available principally from three groups of family dietary surveys; smaller groups of surveys of preschool children have been carried out recently.

1. From 1951 to 1966 national nutrition organizations of 14 countries, sometimes in collaboration with outside agencies, made dietary surveys in 156 localities covering some 4,400 families.

2. From 1959 to 1965, the Interdepartmental Committee on Nutrition

for National Defense included family dietary studies in nutrition surveys in eight South American countries and the West Indies, covering 147 localities and about 4,500 families.

3. From 1965 to 1967, the Office of International Research (formerly ICNND), collaborating with the Institute of Nutrition of Central America and Panama (INCAP), made similar studies in the six Central American countries including nearly 2,600 families. These included sub-samples of intakes of preschool children.

Localities Surveyed by National Nutrition Organizations

Survey sites in the 14 countries were selected to represent different areas, and coverage was more extensive in some cases than in others. Seasonal variations were infrequently represented. Families were generally selected by random methods, often with stratification. Foods were weighed in daily visits to homes for seven days or sometimes less.

Nutrients were calculated with food composition data from various Latin American areas, most commonly of uncooked foods. Vitamin A was expressed as international units, one international unit equivalent to 0.3 micrograms of preformed vitamin A, 0.6 micrograms of beta-carotene, and 1.2 micrograms of other carotenoids with vitamin A activity. The INCAP-ICNND tables used after 1961 applied the same conversion factors but expressed vitamin A value in micrograms (15). Since these tables made no correction for inefficient utilization of vitamin A active carotenoids, the vitamin A values of vegetable foods are probably exaggerated and actual intake levels lower.

In this group of surveys, average results were expressed by locality in 137 cases. Intake was under 1,600 *calories* per person per day in 10 per cent of these places and under 2,000 in 58 per cent. The 2,000 calorie level was near the estimated requirements for many of the population groups, when age, sex, average adult body weight, and climate were taken into account.

Total protein intake was under 30 grams per person per day in 2 per cent of the localities; under 45 grams in 20 per cent; and under 55 grams in 48 per cent. *Animal protein,* shown in 102 localities, was under 30 per cent of total protein in 43 per cent of these places. Average body weight in many of these population groups was under 60 kilograms for men and 55 kilograms or less for women.

In 103 localities reporting *fat,* 5 per cent had under 15 grams per person per day; 44 per cent had under 30 grams, and 81 per cent had under 45 grams.

In the 137 localities, 15 per cent had intakes under 1,000 I.U. of *vitamin A* per person per day; 41 per cent under 2,000 I.U.; and 72 per cent under 3,000 I.U. A total of 14 per cent had from 3,000 to 4,000 I.U. and 15 per cent had over 4,000 I.U. About 3,500 I.U. per person per day was an approximately acceptable level by standards used.

Information on the proportion of *preformed vitamin A* in the total vitamin A intake was shown in only 35 places, and in two-third of these it was under 30 per cent. Since the vitamin A value of vegetable foods may have been overestimated in the food composition tables used, more localities would actually fall into lower intake levels than indicated in the tabulations.

In 105 localities in 10 countries, the distribution of individual families by estimated level of adequacy of vitamin A intake was given. Table 3 shows the proportion of families in each of these countries receiving less than half of the recommended amounts of vitamin A. In all the areas included, 54 per cent of the families were in this low category. If the vitamin A value of vegetable sources is overestimated, a proportion larger than 54 per cent would have less than half of the recommended amount.

Table 3 — *Distribution of Families by Vitamin A Intake Level*

Country	Number of localities	Number of families	Families with half the recommended allowances of vitamin A (%)
Panama	4	104	88
Costa Rica	1	20	85
Nicaragua	2	59	78
Guatemala	12	180	68
Mexico	26	900	64
Peru	18	732	47
Colombia	28	896	46
Venezuela	1	36	45
Brazil	8	215	42
Ecuador	5	139	33
Total	105	3,281	54

The recommended allowances of vitamin A were usually calculated by use of the INCAP standards (1953) adapted from the National Research

Council (U.S.A.) Recommended Allowances (1948), taking age, sex, and adult body weight into account.

