ARCHIVOS LATINOAMERICANOS DE NUTRICION
Organo Oficial de la Sociedad Latinoamericana de Nutrición

Vol. 42 Nº 2, 1992

The nutritional status of Guaymi indians living in Chiriqui province, Republic of Panamá

Douglas L. Taren [1,2], *Diva Sanjur* [2], *Gloria Rivera* [3], *David W.T. Crompton* [2,4]
Malden Nesheim [2], *Jean Tiffany Cox* [2], *E.C.M. Williamson*[4]

We would like to acknowledge the valuable assistance of three local Guaymi health workers; Amanda de la Luz, Clementina de Quintero (q.e.p.d.) and Lucia Rodriguez de Gracia assisted in the survey by interpreting the Guaymi language to Spanish, registering the participants and organizing the flow of the clinic. We also would like to thank Ana Zelédon for her laboratory assistance with this project. This project was supported in part by Smith, Kline, Beecham and by a grant from the U.S. Agency For International Development (AID/DSTE55426 303600).

SUMMARY. Guaymi Indian children have recently been identified as a population group who are at risk for vitamin A deficiency with numerous cases of xerophthalmia with ocular perforation being reported. A fourday parasitological and nutritional clinic based survey was conducted with 335 Guaymi women and children in the towns of San Felix and Alto Caballero to identify the prevalence of parasitic infections and factors associated with malnutrition. A subsample of 79 children, under 19 years of age, from independent families was constructed for the current analysis. The results of the study indicated that 20% of the children had a plasma vitamin A concentration less than 20 μg/dl. Significant associations were identified between ascariasis, age, a food diversity score and vitamin A concentrations. Other indicators of nutritional status were also negatively associated with intestinal parasitic infections, and a modernization index, using multivariate regression analysis. In conclusion, this study identified several factors associated with poor nutritional status that can be used by health officers to identify Guaymi children at risk for malnutrition.

RESUMEN. Estado nutricional de los indios Guaymi que viven en la Provincia de Chiriqui. República de Panamá. Los niños de los indios Guaymi se han identificado recientemente como un población con alto riesgo de deficiencia de vitamina A. En ellos se han encontrado numerosos casos de xerophthalmia con perforaciones oculares. Un ensayo clínico de cuatro días se llevó a cabo con 335 mujeres y niños Guaymi en los pueblos de San Felix y Alto Caballero para identificar la prevalencia de infestaciones de parásitos y factores asociados con malnutrición. Se utilizó una muestra de 79 niños, menores de 19 años, de familias independientes para este análisis. Los resultados del estudio indicaron que 20% de los niños tenían un concentración de vitamina A en el plasma menor de 20 μg/dl. Una asociación significativa fue identificada entre ascaridiasis, edad, y la concentración de vitamina A. Otros indicadores del estado de nutrición se asociaron negativamente con los parásitos intestinales y un indice de modernización. Se usó para ello análisis de regresión multivariable. En conclusión, este estudio identificó ciertos factores asociados con malnutrición que los funcionarios de salud pueden usar para identificar niños Guaymi que presentan un riesgo alto de malnutrición.

INTRODUCTION

There has recently been an increase in the number of reported cases of vitamin A deficiency among the Guaymi Indians living in the central regions of Panama (1). Between 1989 and 1990 there were 22 registered cases of xerophthalmia with ocular perforation in children less than 14 years of age. However, there is only a limited amount of quantitative information available regarding sociocultural factors that relate to the nutritional status of Guaymi which can be used to develop programs to target high risk children for vitamin A interventions programs.

The Guaymi Indians live in small dispersed hamlets, typically of two to six houses with an average number of people in each hamlet of less than 50 people (2). This makes its very difficult to reach them as they are spread out over a region of 6400 km2 in the mountainous areas of the provinces of Veraguas, Chiriqui and Bocas del Toro (3). The Guaymi who live in the eastern region of Chiriqui, where the current study was conducted, rely on agricultural subsistence. Their land is of poor quality which has been

1. Current Address: University of South Florida, College of Public Health, 13301 Bruce B. Downs Blvd., Tampa, Fl 33612, U.S.A.
2. Division of Nutritional Sciences, Cornell University, Ithaca, New York, U.S.A.
3. Sistema Integrado de Salud (SIS) David, Chiriqui, Republic of Panama.
4. WHO Collaborating Centre for Ascariasis, Department of Zoology, University of Glasgow, Glasgow, Scotland, U.K.

exacerbated by slash and burn agriculture which has led to the destruction of most of the primary. vegetation (3). Serious disease among the cattle such as babesiosis, anaplasmosis, warble fly and trypanosomiasis have shifted the use of land even more toward extensive crop cultivation (3,4). However, some livestock are still kept such as cattle, pigs and chickens, but the Guaymi now depend almost entirely on crops for food.

