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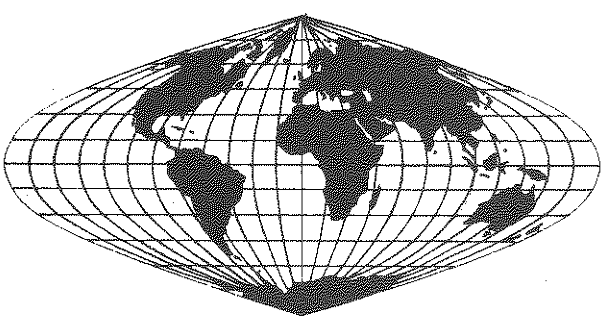
THE NATURE AND EXTENT OF NUTRITIONAL DEFICIENCIES IN THE PERUVIAN ANDES

Marco A. Ferroni



DEPARTMENT OF AGRICULTURAL ECONOMICS
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York 14853

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Introduction

The purpose of this paper is to relate food consumption and nutrient intake patterns in the Peruvian Andes and to assess the incidence of deficiencies in food energy, protein and selected vitamins and minerals. This constitutes one of two types of analyses needed for planning appropriate food policies. The second type is an analysis of the causality of spatial, time-related, socioeconomic and demographic correlates of nutritional deficiencies and an identification of policy variables of predictable impact and cost. In the present study, limited attention is paid to nondietary determinants of nutritional status.

Among several misconceptions regarding nutrition in Peru and other Latin American countries, the two most frequently encountered are (1) nutritional deficiency is synonymous with protein deficiency and (2) the nutritional situation is worse in rural than in urban areas.[1/] The first of these ideas has been challenged[2/] and the prevailing view

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1/ See, for example, Peru (1978) for a government document advancing these views.

2/ For example, Sukhatme (1970, 1972); Waterlow and Payne (1975); and for Latin America, Valverde et al (1975 a, b).

today is that protein and other nutrient deficiencies can usually be traced to insufficient intake of food energy, a hypothesis examined in this paper. The second idea, (rural-urban differences) is tested because (1) rural diets are well balanced, and (2) food security in self-provisioning rural areas is greater than in urban areas where access to food depends on typically low and unstable cash income.

Data and Methods

The analysis draws on portions of the 1971-72 Peruvian National Food Consumption Survey (Encuesta Nacional de Consumo de Alimentos, or ENCA), in which food intake of a year-round statistical sample of 8000 families was monitored by means of the seven-day weighing method. Purchases of food were also observed, but are not reported here. Consumption data were complemented by height and weight measurements of family members, family age/sex characteristics and income by sources. The sample was drawn independently for nine regional divisions of the country. Sampling procedures and field methods are described in Peru (n.d.). In this paper, results based on 1958 observations from the Central and Southern Sierra 3/ (Highlands) are presented. The nutritional situation in rural (settlements of less than 2000 inhabitants) and urban areas are discussed separately.

For nutritional status evaluation, energy and nutrient equivalents of the edible portion of consumed food were determined by means of a food

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3/ The Sierra portions of the Departments of Huanuco, Pasco, Lima, Junin, Huancavelica (Central Sierra), Ayacucho, Apurimac, Cuzco, Arequipa, Puno, Tacna (Southern Sierra). Sierra portions are delimited by the 2000 meter altitudinal contour.

composition table developed largely from published sources.[4/] Daily per capita intake was calculated by dividing weekly family-level consumption by a composite family size-meal attendance index. Nutritional requirements (i.e., recommended intakes), weighted by individual meal attendance, were calculated for each family on the basis of the most recent FAO recommendations of 1977. Protein requirements were adjusted for protein quality of family diets following FAO/WHO (1973). "Minimum" and "ideal" calorie[5/] requirements were estimated, the first based on observed body weights of household members, the second derived from an "ideal" weight for age distribution thought to correspond with a growth pattern only achieved under conditions of adequate food intake. For children under 14 years of age, ideal weights were defined as the 50th percentiles of the year to year distributions of observed weight for age. For later ages, ideal weights were determined by age group-specific linear regressions of weight on height.