Data tabulated in some countries by socioeconomic level showed that lower intakes of calories, fat, total protein, animal protein, vitamin A value, and preformed vitamin A usually corresponded to lower socioeconomic levels. Rural and indigenous classes often belonged to these lower levels.

ICNND Surveys in South America and the West Indies

Food intake data in these surveys were collected by the one-day recall technique, at survey centers, by interviews with housewives. Data of foods consumed in a locality were pooled and locality averages calculated. The food composition data used were essentially those described in the preceding section, and vitamin A was expressed in International Units. Table 4 summarizes nutrient intake in nine areas.

Table 4 — *Calorie, Protein, Fat, and Vitamin A Intake per Person per Day in South America and the West Indies (24-Hour Recall Data, ICNND, 1959-1965)*

Country or area	Sample		Calories	Protein		Fat (g)	Vitamin A*	
	Localities	Families		Total (g)	Animal (%)		Total value I.U.	Preformed (%)
Ecuador	8	329	1,970	58	23	35	4,384	12
Chile	16	278	2,212	70	—	—	6,980	—
Colombia ...	13	322	1,068	31	42	21	391	—
West Indies ..	31	517	1,992	67	50	49	4,101	—
Uruguay	13	1,299	2,580	91	70	93	3,025	33
Bolivia	8	645	1,870	57	41	34	2,671	12
N.E. Brazil ..	15	333	1,472	51	39	16	533	"low"
Venezuela ...	18	509	1,840	66	48	54	1,965	—
Paraguay	25	269	2,354	63	51	54	2,700	50
All areas ..	147	4,501	1,968	63	43	47	3,068	—

* 1 I.U. = 0.3 mcg retinol equivalent.

The low intakes for Colombia may reflect under-reporting. The data for Northeast Brazil represent a problem area following a prolonged drought. Values obtained by Brazilian workers there in another year showed higher values (16).

The average vitamin A intake for the nine areas was over 3,000 I.U.

per person per day. The variations by country were great and reflected time of year as well as place. A distribution of the 147 localities surveyed (Table 5) shows that about 25 per cent consumed less than 1,000 Internationl Units of Vitamin A per person per day, and 60 per cent less

Table 5 — *Distribution of Localities in South America and the Caribbean by Per Capita Intake of Vitamin A (24-Hour Recall Data, ICNND, 1959-1965)*

Country or area	Localities	Vitamin A Intake, I.U.* <1,000	1,000-1,999	2,000-2,999	3,000-3,999	≥4,000
		Per cent distribution				
Ecuador	8	0	0	12	37	50
Chile	16	0	0	0	0	100
Colombia	13	100	0	0	0	0
West Indies	31	0	16	29	16	39
Uruguay	13	0	8	31	54	8
Bolivia	8	12	25	25	12	25
N.E. Brazil	15	100	0	0	0	0
Venezuela	18	11	44	28	17	0
Paraguay	25	23	36	12	4	20
All areas	147	26	17	16	14	26

* 1 I.U. = 0.3 mcg retinol equivalent.

than 3,000 I.U. An acceptable intake was usually estimated at about 3,500 I.U. per person per day.

The ICNND survey in 15 localities of Northeast Brazil in 1960 showed the average intakes of 170 children under two years of age. The intake reported and the recommended allowances estimated per child per day are given in Table 6.

Table 6 — *Calorie, Protein, Fat, and Vitamin A Intake of Children (ICNND, Brazil, 1961)*

Intake	Average	Recommended allowance
Calories	570	900
Total protein, g	16.9	20
Animal protein, g	12.5	—
Fat, g	9.7	—
Vitamin A, mcg	137	500

Table 7 — *Distribution of Average Intakes, by Localities (ICNND, Brazil, 1961)*

Calories	% Distribution	Grams	Total protein % Distribution	Animal protein % Distribution	Fat % Distribution	Vitamin A mcg	Vitamin A % Distribution
400-499	27	<10	0	13	67	<100	33
500-599	40	10-14	40	53	20	100-199	53
600-699	20	15-19	27	27	7	200-299	7
700-799	13	20-25	33	7	7	300-399	7

Calorie levels fall far below recommended allowances. One third of the localities have adequate protein levels, but only 7 per cent (one locality) approaches the recommended allowance of vitamin A. Because of milk supplements used, animal protein formed almost 75 per cent of the total.