We propose that health workers will be able to better target high risk children now living in areas of Panama that are at risk for vitamin A deficiency by identifying factors that can easily be obtained by public health workers. Our current report presents the results of a cross-sectional study that was done to determine what factors related to the nutritional status of Guaymi children with a special emphasis on plasma vitamin A and carotenoid concentrations.

METHODS AND MATERIALS

A four-day survey was conducted on the Guaymi Reserve at the end of June of 1984, the start of the rainy season. Three days were spent at the health center in San Felix and one day at Alto Caballero. San Felix is located 2 km from the Pan-American Highway and is one of four main health centers for Chiriqui Province. The clinic serves an area of 3,660 square kilometers with a population of 45,403 of whom 55.4% are Guaymi (2). Alto Caballero is within the service area of the San Felix clinic. However, it is much more removed and during the rainy season it is necessary to travel by foot, horseback or with a fourwheel drive vehicle after leaving the main highway. It took the research team about 40 minutes on a dirt road to reach the clinic.

The week before the survey, a visit was made by a local health official in order to inform teachers and students of the forth coming survey. A radio broadcast transmitted into the Guaymi Reserve served to inform other members of the community of the study.

A total of 335 Guaymi registered during the survey. Two hundred two people registred from San Felix and 133 people registered from Alto Caballero. Relatives were placed in the same unit. In total, 59 family units consisting of a woman and other relatives were identified. An additional 20 girls under 18 years of age who did not have a parent or another relative present, but provided sociocultural information were added to the 59 families. Therefore, the final analyses included 79 independent observations. The youngest child that was present was selected from each family as the observation.

The information recorded for each participant included name, birthdate or age (in months) and relationships with other participants. If the age of the child was known only in years then it was recorded as the number of years plus 6 months. In this way we minimized the amount of error regarding the anthropometric standards. Further, if the ranges within an age group would be randomly distributed, this method would make the standarized scores unbiased.

Heights (and recumbent lengths for children under two years old), and weights were measured and recorded by the same two investigators throughout the study. The United States of America National Center For Health Statistics (NCHS) standards were used for determining weight-for-age (WA), height-for-age (HA) weight-for-heigth (WH) z-scores (5). Scales were zeroed before and each weighing and calibrated daily with standard weights. Children less than two years of age were weighed in dry underpants. Children older than two years of age were weighed clothed and mean weights sor sets of clothes, by age groups, were subtracted from the gross weight of the children within each age group. In total, 67 children had their height and weight measured. For seven children, all females, no standards were available for their WH measurements. This was because there were no WH standards for girls who are greater than 137 cm in the NCHS standards.

Three milliliters of venous blood were drawn from each participant over the age of two. A finger prick was used to collect blood in two children and venous blood was collected from three children between 1 to 2 years of age. The blood was transferred to a sterile tube containing sodium EDTA as an anticoagulant and stored in a styrofoam container with ice. At the end of the clinic, the blood samples were transported to Hospital Rafael Hernandez in the town of David. Hematocrit values were determined using a microhematocrit centrifuge with capillary tubes. Hemoglobin concentrations were determined using the cyanmethemoglobin method. Hemoglobin and hematocrit values were considered low when they were more than two standard deviations (SD) below the medians for age as described by Dallman (6). The plasma was separated from the blood and then frozen at -20° C and transported in dry ice to the Gorgas Hospital in the Panama Canal Zone for determining the plasma concentrations of vitamin A and carotenoids. These measurements were conducted using the trifluoroacetic acid method described by the International Vitamin A Consultative Group (7). Plasma vitamin A concentrations were considered to be low when they were below 20 μg/dl and carotenoids were considered to be low when they were less than 39 μg/dl (8).