Because of the impossibility of quantifying all factors which codetermine nutritional status, a certain arbitrariness is necessarily involved in defining the cutoff point of intake as a percentage of requirements below which a nutritional deficiency occurs. The conventions adopted in this study are the following: A "certain" deficit is said to occur, for calories, where intake falls short of the minimum requirement and for protein (analyzed jointly with calories), where intake is below 60 percent of the requirement. Families with calorie intakes between

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4/ Significant contributions by FAO advisors in development of the food composition table are acknowledged.

5/ The term "kilocalories" is shortened to "calories" in this paper.

minimum and ideal energy requirement are considered "at risk" of energy deficiency. The "at risk" category is difficult to judge nutritionally. Statistically, it includes some truly deficient families and some families free of deficiency (those with particularly high and low requirements, respectively). It also includes many families with marginal food intake, such that slight stress on their food supply systems (drought, temporary unemployment and income irregularity) is likely to produce deficiency in one or more particularly vulnerable members. In the case of protein, the "at risk" category includes families with intakes between 60 and 100 percent of requirement. For vitamins and minerals, "deficiency" is assumed to occur where observed intake is less than 60 percent of the respective allowance. These conventions were adopted after comparing results obtained with reasonable alternative cutoff points (none of which changed conclusions presented below) and keeping in mind the desirability of maximizing the likelihood that a declared deficiency did in fact occur in the field.

Food Patterns and Nutrient Intake in the Peruvian Highlands

In the Andes, diets are changing rapidly from traditional to modern. Key elements of traditional and largely subsistence-produced diets are potatoes (fresh, or processed into such forms as _chuno_ and _papa seca_), barley, maize, _quinua_ and beans. Their relative and absolute importance in peasant family calorie budgets reflects ecological conditions and farming practices. Whereas potatoes are ubiquitous, the chenopods _quinua_ and _canihua_ are prominent sources of food energy only on the Andean plateau above 3800 meters. Also, in high-altitude herding communities consumption of meat (_alpaca_, _llama_, mutton) and animal fat is relatively frequent. At lower altitudes or where high-altitude communities have access to agricultural land, maize and dried beans dwarf the dietary role of chenopods. Grains are typically eaten boiled as ingredients in soups. Traditional Sierra diets are distinguished by a large proportion of starchy staples to total food, with carbohydrates frequently accounting for as much as 80 percent of total energy intake. Diets are high in protein compared to requirements, very low in sugar and fat and, with the mentioned exception, largely vegetarian. Consumption of fruit, vegetables, eggs and dairy products is infrequent. Apart from the use of dairy products as cash crops, the widespread adult lactose intolerance presumed by Paige et al. (1972) may explain a low level of milk consumption.

The modern diet, on the other hand, is invariant with respect to location. The principal calorie sources are wheat bread and biscuits, rice, noodles, sugar and vegetable oil. Soft drinks and sweets are consumed with great frequency. The modern diet has been prevalent in urban areas for many years, but is increasingly encountered also in the countryside as a result of growing monetization of rural life, decline in subsistence production and consumption, migration, and agricultural policy designed to satisfy market demand for food with imports, industrially processed foods, and commodities such as rice and oil seeds produced by a small agricultural subsector situated in the lowlands along the Pacific Coast.

The modern diet, therefore, is largely purchased and consumption levels of the identified foods and their vegetable, fruit, meat and dairy complements depend on their prices and people's monetary incomes, rather than on family farm production possibilities or the need to turn production into cash through sales.

The bulk of protein, minerals and vitamins (except vitamin A) is derived from starchy staples in traditional diets as a result of the caloric predominance of this food group, the considerable nutrient content per calorie of Andean staples as compared with that of the basic components of purchased diets, and the low consumption of so-called protective foods, at least as recorded by the survey under examination. Quinua and canihua, for example, have 15 times the calcium content of rice on a per calorie basis, more than 4 times that of wheat noodles and 2 to 3 times that of wheat bread. On average, foods of animal origin and fruit and vegetables assume greater importance as sources of protein and micronutrients in the modern diet. But purchases of these commodities depend particularly on monetary income. The low monetary income characteristic of the Andean region suggests that people's nutritional status may worsen as their diets change from traditional to modern because the loss of nutrients incurred by changing to less nutritious staples may not be adequately compensated by greater consumption of so-called protective foods.

