

National Vitamin A Survey in Panama¹

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The prevalence of vitamin A deficiency in a nationally representative sample of children 12–59 months old in Panama was assessed using serum retinol levels and dietary indicators. The median serum retinol level found was $1.27 \pm 0.42 \mu\text{mol/L}$ ($38\mu\text{g/dL}$); 6.0% of the study sample providing adequate blood specimens had levels below $0.7 \mu\text{mol/L}$ ($20\mu\text{g/dL}$), indicating deficient vitamin A intake. The Panama City Metropolitan Area and the country's western region had the highest prevalences of low serum retinol levels (below $0.7 \mu\text{mol/L}$ in 9% and 6% of the study children, respectively), as compared to overall prevalences of 5% in the two other regions studied. Low serum retinol levels were significantly more prevalent among Indians in the study group (primarily Guaymí Indians) than among non-Indians (13% versus 5%). Dietary information provided by the study children's mothers showed that high risk of inadequate dietary vitamin A intake closely paralleled low serum retinol levels; specifically, the highest prevalence of dietary inadequacy was found in the western region, especially among the Indians. The Panamanian Government is currently increasing distribution of high-dose vitamin A capsules to Indian preschoolers in Chiriquí and Bocas del Toro Provinces.

Panama's 1967 National Nutrition Survey showed that 25% of all Panamanian families were consuming less than 15% of the recommended amount of vitamin A and that 50% were consuming less than 31%. The survey also found that 12% of the population had low levels of serum retinol ($<0.7 \mu\text{mol/L}$) (1). Despite these low levels of vitamin A intake and serum retinol, however, no clinical manifestations of deficiency were observed.

Partly as a result of this survey, in 1976 the Panamanian Government passed a law requiring fortification of all sugar with vitamin A. The law was applied from 1976 to 1978 but later fell into disuse because

of technical and economic problems; and in 1980 Quevedo (2), affirming earlier findings, reported that 72% of the population was consuming less than 50% of the recommended levels of vitamin A.

In 1984 a study on the health and nutritional status of the Guaymí Indians of Chiriquí (the westernmost province of Panama) found that 28% of the children 1–4 years old in one community and 45% in another had low serum retinol levels. Among other things, the authors concluded that the average child infested with *Ascaris lumbricoides* had $0.14 \mu\text{mol/L}$ less serum retinol than the average uninfested child (3).

Between 1989 and 1993 hospitals in the western provinces of Bocas del Toro and Chiriquí reported 21 cases of conjunctival ulcers or perforations in children under 14 years old (G. Rivera, personal communication). As a result, high-dose vitamin A capsules (200 000 IU) were distributed in the region.

Because of the relationship between subclinical vitamin A deficiency and child

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mortality (4, 5), in 1992 the Panamanian Ministry of Public Health began pressing sugar mills to comply with the sugar fortification law. The general pertinence of national fortification and its capacity to reach the nation's Indian communities (less than 5% of the population) were questioned by sugar manufacturers. In response, so as to learn more about potential gains from sugar fortification and other alternatives, the health ministry undertook a national survey to determine the population's current vitamin A status. Data from this survey, presented here, provide an up-to-date view of vitamin A nutrition in Panama based on dietary vitamin A intake and plasma retinol levels among children 12–59 months old.

METHODOLOGY

Sample

The sample size needed for the survey was estimated at 950, based on an expected deficiency prevalence of 15%. This sample size was increased by a factor of 1.5 due to cluster sample design effect, and an additional 10% was allowed for nonresponse, giving a total sample size of 1 566.

The study universe was the population 12 to 59 months of age living in private homes in all of Panama's provinces except the Comarca de San Blas and Darién, which were excluded because of their sparse and hard-to-reach populations. The rest of the country was divided into four geographic zones (regions) with shared characteristics: Metropolitan Panama and San Miguelito (large urban area), West (plantation agriculture and Indian population), South Central (relatively arid range land), and North Central (humid highlands with small farms). Samples of equal size were drawn from each region.

The 510 *corregimientos* (local governmental units) were stratified and grouped

based on population size, average income, literacy, and unemployment; each stratum contained approximately 23 000 inhabitants. Fifty-four census segments (a segment comprised 8–11 households, one day's work for a census enumerator) were drawn randomly from the strata of each geographic zone, with probability proportional to size. Two-segment survey clusters were formed from the sampled segment and the segment with the next higher number on the list. Double segments were estimated from census data to contain 7.25 children on average, thus providing ($54 \times 4 \times 7.25 =$) 1 566 study children.