The parents of the children were given small containers for collecting fresh stool samples and were instructed to return them the same or following day. The samples were placed in labelled polypropolene tubes with 10% aqueous formaldehyde. Qualitative stool exams were performed using a modified version of the ethersedimentation technique (9). The results of the stool exams are presented as the presence or absence of different genera. An index of polyparasitism was constructed for the sample and was the number of different genera that were identified during a stool examination. Anthelminthic treatment was offered to all participants according to the instructions prescribed for the medicine (albendazole, Smith, Kline, Beecham, Zentel') with authorization of the local medical doctor. We also took great steps to avoid giving the medication to pregnant women and children under two years of age.

Sociocultural information was collected from the women. This information included a 24 hour dietary recall and was used to develop a food diversity score (10). The score was the summation of the number of different unique food items that the women had eaten the previous day. The food diversity score was chosen as the dietary measurement because it is a measurement of dietary intake that local nutritionists and the number of different food items consumed has been correlated with nutreint intakes (11, 12, 13). The second type of sociocultural information collected was a "modernization index." Five factors were identified apriori as a measure of acculturation into the modern ways. The factors used as part of the index were whether: (1) the woman spoke Spanish, (2) the woman wore shoes, (3) the woman wore traditional or western clothing, (4) the woman was able to read and write Spanish and (S) the woman had made a visit to the city of David during the past 12 months. These five variables were scored 2 for a positive response and 1 for a negative response and added together to arrive at the modernization index (14). Similar summated scales have previously been used to characterized social class in Panama (15). The purpose of adapting this methodology was to provide us with a general measure of how much contact the women have had with people outside their own culture.

Pearson correlations were used to measure the associations between variables and tests of proportions were done with chi-square analysis. Student's t-tests were performed to determine differences between indicators of nutritional status and the presence or absence of intestinal parasites. Multiple regression equations were constructed to determine the association between the sociocultural and parasitological measurements and various indicators of nutritional status. Individual parasitic genera and the level of polyparasitism were included as possible factors for inclusion into the regression model. Other variables that were candidates for inclusion into the regression models included age in months, the modernization index and the food diversity score.

RESULTS

There were 36 boys and 43 girls in the final sample, representing 79 separate family units. The average age was 75.0 ± 7.5 months (l SEM). The presence of shoes was observed on 35.4% of the women interviewed while 72.2% wore traditional dress. Only 7.5% of the women did not speak any Spanish and 48.1% were not able to read or write. Fiftytwo percent had left the reserve within the past year to visit David. The modernization index was normally distributed, with a mean of 7.5 ± 0.2. Similarly, the food diversity score was normally distributed and had a mean of 4.9 ± 0.2. The correlation coefficient between the modernization index and food diversity score was 0.29 ($p < 0.01$).

Parasitology

Stool samples were collected from a total of 56 children. Ova from *Ascaris lumbricoides* were present in 42.8% of the stool samples. The percent of positive examinations for *Trichuris trichuria.*, hookworm and *Strongyloides stercoralis* were 42.8%, 62.5% and 14.3%, respectively. *Giardia intestinales* and *Entamoeba coli* cysts were identified in 3.6% and 44.6% of the samples, respectively. There were no cysts of *Entamoeba histolytica* identified during with the stool examinations.

There was an increase in the proportion of positive stool examinations for *A. lumbricoides* between the 0 - 2 year old age group and in those children older than 8 years of age (Table 1). Similarly, hookworm ova were identified in one third of the samples for the 0 - 2 year old age group and increased to 84% in the 8 - 18 year old group (Table 1). The 0 - 2 year old age group had a slightly greater proportion of positive stools samples for *T. trichuria* compared with the other age groups. There was no clear trend between the age groups for the presence of *Ent. Coli.* The 0 - 2 year old age group had the lowest percent of positive examinations for *Ent. coli* while the 4 - 8 year old age group had the greatest prevalence (Table 1). In general, the presence of *G. intestinales* and *S. stercoralis* were the lowest in each age group. The exception was in the 0 - 2 year old age group who had a 26.7% prevalence for *G. intestinales* which was equal to the prevalence for *A. lumbricoides*.

Polyparasitism was present in 96.4% of the children (Table 2). The mean number of genera identified in the stool samples was 2.1 ± 0.1. Two genera were identified in 14 stool samples (25%); three genera were identified in 19 stool samples (34%), and; four genera were identified in 4 stool samples (7%). Plasma Vitamin A and Carotenoid Concentrations.