ICNND-INCAP Surveys in the Central American Area (1965-1967)

The collection of dietary data and the food composition tables used were those described in the preceding section. However, vitamin A was expressed in micrograms and data were analyzed by individual family. Table 8 shows the average nutrient intake in the various countries.

Table 8 — *Nutrient Intake per Person per Day in Central America and Panama (24-Hour Recall Data, INCAP-ICNND, 1965-1967)*

Country	No. of families	Calories	Protein Total (g)	Protein Animal (%)	Fat (g)	Vitamin A equivalent, mcg* Total	Vitamin A equivalent, mcg* Preformed (%)
Guatemala	307	2,254	72.1	28	41.7	832	16
El Salvador	393	2,158	68.3	29	47.0	501	49
Honduras	429	1,885	60.9	—	47.7	453	48
Nicaragua	453	2,023	66.6	39	50.4	616	40
Costa Rica	555	1,971	56.0	37	47.9	635	39
Panama	457	2,099	62.6	46	47.7	676	26
Average		2,050	63.6	37	47.3	612	37

* 1 mcg of vitamin A (retinol) = 3.3 I.U. of vitamin A.

In a smaller population sample in each country, food consumption data were recorded in home visits for 3-day periods for comparison with the 24-hour recall technique. In several countries for which the data was available, the 3-day method gave lower intakes in general.

Calorie intake averaged 2,050 per person per day varying from 1,885 in Honduras to 2,254 in Guatemala. Total protein averaged about 64 grams and 37 per cent was of animal origin. Guatemala had the highest total protein and the lowest proportion from animal sources. Fat intake averaged 47 grams, varying little between countries. Vitamin A averaged 612 micrograms, varying between countries from 453 micrograms to 832 micrograms. About 37 per cent of the vitamin A was preformed. This proportion also varied between countries, and was lowest in Guatemala with the highest vitamin A intake. A distribution of families in the Central American area by vitamin A intake level and by country is shown in Table 9.

Table 9 — *Distribution of Families in the Central American Area by Level of Vitamin A Intake (ICNND-INCAP Surveys, 1965-1967, 24-Hour Recall Data)*

Country	No. of families	Vitamin A equivalent per person per day, mcg* <400	400-599	600-799	800-999	1000-1199	≥1200
		Distribution of families (%)					
Guatemala	307	43	14	10	6	6	21
El Salvador	393	68	10	7	4	3	8
Honduras	429	64	15	8	3	3	7
Nicaragua	453	53	12	13	5	5	12
Costa Rica	555	52	13	10	6	6	14
Panama	457	49	21	10	6	4	10
All areas	2,594	55	14	10	5	4	12

* 1 mcg of vitamin A (retinol) = 3.3 I.U. of vitamin A.

Over half of all the families had less than 400 mcg of vitamin A per person per day, a very deficient level compared to allowances recommended by the 1965 FAO/WHO Expert Group on vitamin requirements of the order of 1,100 micrograms, as estimated in accordance with these recommendations by INCAP (2). Because the vitamin A value of vegetable foods given in the food composition tables used may be overestimated, intake levels may be even lower.

Table 10 presents preliminary results for 202 preschool children of rural and semi-rural sections in four of the six countries surveyed by the INCAP-NIH teams in the Central American area.