Food habits of the rural population of Peru's Southern Sierra, where 77 percent of ingested calories are derived from subsistence production, conform closely to the traditional Andean diet. Diets consumed in the rural areas of the Central Sierra, where the market economy has penetrated to a greater degree, feature many "urban" or purchased foods, although subsistence-produced potatoes are still a major calorie source. Since mean nutrient requirements for the geographical sample strata under consideration are similar (small differences being due to variations in population age/sex distributions), coefficients of nutrient satisfaction (intake divided by requirement) can be used to rank diets according to their nutrient content per calorie unit (Table 1). The "typical" diet of the rural Southern Sierra has the highest per calorie content of the B-vitamins, vitamin C and iron. It is as high in calcium and protein as diets in urban Sierra areas (despite higher urban milk and meat consumption) but provides the lowest level of satisfaction of vitamin A requirements and the lowest fat intake. Ingestion of these two nutrients grows with urbanization and the dietary changes that accompany a declining calorie subsistence ratio.

Apparent nutrient satisfaction is not only a function of diet composition, but also of food intake level as measured by total calories. These, too, depend on socioeconomic variables among which income is usually considered the most important. A highly significant result for food and nutrition policy planning in the Peruvian Andes which emerges from ENCA, is that the subsistence proportion of income[6/] is positively correlated with total calorie intake. Up to a certain income threshold, the subsistence proportion is indeed the premier determinant of calorie intake. Caloric intake recorded for the rural Southern Sierra--the region with the lowest average income (approximated by total expenditures) and the highest calorie subsistence ratio--is higher than that noted for other sample strata with higher incomes but lower calorie subsistence ratios. It is surpassed only by caloric intake recorded for the urban Central Sierra, a region with twice the disposable income of the rural South. In other words, below the minimum monetary income needed to purchase the nutritionally adequate number of calories embodied in the preferred foods, calorie intake decreases as the proportion of monetary to total (i.e., monetary plus subsistence) income grows.[7/] Among other reasons, this is

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6/ I.e., that proportion of family income which is produced on the family farm as opposed to that generated through wage employment.

7/ For a more exhaustive treatment of this point, see Ferroni (1980).

Table 1. ENCA: Average Daily per Capita Intake of Calories and Nutrients, 4 Geographic Strata (Sierra)a/, Peru 1971-72

		Cal	Prot g.	Fat g.	Ca mg.	Fe mg.	Vit A mcg.	Thia mg.	Ribo mg.	Nia mg.	Vit C mg.	n
Rural Southern Sierra		2255	62.5	23.6	403.6	21.3	206.0	1.53	1.62	24.42	118.12	762
(SAT %)		(105)	(142)		(79)	(178)	(32)	(178)	(137)	(172)	(449)	
CSR	.77											
TEX	21,595											
Rural Central Sierra		1938	53.0	25.7	348.1	16.2	278.9	1.17	1.12	19.31	96.50	668
(SAT %)		(93)	(126)		(68)	(141)	(45)	(136)	(96)	(131)	(372)	
CSR	.59											
TEX	23,294											
Urban Southern Sierra		2029	62.3	37.7	415.3	12.9	473.7	0.89	1.25	15.68	85.20	328
(SAT %)		(98)	(158)		(80)	(106)	(78)	(102)	(103)	(108)	(332)	
CSR	.22											
TEX	37,127											
Urban Central Sierra		2453	64.4	42.9	415.4	15.9	601.2	1.11	1.35	20.39	95.61	200
(SAT %)		(112)	(141)		(81)	(132)	(94)	(127)	(112)	(140)	(361)	
CSR	.22											
TEX	42,637											

a/ CSR = average calorie subsistence ratio, i.e., home-produced calories per total calories.
TEX = average total expenditure per family per year (soles of 1971/72).
(SAT %) = average index of nutrient satisfaction, i.e., (intake/requirement) 100. Requirements are 100% FAO/WHO calorie and nutrient allowances. In the case of calories, the "ideal" requirement is used (see text for definition).
n = sample size (number of families).

due to the growing need for nonfood outlays as people migrate off the farm, as well as to the erosion of purchasing power resulting from food price inflation. The nutritional status of people with incomes below the identified monetary minimum, therefore, will worsen as they change diets from traditional to modern, because the implied decline in the income subsistence ratio leads to a decline in total caloric intake and hence energy deficiency which, in turn, may elicit nutrient deficiency.