Plasma vitamin A concentrations were measured for 45 of the children. The mean concentration was 26.4 ± 1.0 µg/dl (mean ± 1 SEM) and was significantly correlated with the plasma carotenoid concentrations ($r = 0.580$, $p < 0.0001$). Plasma vitamin A concentrations below 20 µg/dl were present in 28.6% of the children under 4 years of age, in 30.0% of the children between 4 and 8 years of age and in 9.5% of the children older than 8 years of age (Table 3). Plasma vitamin A concentrations were significantly

TABLE 1
PREVALENCE OF INTESTINAL PARASITIC INFECTIONS BY AGE GROUPS

	Total (56)	Age Groups 0-2 yr. (15)	2-4 yr. (10)	4-8 yr. (12)	8-18 yr. (19)
Parasite	%	%	%	%	%
A. lumbricoides	42,8	26,7	40,0	50,0	52,6
T. tricuria	42,8	60,0	40,0	33,3	36,8
Hookworm	62,5	33,3	50,0	75,0	84,2
S. stercolis	14,3	6,7	20,0	16,7	15,8
G. intestinalis	3,6	26,7	0,0	8,3	0,0
Ent. coli	44,6	6,7	60,0	75,0	47,4

TABLE 2
INTESTINAL POLYPARASITISM IN GUAYMI CHILDREN

Combinations	Unique	Total	Of total
One Genus		17	30%
Ascaris (A)	1		
Hookworm (H)	4		
Trichuris (T)	11		
Entamoeba (E)	1		
Strongyloides (S)	0		
Giardia (G)	0		
Two Genera		14	25%
A and T	0		
A and H	4		
A and E	1		
T and H	5		
T and G	1		
T and E	2		
T and S	1		
Three Genera		19	34%
A and H and E	12		
A and H and S	2		
A and S and E	1		
T and H and E	3		
T and G and E	1		
Four Genera		4	7%
S and H and E:			
and A	3		
and T	1		
None		2	4%

correlated with age ($r = 0.325$, $p < 0.05$) but not with the modernization index, the food diversity score or polyparasitism. The mean vitamin A concentrations for children with ascariasis was 25.0 ± 1.8 μg/dl and was not significantly different from the children without ascariasis (28.0 ± 1.4 μg/dl). However, in a reduced model with age, the presence of *A. lumbricoides* was significant as part of the best prediction model for plasma vitamin A concentrations (Table 4).

Plasma carotenoid concentrations were obtained for 45 of the children (Table 3). In 63.6% of the children between 2 and 8 years the plasma concentration was less than 39 μg/dl and also 18.8% of the children older than 8 years of age had low plasma carotenoid concentrations. The plasma carotenoid concentrations were correlated with age ($r = 0.336$, $p < 0.05$) and the modernization index ($r = 0.298$, $p < 0.05$). The carotenoid concentrations were not correlated with the food diversity score or polyparasitism. The mean plasma carotenoid concentration was significantly lower in children with ascariasis (65.8 ± 11.2 μg/dl) compared with uninfected children (109.9 ± 18.1, $p < 0.05$). The factors that were included in the best reduced regression equation to predict plasma carotenoid concentrations included the presence of *A. lumbricoides*, the modernization index and age (Table 4).

Weight-for-Age

The mean WA Z-score was 0.888 ± 0.178 for the entire group. The mean WA Z-score did not differ between the age groups (Table 5). In the 0 - 2 year old group 19.0% were more than 2 standard deviations (2SD) below the reference median as were 12.5% of the 2 - 4 year old. In addition, 18.2% and 15.8% of the 4 - 8 and 8 - 18 year old age groups, respectively had WA Z-scores more than 2SDs below the NCHS reference standards. The WA Z-scores were not independently correlated with either age, the modernization index, the food diversity score or the number of parasitic genera identified in the stool examinations. However, a significant multiple regression model to predict WA Z-scores included the modernization index and the food diversity score (Table 4).

Height-for-Age

The mean HA Z-score was -2.077 ± 0.225 for the group. The heightfor-age Z-scores were negatively correlated with age ($r = -0.214$, $p < 0.10$) and with polyparasitism ($r = -0.285$, $p = 0.05$). However, it was not significantly correlated with the modernization index or the food diversity score. The factors included in the best reduced regression model to predict HA Z-scores included the modernization index and polyparasitism (Table 4).