Table 10 — *Nutrient Intake of Preschool Children in Rural Sectors of Four Countries in the Central American Area (INCAP-NIH, 1965-1967, 1-day weighing method)*

	Honduras	Nicaragua	Costa Rica	Panama	Total
Number of children	46	30	69	57	202
Calories: Average	1,059	1,098	1,083	1,099	1,084
% of standard*	88	91	92	97	93
Intake levels			Per cent distribution		
400- 599	11	10	9	5	8
600- 799	17	17	13	26	18
800- 999	15	23	25	19	21
1000-1199	24	17	19	18	20
1200-1399	15	13	19	11	15
≧1400	17	20	16	21	18
Protein: Average	33.3 gm	32.0 gm	28.2 gm	30.6 gm	30.6 gm
% of standard*	126	119	108	118	116
% animal sources	41	24	47	44	41
Intake levels			Per cent distribution		
<10 grams	7	7	1	0	3
10-14 grams	7	0	4	7	5
15-19 grams	13	7	17	12	13
20-24 grams	9	13	22	19	17
25-29 grams	7	20	17	18	15
≧30 grams	59	53	38	44	47
Fat: Average	26.4 gm	26.7 gm	29.5 gm	26.2 gm	27.4 gm
Intake levels			Per cent distribution		
<10 grams	20	7	3	14	10
10-19 grams	22	43	32	35	33
20-29 grams	22	13	28	21	22
30-39 grams	15	17	14	16	15
≧40 grams	22	20	23	14	20
Vitamin A: Average	218 mcg	165 mcg	293 mcg	280 mcg	253 mcg
% of standard*	34	25	46	45	40
% animal sources	47	41	46	35	42
Intake levels			Per cent distribution		
2- 99 mcg	37	40	23	24	29
100-199 mcg	17	27	23	24	23
200-399 mcg	26	30	35	24	29
400-599 mcg	17	0	9	18	12
600-799 mcg	2	3	1	4	2
≧800 mcg	0	0	9	5	5

* Standards follow FAO/WHO recommended allowances for calories, protein, and vitamin A.

The group of children as a whole received an average of 1,084 *calories* per child per day, or 93 per cent of the estimated requirements.* The intake in the four areas varied from 88 per cent of the estimated needs in Honduras to 97 per cent in Panama. Despite favorable average levels, one fourth of the children had from 400 to 799 calories per day.

The *protein* intake was 30.6 grams per child per day in the group as a whole, or 116 per cent of the recommended amount. However, 8 per cent of the children obtained less than 15 grams of protein per day, or 60 per cent and less of the recommended allowance. Average intakes exceeded allowances in all four areas. Animal protein (principally from milk) formed 41 per cent of the total in the group as a whole, varying from 24 per cent in Nicaragua to 47 per cent in Costa Rica.

The intake of *fat* was 27.4 grams per child in the group as a whole, varying little between areas. Ten per cent of the children obtained less than 10 grams per day.

While calorie and protein intakes were therefore satisfactory for a majority of the children, small segments had extremely low levels. In the case of the *vitamin A* value of the diets, however, the intake was deficient for a large majority, by the standards used. The average intake of the group as a whole was 40 per cent of the estimated needs. This varied from 25 per cent in Nicaragua to 47 per cent in Honduras. Only 7 per cent of the children had intakes of 600 micrograms or over, a level close to the estimated needs of the average. In the group as a whole, 42 per cent of the vitamin A value of the diets was from animal sources. This proportion varied from 35 per cent in Panama to 47 per cent in Honduras.

V. RECOMMENDATIONS ON TREATMENT AND PREVENTION OF VITAMIN A DEFICIENCY

Treatment

The Technical Group recommends the following course of treatment in manifest cases of vitamin A deficiency.

1. First three days: 10,000 I.U. per kilogram of actual body weight

* Standards for calories, protein, and vitamin A follow recommendations of the FAO/WHO expert committees on the respective subjects.

per day of watermiscible vitamin A orally, plus the same amount intramuscularly, equal to a total of 20,000 I.U. per kilogram* per day.

2. Next three days: 10,000 I.U. per kilogram per day orally. Then a maintenance dose of about 10,000 I.U. per day provided by about 10 ml of cod liver oil, two or three times the recommended allowance for age, or about 5,000 I.U. per child per day orally.