Apparent Incidence of Nutritional Deficiencies in The Peruvian Andes

Energy and Protein

When calorie intake falls short of requirements, a part of dietary protein is metabolized as energy and no longer counts against protein needs. A calorie intake exceeding the requirement, on the other hand, allows an individual to remain in positive nitrogen balance even when his/her diet is slightly protein deficient. The physiological interaction between the two nutritional principles demands that the incidence of protein deficiency be assessed in conjunction with the adequacy of calorie nutrition. Contingency tables of levels of calorie versus protein satisfaction are useful statistical devices for this purpose.

Of the combined population of families of the rural and urban Central and Southern Sierra, 37 percent consume less than the minimum allowance of food energy and another 16 percent are classified in the "at-risk" category (Table 2). Although the average coefficients of calories are close to 100 percent, about one out of two families is deficient or at risk of being deficient in food energy in the sense that the total quantity of food available to the family is insufficient to satisfy energy needs of all family members. On dividing the sample into one urban and one rural

Table 2. ENCA: Incidence of Protein-Calorie Deficit in Central and Southern Sierra, Percent of Sampled Families a/, 1971-72

A. Rural Southern Sierra

	Calories			
Protein	Deficit	At Risk	No Deficit	Total
Deficit	11 [1]	1 [4]	2 [7]	14
At Risk	16 [2]	8 [5]	8 [8]	32
No Deficit	8 [3]	5 [6]	41 [9]	54
Total	35	14	51	100

B. Rural Central Sierra

	Calories			
Protein	Deficit	At Risk	No Deficit	Total
Deficit	6 [1]	- [4]	- [7]	6
At Risk	23 [2]	4 [5]	2 [8]	29
No Deficit	12 [3]	15 [6]	38 [9]	65
Total	41	19	40	100

C. Urban Southern Sierra

	Calories			
Protein	Deficit	At Risk	No Deficit	Total
Deficit	14 [1]	- [4]	- [7]	14
At Risk	17 [2]	2 [5]	2 [8]	21
No Deficit	16 [3]	13 [6]	36 [9]	65
Total	47	15	38	100

D. Urban Central Sierra

	Calories			
Protein	Deficit	At Risk	No Deficit	Total
Deficit	1 [1]	- [4]	- [7]	1
At Risk	11 [2]	1 [5]	- [8]	12
No Deficit	5 [3]	13 [6]	69 [9]	87
Total	17	14	69	100

a/ See text for definitions and interpretation.

stratum, it appears that the urban incidence of energy deficiency (certain and "at risk") is similar to the rural (50 and 54 percent of families, respectively).

Cell 1 in Table 2 groups families affected by certain calorie and protein deficiency. Although no firm nutritional conclusion can be drawn for the category of protein satisfaction that corresponds to cell 2, the low energy intake of families in this cell is likely to cause negative nitrogen balance even in instances where protein requirements are met. Cells 1 and 2 thus denote areas of protein-energy malnutrition.

The population fraction in the protein-energy deficient category (the sum of percentages in cells 1 and 2) amounts to 27 and 29 percent in the rural Southern and the rural Central Sierra, respectively. Thirty-one and 12 percent of urban families in the Southern and Central Highlands are exposed to protein-energy malnutrition. There is thus no clear-cut variation in the incidence of protein-energy deficiency along rural/urban lines. Differences in average subsistence ratios and income appear to be responsible for the differences in the incidence of protein-energy malnutrition between sample strata.

The remaining contingency cells in Table 2 denote areas of uncertain nutritional interpretation as well as fields of clear absence of protein-energy deficiency. Cell 3 groups calorie deficient families whose protein intakes exceed full requirements. Diets of these households are likely to be poor in such nonprotein staples as fats, oil and sugar.