TABLE 3
BIOCHEMICAL VALUES BY AGE GROUPS

Age Group	Hematocrit %	Hemoglobin gm/dl	Carotenoid μg/dl	Vitamin A μg/dl
0-2 yrs.	33,9 ± 1,01[1] (5/5)[2]	12,6 ± 0,4 (0/3)	62,7 ± 14,2 (0/3)[3]	28,2 ± 4,2 (1/3)
2-4 yrs.	34,7 ± 0,6 (15/15)	11,6 ± 0,2 (3/13)	80,0 ± 19,1 (3/11)	24,5 ± 2,0 (3/11)
4-8 yrs.	35,5 ± 0,8 (4/12)	11,9 ± 0,2 (2/11)	54,2 ± 9,7 (4/11)	23,4 ± 2,4 (3/10)
8-18 yrs.	36,6 ± 0,6 (7/25)	12,3 ± 0,3 (9/25)	105,0 ± 15.7 (2/22)	28,6 ± 1,2 (2/19)

1. Means ± 1 SEM .

2. Number of children with low values. Low values for hemoglobin and hematocrits values are set at less than 2 DSs from the median for age from Dallman 1977. Hematocrit values are set at the following levels: 0-2 yrs., 33%; 2-4 yrs., 34%; 4-8 yrs., 35%; 8-18 yrs., 36%. Hemoglobin values are set at the following levels: 0-4 yrs., 11.0 gm/dl ; 4-8 yrs., 11.5 gm/dl; 8-18 yrs., 12.0 gm/dl.

3. Number of children with low values. Low values are those set by the ICCND 1963. Vitamin A values are considered low when below 20 μg/dl and carotenoid values are considered to be low when below 39 μg/dl.

Weight-for-Height

The mean WA Z-score was 0.589 ± 0.204 for the complete group. Only one child in the 0 - 2 year old group was more than 2 SDs below the reference median. The WH Z-scores were significantly correlated with age ($r = 0.455$, $p < 0.001$) but not with the modernization index, the food diversity score, or polyparasitism. The best reduced model included the modernization index and age (Table 4).

Hematocrit Values

The mean hematocrit value was 35.4 ± 0.4%. All of the children under 4 years of age had a low hematocrit while 29.7% of those between 4 and 18 years of age had a low hematocrit (Table 5). The hematocrit values were significantly correlated with age ($r = 0.337$, $p < 0.01$) but not with the modernization index, the food diversity score or polyparasitism. Hematocrit values were not significantly lower for children infected with hookworm or *T. trichuria* compared with uninfected children. However, the best reduced model included both age and the presence of hookworm infections (Table 4)

Hemoglobin Concentrations

Low hemoglobin values were present in 18.8% of the children under 4 years of age, in 18.2% between 4 and 8 years of age, and in 36.0% between 8 and 18 years of age (Table 4). The hemoglobin concentrations were significantly correlated with age ($r = 0.360$, $p < 0.01$) and with the modernization index ($r = 0.297$, $p < 0.05$) but not with the food diversity scores or polyparasitism. Hemoglobin concentrations were not significantly lower in children infected with hookworm or *T. trichuria* compared with uninfected children. However, the best reduced regression model for predicting hemoglobin values included the modernization index, age and the presence of hookworm (Table 4).

DISCUSSION

The data presented in this study are from a subsample of children who were part of a larger survey which obtained baseline information about the nutritional and parasitic status of Guaymi Indians (11, 12, 16). The selection of the subsample was designed to make the observations indepen-