All households in each double segment were visited, and where one or more children 12 to 59 months of age were present, one of these was selected for participation in the study. If more than one eligible child was found in the household, one was randomly selected based on the highest number birth month (January = 1, December = 12).

Data Collection

Ten two-person teams composed of a nurse and laboratory technician were trained by medical professionals (physicians and nutritionists) in the procedure for administering the survey questionnaire, collecting blood specimens, and taking heights and weights.

Weights were taken in kilograms to the nearest 0.1 kg on minimally dressed children (underwear) using hanging scales (Salter-type, 25 kg capacity, 100 g precision) with the child suspended in a pants-like sling. Standing height was measured in centimeters to the nearest millimeter on children over 24 months old without shoes using fiberglass measuring tapes tacked to the wall and a square to align the wall measurement with the top of the child's head. Recumbent length was measured in centimeters to the nearest millimeter on children 12–24 months old

using a standard UNICEF-design infantometer.

The survey was conducted during the period of March-June 1992. The collected data were entered into an EPI-INFO data base, and statistical calculations were made using the same package. The statistical procedures applied were the chi-square test and analysis of variance (ANOVA).

Indicators

Plasma Retinol

Blood specimens were drawn into 10 mL syringes and immediately transferred gently to heparinized vacutainers that were kept on ice in the dark for up to six hours until the plasma could be separated and frozen. Frozen plasmas were transported on dry ice to the health ministry's vaccine storage center and subsequently to the headquarters of the Institute of Nutrition of Central America and Panama (INCAP) in Guatemala City for analysis. The retinol concentration of each specimen was measured spectrophotometrically before and after ultraviolet destruction of the retinol, using the method described by Bessey et al. (6).

Vitamin A Intake

The risk of inadequate vitamin A intake was evaluated using a modified version of the Simplified Dietary Assessment (SDA) methodology proposed by the International Vitamin A Consultative Group (IVACG) (7). Scores for vitamin A intake during the previous day and week were calculated for each child.

Related Matters

The nutritional status of the survey children was assessed by comparing their weight-for-age Z-scores with the WHO standard using the anthropometric software of EPI-INFO (8).

Regarding morbidity, the incidence of diarrhea and upper respiratory infections among the study children during the two weeks preceding the survey was determined by questioning their mothers. No attempt was made to impose criteria on the mother's definition of disease symptoms.

Breast-feeding information, including data on the duration of current and prior breast-feeding, was obtained from each child's mother during the interview. The interviewer also collected information about maternal education (the various educational levels being defined as illiterate, incomplete primary, complete primary, incomplete secondary, and complete secondary) and determined whether each household should be considered Indian or non-Indian based on the mother's native language, dress, and place of residence.

RESULTS

Blood Specimens

The survey population consisted of 1 389 children 12 to 59 months old, from whom 1 103 usable blood specimens were obtained (the missing specimens were hemolyzed or of insufficient volume). The distribution of these 1 389 participants by region, maternal education, ethnic group, and age is shown in Table 1. Nearly all of the Indian children included in the survey were residing in the western region.

Plasma Retinol

The median plasma retinol concentration was 1.27 $\mu\text{mol/L}$ (SD = ± 0.42), with no significant difference being found between the four regions. However, a statistically significant difference ($P < 0.001$) was found between the median retinol concentrations of the Indians ($1.06 \pm 0.40 \mu\text{mol/L}$) and non-Indians (1.30 ± 0.42

Table 1. Distribution of study children and blood specimens by geographic region, maternal education, ethnic origin, and age group.

	Total sample		Blood specimens	
	No.	%	No.	%
<i>Region:*</i>				
West	397	29	326	30
South Central	294	21	244	22
North Central	409	29	324	29
Panama City				
Metropolitan Area	289	21	209	19
Total	1 389	100	1 103	100
<i>Maternal education:</i>				
Illiterate (no primary school)	61	4		
Incomplete primary	179	13		
Complete primary	369	27		
Incomplete secondary	409	30		
Complete secondary	355	26		
Missing information	16	1		
Total	1 389	100		
<i>Ethnic group:</i>				
Indian	128	9		
Non-Indian	1 236	89		
No response	25	2		
Total	1 389	100		
<i>Age (months):</i>				
12-23	323	23		
24-35	395	29		
36-47	352	25		
48-59	319	23		
Total	1 389	100		

*The indicated regions contain the following provinces: West—Chiriquí, Veraguas, Bocas del Toro, South Central—Los Santos, Herrera, Coclé, North Central—Colón, East Panama, West Panama; Panama City Metropolitan Area—Metropolitan Panama City and San Miguelito

$\mu\text{mol/L}$). The prevalences of retinol levels below $0.7 \mu\text{mol/L}$ in various survey subgroups are shown in Table 2. A strong contrast was found between Indians and non-Indians, low retinol levels being 2.6 times more prevalent among the Indians. Figure 1 shows the distribution of retinol levels found in plasma specimens from the study children of Indians and non-Indians. The curve for the Indian group

is displaced notably to the left of the curve for the non-Indians.