Although some protein deficiency may occur among members of families in cell 3 because of physiological interdependence of the two food constituents, the limiting variable in this case is clearly energy and not protein. It is a noteworthy feature of Sierra diets that calorie intakes as low as those implied by appearance in cell 3 are compatible with protein intakes exceeding full requirements (see also cell 6). Protein intake is nutritionally adequate as energy levels approach the recommended values. With exception of the rural Southern Sierra no families appear in cells 4 and 7 of the contingency tables, and the number of observations falling in cells 5 and 8 is minimal. (Precise nutritional conclusions cannot be drawn with respect to cell 5 where protein <u>and</u> energy intake are at risk. The likelihood of deficiency in either or both food constituents is positive but small in this category. The fraction of families in it, low in all cases, decreases with urbanization, because protein requirements decrease with improving urban protein quality). Cells 6, 8 and 9, which assemble households without protein deficit and with only a slight chance of energy insufficiency (cell 6), contain more than 50 percent of the observations under study in all regions. These frequencies as well as the appropriate marginal totals lend support to the conclusion that in the Sierra and for family aggregates (as opposed to individuals) the consumption of current diets in amounts that satisfy energy requirements will automatically assure sufficient and in many cases abundant protein levels. The diet changes occurring in the Sierra do not appear to affect the incidence of protein deficiency in instances where calorie allowances are met.

In accordance with growing world-wide evidence that protein deficiencies depend on the level of calorie intake, the ENCA survey shows that the root of the nutrition problem in the Peruvian Andes is caloric undernutrition which, as a result of interaction between calories and protein, may or may not lead to protein malnutrition. The malnourished in the Andes suffer from quantitative food deficiency. Their diets cannot be said to be inherently low in protein sources.

Selected Minerals and Vitamins

The evaluation of dietary adequacy of the so-called micronutrients is much more difficult than that for food energy and even protein, because requirements for micronutrients are less well defined, their absorption is less well understood, and differences between dietary micronutrient potential and actual availability may be large and depend on cooking practices, food storage conditions and preservation methods.

Dietary patterns of the rural Sierra have been characterized as calcium deficient by Collazos and co-workers (1960) and on first sight Table 3 moderately confirms this contention. The apparently calcium deficient population fraction varies from one-fourth to one-half between

Table 3. ENCA: Incidence of Calcium Deficiency in Southern and Central Sierra by Degrees of Calorie And Protein Adequacy (Percent)[a], 1971-72

Calories and Protein	Calcium							
	RSS		RCS		USS		UCS	
	D	ND	D	ND	D	ND	D	ND
C, P $\geqslant$ 100	5	37	7	31	3	33	6	63
C, P < 100	26	10	27	6	27	6	11	3
C < 100, P $\geqslant$ 100	5	8	17	11	13	16	10	7
C $\geqslant$ 100, P < 100	3	6	--	1	1	1	--	--
Total	39	61	51	49	44	56	27	73

a/ D = deficient (intake $\angle$ 60% of allowance); ND = not deficient.
C, P: percent indices of satisfaction of calories, protein. Deficiency is defined as intake $\angle$ 100% of ideal requirement in the case of calories and $\angle$ 100% of the full allowance in the case of protein.

the four geographical strata considered without a clear effect of urbanization emerging. However, the great majority of calcium deficient families are simultaneously deficient in calories and, to a lesser extent, protein. Furthermore, personal observation of food habits in rural areas suggests that calcium intake recorded in dietary surveys such as ENCA or those carried out by Collazos et al. is considerably less than actual intake, thus supporting the notion that calcium is not a nutrient that warrants specific policy attention in the Sierra. The use of cal (calcium oxide) and other calcium compounds as condiments, as well as geophagy, presumably an adaptive response aimed at satisfying mineral requirements, are not easily observed in conventional food consumption surveys, but are frequent in practice. From a survey expressly designed to monitor nonconventional dietary vectors of calcium, Baker and Mazess (1965) conclude that the inhabitants of the rural Southern Sierra appear to "meet or exceed most of the calcium intakes recommended in the United States."