TABLE 4
REGRESSION MODELS FOR PREDICTING NUTRITIONAL STATUS OF GUAYMI CHILDREN

Reduced Regression Models	F	r^2	p
Vitamin A (μg/dl) = 23,8 - 4,9(ASCARIS)[1] + 0,05 (AGE) (2,2)[2] (0,02)	4,9	0,24	0,01
Carotenoids (μg/dl) = (-4,2) - 50,9(ASCARIS) + 8,8(MI) + 0,4 (AGE) (21,0) (6,8) (0,04)	5,2	0,23	0,01
WA (Z-score) = (-2,92) + 0,36(MI) + 0,16 (FD) (0,11) (0,09)	5,5	0,19	0,01
HA (Z-score) = (-3,98) + 0,30 (MI) - 0,32 (POLYPARA) (0,10) (0,16)	6,4	0,21	0,01
WH (Z-score) = (-1,68)+ 0,19(MI) + 0,02 (AGE) (0,14) (0,006)	9,0	0,18	0,01
Hematocrit (%) = 34,1 + 0,02(AGE) + 0,93 (HOOKWORM) (0,01) (0,90)	2,9	0,11	0,10
Hemoglobin (g/dl) = 10,2 + 0,17 (MI) + 0,006 (AGE) - 0,54 (HOOKWORM) (0,10) (0,003) (0,36)	3,3	0,22	0,05

1. Variables in parenthesis are: ASCARIS - presence or absence of infections; AGE - age in months; MI - modernization index; FD - food diversity score; POLYPARA - number of intestinal parasitic genera; HOOKWORM - presence or absence of hookworm infections.

2. Number in parenthesis are standard errors of the partial beta-coefficients.

TABLE 5
ANTHROPOMETRIC MEASUREMENTS BY AGE GROUPS

Age Group	Weight-forAge Z-score	Height-forAge Z-score	Weight-for-Height Z-score
0-2 yrs.	-0,889 ± 0,432[1] (4/21)[2]	-1,263 ± 0,573 (8/21)	-0,253 ± 0,201 (1/21)
2-4 yrs.	-0,804 ± 0,349 (2/16)	-2,528 ± 0,295 (10/16)	-0,939 ± 0,427 (0/17)
4-8 yrs.	-0,821 ± 0,285 (2/11)	-2,279 ± 0,316 (6/11)	-1,643 ± 0,804 (0/13)
8-18 yrs.	-0,997 ± 0,259 (3/19)	-2,479 ± 0,313 (12/19)	-1,643 ± 0,804 (0/9)

1. Means ± 1 SEM.
2. Number of children greater than 2 SDs below NCHS median by total number of children measured.

dent of each other by including only the youngest member of each family unit in the sample.

Although, these data were collected in 1984, we know that the social and health situation of the Guaymi has not improved since this time. In fact, the recent economic crises that is present in Panama has not made it possible to provide addditional services to the Guaymi. Further, the Guaymi population continues to remain isolated from the contemporary Panamamian culture. More importantly, the first cases of xerophthalmia in Panama, after more than a 10 year hiatus, have been reported within the Guaymi Population (1). Therefore, the associations that were identified in the present study are even more important to consider as part of developing government policies and programs that will target this high risk population.

The proportion of children with plasma vitamin A levels less than 20 μg/dl was 29% for children under 9 years of age. Others have reported that 100% of children with serum vitamin A levels less than 20 μg/dl had a positive retinol dose response (RDR) test (17). The RDR test is considered to be more sensitive to marginal levels of vitamin A deficiency suggesting that a significant number of Guaymi children had some level of vitamin A deficiency (18).

The proportion of children with serum vitamin A levels below 20 μg/dl also suggests that there were a significant number of children who were at risk for morbidity and mortality secondary to measles, diarreal diseases and respiratory diseases (19, 20, 21). Therefore, vitamin A supplementation in this population may decrease childhood morbidity and mortality. Vitamin A supplementation has been reported to decrease the duration of morbidity from measles complicated by pneumonia and diarrhea in a population of children who had vitamin A levels less than 20 μg/dl but where clinically apparent vitamin A deficiency was rare (19). Community vitamin A supplementation trials have also decreased total mortality in populations that have about 20% of the children with serum vitmain A levels less than 10 μg/dl and 60% of the children with concentrations levels greater than 20 μg/dl (22).

It is possible that the actual prevalence of vitamin A deficiency in the Guaymi population at the time of the survey was greater than reported in this study since it was conducted with children who volunteered for the study and were present at a health clinic on the days of the survey. Nonetheless, the variables that were included in this study represent the type of information that health workers are able to easily obtain through clinic visits and rapid community assessments (23). It also illustrates that vitamin A supplementation programs will need to reach those Guaymi children who live in more traditional households. This observation is very significant within this population, since the Guaymi live in very remote areas and in sparsely populated villages.