3. Vigorous treatment of the underlying condition which is frequently associated with xerophthalmia.

4. Adequate food intake, with particular reference to amount and quality of dietary protein and calories.

Specific Protection

Specific protection measures are directed at those groups which are susceptible to severe manifestations of vitamin A deficiency: young children, and pregnant and nursing women.

Infants and Preschool Children

It is suggested that 100,000 I.U. of watermiscible vitamin A be administered orally one to four times a year for at least two years, to all children from the third month of life on, in areas where avitaminosis A is a public health problem. The proposed dose is in the order of magnitude of the recommended allowances, and may be administered at quarterly intervals. Such a program could be linked to existing programs of maternal and child health.

Pregnant and Lactating Women

The Technical Group does not recommend administration of vitamin A to pregnant women beyond the daily allowances recommended by the WHO/FAO Expert Committee on vitamin requirements, which are those for the normal adult. According to some indications, high doses of vitamin A during pregnancy may have harmful effects on the fetus (17).

On the other hand, the Technical Group suggests that lactating women

* For the convenience of local health workers, dosage schedules are expressed as I.U. instead of retinol.

be given an oral dose of 100,000 I.U. of watermiscible vitamin A immediately after delivery to protect the child during the first weeks of life. This can easily be done through maternity services. The Group also suggests that the collaboration of the traditional midwives be enlisted in referring lactating mothers to health centers for preventive dosage.

The newborn child should not be given a high dose of vitamin A since the very young seem particularly susceptible to hypervitaminosis A (17).

Although the Group recognizes that information on the effectiveness of the proposed measures is still scarce, it feels that they may be useful in the protection of vulnerable groups.

Recommended Preparations

Preformed vitamin A (i.e., vitamin A alcohol or retinol) rather than carotene should be used during the first year of life whenever possible.

Abundant evidence indicates that watermiscible preparations of preformed vitamin A are best utilized by the body, whether administered orally or intramuscularly.

When a watermiscible form is not available, an oily preparation may be used, but only by the oral route and accompanying a feeding. Solutions of vitamin A in oil are not satisfactorily utilized when administered intramuscularly.

Vitamin A applied locally in an ointment does not protect the eye or correct the underlying cause. Such ointments give a false sense of security and should be avoided.

When synthetic vitamin A is not available, the value of natural sources of vitamin A such as red palm oil, cod liver oil, green leafy vegetables, etc., should be stressed, and their use in the diet or as supplements encouraged.

Vitamin A in Emergency Situations

Lastly, the Technical Group wishes to call attention to the need for protecting displaced persons and victims of natural or man-made disasters against the risk of vitamin A deficiency. Here again watermiscible vitamin A can be used efficiently in essentially comparable amounts.

Prevention

Specific Measures

1. Enrichment with vitamin A of foods such as dried skim milk, etc., widely distributed by UNICEF, CARE, Food for Peace, and other programs.

2. Enrichment of dietary supplements, in particular low-cost high-protein foods for infants and preschool children.

3. Enrichment of items in very general use, such as cereal products, vegetable oils, other fats, etc.

Techniques for enrichment of bread and other cereal products with B-vitamins and minerals were developed over the last 30 years as low-cost commercially produced B-vitamins became available. The recent development of inexpensive dry forms of vitamin A has expanded the possibilities of cereal enrichment. A flour enrichment program initiated in the Near East in 1967 included vitamin A, thiamin, riboflavin, niacin, and iron. Flour produced in domestic mills was enriched at the mill. Bread baked by local processes showed vitamin A losses of 20 per cent or less. The enrichment with vitamin A of flour and some other common foods has been started in India and similar measures are to be initiated in other areas.

General Measures

Measures for improving nutritional conditions in a population include nutrition education at different levels.

(a) The need for greater knowledge of nutrition in the medical profession has long been stressed. Courses of biochemistry, physiology, clinical disease, and pathology in medical schools should include more nutrition science and its application. Recently a few medical school graduates and medical students were sent to nutrition institutes and other study centers, often in areas where nutritional disease exists. This practice should be extended and intensified.