Iron deficiency appears to be even rarer than calcium shortage when judged on the basis of food intake. The data in Table 4 were calculated on the assumption of a low 8 percent absorption rate, given that, in the

Table 4. ENCA: Incidence of Iron Deficiency in Southern And Central Sierra by Degrees of Calorie and Protein Adequacy (Percent)[a/]

Calories and Protein	Iron							
	RSS		RCS		USS		UCS	
	D	ND	D	ND	D	ND	D	ND
C, P $\geq$ 100	--	41	--	39	--	36	--	69
C, P $<$ 100	5	31	5	29	12	21	3	10
C $<$ 100, P $\geq$ 100	--	9	--	1	--	2	--	--
C $\geq$ 100, P $<$ 100	1	13	1	25	2	27	1	17
Total	6	94	6	94	14	86	4	96

a/ For interpretation, see Table 3 and text p. 13.

Sierra, the bulk of dietary iron is derived from grains and potatoes.[8/] Other evidence from the Andes supports the notion that the incidence of iron deficiency is low. On the basis of dietary and biochemical analyses, Collazos et al. placed the maximum figure at 15 percent. In a study of public health conditions in four Peruvian villages located in various ecological zones, Buck et al. (1968) did not point to iron deficiency anemia in their high-altitude community. This is explained apart from the considerable iron content of Andean diets, by a low prevalence of parasite infection (particularly hookworm) in the dry, cold Sierra climate and a high intake of ascorbic acid. Brise and Hallberg (1962) have shown that ascorbic acid promotes iron absorption because of its reducing action in the gastrointestinal lumen which delays and in some cases prevents the formation of insoluble iron compounds.

The incidence of vitamin C deficiency is extremely small in the Peruvian Sierra and almost exclusively associated with calorie levels below 100 percent of satisfaction (Table 5). Even adopting the across-the-board 50 percent loss coefficient suggested by Davidson et al. (1975) for cases where losses are unknown, it appears safe to assume that requirements for this nutrient are met in the large majority of cases. There are

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8/ An alternative and--because it accounts for between-family variation in diet composition--more appealing approach to the estimation of the proportion of deficient families was also used. The approach (sometimes used by FAO in the analysis of diet surveys) consists of the comparison of physiological requirements unadjusted for diet quality with iron intake as calculated by means of the food composition table, but expressed in terms of absorbable iron on the basis of food group-specific coefficients of absorption which have been determined in laboratory experiments. Moore (1968) has published such coefficients for both deficient and not deficient individuals. His (higher) coefficients for deficient individuals were used in order to increase the chance of making a correct decision when assigning a family to the iron deficient category. Because of the high iron potential of Sierra diets no iron deficiency was detected by this approach.

Table 5. ENCA: Incidence of Vitamin C Deficiency in Southern And Central Sierra by Degrees of Calorie And Protein Adequacy (Percent)[a/]

Calories and Protein	Vitamin C							
	RSS		RCS		USS		UCS	
	D	ND	D	ND	D	ND	D	ND
C, P $\geqslant$ 100	1	40	1	37	1	35	--	69
C, P $<$ 100	4	32	7	27	2	30	1	13
C $<$ 100, P $\geqslant$ 100	1	12	2	25	1	28	1	16
C $\geqslant$ 100, P $<$ 100	--	10	--	1	--	3	--	--
Total	6	94	10	90	4	96	2	98

a/ For interpretation, see Table 3 and text.

indications, furthermore, that losses from potatoes, the principal dietary source of ascorbic acid, may not be large in the rural Sierra. The practice of roasting potatoes in makeshift ovens built with hot stones (watias), fairly widespread in the South, the habit of boiling the unpeeled potato to a point where its center is still almost raw, and the consumption of the water in which potatoes were boiled in the form of soup (chupe) appear to contribute significantly to the conservation of the vitamin C content of the fresh tuber.