Our previous work in Panama (26) has indicated that the level of parasitic infections relate to the socioeconomic conditions of children living in other rural and semiurban areas of Chiriqui. The current findings with Guaymi children are congruent with those findings and that of others (27) regarding the relationship between parasitic infections and socioeconomic status. The poorer housing conditions of the Guaymi Indians and previous studies that report they do not usually have latrines in their villages and often defecate near water sources support that the findings that a greater prevalence of parasitic infections exits among this group of children compared with other children in Panama (26, 28, 29). Although, not considered pathogenic, the presence of E. coli in the stool of the children, further supports that there is a fecaloral route of transmission of diseases occuring in these children. Furthermore, the infrequent use of shoes among the Guaymi women also indicates that exposure to hookworm infections may continue past preschool years and probably results in the increasing prevalence of infection with age as reported in this study and with our previous report that included the older Guaymi women (18).

The negative association between parasitism and nutritional status that was evident in this study has also been reported to exist in nonGuaymi children living in Panama (30, 31). Hookworm, ascariasis, and polyparasitism were the parasitological factors that had the strongest relationships with nutritional status. These relationships were identified only after adjustments were made for age because of the age range ofthe children who participated in the study.

The association between ascariasis and lower plasma vitamin A concentrations was reported in other children living in Panama (30). Further, this relationship was strongest in rural children who had a large proportion of their dietary vitamin A from carotenoids (30). Thus, the high correlation between plasma carotenoid and vitamin A concentrations in the present study indicate that one of the primary vitamin A sources for these Guaymi children is from the limited amount of carotenoid rich foods (7) which in the presence of ascariasis may place them at a higher risk for vitamin A deficiency. Other studies have also reported that vitamin A absorption is decreased with ascariasis as well as fat absorption which is needed to increase vitamin A absorption (32 - 35). Finally, the relationship found between hookworm infections and anemia in this study is supported by the large amount of intestinal blood loss that hookworm infections are known to cause (36).

In conclusion, the most important findings regarding the nutritional status of the children in this study are that the Guaymi children had heavy burdens of parasitic infections, accompanied by chronic undernutrition and marginal levels of iron and vitamin A status. We also were able to identify several factors that were related to nutritional status including the modernization index, age of the child and the presence of ascariasis, hookworm infections and polyparasitism.

REFERENCES

1. Vitamin A Field Support Project (VITAL). Taller regional sobre estrategias para mejorar el estado de vitamina A en América Latina y el Caribe. Guatemala, June 57, 1990.
2. Young P. D. Ngawbe Tradition and Change Among the Western Guaymi of Panama. Illinois Studies in Anthropology. Nº. 7., University of Illinois Press, Urbana, Ill, 1971.
3. Steward JH. Handbook of South American Indians. Vol. IV. The Circum Caribbean Tribes. New York, Cooper Square, 1963.
4. Arosemena MM. Revista Lotería Volume 324, 1983.
5. National Center For Health Statistics. NCHS Growth Charts 1976. Monthly Vital Statistics Report, No. 3., Washington, D.C., DHEW Publication 7601120, Vol 25.
6. Dallman PR. New approaches to screening for iron deficiency. J Pediatr 90:678-681, 1977.
7. International Vitamin A Consultative Group. Biochemical methodologies for the assessment of vitamin A status. Report of the International Vitamin A Consultative Group. Washington, D.C., Nutrition Foundation, 1984.
8. Interdepartmental Committee for Nutrition and National Defense. Manual for Nutrition Surveys. 2nd. Ed., Washington, D.C., U.S. Government Printing Office, 1963.
9. Hall A. Intestinal helminths of man: the interpretation of faecal egg counts. Parasitology 85:605-613, 1982.
10. Sanjur D. Social and Cultural Perspectives in Nutrition. Englewood Cliffs, Prentice Hall, 1982.
11. Schorr BC., Sanjur D., and Erickson E. Teenage food habits. Journal of the American Dietetic Association 61:415, 1972.
12. Caliendo MA and Sanjur D. The dietary status of preschool children. Journal of Nutrition Education 10:2, 1978.
13. Taren D. Effects of Ascaris lumbricoides on the Nutritional Status of Children in Chiriqui Province Republic of Panama. Doctor of Philosophy Dissertation, Ithaca, NY, Cornell University, 1986.
14. Crompton DWT, Nesheim MC, Rivera G, et al. Health and Nutrition of Guaymi Indians. A Report of a survey carried out in 1984 in Chiriqui Panama. Ithaca, NY, Cornell University, 1984.
15. SmiciklasWright H, KrebsSmith SM., KrebsSmith J. Variety in Foods. In: What is America Eating National Academy Press, Washington, D.C., 1986, pgs. 126-140.
16. Pedhauzer EJ. Multiple Reqression in Behavioral Research 2nd. Edition, Holt, Rinehart and Winston, NY, 1982.
17. Tucker K., Sanjur D. Maternal employment and child nutrition in Panama. Soc Sci Med 26(6):605-612, 1988.
18. Sanjur D, Crompton DWT, Taren DL, et al. Intestinal parasitic infections in Guaymi Indians from Chiriqui, Panama. Medecine and Chirurgie Digestives (France). In Press.
19. Flores H, Campos R, Araugo CRC, Underwood BA. Assessment of marqinal vitamin A deficiency in Brazilian children using the relative dose respose procedure. Am J Clin Nutr 40:1281-1289, 1984