Maternal education was also found to bear a significant relationship to plasma retinol levels. Specifically, the prevalence of low retinol levels (less than $0.7 \mu\text{mol/L}$) among children of mothers with less than complete primary education was notably greater than that among children whose mothers had finished primary

Table 2. Prevalences of vitamin A deficiency, as indicated by plasma retinol levels and estimated high dietary risk, by sociodemographic variables. NS = not significant ($P \geq 0.05$).

	Plasma retinol	High dietary risk	
	< 0.7 $\mu\text{mol/L}$ (%)	24 hr (%)	7 days (%)
<i>Region:</i>			
West	6	28	19
South Central	5	19	9
North Central	5	20	6
Panama City Metropolitan Area	9	18	5
Significance (chi-square)	NS	$P < 0.01$	$P < 0.001$
<i>Maternal education:</i>			
Illiterate	8	48	39
Incomplete primary	9	31	17
Complete primary	6	23	11
Incomplete secondary	6	16	6
Complete secondary	2	16	3
Significance (chi-square)	$P < 0.05$	$P < 0.001$	$P < 0.001$
<i>Ethnic group:</i>			
Indian	13	41	33
Non-Indian	5	20	8
Significance (chi-square)	$P < 0.001$	$P < 0.001$	$P < 0.001$
<i>Age (months):</i>			
12–23	7	19	8
24–35	5	23	14
36–47	8	24	10
48–59	4	20	7
Significance (chi-square)	NS	NS	$P < 0.05$

school (9% vs. 5%) and roughly four times greater than the prevalence among whose mothers had a complete secondary education (9% vs. 2%).

As Table 2 indicates, no significant differences were found between plasma retinol levels in different age groups.

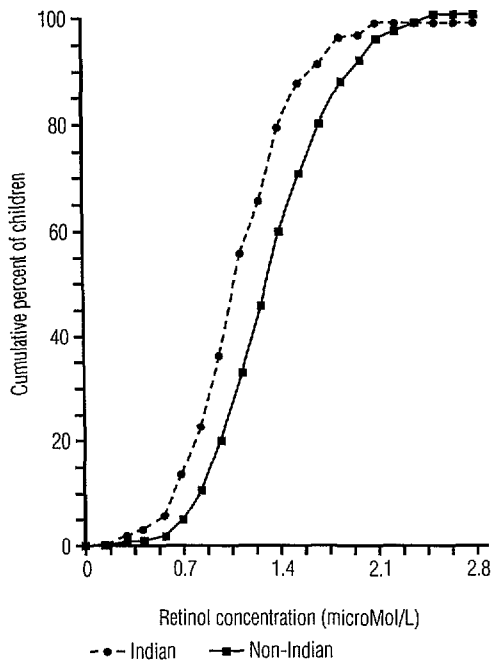
Vitamin A Intake

Dietary risk scores were calculated for estimated vitamin A intake during the preceding 24 hours and 7 days. Children

consuming less than 70% of the recommended minimum (400 retinol equivalents per day) were considered at high risk of inadequate vitamin A intake. The prevalences of high dietary risk by region, maternal education, ethnic group, and age group are shown in Table 2.

The highest prevalence of dietary risk was found in the West, while the lowest was found in the Panama City Metropolitan Area. Children of illiterate mothers, as compared to those whose mothers had completed secondary school, ran 13

Figure 1. Distribution of serum retinol levels in the study children, by ethnic group.



times the estimated dietary risk of inadequate vitamin A intake over the preceding 7 days. In this same vein, Indians (as compared to non-Indians) appeared to run twice the estimated dietary risk of inadequate intake over the preceding 24 hours and four times the risk over the preceding 7 days (see Table 2).

Other Factors

Nutritional Status

The prevalence of weight-for-age scores under 1 Z below the median of the WHO standard ranged from a high of 35% in the West to 23% in Metropolitan Panama. No significant relationship was found between weight-for-age and serum retinol levels.

Morbidity

Children who had experienced diarrhea in the two weeks preceding the interview were significantly more likely to have low plasma retinol levels (9% vs. 4%, $P < 0.05$). In contrast, children who had respiratory disease during the preceding two weeks tended to have the same plasma retinol levels as healthy children.