Allowances for the B complex vitamins, thiamin, riboflavin and niacin were calculated per calorie of the ideal energy requirement. Despite the relatively high resulting recommended intakes, the apparent incidence of deficiency in B vitamins is low (Tables 6, 7, 8). The largest deficit recorded is that for riboflavin, not unexpectedly, because of the importance of cereals in Sierra diets. On a unit calorie basis, cereals are a richer source of thiamin and niacin than riboflavin. The latter nutrient is found in higher concentrations in milk, dairy products and eggs. Meat and

Table 6. ENCA: Incidence of Thiamin Deficiency in Southern And Central Sierra by Degrees of Calorie And Protein Adequacy (Percent)[a/]

Calories and Protein	Thiamin							
	RSS		RCS		USS		UCS	
	D	ND	D	ND	D	ND	D	ND
C, P $\geqslant$ 100	--	42	--	38	--	36	--	69
C, P $<$ 100	4	32	7	26	11	22	2	11
C $<$ 100, P $\geqslant$ 100	1	13	1	27	2	27	1	17
C $\geqslant$ 100, P $<$ 100	--	8	--	1	--	2	--	--
Total	5	95	8	92	13	87	3	97

a/ For interpretation, see Table 3 and text.

Table 7. ENCA: Incidence of Riboflavin Deficiency in Southern And Central Sierra by Degrees of Calorie And Protein Adequacy (Percent)[a/]

Calories and Protein	Riboflavin							
	RSS		RCS		USS		UCS	
	D	ND	D	ND	D	ND	D	ND
C, P $\geqslant$ 100	--	41	--	38	--	36	--	69
C, P $<$ 100	9	27	19	15	17	16	4	9
C $<$ 100, P $\geqslant$ 100	--	13	4	23	3	26	1	17
C $\geqslant$ 100, P $<$ 100	--	10	--	1	--	2	--	--
Total	9	91	23	77	20	80	5	95

a/ For interpretation, see Table 3 and text.

Table 8. ENCA: Incidence of Niacin Deficiency in Southern And Central Sierra by Degrees of Calorie And Protein Adequacy (Percent)[a/]

Calories and Protein	Niacin							
	RSS		RCS		USS		UCS	
	D	ND	D	ND	D	ND	D	ND
C, P $\geqslant$ 100	--	42	--	38	--	36	--	69
C, P < 100	4	31	6	28	13	20	1	12
C < 100, P $\geqslant$ 100	--	13	--	27	1	28	--	18
C $\geqslant$ 100, P < 100	--	10	--	1	--	2	--	--
Total	4	96	6	94	14	86	1	99

a/ For interpretation, see Table 3 and text.

leafy vegetables contain more riboflavin than thiamin. These foods, however, are not consumed in large quantities in rural areas and their higher average urban consumption is disproportionately accounted for by the rich. Unaware of clinical signs attributable to deficiencies of thiamin and niacin, Collazos et al. diagnosed cheilosis and skin abnormalities in several Sierra locations. These lesions are associated with riboflavin deficiency, but it is difficult to separate the nutritional effect from the role of high-altitude wind and frost in their etiology. The ENCA data on riboflavin as well as the other B complex vitamins do not justify the recommendation of fortification programs for the Sierra. Where deficiency in these nutrients occurs it is largely a consequence of undernutrition and more appropriately corrected by measures capable of raising overall food consumption levels.

As expected from average intake levels and coefficients of satisfaction presented in Table 1, the calculated frequency of vitamin A deficiency is large, particularly in rural areas (Table 9). Eighty-two percent of households are classified as deficient in the rural Southern Sierra, 72 percent in the rural Central Sierra, 52 percent in the urban Southern and 36 percent in the rural Central Sierra. In rural areas, deficits appear with about equal frequency in situations of sufficient calorie intake and in cases where calorie allowances are not met. In urban areas the incidence of vitamin A deficiency is more clearly related to the level of caloric satisfaction attained.