(b) Professionals in direct contact with the public, including nurses, schoolteachers, public health and social workers, agricultural extension agents, and others, should have nutrition knowledge at both technical and applied levels. Problems such as avitaminosis A in certain areas should be of specific concern to professionals there. Although food habits do change, the direction of change toward desired goals is difficult to accomplish. Conditions under which food habits ordinarily change, and the obstacles which may impede a desired change, must be known. The social anthropologist can provide such knowledge, essential for increasing consumption of foods to meet nutritional needs.

(c) Nutrition education of the consumer should encourage the preferential consumption of those cereal, vegetable, and fruit varieties which are richest in vitamin A precursors, especially in areas where avitaminosis A is prevalent. Staples such as maize, sweet potatoes and potatoes, plantains, etc., in developing areas vary widely in carotene content and varieties of these products which are low in carotene are often those most widely used. Certain rich carotene sources in green leaves, eaten in some areas, remain unused in others. The effects of traditional food habits and beliefs about foods, especially in relation to children, as well as economic factors, should be considered in planning nutrition education for the general population.

(d) Governments should stimulate increased production of foods known to be good sources of vitamin A. These foods should be acceptable and within economic reach of the needier sectors of the population. Fruit, vegetable, and animal production should be planned to provide year-around vitamin A sources. Such measures require collaboration of agricultural, social, economic, and nutrition scientists.

VI. RECOMMENDATIONS FOR FURTHER RESEARCH

Action by PAHO is desirable for the encouragement of:

1. The standardization and cross-checking of techniques used in the study of hypovitaminosis A in the Region, particularly:

   a. Chemical methods for the estimation of retinol and carotenoids in blood.

   b. Methods for measuring the efficiency of dark adaptation.

2. Surveys of food consumption of individuals particularly of the vulnerable groups, in areas or population sectors in which deficiencies are probable, including information necessary for planning practical preventive measures.

3. The improvement of food composition tables by accumulation of

further data on retinol and carotenoids especially in foods which form important sources of these substances. The food composition tables should have separate entries for retinol, beta-carotene, and other vitamin A active carotenoids, as well as a summation of the vitamin A active substances expressed as "retinol equivalence," in accordance with standards mentioned in Part IV.

4. Recording in population census figures blind individuals and ages at which blindness began.

Other areas in which PAHO should encourage research:

1. Epidemiology of xerophthalmia in the preschool child, especially aspects important in practical application of health measures.

2. Blindness survey of children under six years and relation of the blindness to vitamin A deficiency.

3. The fate of survivors of severe vitamin A deficiency under six years.

4. Relation between xerophthalmia and keratomalacia and factors which precipitate keratomalacia.

5. The effectiveness of various preventive techniques for the control of vitamin A deficiencies.

6. Liver reserves of vitamin A through examination of livers obtained at autopsy in accidental deaths.

7. Relationship between dietary intake of vitamin A, serum level, and liver stores.

8. Development of methods for the evaluation of liver stores of vitamin A in an intact animal.

9. Comparative study of the effect of oral and intramuscular administration of vitamin A preparations on liver stores and serum levels of vitamin A.

10. Use of modern histochemical techniques on children who have died of severe vitamin A deficiency.

11. The transfer of vitamin A from the mother to the human fetus at various stages of development.

12. Techniques for the fortification of dietary staples with vitamin A under varying commercial and socioeconomic conditions.

13. Urinary excretion of vitamin A metabolites in the diagnosis of deficiency state.

VII. CONCLUSIONS

The general consensus of the clinical, biochemical, and dietary data presented indicates that hypovitaminosis A is a problem of public health importance in the Americas. While indications of vitamin A deficiencies are greater in some geographic areas or countries than in others, a portion of the population in most areas is affected, and this is commonly the young children in the poorer groups.

The international agencies should stimulate action to prevent and control this disease through national health services and encourage research to fill identified gaps in the current knowledge of vitamin A nutriture. Some important measures are proposed and areas for needed research are indicated in this report.

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