Breast-feeding

Children 12–23 months old who were still being breast-fed had average plasma retinol levels significantly lower than those of weaned children the same age (1.24 versus 1.36 $\mu\text{mol/L}$, $P < 0.05$ by ANOVA).

Ethnic Group

The survey found the Indians studied to differ significantly from the non-Indians in various ways—in addition to having the relatively low plasma retinol levels already noted. Indian mothers were far less educated than non-Indian mothers and were more than twice as likely (67% vs. 29%, $P < 0.05$) to be breast-feeding a child 12–18 months old. Indian children were three times more likely to have had diarrhea during the two weeks preceding the interview (25% vs. 8%, $P < 0.001$), and Indian family heads were twice as likely to be subsistence farmers and 30% more likely to be unemployed than non-Indian family heads.

DISCUSSION AND CONCLUSIONS

The vitamin A status of Panamanian children appears to have improved between 1976 and 1992, the overall indicated prevalence of plasma retinol levels below 0.7 $\mu\text{mol/L}$ declining from 12% to 6% in this period. However, 23% of the population in the present study had ret-

inol levels between 0.70 and 1.05 $\mu\text{mol/L}$ (20–30 $\mu\text{g/dL}$) indicating "marginal" vitamin A deficiency. Several studies have shown reductions in child mortality to result from providing vitamin A to subclinically deficient populations (4, 5). Flores and coworkers have shown that vitamin A-replete children do not have serum retinol concentrations below 1.05 $\mu\text{mol/L}$ (30 $\mu\text{g/dL}$) (9). Thus, the current survey data suggest that 29% of all Panamanian children could benefit from improved vitamin A status.

Diarrhea and viral infections are known to depress levels of retinol in the circulation and to cause loss of retinol in the urine (10–12). Diarrheal morbidity in the two weeks prior to the survey was significantly associated with low plasma retinol levels. Ascarid parasitosis was reportedly associated with a 0.14 $\mu\text{mol/L}$ reduction in plasma retinol levels in the same indigenous population in western Panama (3). However, the present survey found a 0.24 $\mu\text{mol/L}$ difference between median plasma retinol levels in Indian and non-Indian populations, a difference nearly double that associated with *Ascaris* infestation.

The IVACG recommends using 24-hour recall of dietary vitamin A intake in populations with monotonous diets and 7-day recall in populations with greater dietary diversity. Both periods were examined in this survey because of the urban-rural and ethnic diversity of the study populations. Because it captures less frequently consumed vitamin A sources in more varied diets, the 7-day recall generally shows a lower prevalence of high dietary risk than the 24-hour recall, as was observed most notably in Metropolitan Panama and among non-Indian families. The greater prevalence of high dietary risk observed among Indian families in both recall periods suggests low dietary diversity. Thus, future dietary studies using this methodology in these In-

dian communities could probably dispense with the 7-day recall period.

Of the four geographic regions covered, Metropolitan Panama City had the highest prevalence of low plasma retinol levels but the lowest risk of dietary inadequacy. This apparent contradiction is not explained by diarrheal or respiratory morbidity levels and remains open for further investigation.

The 13% prevalence of low retinol levels found in the Indian population, coupled with a high risk of inadequate vitamin A intake in this same group, gives cause for concern. According to the World Health Organization, vitamin A deficiency constitutes a moderate public health problem if over 10% of the population has serum (or plasma) retinol levels below 0.7 $\mu\text{mol/L}$ (13). Based on this criterion, vitamin A deficiency is a localized public health problem in the indigenous population. This conclusion is supported by reports of over 20 cases of xerophthalmia in hospitals of Chiriquí and Bocas del Toro Provinces that serve the Indian communities of western Panama.

Most of the indigenous residents surveyed were Guaymí Indians living in Chiriquí and Bocas del Toro Provinces. The Cuna Indians of San Blas and lesser groups from Darién were not surveyed. Thus, the findings reported here relate primarily to the Guaymí.

Several characteristics of the Indian population were closely associated in our survey with low plasma retinol levels. These characteristics—including poor maternal education, prolonged breastfeeding, a high prevalence of diarrheal disease, low dietary vitamin A intake, and dependence on subsistence agriculture—are all indicative of the precarious and generally impoverished living conditions of the Guaymí. The Panamanian Government is distributing high-dose vitamin A capsules (200 000 IU) to preschool-age Indian children in Chiriquí and Bocas del

Toro to control the deficiency. Additional efforts are aimed at improving dietary habits.

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