Table 9. ENCA: Incidence of Vitamin A Deficiency in Southern And Central Sierra by Degrees of Calorie And Protein Adequacy (Percent)[a/]

Calories and Protein	Vitamin A							
	RSS		RCS		USS		UCS	
	D	ND	D	ND	D	ND	D	ND
C, P $\geqslant$ 100	31	10	24	14	10	26	18	52
C, P $<$ 100	33	3	28	6	26	7	8	5
C $<$ 100, P $\geqslant$ 100	10	4	19	8	15	14	10	7
C $\geqslant$ 100, P $<$ 100	8	1	1	--	1	1	--	--
Total	82	18	72	28	52	48	36	64

a/ For interpretation, see Table 3 and text.

Collazos et al. diagnosed several clinical symptoms of vitamin A deficiency in their Sierra nutrition studies, including keratinization of epithelial tissues and follicular hyperkeratosis. Xerophthalmia is occasionally seen in Andean villages. But clinical deficiency symptoms, Collazos and coworkers note, are considerably less frequent than might be expected from the low consumption of foods rich in vitamin A. ENCA, too, reveals unrealistically low levels of retinol intake for many rural families. And seasonality in retinol intake does not appear to be so marked that high intakes and formation of reserve liver stores in some months might compensate for low intakes in other months. Part of the gap between observed retinol intake and requirements is likely due to underreporting of consumption of sources of vitamin A activity, as in the case of calcium. However, considering that, because of the possibility of liver stores, vitamin A deficiency symptoms can only develop with chronically low intakes, it seems inevitable to conclude the existence of a real and widespread rural deficit in this nutrient. The conclusion is further supported by the low fat content of Sierra diets, since the absorption of carotene from vegetable sources is positively influenced by the amount of fat in the diet (Roel et al. 1958).

Conclusion

More often than not, the nutritional deficiencies which affect many of the world's poor are of a quantitative rather than of a qualitative nature. The intake of protein and most other nutrients is normally adequate when calorie requirements are met. But food consumption often falls short of calorie needs and nutrient deficiency may then occur as a result of the energy or food gap. The exception confirming this rule in the

Peruvian Sierra is that rural diets are inherently deficient in vitamin A. The region's most conspicuous nutrition problem, however, is insufficiency of energy. If, as seems reasonable, only energy intake levels equal to or exceeding the ideal allowance are considered acceptable in terms of nutritional welfare, then the diets of half the population of Sierra families are quantitatively or energetically below acceptable levels.

Sierra-wide, the incidence of calorie deficiency is similar in rural and urban areas. However, if the Central and Southern Sierra are compared with each other, it is seen that urban prevalence of undernutrition is considerably larger than rural in the South and much less than rural in the Center. This is a consequence of regional differences in income opportunities in the monetary and/or the subsistence economy. Calorie deficiency is unlikely to occur where subsistence farming or a combination of subsistence and commercial farming is practiced on enough land to occupy and feed a family--the situation of many families in the monetarily poor Southern Sierra. Undernutrition does occur where people migrate seasonally or permanently to off-farm employment not sufficiently remunerative to permit a nutritionally adequate level of food consumption. In Peru, and from national population figures, this is the situation of approximately two million families that do not have the identified minimum amount of land and/or that migrate to an urban area with the expectation of improving their living conditions.

Caloric deficiency is appropriately corrected by increased staple food consumption, regardless of diet type. This definitely requires income supplementation or redistribution, although other factors may also have to be manipulated to achieve maximum nutritional effect. In rural areas, attention should be placed in particular on ways of increasing on-farm, i.e., subsistence income. At the family level, this is more cost-effective in nutritional terms than monetary income supplementation (minimum wage policy, price subsidies), since--contrary to additions in monetary income--all of the increase in subsistence income is by definition consumed.

The large apparent incidence of vitamin A deficiency implies that consumption of foods rich in this nutrient is very tenuously related to the income variables considered here. The only potentially successful income policy aimed at reducing the vitamin A deficit is therefore the promotion of horticulture for subsistence consumption. Nutrition education is important to point out to homemakers economic foods of high vitamin A content and to increase the demand for vegetables. And the feasibility of vitamin A fortification of diets should be assessed. Fortification may take the form of a vaccination campaign in which one or two massive annual oral doses of the nutrient are administered to target individuals, particularly preschool children. Or it may consist of the fortification of a centrally processed, widely consumed cheap food such as sugar.

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