20. Underwood BA. "Vitamin A Deficiency as a Public Health Problem & Assessment Methods." Presented at the IX Latinamerican Congress of Nutrition, San Juan, Puerto Rico, September 22-26, 1991.

21. Hussey GD, Klein M. A randomized controlled trial of vitmain A in children with severe measles. New Enql J Med 323: 160-164, 1990.

22. Feachem RG. Vitamin A deficiency and diarrhoea: A review of interrelationships and their implications for the control of xerophthalmia and diarrhoea. Tropical Disease Bulletin 84:R1 - R16, 1987.

23. Sommer A, Katz J and Tarwotjo I. Increased risk of respiratory disease and diarrhea in children with preexisting milk vitamin A deficiency. Am J Clin Nutr 40:1090-1095, 1984.

24. Rahmathullah L, Underwood BA, Thulasiraj RD, et al. Reduced mortality among children in southern India receiving a small weekly dose of vitamin A. New Engl J Med 323:929-935, 1990.

25. Scrimshaw SCM, Hurtado E. Rapid Assesment Procedures for Nutrition and Primary Health Care. United Nations University, Tokyo, 1987.

26. Holland CV, Taren DL, Crompton DWT, et al. Intestinal parasitism as an indicator of socioeconomic environment in panamanian children. Social Science and Medicine 26:209-213, 1987.

27. Sanjur D. Socioeconomic and cultural factors in ascariasis. In: Crompton, D.W.T., Nesheim, M.C., Pawlowski, Z.S., eds., Ascariasis and its Prevention and Control. London, Taylor and Francis, 1989, pp. 301-320.

28. Heckadon MS, Martijnelli de Heckadon S. El oriente chiricano: estudio preliminar sobre la situacion social. Revista Loteria 325:531, 1983.

29. Reeves WC, Peters CJ, Lander JJ, et al. Differences in the prevalence of hepatitis B antigen and antibody among Panamanian Indian populations. J Infect Dis 128:265-270, 1973.

30. Taren DL, Nesheim MC, Crompton DWT, et al. Contributions of ascariasis to poor nutritional status in children from Chiriqui Province, Republic of Panama. Parasitology 95:603613, 1987.

31. Carrera E, Nesheim MC, Crompton DWT, et al. Lactose maldigestion in Ascaris-infected preschool children. Am J Clin Nutr 39:255-264, 1984.

32. Sivakumar B, Reddy V. Absorption of vitamin A in children with ascariasis. J Trop Med Hyg 78;1445, 1975.

33. Reddy V, Vijayaraghavan KT, Mathur KK. Effect of deworming and vitamin A administration on serum vitamin A levels in preschool children. J Trop Pediatr 32;196-9, 1986.

34. Mahalanabis D, Jalan KN, Maitra TK, et al. Vitamin A absorption in ascariasis. Am J Clin Nutr 9;1372-5, 1976.

35. Tripathy K, Duque E, Bolanos O, et al. Malabsorption syndrome in ascariasis. Am J Clin Nutr 25;1276-81, 1972.

36. Schad GA, Banwell JG. Hookworms. In: Warren K.S., Mahmoud, A.A.F., eds., Tropical and Geographic Medicine. New York, McGraw-Hill, 1984, pp.359-72.